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## ***105 MSPS 3-Channel AFE with Sensor Timing Generation and LVDS/CMOS Data Output***

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### **DESCRIPTION**

The WM8231 is a 16-bit analogue front end/digitiser IC which processes and digitises the analogue output signals from CCD sensors or Contact Image Sensors (CIS) at pixel sample rates of up to 35 MSPS per channel.

The device has three analogue signal processing channels each of which contains Reset Level Clamping, Correlated Double Sampling (also Sample and Hold), Programmable Gain, Automatic Gain Control (AGC) and Offset adjust functions.

The output from each of these channels is time multiplexed, in pairs, into three high-speed 16-bit Analogue to Digital Converters. The digital data is available in a variety of output formats via the flexible data port.

The WM8231 has a user selectable LVDS or CMOS output architecture.

An internal 5-bit DAC is supplied for internal reference level generation. This may be used during CDS to reference CIS signals or during clamping to clamp CCD signals. An external reference level may also be supplied. ADC references are generated internally, ensuring optimum performance from the device.

A programmable automatic Black-Level Calibration function is available to adjust the DC offset of the output data.

The WM8231 features a sensor timing clock generator for both CCD and CIS sensors. The clock generator can accept a slow or fast reference clock input and also has a flexible timing adjustment function for output timing clocks to allow use of many different sensors.

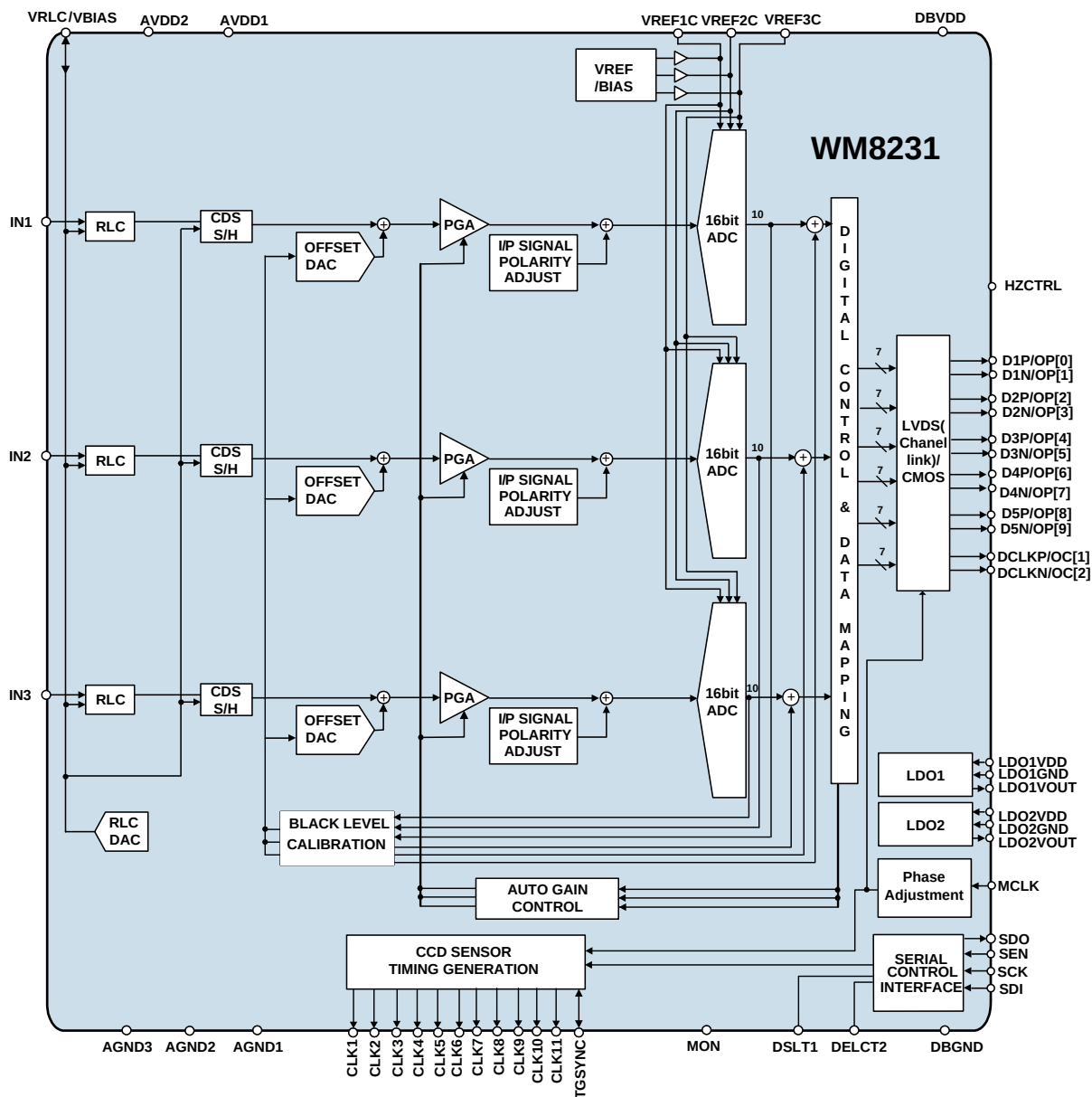
### **FEATURES**

- 105 MSPS conversion rate
- 16-bit ADC resolution
- Current consumption – 230mA
- 3.3V single supply operation
- Sample and hold / correlated double sampling
- Programmable offset adjust (8-bit resolution)
- Flexible clamp timing
- Pixel clamp / line clamp mode
- Programmable clamp voltage
- Programmable CIS/CCD timing generator
- Internally generated voltage references
- Compliant for Spread Spectrum Clock
- LVDS/CMOS output options
  - LVDS 5-pair 315 MHz 35-bit data
  - CMOS 90 MHz output maximum
- Complete on chip clock generator. MCLK 5 – 35 MHz.
- Internal timing adjustment
- Automatic Gain Control
- Automatic Black Level Calibration
- 56-lead QFN package 8mm x 8mm
- Serial control interface

### **APPLICATIONS**

- Digital copiers
- USB 2.0 compatible scanners
- Multi-function peripherals
- High-speed CCD/CIS sensor interface

## BLOCK DIAGRAM



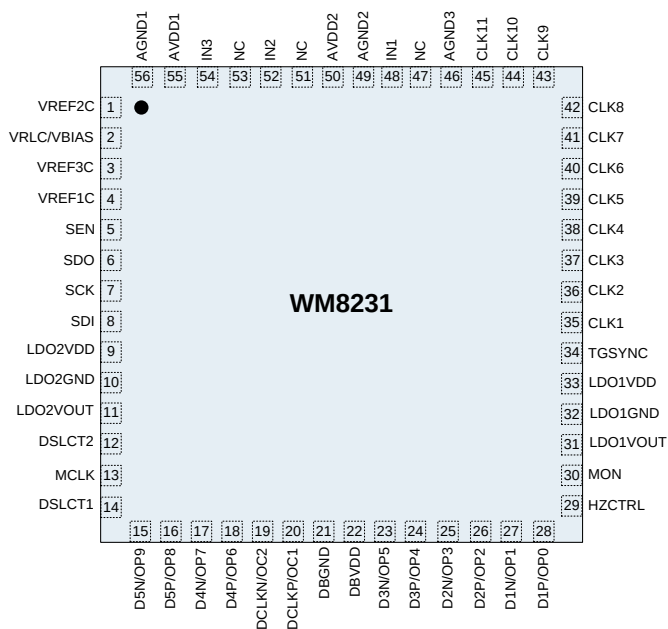
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## PIN CONFIGURATION



## ORDERING INFORMATION

| DEVICE        | TEMPERATURE RANGE | PACKAGE                                                      | MOISTURE SENSITIVITY LEVEL | PEAK SOLDERING TEMPERATURE |
|---------------|-------------------|--------------------------------------------------------------|----------------------------|----------------------------|
| WM8231GEFL/V  | -40 to 85°C       | 56-lead QFN<br>(8 x 8 x 0.85 mm)<br>(Pb-free)                | MSL3                       | 260°C                      |
| WM8231GEFL/RV | -40 to 85°C       | 56-lead QFN<br>(8 x 8 x 0.85 mm)<br>(Pb-free, tape and reel) | MSL3                       | 260°C                      |

Reel quantity = 2,200

**PIN DESCRIPTION**

| PIN | NAME         | TYPE            | DESCRIPTION                                                                                |
|-----|--------------|-----------------|--------------------------------------------------------------------------------------------|
| 1   | VREF2C       | Analogue output | Mid reference voltage.<br>This pin must be connected to AGND via a decoupling capacitor.   |
| 2   | VRLC/VBIAS   | Analogue I/O    | Reference voltage input/output                                                             |
| 3   | VREF3C       | Analogue output | Lower reference voltage.<br>This pin must be connected to AGND via a decoupling capacitor. |
| 4   | VREF1C       | Analogue output | Upper reference voltage.<br>This pin must be connected to AGND via a decoupling capacitor. |
| 5   | SEN          | Digital input   | Enables the serial interface when high                                                     |
| 6   | SDO          | Digital output  | Serial interface data output                                                               |
| 7   | SCK          | Digital input   | Serial interface clock                                                                     |
| 8   | SDI          | Digital input   | Serial interface data input                                                                |
| 9   | LDO2VDD      | Supply          | Analogue supply                                                                            |
| 10  | LDO2GND      | Supply          | Analogue ground                                                                            |
| 11  | LDO2VOUT     | Supply          | LDO output<br>This pin must be connected to AGND via a decoupling capacitor.               |
| 12  | DSLCT2       | Analogue input  | Device select 2                                                                            |
| 13  | MCLK         | Analogue input  | Master clock                                                                               |
| 14  | DSLCT1       | Analogue input  | Device select 1                                                                            |
| 15  | D5N/OP[9]    | LVDS output     | LVDS Data output 5 – Negative / CMOS output 9                                              |
| 16  | D5P/OP[8]    | LVDS output     | LVDS Data output 5 – Positive / CMOS output 8                                              |
| 17  | D4N/OP[7]    | LVDS output     | LVDS Data output 4 – Negative / CMOS output 7                                              |
| 18  | D4P/OP[6]    | LVDS output     | LVDS Data output 4 – Positive / CMOS output 6                                              |
| 19  | DCCLKN/OC[2] | LVDS output     | LVDS Clock Output – Negative/ CMOS flag output                                             |
| 20  | DCCLKP/OC[1] | LVDS output     | LVDS Clock Output – Positive/ CMOS clock output                                            |
| 21  | DBGND        | Supply          | Analogue ground.                                                                           |
| 22  | DBVDD        | Supply          | Analogue supply.                                                                           |
| 23  | D3N/OP[5]    | LVDS output     | LVDS Data output 3 – Negative / CMOS output 5                                              |
| 24  | D3P/OP[4]    | LVDS output     | LVDS Data output 3 – Positive / CMOS output 4                                              |
| 25  | D2N/OP[3]    | LVDS output     | LVDS Data output 2 – Negative / CMOS output 3                                              |
| 26  | D2P/OP[2]    | LVDS output     | LVDS Data output 2 – Positive / CMOS output 2                                              |
| 27  | D1N/OP[1]    | LVDS output     | LVDS Data output 1 – Negative / CMOS output 1                                              |
| 28  | D1P/OP[0]    | LVDS output     | LVDS Data output 1 – Positive / CMOS output 0                                              |
| 29  | HZCTRL       | Digital input   | Internal use only. Must be connected to AGND.                                              |
| 30  | MON          | Analogue output | Clock monitor                                                                              |
| 31  | LDO1VOUT     | Supply          | LDO output.<br>This pin must be connected to AGND via a decoupling capacitor.              |
| 32  | LDO1GND      | Supply          | Analogue ground                                                                            |
| 33  | LDO1VDD      | Supply          | Analogue supply                                                                            |
| 34  | TGSYNC       | Digital I/O     | Sensor Timing Sync pulse                                                                   |
| 35  | CLK1         | Digital output  | Sensor Timing Output 1                                                                     |
| 36  | CLK2         | Digital output  | Sensor Timing Output 2                                                                     |
| 37  | CLK3         | Digital output  | Sensor Timing Output 3                                                                     |
| 38  | CLK4         | Digital output  | Sensor Timing Output 4                                                                     |
| 39  | CLK5         | Digital output  | Sensor Timing Output 5                                                                     |
| 40  | CLK6         | Digital output  | Sensor Timing Output 6                                                                     |
| 41  | CLK7         | Digital output  | Sensor Timing Output 7                                                                     |
| 42  | CLK8         | Digital output  | Sensor Timing Output 8                                                                     |
| 43  | CLK9         | Digital output  | Sensor Timing Output 9                                                                     |
| 44  | CLK10        | Digital output  | Sensor Timing Output 10                                                                    |
| 45  | CLK11        | Digital output  | Sensor Timing Output 11                                                                    |
| 46  | AGND3        | Supply          | Analogue ground                                                                            |

| PIN | NAME  | TYPE           | DESCRIPTION              |
|-----|-------|----------------|--------------------------|
| 47  | NC    | Not connect    | Not connected internally |
| 48  | IN2   | Analogue input | Analogue input 2         |
| 49  | AGND2 | Supply         | Analogue ground          |
| 50  | AVDD2 | Supply         | Analogue supply          |
| 51  | NC    | Not connect    | Not connected internally |
| 52  | INP4  | Analogue input | Analogue input 4         |
| 53  | NC    | Not connect    | Not connected internally |
| 54  | INP6  | Analogue input | Analogue input 6         |
| 55  | AVDD1 | Supply         | Analogue supply          |
| 56  | AGND1 | Supply         | Analogue ground          |

## ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings are stress ratings only. Permanent damage to the device may be caused by continuously operating at or beyond these limits. Device functional operating limits and guaranteed performance specifications are given under Electrical Characteristics at the test conditions specified.



ESD Sensitive Device. This device is manufactured on a CMOS process. It is therefore generically susceptible to damage from excessive static voltages. Proper ESD precautions must be taken during handling and storage of this device.

Cirrus Logic tests its package types according to IPC/JEDEC J-STD-020 for Moisture Sensitivity to determine acceptable storage conditions prior to surface mount assembly. These levels are:

MSL1 = unlimited floor life at <30°C / 85% Relative Humidity. Not normally stored in moisture barrier bag.

MSL2 = out of bag storage for 1 year at <30°C / 60% Relative Humidity. Supplied in moisture barrier bag.

MSL3 = out of bag storage for 168 hours at <30°C / 60% Relative Humidity. Supplied in moisture barrier bag.

The Moisture Sensitivity Level for each package type is specified in Ordering Information.

| CONDITION                                                | MIN                   | MAX         |
|----------------------------------------------------------|-----------------------|-------------|
| Analogue supply voltage: AVDD1-2, LDO1VDD-LDO2VDD, DBVDD | GND - 0.3V            | GND + 5V    |
| Analogue grounds: AGND1-3, LDO1GND-LDO2VDD, DBGND        | GND - 0.3V            | GND + 0.3V  |
| Analogue inputs (IN1-6)                                  | GND - 0.3V            | AVDD + 0.3V |
| Other Analogue pins                                      | GND - 0.3V            | AVDD + 0.3V |
| Digital I/O pins                                         | GND - 0.3V            | AVDD + 0.3V |
| Operating temperature range: T <sub>A</sub>              | -40°C                 | +85°C       |
| Storage temperature prior to soldering                   | 30°C max / 85% RH max |             |
| Storage temperature after soldering                      | -65°C                 | +150°C      |

### Notes:

- GND denotes the voltage of any ground pin.
- AGND, LDOGND and DBGND pins are intended to be operated at the same potential. Differential voltages between these pins will degrade performance.

## RECOMMENDED OPERATING CONDITIONS

| CONDITION                   | SYMBOL                                  | MIN  | TYP | MAX  | UNITS |
|-----------------------------|-----------------------------------------|------|-----|------|-------|
| Operating temperature range | T <sub>A</sub>                          | -40  |     | 85   | °C    |
| Analogue Supply voltage     | AVDD1-2<br>LDO1VDD-<br>LDO2VDD<br>DBVDD | 2.97 | 3.3 | 3.63 | V     |

## ELECTRICAL CHARACTERISTICS

### Test Conditions

AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND = 0V, T<sub>A</sub> = 25°C, MCLK = 35MHz unless otherwise stated.

| PARAMETER                                                                                 | SYMBOL             | TEST CONDITIONS                                               | MIN                           | TYP    | MAX    | UNIT    |
|-------------------------------------------------------------------------------------------|--------------------|---------------------------------------------------------------|-------------------------------|--------|--------|---------|
| <b>Overall System Specification (including 10-bit ADC, PGA, Offset and CDS functions)</b> |                    |                                                               |                               |        |        |         |
| Conversion rate per channel                                                               |                    |                                                               | 5                             |        | 35     | MSPS    |
| Full-scale input voltage<br>(see Note 1)                                                  |                    | ADCFS=0, Max Gain                                             |                               | 0.12   |        | Vp-p    |
|                                                                                           |                    | ADCFS=0, Min Gain                                             |                               | 2.0    |        | Vp-p    |
|                                                                                           |                    | ADCFS=1, Max Gain                                             |                               | 0.18   |        | Vp-p    |
|                                                                                           |                    | ADCFS=1, Min Gain                                             |                               | 3.0    |        | Vp-p    |
| Input signal voltage range                                                                | V <sub>IN</sub>    | SF_INP=0                                                      | AGND                          |        | AVDD   | V       |
|                                                                                           |                    | SF_INP=1                                                      | AGND                          |        | 1.2    | V       |
| Input capacitance                                                                         | C <sub>IN</sub>    | Inputs to AGND                                                |                               | 10     | 12     | pF      |
| Full-scale transition error                                                               |                    | Gain = 0dB;<br>AGAIN[4:0] = 02(hex)<br>DGAIN[11:0] = 6AB(hex) |                               | 20     |        | mV      |
| Zero-scale transition error                                                               |                    | Gain = 0dB;<br>AGAIN[4:0] = 02(hex)<br>DGAIN[11:0] = 6AB(hex) |                               | 20     |        | mV      |
| Differential non-linearity                                                                | DNL                | 10-bit                                                        |                               | +/-0.5 | +/-1.5 | LSB     |
| Integral non-linearity (pk-pk/2)                                                          | INL                | 10-bit                                                        |                               | +/-1   | +/-4   | LSB     |
| Channel to channel gain matching                                                          | Min Gain           |                                                               |                               | 5      |        | %       |
|                                                                                           | Max Gain           |                                                               |                               | 15     |        | %       |
| Output noise                                                                              |                    | 10-bit, Unity Gain<br>(Unused channels grounded)              |                               | 0.5    | 2.5    | LSB rms |
| Channel to channel crosstalk                                                              |                    | 10-bit                                                        |                               | +/-0.5 |        | LSB     |
| Channel to channel offset matching                                                        |                    | BLC disabled                                                  |                               | 70     | 210    | mV      |
| <b>Programmable Gain Amplifier</b>                                                        |                    |                                                               |                               |        |        |         |
| Total Resolution (Ga + Gd)                                                                | G <sub>T</sub>     |                                                               |                               | 12     |        | bits    |
| Analogue Gain                                                                             | G <sub>a</sub>     |                                                               | 0.6 + 0.3 * AGAIN[4:0]        |        |        | V/V     |
| Max gain, each channel (Ga)                                                               | G <sub>a</sub> MAX | AGAIN[4:0] = 1F(hex)                                          | 8.00                          | 9.9    | 11.43  | V/V     |
| Min gain, each channel (Ga)                                                               | G <sub>a</sub> MIN | AGAIN[4:0] = 0(hex)                                           | 0.44                          | 0.6    | 0.77   | V/V     |
| Digital Gain                                                                              | G <sub>d</sub>     |                                                               | DGAIN[11:0] / 2 <sup>11</sup> |        |        | V/V     |
| Max gain, each channel (Gd)                                                               | G <sub>d</sub> MAX | DGAIN[11:0] = FFF(hex)                                        |                               | 2      |        | V/V     |
| Min gain, each channel (Gd)                                                               | G <sub>d</sub> MIN | DGAIN[11:0] = 400 (hex)                                       |                               | 0.5    |        | V/V     |
| Max gain, each channel<br>(Ga + Gd)                                                       | G <sub>T</sub> MAX | AGAIN[4:0] = 1F(hex)<br>DGAIN[11:0] = FFF(hex)                |                               | 19.8   |        | V/V     |
| Min gain, each channel<br>(Ga + Gd)                                                       | G <sub>T</sub> MIN | AGAIN[4:0] = 0(hex)<br>DGAIN[11:0] = 400 (hex)                |                               | 0.3    |        | V/V     |
| <b>Analogue to Digital Converter</b>                                                      |                    |                                                               |                               |        |        |         |
| Resolution                                                                                |                    |                                                               |                               | 16     |        | bits    |
| Speed                                                                                     |                    |                                                               |                               |        | 70     | MSPS    |



**Test Conditions**

AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND = 0V, T<sub>A</sub> = 25°C, MCLK = 35MHz unless otherwise stated.

| PARAMETER                                   | SYMBOL               | TEST CONDITIONS                         | MIN           | TYP          | MAX           | UNIT    |
|---------------------------------------------|----------------------|-----------------------------------------|---------------|--------------|---------------|---------|
| References                                  |                      |                                         |               |              |               |         |
| Upper reference voltage                     | V <sub>REF1C</sub>   | ADCFS=0<br>ADCFS=1                      |               | 2.05<br>2.25 |               | V<br>V  |
| Lower reference voltage                     | V <sub>REF3C</sub>   | ADCFS=0<br>ADCFS=1                      |               | 1.25<br>1.05 |               | V<br>V  |
| Input return bias voltage                   | V <sub>REF2C</sub>   |                                         | 1.14          | 1.2          | 1.26          | V       |
| Diff. Reference voltage<br>(VREF1C-VREF3C)  | V <sub>REF1C3C</sub> | ADCFS=0<br>ADCFS=1                      | 0.72<br>1.00  | 0.8<br>1.2   | 0.88<br>1.35  | V<br>V  |
| Output resistance<br>VREF1C, VREF3C, VREF2C |                      |                                         |               | 1            |               | Ω       |
| VRLC/Reset-Level Clamp (RLC)                |                      |                                         |               |              |               |         |
| VRLC input voltage range<br>(see Note 2)    | VRLC                 | SF_INP=0                                | 0.11          |              | 3.0           | V       |
|                                             |                      | SF_INP=1                                | 0.11          |              | 1.2           |         |
| RLC switching impedance                     |                      |                                         |               | 50           |               | Ω       |
| RLC short-circuit current                   |                      |                                         |               | 2            |               | mA      |
| RLC output resistance                       |                      |                                         |               | 2            |               | Ω       |
| RLC Hi-Z leakage current                    |                      | VRLC = 0 to AVDD                        |               |              | 1             | μA      |
| RLCDAC resolution                           |                      |                                         |               | 5            |               | bits    |
| RLCDAC step size                            | V <sub>RLCSTEP</sub> | VRLC_TOP_SEL=0                          |               | 0.09         |               | V/step  |
|                                             |                      | VRLC_TOP_SEL=1                          |               | 0.048        |               |         |
| RLCDAC output voltage at<br>code 0(hex)     | V <sub>RLCBOT</sub>  | VRLC_TOP_SEL=0,<br>VRLC_VSEL[4:0]=00000 |               | 0.2          |               | V       |
|                                             |                      | VRLC_TOP_SEL=1,<br>VRLC_VSEL[4:0]=00000 |               | 0.11         |               | V       |
| RLCDAC output voltage at<br>code 1F(hex)    | V <sub>RLCTOP</sub>  | VRLC_TOP_SEL=0,<br>VRLC_VSEL[4:0]=11111 |               | 3.0          |               | V       |
|                                             |                      | VRLC_TOP_SEL=1,<br>VRLC_VSEL[4:0]=11111 |               | 1.6          |               | V       |
| VRLC DNL                                    |                      |                                         |               | 0.5          |               | LSB     |
| VRLC INL                                    |                      |                                         |               | 0.5          |               | LSB     |
| Offset DAC, Monotonicity Guaranteed         |                      |                                         |               |              |               |         |
| Resolution                                  |                      |                                         |               | 8            |               | bits    |
| Differential non-linearity                  | DNL                  |                                         |               | 0.5          | 1             | LSB     |
| Integral non-linearity                      | INL                  |                                         |               | 0.5          | 1             | LSB     |
| Step size                                   |                      |                                         |               | 2.04         |               | mV/step |
| Output voltage                              |                      | Code 00(hex)                            | -400          | -250         | -100          | mV      |
|                                             |                      | Code FF(hex)                            | +100          | +250         | +400          | mV      |
| DIGITAL SPECIFICATIONS                      |                      |                                         |               |              |               |         |
| Digital Inputs                              |                      |                                         |               |              |               |         |
| High level input voltage                    | V <sub>IH</sub>      |                                         | 0.7 *<br>AVDD |              |               | V       |
| Low level input voltage                     | V <sub>IL</sub>      |                                         |               |              | 0.2 *<br>AVDD | V       |
| High level input current                    | I <sub>IH</sub>      |                                         |               |              | 1             | μA      |
| Low level input current                     | I <sub>IL</sub>      |                                         |               |              | 1             | μA      |
| Input capacitance                           | C <sub>I</sub>       |                                         |               | 5            |               | pF      |

**Test Conditions**

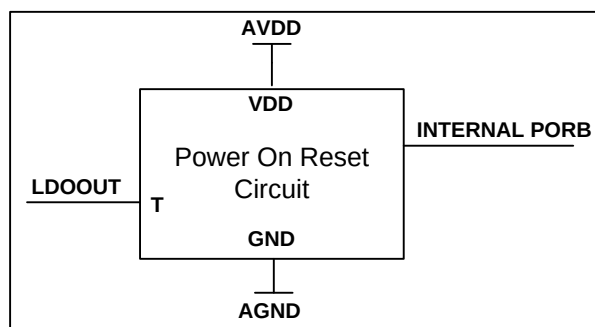
AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND = 0V, T<sub>A</sub> = 25°C, MCLK = 35MHz unless otherwise stated.

| PARAMETER                                                                                       | SYMBOL              | TEST CONDITIONS                    | MIN        | TYP  | MAX        | UNIT |
|-------------------------------------------------------------------------------------------------|---------------------|------------------------------------|------------|------|------------|------|
| <b>CMOS Outputs</b>                                                                             |                     |                                    |            |      |            |      |
| High level output voltage                                                                       | V <sub>OH</sub>     | I <sub>OH</sub> = 6mA              | AVDD – 0.5 |      |            | V    |
| Low level output voltage                                                                        | V <sub>OL</sub>     | I <sub>OL</sub> = 1mA              |            |      | 0.5        | V    |
| High impedance output current                                                                   | I <sub>OZ</sub>     |                                    |            |      | 1          | μA   |
| <b>TG Outputs</b>                                                                               |                     |                                    |            |      |            |      |
| High level output voltage                                                                       | V <sub>OHTG</sub>   | I <sub>OH</sub> = 1mA              | AVDD – 0.5 |      |            | V    |
| Low level output voltage                                                                        | V <sub>OLTG</sub>   | I <sub>OL</sub> = 1mA              |            |      | 0.5        | V    |
| High impedance output current                                                                   | I <sub>OZTG</sub>   | Grounded                           |            |      | 1          | μA   |
| <b>Digital IO Pins</b>                                                                          |                     |                                    |            |      |            |      |
| Applied high level input voltage                                                                | V <sub>IH</sub>     |                                    | 0.7 * AVDD |      |            | V    |
| Applied low level input voltage                                                                 | V <sub>IL</sub>     |                                    |            |      | 0.2 * AVDD | V    |
| High level output voltage                                                                       | V <sub>OH</sub>     | I <sub>OH</sub> = 1mA              | AVDD – 0.5 |      |            | V    |
| Low level output voltage                                                                        | V <sub>OL</sub>     | I <sub>OL</sub> = 1mA              |            |      | 0.5        | V    |
| Low level input current                                                                         | I <sub>IL</sub>     |                                    |            |      | 1          | μA   |
| High level input current                                                                        | I <sub>IH</sub>     |                                    |            |      | 1          | μA   |
| Input capacitance                                                                               | C <sub>I</sub>      |                                    |            | 5    |            | pF   |
| Output Impedance                                                                                | R <sub>O</sub>      | I <sub>O</sub> = 1mA               |            | 22   |            | Ω    |
| High impedance output current                                                                   | I <sub>OZ</sub>     |                                    |            |      | 1          | μA   |
| <b>LVDS Outputs</b>                                                                             |                     |                                    |            |      |            |      |
| Differential load impedance                                                                     | R <sub>L</sub>      |                                    | 90         | 100  | 110        | Ω    |
| Differential steady-state output voltage magnitude                                              | V <sub>OD</sub>     | LVDS_AMP=011, R <sub>L</sub> =100Ω |            | 200  |            | mV   |
| Change in the steady-state differential output voltage magnitude between opposite binary states | Δ V <sub>OD</sub>   | R <sub>L</sub> =100Ω               |            |      | 15         | mV   |
| Steady-state common-mode output voltage                                                         | V <sub>OC(SS)</sub> | R <sub>L</sub> =100Ω               |            | 1.25 |            | V    |
| Peak-to-peak common-mode output                                                                 | V <sub>OC(PP)</sub> |                                    |            | 20   | 50         | mV   |
| Short-circuit output current                                                                    | I <sub>OS</sub>     |                                    | –6         |      | 6          | mA   |
| High-impedance state output current                                                             | I <sub>OZ</sub>     |                                    | –10        |      | 10         | uA   |
| <b>Supply Currents</b>                                                                          |                     |                                    |            |      |            |      |
| Total supply current – active                                                                   |                     | SF_INP=0, SF_VRLC=0                |            | 230  |            | mA   |
|                                                                                                 |                     | SF_INP=1, SF_VRLC=1                |            | 250  |            | mA   |
| Total supply current – full power down mode                                                     |                     |                                    |            | 1.2  |            | mA   |

**Notes:**

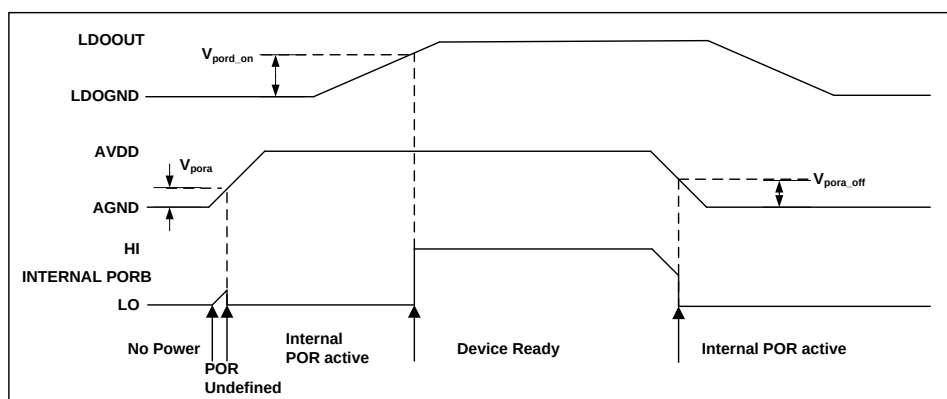
- Full-scale input voltage** denotes the differential input signal amplitude (V<sub>IN</sub>-VRLC in non-CDS mode, V<sub>IN</sub>-RESET level in CDS mode) that corresponds to the ADC full-scale input level.
- If AVDD < 3.0V, the VRLC input voltage must not exceed AVDD.**

## INTERNAL POWER ON RESET CIRCUIT



**Figure 1 Internal Power On Reset Circuit Schematic**

The WM8231 includes an internal Power-On-Reset Circuit, as shown in Figure 1, which is used reset the digital logic into a default state after power up. The POR circuit is powered from AVDD and monitors LDOOUT. It asserts PORB low if AVDD or LDOOUT is below a minimum threshold.



**Figure 2 Typical Power up Sequence where AVDD is Powered before LDOOUT**

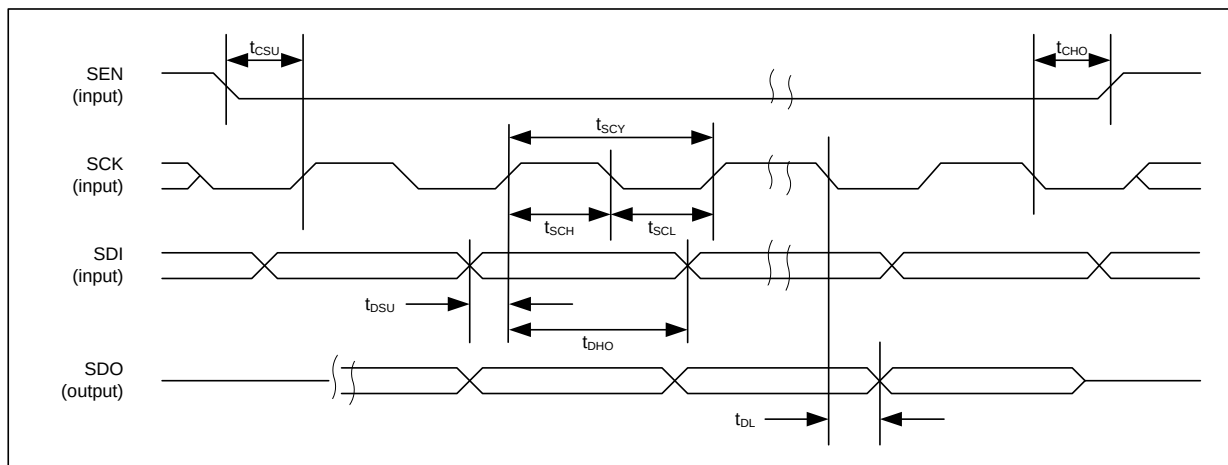
Figure 2 shows a typical power-up sequence where AVDD is powered up first. When AVDD rises above the minimum threshold,  $V_{pora}$ , there is enough voltage for the circuit to guarantee PORB is asserted low and the chip is held in reset. In this condition, all writes to the control interface are ignored. When LDOOUT rises to  $V_{pord\_on}$ , PORB is released high and all registers are in their default state and writes to the control interface may take place. On power down, where AVDD falls first, PORB is asserted low whenever AVDD drops below the minimum threshold  $V_{pora\_off}$ .

| SYMBOL          | MIN | TYP | MAX | UNIT |
|-----------------|-----|-----|-----|------|
| $V_{pora}$      | 0.4 | 0.6 | 0.8 | V    |
| $V_{pora\_off}$ | 0.4 | 0.6 | 0.8 | V    |
| $V_{pord\_on}$  | 0.5 | 0.7 | 0.9 | V    |

**Table 1 Typical POR Operation (typical values, not tested)**

## SIGNAL TIMING REQUIREMENTS

### SERIAL CONTROL INTERFACE



**Figure 3 Serial Interface Timing**

| PARAMETER                           | SYMBOL    | TEST CONDITIONS | MIN  | TYP | MAX | UNITS |
|-------------------------------------|-----------|-----------------|------|-----|-----|-------|
| SEN falling edge to SCK rising edge | $t_{CSU}$ |                 | 20   |     |     | ns    |
| SCK falling edge to SEN rising edge | $t_{CHO}$ |                 | 20   |     |     | ns    |
| SCK pulse cycle time                | $t_{SCY}$ |                 | 83.3 |     |     | ns    |
| SCK pulse width low                 | $t_{SCL}$ |                 | 33   |     |     | ns    |
| SCK pulse width high                | $t_{SCH}$ |                 | 33   |     |     | ns    |
| SDI to SCK set-up time              | $t_{DSU}$ |                 | 20   |     |     | ns    |
| SDI to SCK hold time                | $t_{DHO}$ |                 | 20   |     |     | ns    |
| SCK falling edge to SDO transition  | $t_{DL}$  |                 |      |     | 33  | ns    |

The internal control registers are programmable via the serial digital control interface. The register contents can be read back via the serial interface on pin SDO.

It is recommended that a software reset is carried out after the power-up sequence, before writing to any other register. This ensures that all registers are set to their default values.

## DEVICE IDENTIFICATION

Up to 4 WM8231 devices can share a common set of serial interface pins. Each device on the common interface bus must be given a different device ID. The device ID is set by the input pin DSLCT2 and DSLCT1 as shown in Table 2.

| DSLCT2 | DSLCT1 | DEVICE ID (ID[1:0]) |
|--------|--------|---------------------|
| L      | L      | 00                  |
| L      | H      | 01                  |
| H      | L      | 10                  |
| H      | H      | 11                  |

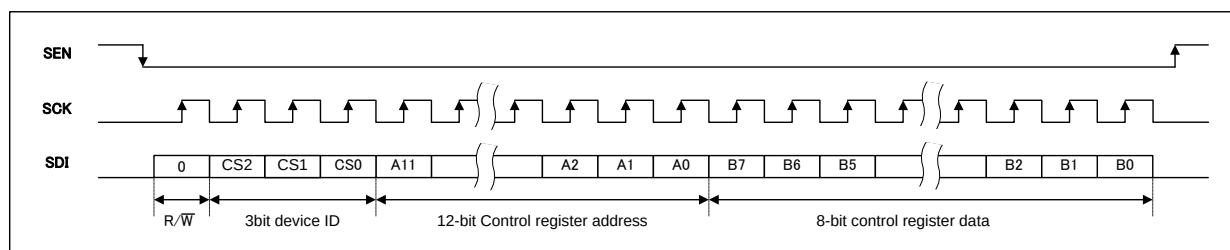
**Table 2 Device Identification**

## REGISTER WRITE

Figure 4 shows the sequence of operations for performing a register write. Three pins, SCK, SDI and SEN are used for the control interface. A 16-bit address (R/W, CS0, CS1, CS2, A11 to A0) is clocked in through SDI, MSB first, followed by an 8-bit data word (b7 to b0), also MSB first. Setting address bit R/W to 0 indicates that the operation is a register write. The device ID bits (CS0 and CS1) indicate which device is being written to on a shared control bus. A register write with CS2 set to 1 writes data to all devices on the common bus. Each bit is latched on the rising edge of SCK. When the data has been shifted into the device, a rising edge on the SEN pin transfers the data to the appropriate internal register.

| CS2 | CS1<br>(DSLCT2) | CS0<br>(DSLCT1) | DESCRIPTION                      |
|-----|-----------------|-----------------|----------------------------------|
| 0   | ID[1:0]         |                 | Indicated a device to write data |
| 1   | X               | X               | Writes data to all devices       |

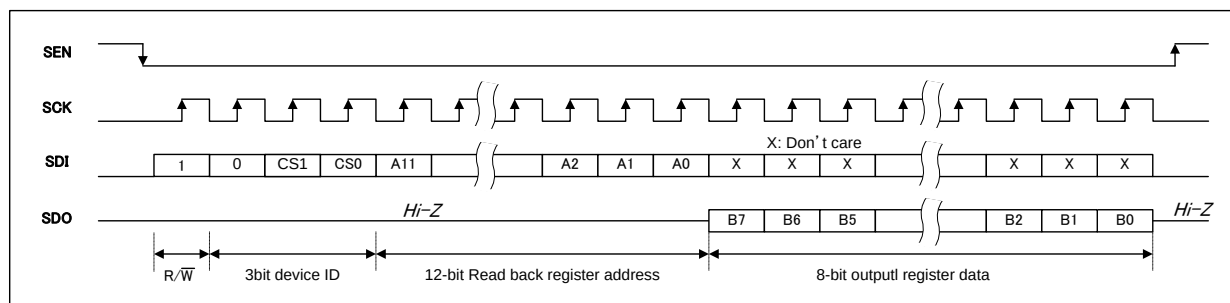
**Table 3 Device Identification**



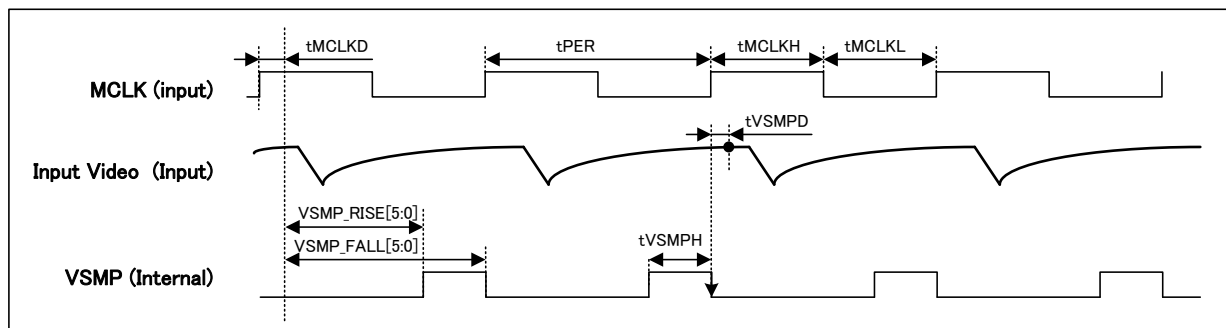
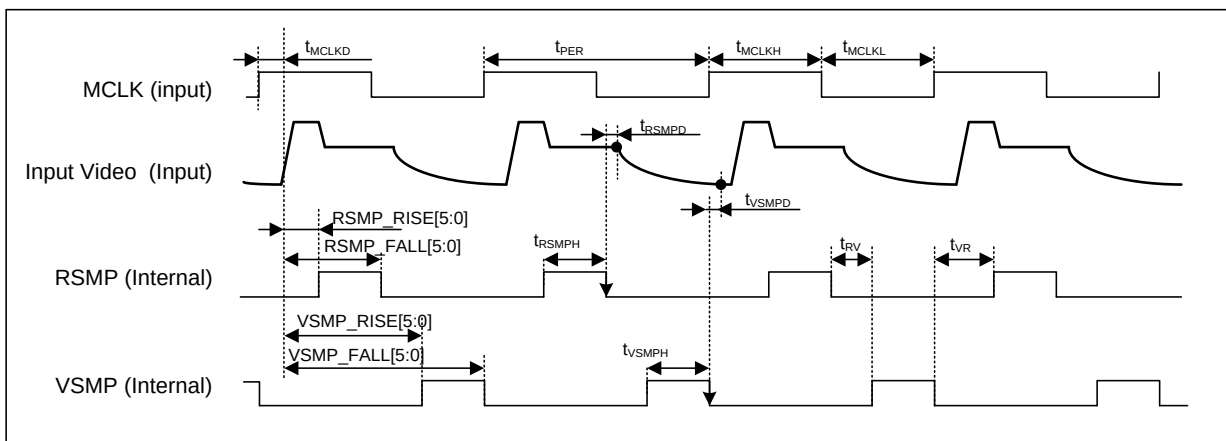
**Figure 4 Serial Interface Register Write**

## REGISTER READ-BACK

Figure 5 shows register read-back in serial mode. Read-back is initiated by writing to the serial bus as described above but with address bit R/W set to 1, followed by an 8-bit dummy data word. Writing address (A11 to A0) will cause the contents (B7 to B0) of corresponding register in the addressed device to be output MSB first on pin SDO (on the following edge of SCK). In this mode, the CS2 register should be set to 0.



**Figure 5 Serial Interface Register Read-back**

**INPUT VIDEO SAMPLING**
**NON-CDS (S/H) MODE**

**Figure 6 Input Video Timing (Non-CDS (S/H) mode)**
**CDS MODE**

**Figure 7 Input Video Timing (CDS mode)**

**Test Conditions**

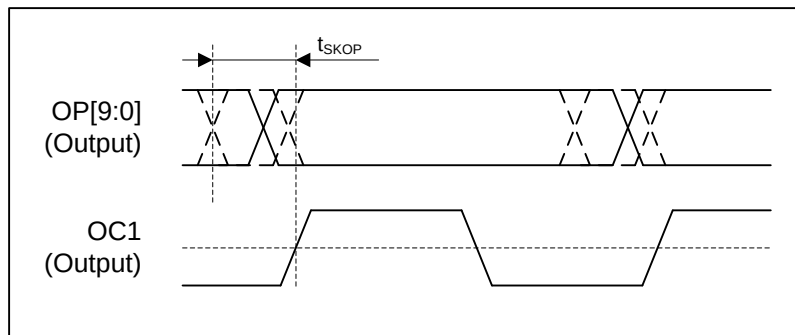
AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND = 0V, T<sub>A</sub> = 25°C, MCLK = 35MHz unless otherwise stated.

| PARAMETER                                                          | SYMBOL             | TEST CONDITIONS                                    | MIN                    | TYP                    | MAX                          | UNITS |
|--------------------------------------------------------------------|--------------------|----------------------------------------------------|------------------------|------------------------|------------------------------|-------|
| MCLK cycle period (see note 2)                                     | t <sub>PER</sub>   |                                                    | 28.6                   |                        | 200                          | ns    |
| MCLK high period (see note 2)                                      | t <sub>MCLKH</sub> |                                                    | 0.4 * t <sub>PER</sub> | 0.5 * t <sub>PER</sub> | 0.6 * t <sub>PER</sub>       | ns    |
| MCLK low period (see note 2)                                       | t <sub>MCLKL</sub> |                                                    | 0.4 * t <sub>PER</sub> | 0.5 * t <sub>PER</sub> | 0.6 * t <sub>PER</sub>       | ns    |
| MCLK rising edge to DLL tap 0                                      | t <sub>MCLKD</sub> |                                                    |                        | 18                     |                              | ns    |
| Aperture delay<br>(from RSMP falling edge)                         | t <sub>RSMPD</sub> |                                                    |                        | 5                      |                              | ns    |
| Aperture delay<br>(from VSMP falling edge)                         | t <sub>VSMPD</sub> |                                                    |                        | 5                      |                              | ns    |
| RSMP high period                                                   | t <sub>RSMPH</sub> |                                                    | 5                      |                        |                              | ns    |
| VSMP high period                                                   | t <sub>VSMPH</sub> |                                                    | 5                      |                        | 28 *<br>t <sub>PER</sub> /60 | ns    |
| RSMP falling edge to VSMP rising edge                              | t <sub>RV</sub>    |                                                    | 0.5                    |                        |                              | ns    |
| VSMP falling edge to RSMP rising edge                              | t <sub>VR</sub>    |                                                    | 0.5                    |                        |                              | ns    |
| Output data latency<br>(from 1 <sup>st</sup> falling edge of VSMP) | LAT                | LVDS 10-bit 5pair mode                             |                        | 18                     |                              | clock |
|                                                                    |                    | LVDS 10-bit 3pair mode,<br>CMOS 10-bit output mode |                        | 16                     |                              | clock |
|                                                                    |                    | Other output modes                                 |                        | 17                     |                              | clock |

**Notes:**

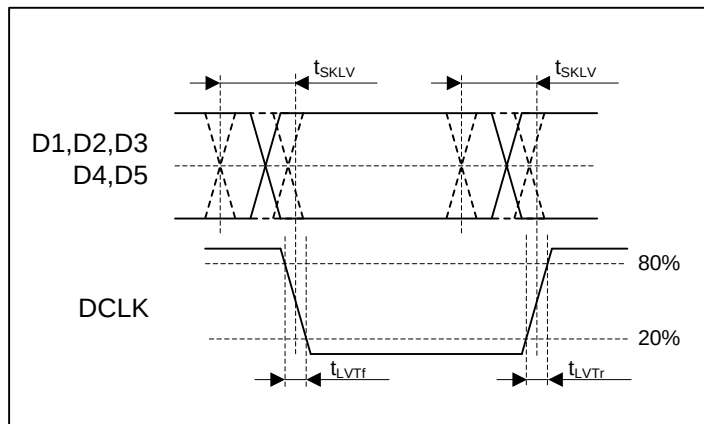
- 1clock = t<sub>PER</sub> (MCLK cycle period)
2. MCLK cycle period and MCLK high/low period are measured at 50% of the respective rising/falling edges

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION              |
|-------------------------|-----|----------------|---------|--------------------------|
| R130 (82h)<br>RSMP rise | 5:0 | RSMP_RISE[5:0] | 01_1100 | RSMP rise edge (0 to 59) |
| R131 (83h)<br>RSMP fall | 5:0 | RSMP_FALL[5:0] | 10_0110 | RSMP fall edge (0 to 59) |
| R132 (84h)<br>VSMP rise | 5:0 | VSMP_RISE[5:0] | 00_1000 | VSMP rise edge (0 to 59) |
| R133 (85h)<br>VSMP fall | 5:0 | VSMP_FALL[5:0] | 10_1000 | VSMP fall edge (0 to 59) |

**OUTPUT DATA TIMING (CMOS OUTPUT)**

**Figure 8 CMOS Output Data Timing**
**Test Conditions**

AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND= 0V,  $T_A = 25^\circ\text{C}$ , MCLK= 30MHz unless otherwise stated.

| PARAMETER        | SYMBOL     | TEST CONDITIONS | MIN | TYP    | MAX | UNITS |
|------------------|------------|-----------------|-----|--------|-----|-------|
| Data output skew | $t_{SKOP}$ |                 |     | +/-500 |     | ps    |

**OUTPUT DATA TIMING (LVDS OUTPUT)**

**Figure 9 LVDS Output Data Timing**
**Test Conditions**

AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND= 0V,  $T_A = 25^\circ\text{C}$ , MCLK= 35MHz unless otherwise stated.

| PARAMETER                    | SYMBOL      | TEST CONDITIONS | MIN | TYP    | MAX | UNITS |
|------------------------------|-------------|-----------------|-----|--------|-----|-------|
| LVDS output skew             | $t_{SKLV}$  |                 |     | +/-250 |     | ps    |
| LVDS output signal rise time | $t_{LVTr}$  |                 |     |        | 1   | ns    |
| LVDS output signal fall time | $t_{LVTrf}$ |                 |     |        | 1   | ns    |



## DEVICE DESCRIPTION

### INTRODUCTION

A block diagram of the device showing the signal path is presented on the front page of this datasheet.

The WM8231 samples up to three inputs (IN1, IN2 and IN3) simultaneously. The device then processes the sampled video signal with respect to the video reset level or an internally/externally generated reference level using between one and six processing channels.

Each processing channel consists of an Input Sampling block with optional Reset Level Clamping (RLC) and Correlated Double Sampling (CDS), an 8-bit programmable offset DAC and a 12-bit Programmable Gain Amplifier (PGA).

The ADC then converts each resulting analogue signal to a digital word. The digital output from the ADC is presented in a variety of possible output formats in LVDS and CMOS format.

On-chip control registers determine the configuration of the device, including the offsets and gains applied to each channel. These registers are programmable via a serial interface.

The device has an automatic Black-Level Calibration function which allows the D.C. offset determined during the optically-black pixels at the beginning of the linear sensor to be removed during the image-pixels.

The WM8231 also has an Automatic Gain Control function which automatically adjusts the gain to an appropriate level for a detected input level.

The device incorporates a sensor timing generation function which allows CCD and CMOS sensor timing to be controlled directly from the device using internal clock generation and register settings.

### RESET LEVEL CLAMPING (RLC)

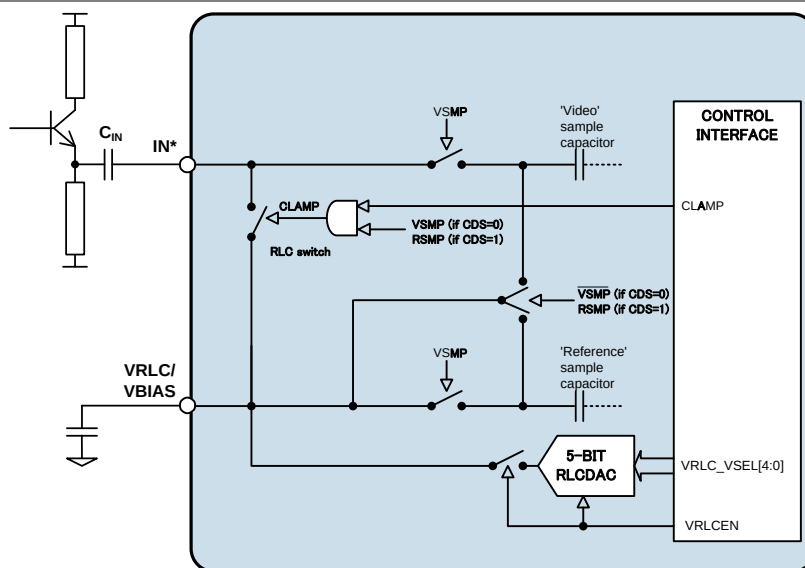
To ensure that the signal applied to the WM8231 lies within the supply voltage range (0V to AVDD), the output signal from a CCD is usually level shifted by coupling through a capacitor,  $C_{IN}$ . The RLC circuit clamps the WM8231 side of this capacitor to a suitable voltage through a CMOS switch during the CCD reset period (pixel clamping) or during the black pixels (line clamping). In order for clamping to produce correct results the input voltage during the clamping must be a constant value.

Note that if the A.C. coupling capacitor ( $C_{IN}$ ) is used in non-CDS mode (CDS=0), then to minimise code drift, line clamping should be used and internal input voltage buffers enabled using the CLPMD register bit. Alternatively, if the input signal contains a stable reference/reset level, then pixel clamping should be used, and the voltage buffers need not be enabled.

The WM8231 allows the user to control the RLC switch in a variety of ways as illustrated in Figure 10. This figure shows a single channel; however, all 3 channels are identical, each with its own clamp switch controlled by the common CLMP signal.

The method of control chosen depends upon the characteristics of the input video. The VRLCEN register bit must be set to 1 to enable clamping; otherwise, the RLC switch cannot be closed (by default VRLCEN=1).

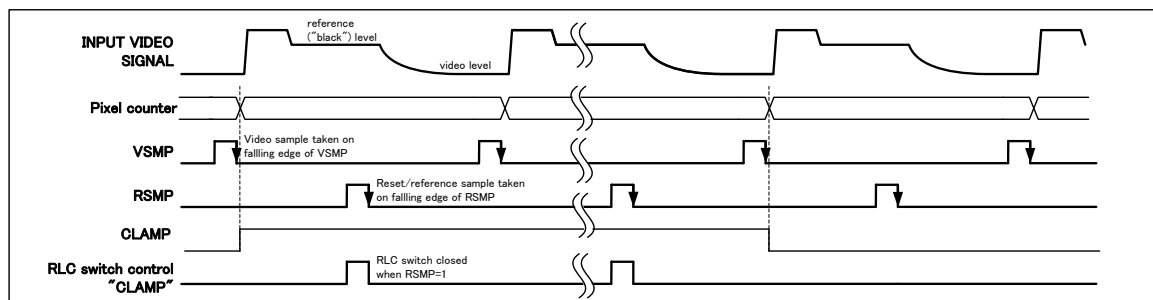
Note that unused inputs should be left floating, or grounded through a decoupling capacitor, if reset level clamping is used.



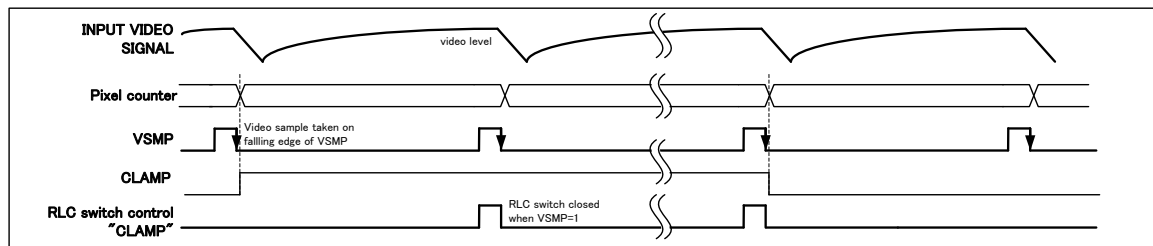
**Figure 10 RLC Clamp Control Options**

When an input waveform has a stable reference level on every pixel, it may be desirable to clamp every pixel during this period. Setting CLAMP=high means that the RLC switch is closed whenever the RSMP is high, as shown in Figure 11.

In non-CDS operation, setting CLAMP=high means that the RLC switch is closed whenever the VSM is high, as shown in Figure 12.



**Figure 11 Reset Level Clamp Operation, CDS Operation Shown**



**Figure 12 Line Clamp Operation, non-CDS operation shown**

## CDS/NON-CDS PROCESSING

For CCD type input signals, containing a fixed reference/reset level, the signal may be processed using Correlated Double Sampling (CDS), which will remove pixel-by-pixel common mode noise. With CDS processing, the input waveform is sampled at two different points in time for each pixel, once during the reference/reset level and once during the video level. To sample using CDS, register bit CDS must be set to 1 (default = 0). This causes the signal reference to come from the video reference level as shown in Figure 13.

For input signals that do not contain a reference/reset level (e.g. CIS sensor signals), non-CDS processing is used (CDS=0). In this case, the video level is processed with respect to the voltage on pin VRLC/VBIAS. The VRLC/VBIAS voltage is sampled at the same time as input samples the video level in this mode. Note that if the A.C. coupling capacitor ( $C_{IN}$ ) is used in non-CDS mode (CDS=0), then to minimise code drift, line clamping should be used and internal input voltage buffers enabled using the CLPMD register bit. Alternatively, if the input signal contains a stable reference/reset level, then pixel clamping should be used, and the voltage buffers need not be enabled.

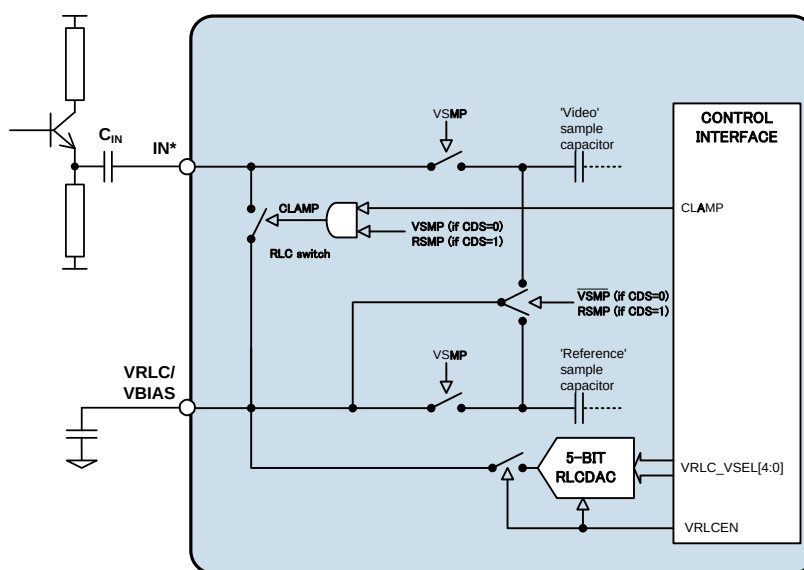


Figure 13 CDS/non-CDS Input Configuration

## OFFSET ADJUST AND PROGRAMMABLE GAIN

The output from the CDS block is a differential signal, which is added to the output of an 8-bit Offset DAC to compensate for offsets and then amplified by a 12-bit PGA. The gain and offset for each channel are independently programmable by writing to control bits DACINP[7:0] for the Offset DAC, and AGAIN[4:0] and DGAIN[11:0] for the PGA.

The gain characteristic of the WM8231 PGA is shown in Figure 14.

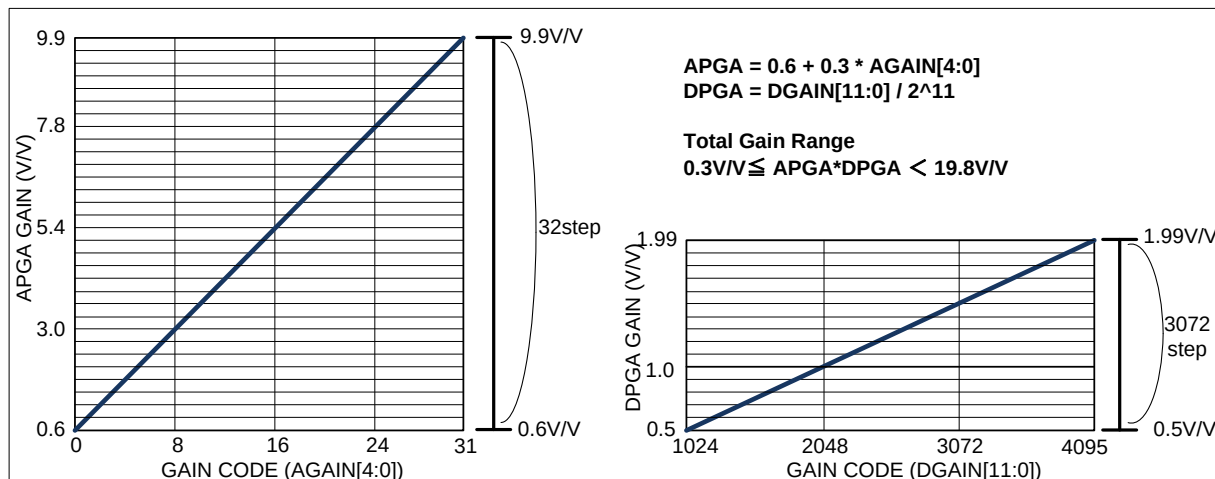


Figure 14 PGA Gain Characteristic

## ADC INPUT BLACK LEVEL ADJUST

The output from the PGA can be offset to match the full-scale range of the differential ADC ( $1.5 * [VREF1C - VREF3C]$ ).

For negative-going input video signals, a black level (zero differential) output from the PGA should be offset to the top of the ADC range by setting register bits PGAFS=0. For positive going input signals the black level should be offset to the bottom of the ADC range by setting PGAFS=1.

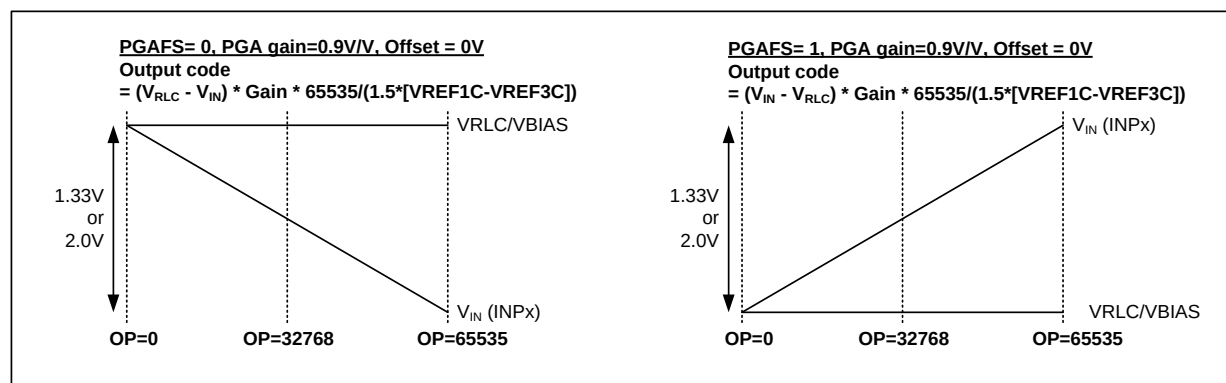
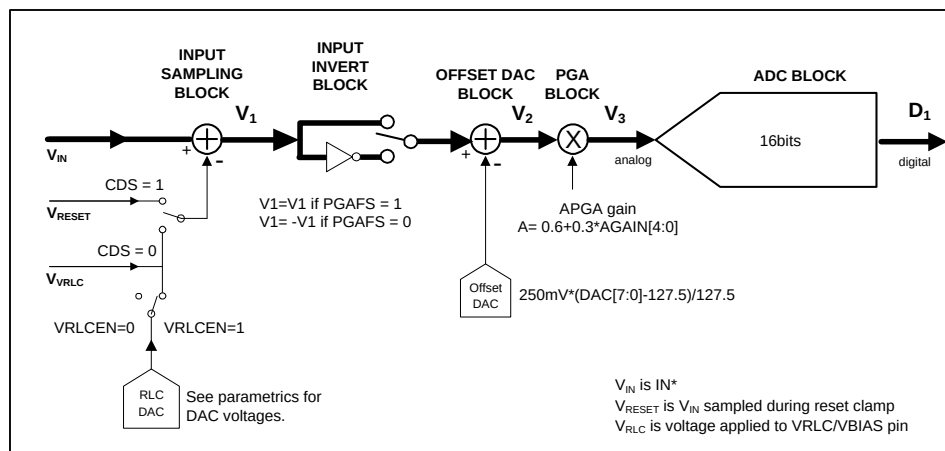


Figure 15 ADC Input Black Level Adjust Settings

## OVERALL SIGNAL FLOW SUMMARY

Figure 16 represents the processing of the video signal through the WM8231.



**Figure 16 Overall Signal Flow**

The **INPUT SAMPLING BLOCK** produces an effective input voltage  $V_1$ . For CDS, this is the difference between the input video level  $V_{IN}$  and the input reset level  $V_{RESET}$ . For non-CDS this is the difference between the input video level  $V_{IN}$  and the voltage on the VRLC/BIAS pin,  $V_{VRLC}$ , optionally set via the RLC DAC.

The **OFFSET DAC BLOCK** then adds the amount of fine offset adjustment required to move the black level of the input signal towards 0V, producing  $V_2$ .

The **PGA BLOCK** then amplifies the white level of the input signal to maximise the ADC range, outputting voltage  $V_3$ .

The **ADC BLOCK** then converts the analogue signal,  $V_3$ , to a 16-bit unsigned digital output,  $D_1$ .

## ADC PGA BIAS CURRENT CONTROL

The WM8231 can be changed the bias current for PGA and ADC comparator as the following step. It would be effective for high frequency operation.

1. R1C0h=1
2. R1CBh=11h

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT | DESCRIPTION                                           |
|-------------------------------------|-----|-----------|---------|-------------------------------------------------------|
| R448 (1C0h)<br>User access control2 | 0   | User_KEY2 | 0       | 0 = User access2 disabled<br>1 = User access2 enabled |

| REGISTER ADDRESS            | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                    |
|-----------------------------|-----|---------|---------|--------------------------------------------------------------------------------|
| R459 (1CBh)<br>Comp control | 1:0 | PT_COMP | 01      | 01 = Standard operation<br>11 = High performance operation<br>Other = Inhibit. |

### Notes:

1. To change the Comp control, the USER\_KEY2 bit must be set to '1'.
2. If it's not required to change this register, must be set as default.

## PLL DLL SETUP

The WM8231 supports a wide range of MCLK input frequencies. The PLL\_EXDIV\_SEL[2:0], LVDLGAIN[1:0] and DLGAIN[1:0] fields must be configured according to the MCLK frequency and the applicable data-output format – see Table 4. Note the LVDLGAIN field is not used in CMOS mode.

Note that after PLL and DLL configuration, the device must be reset as follows:

- R03[1:0]=11 (PDMD=1, PD=1)
- Delay 1 ms
- R03[1:0]=00 (Normal operation)

Under default conditions, the LDO2 voltage is 1.8V. To select 2.0V output as noted in Table 4, the following control sequence is required:

- R1B0h[0]=1
- R1B4h=12h

| Data Format                                                    | Max sample rate | MCLK frequency (MHz) | 30.1 ~ 35.0 | 30.0 | 25.0 ~ 29.9 | 15.1 ~ 23.3 | 15.0 | 12.5 ~ 14.99 | 10.0 ~ 12.49 | 8.33 ~ 9.99 | 7.5 ~ 8.32 | 5.0 ~ 7.49 |
|----------------------------------------------------------------|-----------------|----------------------|-------------|------|-------------|-------------|------|--------------|--------------|-------------|------------|------------|
|                                                                |                 |                      |             |      |             |             |      |              |              |             |            |            |
| CMOS 10-bit                                                    | 30 MHz          | PLL_EXDIV_SEL[2:0]   | —           | 000  | 000         | 001         | 001  | 001          | 001          | 001         | 010        | 010        |
|                                                                |                 | DLGAIN[1:0]          | —           | 01   | 01          | 01          | 01   | 10           | 10           | 10          | 10         | 10         |
|                                                                |                 | LDO2 voltage         | —           | 1.8V | 1.8V        | 1.8V        | 1.8V | 1.8V         | 1.8V         | 1.8V        | 1.8V       | 1.8V       |
| LVDS 10-bit 5-pair                                             | 35 MHz          | PLL_EXDIV_SEL[2:0]   | 001         | 001  | 001         | 010         | 010  | 010          | 011          | 011         | 011        | 100        |
|                                                                |                 | LVDLGAIN[1:0]        | 01          | 01   | 01          | 01          | 01   | 10           | 10           | 10          | 10         | 10         |
|                                                                |                 | DLGAIN[1:0]          | 01          | 01   | 01          | 01          | 01   | 10           | 10           | 10          | 10         | 10         |
|                                                                |                 | LDO2 voltage         | 1.8V        | 1.8V | 1.8V        | 1.8V        | 1.8V | 1.8V         | 1.8V         | 1.8V        | 1.8V       | 1.8V       |
| LVDS 16-bit 5-pair<br>LVDS 10-bit 3-pair<br>LVDS 12-bit 4-pair | 30 MHz          | PLL_EXDIV_SEL[2:0]   | —           | 000  | 000         | 001         | 001  | 001          | 001          | 001         | 010        | 010        |
|                                                                |                 | LVDLGAIN[1:0]        | —           | 00   | 01          | 01          | 01   | 01           | 01           | 10          | 10         | 10         |
|                                                                |                 | DLGAIN[1:0]          | —           | 01   | 01          | 01          | 01   | 10           | 10           | 10          | 10         | 10         |
|                                                                |                 | LDO2 voltage         | —           | 2.0V | 1.8V        | 1.8V        | 1.8V | 1.8V         | 1.8V         | 1.8V        | 1.8V       | 1.8V       |
| LVDS 16-bit 3-pair                                             | 15 MHz          | PLL_EXDIV_SEL[2:0]   | —           | —    | —           | —           | 001  | 001          | 001          | 001         | 010        | 010        |
|                                                                |                 | LVDLGAIN[1:0]        | —           | —    | —           | —           | 00   | 01           | 01           | 01          | 01         | 01         |
|                                                                |                 | DLGAIN[1:0]          | —           | —    | —           | —           | 01   | 10           | 10           | 10          | 10         | 10         |
|                                                                |                 | LDO2 voltage         | —           | —    | —           | —           | 2.0V | 1.8V         | 1.8V         | 1.8V        | 1.8V       | 1.8V       |

**Table 4 PLL and DLL Setting**

| REGISTER ADDRESS                   | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                      |
|------------------------------------|-----|--------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R28 (1Ch)<br>PLL divider control 1 | 6:4 | PLL_EXDIV_SEL[2:0] | 001     | Select EX DIV ratio.<br>Need to set according to input frequency. See Table 4.<br>000 = 1<br>001 = 2<br>010 = 4<br>011 = 8<br>100 = 16<br>101 to 111 = reserved. |

| REGISTER ADDRESS           | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                              |
|----------------------------|-----|-------------|---------|------------------------------------------------------------------------------------------|
| R128 (80h)<br>DLL config 1 | 5:4 | DLGAIN[1:0] | 01      | gain control of DLL delay line<br>Need to set according to input frequency. See Table 4. |

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                   |
|----------------------------|-----|---------------|---------|-----------------------------------------------------------------------------------------------|
| R129 (81h)<br>DLL config 2 | 5:4 | LVDLGAIN[1:0] | 01      | gain control of LVDS DLL delay line<br>Need to set according to input frequency. See Table 4. |

| REGISTER ADDRESS                   | BIT | LABEL    | DEFAULT | DESCRIPTION                                         |
|------------------------------------|-----|----------|---------|-----------------------------------------------------|
| R432 (1B0h)<br>User access control | 0   | USER_KEY | 0       | 0 = User access disabled<br>1 = User access enabled |

| REGISTER ADDRESS            | BIT | LABEL     | DEFAULT | DESCRIPTION                    |
|-----------------------------|-----|-----------|---------|--------------------------------|
| R436 (1B4h)<br>LDO2 control | 4:0 | LDO2_VSEL | 1_0000  | 1_0000 = 1.8V<br>1_0010 = 2.0V |

**Notes:**

1. To change the LDO2 control, the USER\_KEY bit must be set to '1'.
2. If it's not required to change this register, it must be set as default.



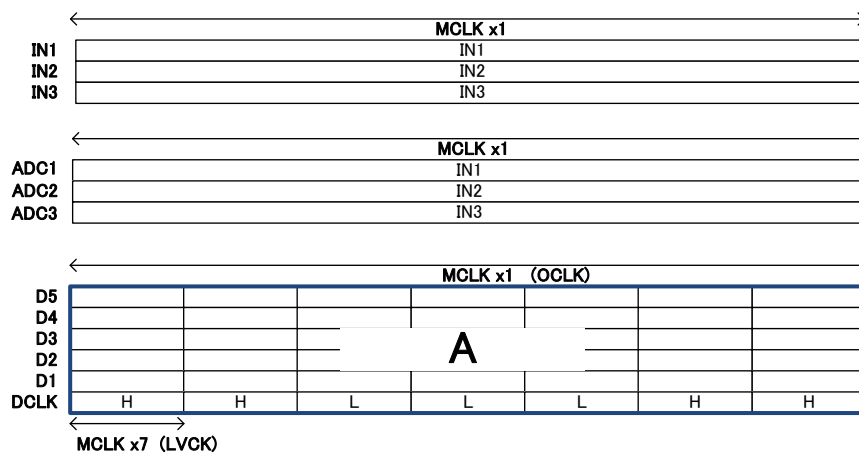
## OUTPUT DATA FORMAT

The output from the WM8231 can be presented in several different formats under control of the CMOSMODE and the LVDSMODE register. Depending on the output modes as shown in Table 5.

| MODES | DESCRIPTION        | OUTPUT DATA RATE | MAXIMUM MCLK RATE |
|-------|--------------------|------------------|-------------------|
| 1     | LVDS 10-bit 5-pair | MCLK x 7         | 35 MHz            |
| 2     | LVDS 16-bit 5-pair | MCLK x 10.5      | 30 MHz            |
| 3     | LVDS 10-bit 3-pair | MCLK x 10.5      | 30 MHz            |
| 4     | LVDS 16-bit 3-pair | MCLK x 21        | 15 MHz            |
| 5     | LVDS 12-bit 4-pair | MCLK x 10.5      | 30 MHz            |
| 6     | CMOS 10-bit        | MCLK x 3         | 30 MHz            |

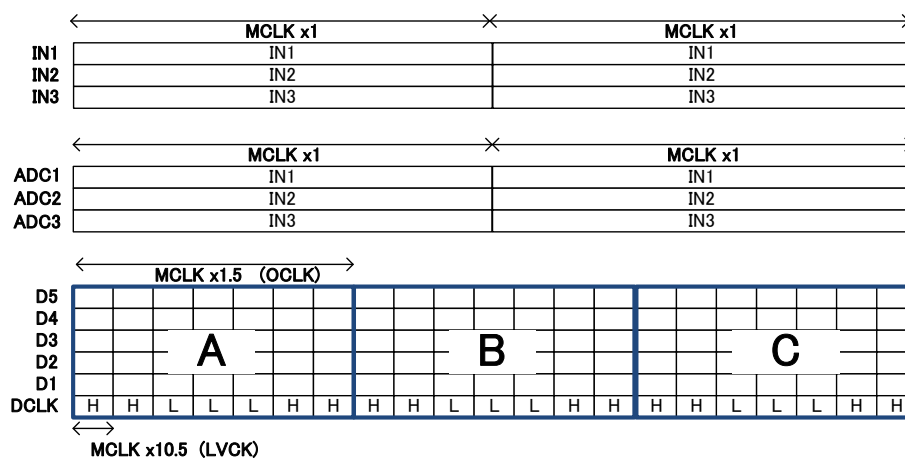
Table 5 Output Format and Data Rate

### LVDS 10-BIT 5PAIR MODE



| A    |        |        |        |        |        |        |        |
|------|--------|--------|--------|--------|--------|--------|--------|
| D5   | S0     | S1     | S2     | IN1[0] | IN1[1] | IN1[2] | IN1[3] |
| D4   | IN1[4] | IN1[5] | IN1[6] | IN1[7] | IN1[8] | IN1[9] | S3     |
| D3   | S4     | IN2[0] | IN2[1] | IN2[2] | IN2[3] | IN2[4] | IN2[5] |
| D2   | IN2[6] | IN2[7] | IN2[8] | IN2[9] | IN3[0] | IN3[1] | IN3[2] |
| D1   | IN3[3] | IN3[4] | IN3[5] | IN3[6] | IN3[7] | IN3[8] | IN3[9] |
| DCLK | H      | H      | L      | L      | L      | H      | H      |

Table 6 10-bit 5pair LVDS Output Format

**LVDS 16-BIT 5PAIR MODE**


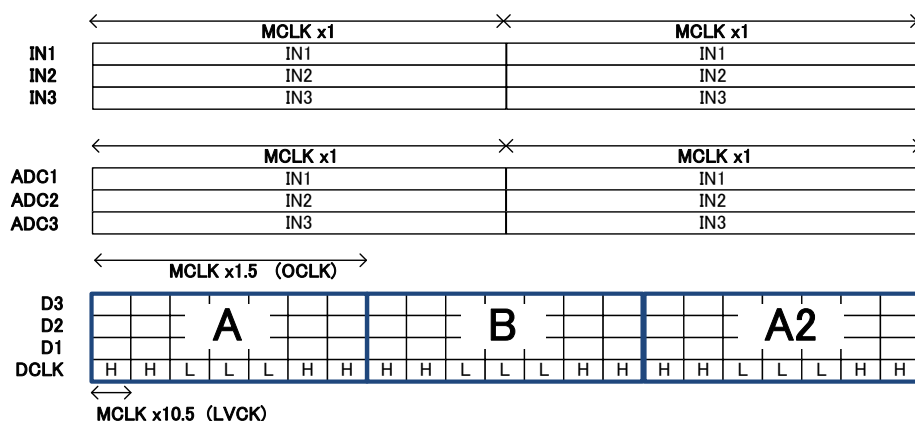
| A    |         |         |         |         |         |         |         |
|------|---------|---------|---------|---------|---------|---------|---------|
| D5   | S0      | S1      | S2      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  |
| D4   | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | IN1[10] |
| D3   | IN1[11] | IN1[12] | IN1[13] | IN1[14] | IN1[15] | IN2[0]  | IN2[1]  |
| D2   | IN2[2]  | IN2[3]  | IN2[4]  | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  |
| D1   | IN2[9]  | IN2[10] | IN2[11] | IN2[12] | IN2[13] | IN2[14] | IN2[15] |
| DCLK | H       | H       | L       | L       | L       | H       | H       |

| B    |         |         |         |         |         |         |         |
|------|---------|---------|---------|---------|---------|---------|---------|
| D5   | S0      | S1      | S2      | IN3[0]  | IN3[1]  | IN3[2]  | IN3[3]  |
| D4   | IN3[4]  | IN3[5]  | IN3[6]  | IN3[7]  | IN3[8]  | IN3[9]  | IN3[10] |
| D3   | IN3[11] | IN3[12] | IN3[13] | IN3[14] | IN3[15] | IN1[0]  | IN1[1]  |
| D2   | IN1[2]  | IN1[3]  | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  |
| D1   | IN1[9]  | IN1[10] | IN1[11] | IN1[12] | IN1[13] | IN1[14] | IN1[15] |
| DCLK | H       | H       | L       | L       | L       | H       | H       |

| C    |         |         |         |         |         |         |         |
|------|---------|---------|---------|---------|---------|---------|---------|
| D5   | S0      | S1      | S2      | IN2[0]  | IN2[1]  | IN2[2]  | IN2[3]  |
| D4   | IN2[4]  | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  | IN2[9]  | IN2[10] |
| D3   | IN2[11] | IN2[12] | IN2[13] | IN2[14] | IN2[15] | IN3[0]  | IN3[1]  |
| D2   | IN3[2]  | IN3[3]  | IN3[4]  | IN3[5]  | IN3[6]  | IN3[7]  | IN3[8]  |
| D1   | IN3[9]  | IN3[10] | IN3[11] | IN3[12] | IN3[13] | IN3[14] | IN3[15] |
| DCLK | H       | H       | L       | L       | L       | H       | H       |

**Table 7 16-bit 5pair LVDS Output Format**

## LVDS 10-BIT 3PAIR MODE

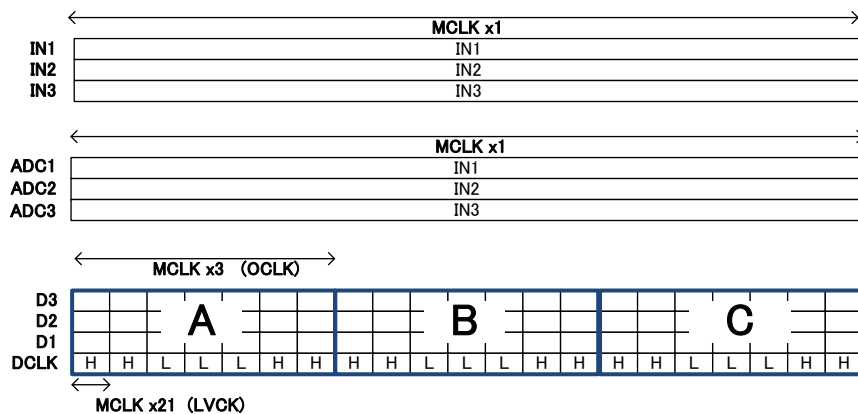


| A    |    |        |        |        |        |        |        |
|------|----|--------|--------|--------|--------|--------|--------|
| D3   | S0 | IN1[0] | IN1[1] | IN1[2] | IN1[3] | IN1[4] | IN1[5] |
| D2   |    | IN1[6] | IN1[7] | IN1[8] | IN1[9] | IN2[0] | IN2[1] |
| D1   |    | IN2[3] | IN2[4] | IN2[5] | IN2[6] | IN2[7] | IN2[8] |
| DCLK |    | H      | H      | L      | L      | L      | H      |

| B    |    |        |        |        |        |        |        |
|------|----|--------|--------|--------|--------|--------|--------|
| D3   | S0 | IN3[0] | IN3[1] | IN3[2] | IN3[3] | IN3[4] | IN3[5] |
| D2   |    | IN3[6] | IN3[7] | IN3[8] | IN3[9] | IN1[0] | IN1[1] |
| D1   |    | IN1[3] | IN1[4] | IN1[5] | IN1[6] | IN1[7] | IN1[8] |
| DCLK |    | H      | H      | L      | L      | L      | H      |

| A2   |    |        |        |        |        |        |        |
|------|----|--------|--------|--------|--------|--------|--------|
| D3   | S0 | IN2[0] | IN2[1] | IN2[2] | IN2[3] | IN2[4] | IN2[5] |
| D2   |    | IN2[6] | IN2[7] | IN2[8] | IN2[9] | IN3[0] | IN3[1] |
| D1   |    | IN3[3] | IN3[4] | IN3[5] | IN3[6] | IN3[7] | IN3[8] |
| DCLK |    | H      | H      | L      | L      | L      | H      |

Table 8 10-bit 3pair LVDS Output Format

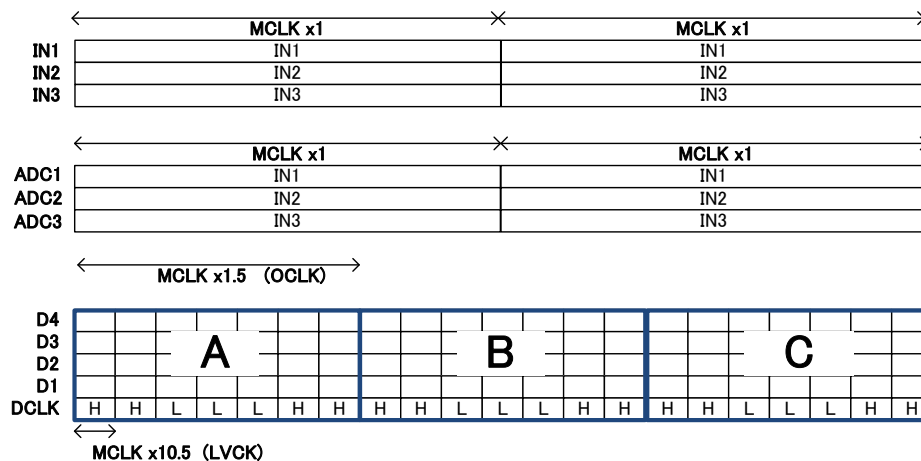
**LVDS 16-BIT 3PAIR MODE**


| A    |         |         |         |         |         |        |         |
|------|---------|---------|---------|---------|---------|--------|---------|
| D3   | S0      | S1      | S2      | IN1[0]  | IN1[1]  | IN1[2] | IN1[3]  |
| D2   | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9] | IN1[10] |
| D1   | IN1[11] | IN1[12] | IN1[13] | IN1[14] | IN1[15] | S3     | S4      |
| DCLK | H       | H       | L       | L       | L       | H      | H       |

| B    |         |         |         |         |         |        |         |
|------|---------|---------|---------|---------|---------|--------|---------|
| D3   | S0      | S1      | S2      | IN2[0]  | IN2[1]  | IN2[2] | IN2[3]  |
| D2   | IN2[4]  | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  | IN2[9] | IN2[10] |
| D1   | IN2[11] | IN2[12] | IN2[13] | IN2[14] | IN2[15] | S3     | S4      |
| DCLK | H       | H       | L       | L       | L       | H      | H       |

| C    |         |         |         |         |         |        |         |
|------|---------|---------|---------|---------|---------|--------|---------|
| D3   | S0      | S1      | S2      | IN3[0]  | IN3[1]  | IN3[2] | IN3[3]  |
| D2   | IN3[4]  | IN3[5]  | IN3[6]  | IN3[7]  | IN3[8]  | IN3[9] | IN3[10] |
| D1   | IN3[11] | IN3[12] | IN3[13] | IN3[14] | IN3[15] | S3     | S4      |
| DCLK | H       | H       | L       | L       | L       | H      | H       |

**Table 9 16-bit 3pair LVDS Output Format**

**LVDS 12-BIT 4PAIR MODE**


| A    |        |        |        |        |         |         |         |
|------|--------|--------|--------|--------|---------|---------|---------|
| D4   | S0     | IN1[0] | IN1[1] | IN1[2] | IN1[3]  | IN1[4]  | IN1[5]  |
| D3   | IN1[6] | IN1[7] | IN1[8] | IN1[9] | IN1[10] | IN1[11] | S1      |
| D2   | S2     | S3     | IN2[0] | IN2[1] | IN2[2]  | IN2[3]  | IN2[4]  |
| D1   | IN2[5] | IN2[6] | IN2[7] | IN2[8] | IN2[9]  | IN2[10] | IN2[11] |
| DCLK | H      | H      | L      | L      | L       | H       | H       |

| B    |        |        |        |        |         |         |         |
|------|--------|--------|--------|--------|---------|---------|---------|
| D4   | S0     | IN3[0] | IN3[1] | IN3[2] | IN3[3]  | IN3[4]  | IN3[5]  |
| D3   | IN3[6] | IN3[7] | IN3[8] | IN3[9] | IN3[10] | IN3[11] | S1      |
| D2   | S2     | S3     | IN1[0] | IN1[1] | IN1[2]  | IN1[3]  | IN1[4]  |
| D1   | IN1[5] | IN1[6] | IN1[7] | IN1[8] | IN1[9]  | IN1[10] | IN1[11] |
| DCLK | H      | H      | L      | L      | L       | H       | H       |

| C    |        |        |        |        |         |         |         |
|------|--------|--------|--------|--------|---------|---------|---------|
| D4   | S0     | IN2[0] | IN2[1] | IN2[2] | IN2[3]  | IN2[4]  | IN2[5]  |
| D3   | IN2[6] | IN2[7] | IN2[8] | IN2[9] | IN2[10] | IN2[11] | S1      |
| D2   | S2     | S3     | IN3[0] | IN3[1] | IN3[2]  | IN3[3]  | IN3[4]  |
| D1   | IN3[5] | IN3[6] | IN3[7] | IN3[8] | IN3[9]  | IN3[10] | IN3[11] |
| DCLK | H      | H      | L      | L      | L       | H       | H       |

**Table 10 12-bit 4pair LVDS Output Format**

## LVDS SYNCHRONOUS OUTPUT

The LVDS synchronous output function can be used in LVDS 16-bit 5pair mode, 10-bit 3pair mode and 12-bit 4 pair mode. In these LVDS output mode, the output data packet cycle is not same as MCLK clock period, so that the output data at pixel counter = 0 will not be same format when the line length is odd number.

If OUTSYNC = 1, the LVDS output format will be synchronized to pixel counter = 0.

When the line length is even number, the output data at pixel counter = 0 will be always same format, so that the OUTSYNC is invalid. Also, the OUTSYNC is invalid in other LVDS and CMOS format. The following shows detailed information of this mode.

### Odd number line length

In odd number line length operation, the output data at pixel counter = 0 will not be same format as shown in Figure 17. When set the OUTSYNC register, the LVDS output format will be synchronized to pixel counter = 0 as shown in Figure 18 below.

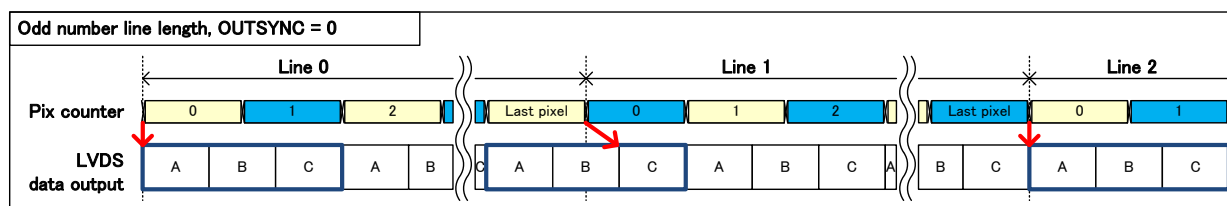


Figure 17 LVDS output data cycle (odd number line length, OUTSYNC=0)

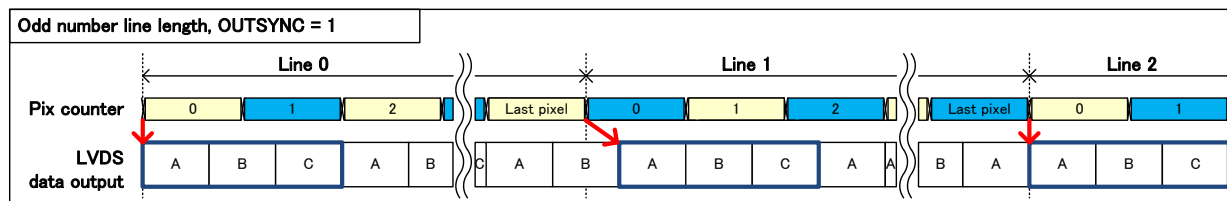


Figure 18 LVDS output data cycle (odd number line length, OUTSYNC=1)

### Even number line length

When the line length is even number, the output data at pixel counter = 0 will be always same format, so that the OUTSYNC is invalid.

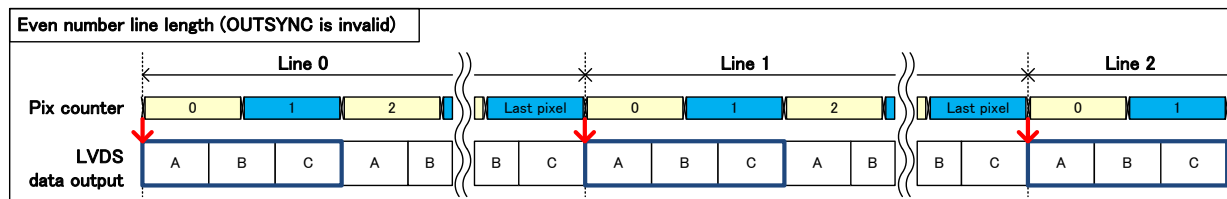


Figure 19 LVDS output data cycle (even number line length)

## LVDS DATA OUTPUT ORDER

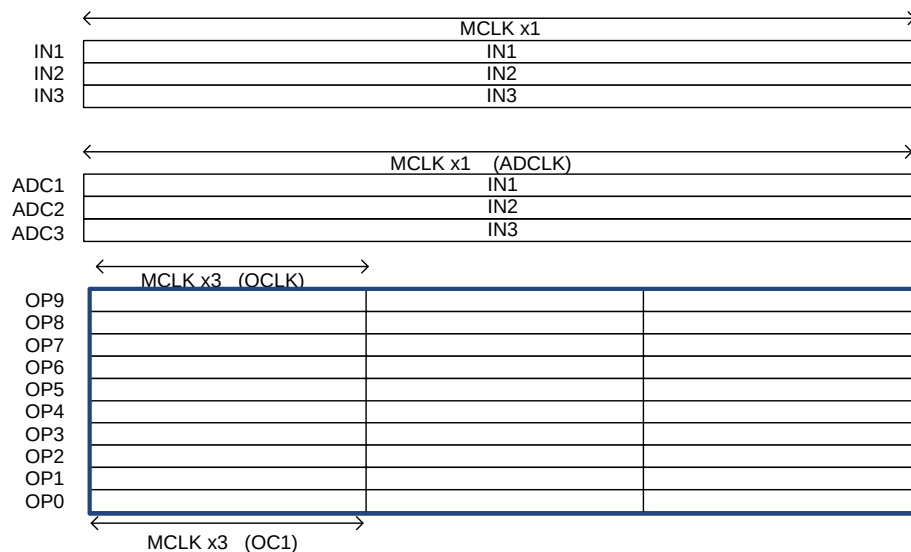
The WM8231 can be presented 2 types of LVDS data output order, Ascending order mode and Descending order mode as the following.

| Ascending Order Mode |         |         |         |         |         |         |         | Decending Order Mode |         |         |         |         |         |         |         |
|----------------------|---------|---------|---------|---------|---------|---------|---------|----------------------|---------|---------|---------|---------|---------|---------|---------|
| 10bit 5pair mode     |         |         |         |         |         |         |         | 10bit 5pair mode     |         |         |         |         |         |         |         |
| D5                   | S0      | S1      | S2      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  | D5                   | S4      | S3      | S2      | IN1[9]  | IN1[8]  | IN1[7]  | IN1[6]  |
| D4                   | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | S3      | D4                   | IN1[5]  | IN1[4]  | IN1[3]  | IN1[2]  | IN1[1]  | IN1[0]  | S1      |
| D3                   | S4      | IN2[0]  | IN2[1]  | IN2[2]  | IN2[3]  | IN2[4]  | IN2[5]  | D3                   | S0      | IN2[9]  | IN2[8]  | IN2[7]  | IN2[6]  | IN2[5]  | IN2[4]  |
| D2                   | IN2[6]  | IN2[7]  | IN2[8]  | IN2[9]  | IN3[0]  | IN3[1]  | IN3[2]  | D2                   | IN2[3]  | IN2[2]  | IN2[1]  | IN2[0]  | IN3[9]  | IN3[8]  | IN3[7]  |
| D1                   | IN3[3]  | IN3[4]  | IN3[5]  | IN3[6]  | IN3[7]  | IN3[8]  | IN3[9]  | D1                   | IN3[6]  | IN3[5]  | IN3[4]  | IN3[3]  | IN3[2]  | IN3[1]  | IN3[0]  |
| DCLK                 | H       | H       | L       | L       | L       | H       | H       | DCLK                 | H       | H       | L       | L       | L       | H       | H       |
| 16bit 5pair mode     |         |         |         |         |         |         |         | 16bit 5pair mode     |         |         |         |         |         |         |         |
| D5                   | S0      | S1      | S2      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  | D5                   | S2      | S1      | S0      | IN1[15] | IN1[14] | IN1[13] | IN1[12] |
| D4                   | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | IN1[10] | D4                   | IN1[11] | IN1[10] | IN1[9]  | IN1[8]  | IN1[7]  | IN1[6]  | IN1[5]  |
| D3                   | IN1[11] | IN1[12] | IN1[13] | IN1[14] | IN1[15] | IN2[0]  | IN2[1]  | D3                   | IN1[4]  | IN1[3]  | IN1[2]  | IN1[1]  | IN1[0]  | IN2[15] | IN2[14] |
| D2                   | IN2[2]  | IN2[3]  | IN2[4]  | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  | D2                   | IN2[13] | IN2[12] | IN2[11] | IN2[10] | IN2[9]  | IN2[8]  | IN2[7]  |
| D1                   | IN2[9]  | IN2[10] | IN2[11] | IN2[12] | IN2[13] | IN2[14] | IN2[15] | D1                   | IN2[6]  | IN2[5]  | IN2[4]  | IN2[3]  | IN2[2]  | IN2[1]  | IN2[0]  |
| DCLK                 | H       | H       | L       | L       | L       | H       | H       | DCLK                 | H       | H       | L       | L       | L       | H       | H       |
| 10bit 3pair mode     |         |         |         |         |         |         |         | 10bit 3pair mode     |         |         |         |         |         |         |         |
| D3                   | S0      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  | IN1[4]  | IN1[5]  | D3                   | S0      | IN1[9]  | IN1[8]  | IN1[7]  | IN1[6]  | IN1[5]  | IN1[4]  |
| D2                   | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | IN2[0]  | IN2[1]  | IN2[2]  | D2                   | IN1[3]  | IN1[2]  | IN1[1]  | IN1[0]  | IN2[9]  | IN2[8]  | IN2[7]  |
| D1                   | IN2[3]  | IN2[4]  | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  | IN2[9]  | D1                   | IN2[6]  | IN2[5]  | IN2[4]  | IN2[3]  | IN2[2]  | IN2[1]  | IN2[0]  |
| DCLK                 | H       | H       | L       | L       | L       | H       | H       | DCLK                 | H       | H       | L       | L       | L       | H       | H       |
| 16bit 3pair mode     |         |         |         |         |         |         |         | 16bit 3pair mode     |         |         |         |         |         |         |         |
| D3                   | S0      | S1      | S2      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  | D3                   | S4      | S3      | S2      | IN1[15] | IN1[14] | IN1[13] | IN1[12] |
| D2                   | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | IN1[10] | D2                   | IN1[11] | IN1[10] | IN1[9]  | IN1[8]  | IN1[7]  | IN1[6]  | IN1[5]  |
| D1                   | IN1[11] | IN1[12] | IN1[13] | IN1[14] | IN1[15] | S3      | S4      | D1                   | IN1[4]  | IN1[3]  | IN1[2]  | IN1[1]  | IN1[0]  | S1      | S0      |
| DCLK                 | H       | H       | L       | L       | L       | H       | H       | DCLK                 | H       | H       | L       | L       | L       | H       | H       |
| 12bit 4pair mode     |         |         |         |         |         |         |         | 12bit 4pair mode     |         |         |         |         |         |         |         |
| D4                   | S0      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  | IN1[4]  | IN1[5]  | D4                   | S3      | IN1[11] | IN1[10] | IN1[9]  | IN1[8]  | IN1[7]  | IN1[6]  |
| D3                   | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | IN1[10] | IN1[11] | S1      | D3                   | IN1[5]  | IN1[4]  | IN1[3]  | IN1[2]  | IN1[1]  | IN1[0]  | S2      |
| D2                   | S2      | S3      | IN2[0]  | IN2[1]  | IN2[2]  | IN2[3]  | IN2[4]  | D2                   | S1      | S0      | IN2[11] | IN2[10] | IN2[9]  | IN2[8]  | IN2[7]  |
| D1                   | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  | IN2[9]  | IN2[10] | IN2[11] | D1                   | IN2[6]  | IN2[5]  | IN2[4]  | IN2[3]  | IN2[2]  | IN2[1]  | IN2[0]  |
| DCLK                 | H       | H       | L       | L       | L       | H       | H       | DCLK                 | H       | H       | L       | L       | L       | H       | H       |

**Table 11 LVDS DATA OUTPUT ORDER**

| REGISTER ADDRESS           | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                   |
|----------------------------|-----|-----------|---------|-------------------------------------------------------------------------------|
| R7 (07h)<br>output control | 3   | LVDSORDER | 0       | control LVDS data output order<br>0 = descending order<br>1 = ascending order |

## CMOS OUTPUT MODE



| A   |        |        |        |
|-----|--------|--------|--------|
| OP9 | IN1[9] | IN2[9] | IN3[9] |
| OP8 | IN1[8] | IN2[8] | IN3[8] |
| OP7 | IN1[7] | IN2[7] | IN3[7] |
| OP6 | IN1[6] | IN2[6] | IN3[6] |
| OP5 | IN1[5] | IN2[5] | IN3[5] |
| OP4 | IN1[4] | IN2[4] | IN3[4] |
| OP3 | IN1[3] | IN2[3] | IN3[3] |
| OP2 | IN1[2] | IN2[2] | IN3[2] |
| OP1 | IN1[1] | IN2[1] | IN3[1] |
| OP0 | IN1[0] | IN2[0] | IN3[0] |

**Table 12 10-bit CMOS Output Format**

## CLOCK TIMING CONFIGURATION

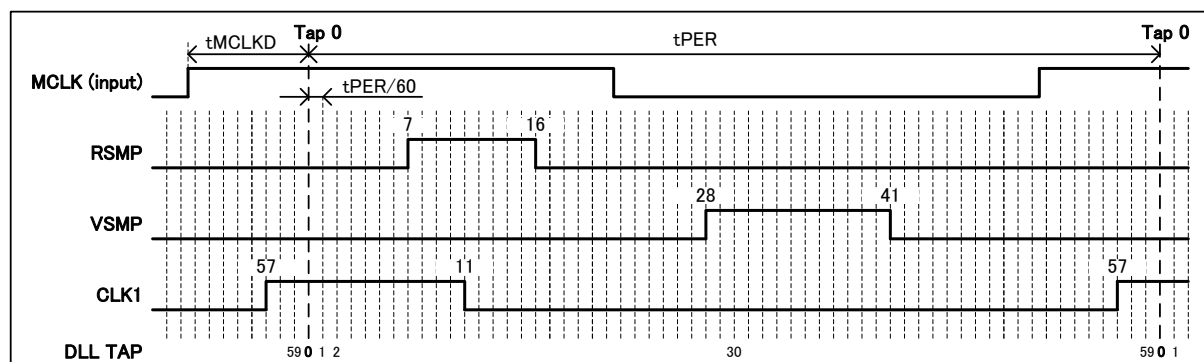
The RSMP signal, VSMP signal and clock output from CLK pin are generated internally by 60 tap DLL circuit. The rising and falling timing of each clock is set by DLL tap setting. The following setting and timing chart shows example configuration for RSMP, VSMP and CLK1.

**RSMP:** 0x82(RSMP\_RISE)=0x07(dec7), 0x83(RSMP\_FALL)=0x10(dec16)

**VSMP:** 0x84(VSMP\_RISE)=0x1C(dec28), 0x85(VSMP\_FALL)=0x29(dec41)

**CLK1:** 0x87(CLK1\_RISE)=0x39(dec57), 0x88(CLK1\_FALL)=0x0B(dec11)





**Figure 20 Clock Timing Configuration**

| REGISTER ADDRESS      | BIT | LABEL            | DEFAULT | DESCRIPTION     |
|-----------------------|-----|------------------|---------|-----------------|
| R130 (82h) RSMP rise  | 5:0 | RSMP_RISE [5:0]  | 01_1100 | RSMP rise edge  |
| R131 (83h) RSMP fall  | 5:0 | RSMP_FALL [5:0]  | 10_0110 | RSMP fall edge  |
| R132 (84h) VSMP rise  | 5:0 | VSMP_RISE [5:0]  | 10_1000 | VSMP rise edge  |
| R133 (85h) VSMP fall  | 5:0 | VSMP_FALL [5:0]  | 00_1000 | VSMP fall edge  |
| R134 (86h) TCLKO rise | 5:0 | TCLKO_RISE [5:0] | 11_0111 | TCLKO rise edge |
| R135 (87h) CLK1 rise  | 5:0 | CLK1_RISE[5:0]   | 00_1010 | CLK1 rise edge  |
| R136 (88h) CLK1 fall  | 5:0 | CLK1_FALL[5:0]   | 01_1001 | CLK1 fall edge  |
| R137 (89h) CLK2 rise  | 5:0 | CLK2_RISE[5:0]   | 01_1001 | CLK2 rise edge  |
| R138 (8Ah) CLK2fall   | 5:0 | CLK2_FALL[5:0]   | 10_1000 | CLK2 fall edge  |
| R139 (8Bh) CLK3 rise  | 5:0 | CLK3_RISE[5:0]   | 10_1000 | CLK3 rise edge  |
| R140 (8Ch) CLK3 fall  | 5:0 | CLK3_FALL[5:0]   | 00_1010 | CLK3 fall edge  |
| R141 (8Dh) CLK4 rise  | 5:0 | CLK4_RISE[5:0]   | 00_0000 | CLK4 rise edge  |
| R143 (8Fh) CLK5 rise  | 5:0 | CLK5_RISE[5:0]   | 00_1010 | CLK5 rise edge  |
| R144 (90h) CLK5 fall  | 5:0 | CLK5_FALL[5:0]   | 10_1000 | CLK5 fall edge  |
| R145 (91h) CLK6 rise  | 5:0 | CLK6_RISE[5:0]   | 00_1010 | CLK6 rise edge  |
| R146 (92h) CLK6 fall  | 5:0 | CLK6_FALL[5:0]   | 10_1000 | CLK6 fall edge  |

## SENSOR TIMING GENERATION

The WM8231 provides two types of clock internally. C\_CK\* are high speed clocks, these clocks can set the clock phase by using fine pitch phase control. P\_CK\* are pixel rate signals which is selected by PO0 to PO7. The WM8231 has eleven sensor TG outputs pins. CLK1 is for clock type use only. CLK2, CLK3, CLK4, CLK5 and CLK6 are selectable high speed type signal or pulse type signal. CLK7, CLK8, CLK9, CLK10 and CLK11 are pulse type use only.

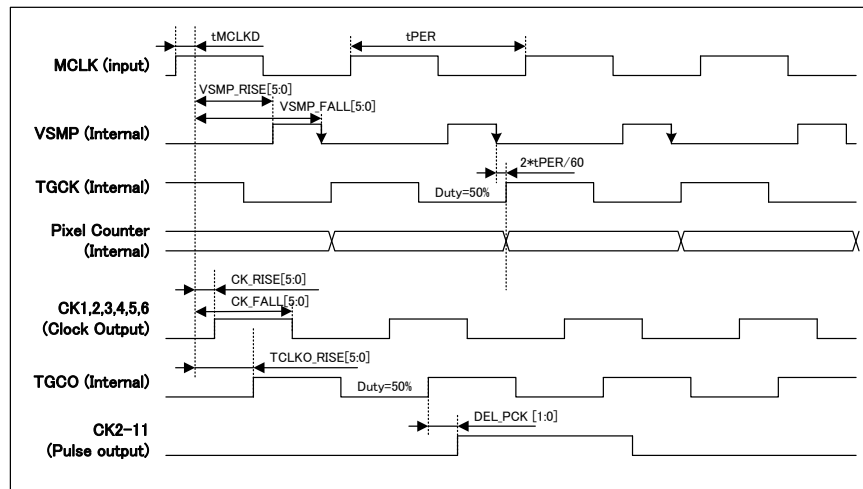
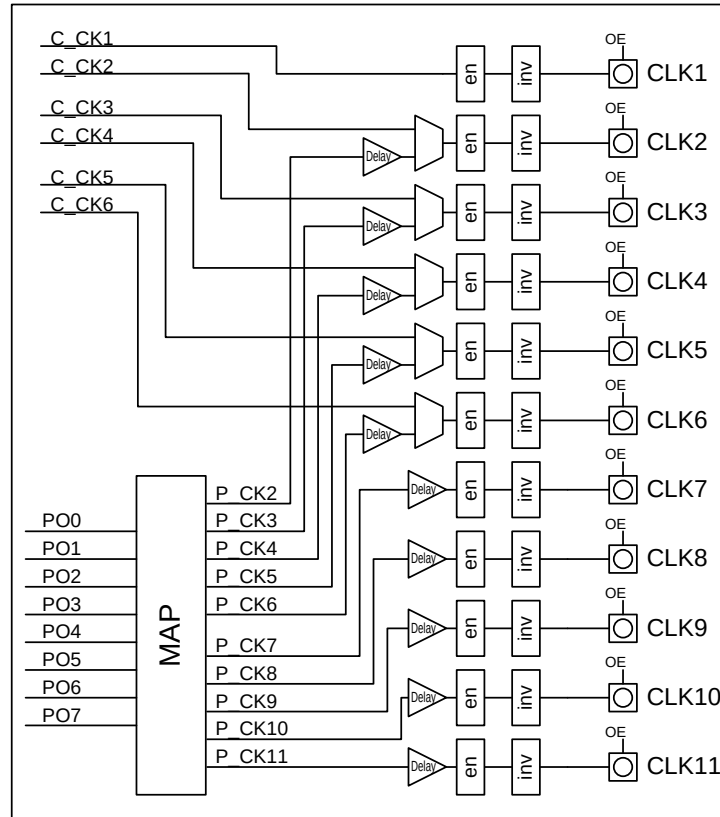


Figure 21 TG Output Timing

| REGISTER ADDRESS           | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                      |
|----------------------------|-----|----------------|---------|----------------------------------------------------------------------------------|
| R176 (B0h)<br>– R177 (B1h) | 5:0 | DEL_PCK*[1:0]  | 00      | control delay for pulse output<br>00 = 0nsec, 01 = 1nsec, 10 = 2nsec, 11 = 3nsec |
| R135 (81h)                 | 5:0 | CLK*_RISE[5:0] |         | CLK* rise edge (0 to 59)                                                         |
| – R146 (92h)               | 5:0 | CLK*_FALL[5:0] |         | CLK* fall edge (0 to 59)                                                         |

### TG MASTER MODE OPERATION

In master mode, line length is defined by LLENGTH register.

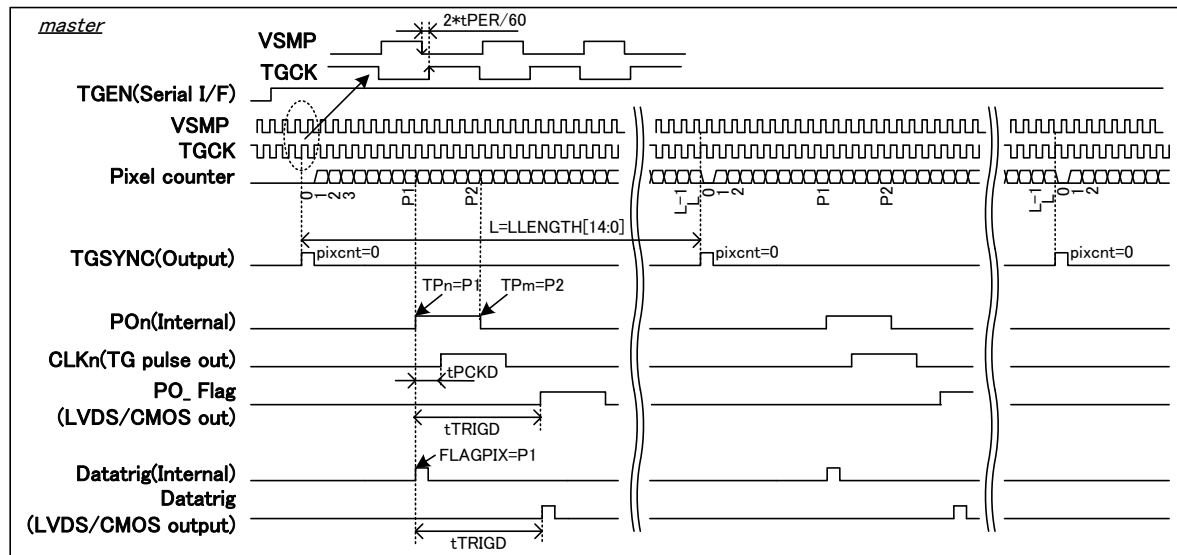


Figure 22 Master Mode Pixel Counter and Line Start Timing

### TG SLAVE MODE OPERATION

In slave mode, line length depends on TGSYNC input. The pixel counter is reset by TGSYNC input.

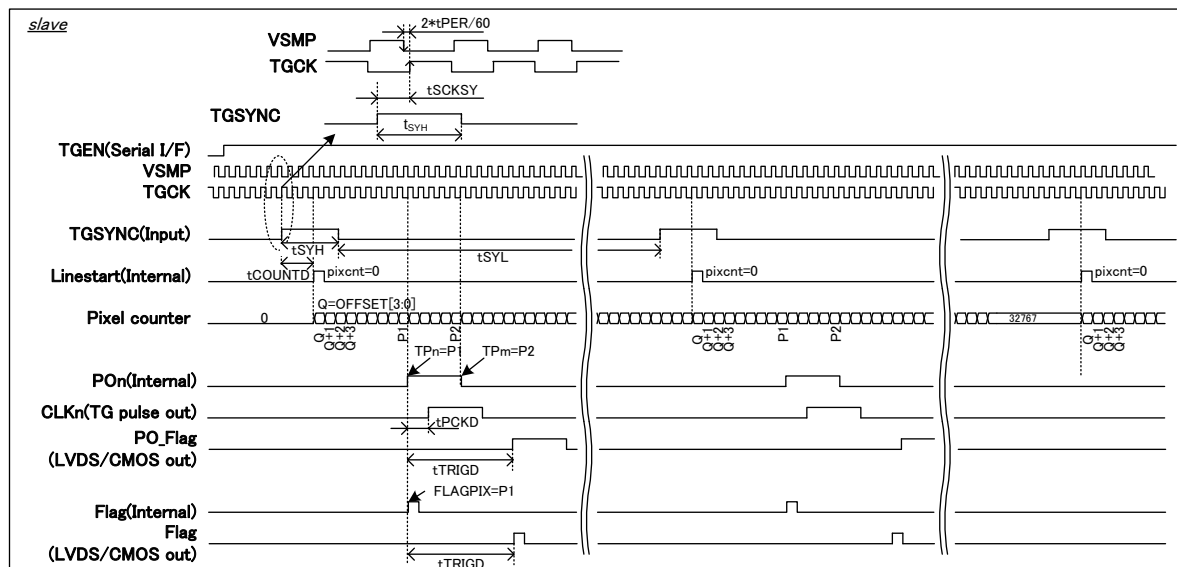


Figure 23 Slave Mode Pixel Counter and Line Start Timing

**Test Conditions**

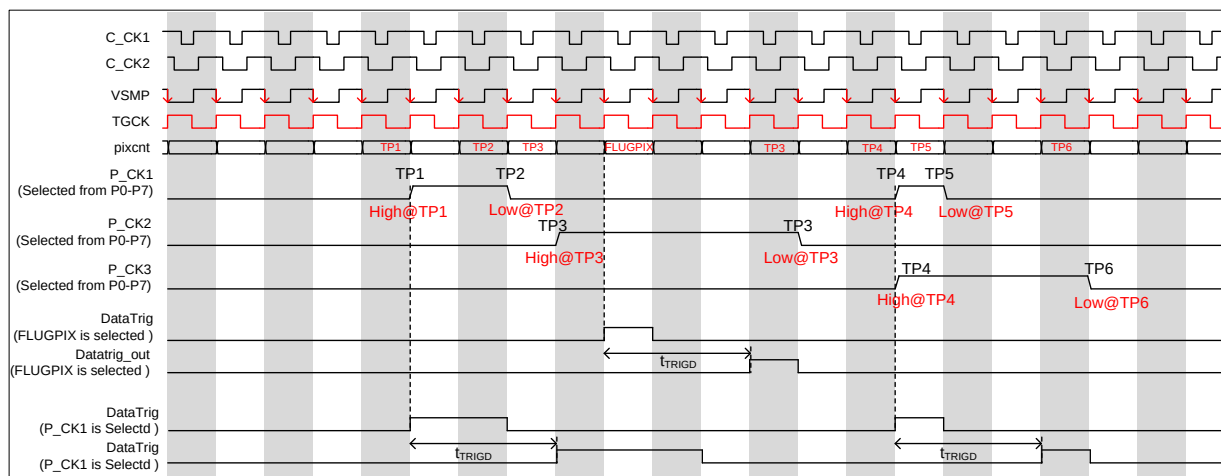
AVDD = LDOVDD = DBVDD = 3.3V, AGND = LDOGND = DBGND = 0V, T<sub>A</sub> = 25°C, MCLK = 35MHz unless otherwise stated.

| PARAMETER                                           | SYMBOL              | TEST CONDITIONS         | MIN                  | TYP                  | MAX                      | UNITS |
|-----------------------------------------------------|---------------------|-------------------------|----------------------|----------------------|--------------------------|-------|
| TGSYNC Setup time<br>(only for slave mode)          | t <sub>SCKSY</sub>  |                         | t <sub>PER</sub> / 4 | t <sub>PER</sub> / 2 | 3 * t <sub>PER</sub> / 4 | ns    |
| Pixel counter start timing<br>(only for slave mode) | t <sub>COUNTD</sub> |                         |                      | 2                    |                          | clock |
| TGSYNC high period<br>(only for slave mode)         | t <sub>SYH</sub>    |                         | 1                    |                      |                          | clock |
| TGSYNC low period<br>(only for slave mode)          | t <sub>SYL</sub>    |                         | 1                    |                      |                          | clock |
| Data trigger timing delay                           | t <sub>TRIGD</sub>  | LVDS 10-bit 5pair mode  |                      | 22                   |                          | clock |
|                                                     |                     | LVDS 10-bit 3pair mode  |                      | 20                   |                          | clock |
|                                                     |                     | CMOS 10-bit output mode |                      | 21                   |                          | clock |
| TG pulse output timing delay                        | t <sub>PCKD</sub>   |                         |                      | 2                    |                          | clock |

**Note:**

1clock = t<sub>PER</sub> (MCLK cycle period)

| REGISTER ADDRESS | BIT | LABEL        | DEFAULT   | DESCRIPTION                                                     |
|------------------|-----|--------------|-----------|-----------------------------------------------------------------|
| R160 (A0h)       | 7:4 | OFFSET[3:0]  | 0000      | offset count (only for slave mode)                              |
|                  | 2   | POLSYNC      | 0         | polarity of Sync signal<br>0 = positive edge, 1 = negative edge |
|                  | 1   | TGMD         | 0         | TG operation mode<br>0 = slave, 1 = master                      |
|                  | 0   | TG_EN        | 0         | TG enable<br>0 = disable, 1 = enable                            |
| R161 (A1h)       | 7:0 | LLENGTH[7:0] | 0000_0000 | the number of pixels in 1line (only for master mode)            |
| R162 (A2h)       | 6:0 | LLENGTH[6:0] | 000_0000  | the number of pixels in 1line (only for master mode)            |

**TG PULSE AND TRIGGER DATA**


**Figure 24 TG Pulse Toggle Setting and Data Trigger Timing**

## TG PULSE

The WM8231 can generate 8 TG pulses internally (PO0 – PO7). These pulses are generated by the toggle point setting registers (TP\*) and polarity setting registers (POL\*\_PO\*). WM8231 provided up to 32 toggle point by using TP0 to TP31. PO0-PO7 signals can be assigned to CLK2-CLK11 by SEL\_PCK\* and SEL\_CLK\* register.

## TRIGGER DATA

The WM8231 can implement trigger data in LVDS output.(S0,S1,S2,S3 and S4) This can be selected by two methods. One is the FLAGPIX register which can be set one pixel for each line. The other is to apply a PO\* pulse. Figure 24 shows the trigger data implementation timing.

## CHANNEL ID

Also WM8231 can implement channel identification data instead of trigger data. Table 13 shows the matrix of input channel and channel ID.

|     | ID[1] | ID[0] |
|-----|-------|-------|
| IN1 | 0     | 1     |
| IN2 | 1     | 0     |
| IN3 | 1     | 1     |

**Table 13 Channel ID**

Channel ID can be assigned to flag data (S0, S1, S2, S3 or S4). The following is the example of channel ID assignment.

Example: Assigned channel ID to flag data as ID[1]=S2, ID[0]=S3.

If output data is as follows, channel ID will be IN1. (i.e. ID[1]=S2=0, ID[0]=S3=1)

| A    |        |        |        |        |        |        |        |
|------|--------|--------|--------|--------|--------|--------|--------|
| D5   | S0     | S1     | S2     | IN1[0] | IN1[1] | IN1[2] | IN1[3] |
| D4   | IN1[4] | IN1[5] | IN1[6] | IN1[7] | IN1[8] |        | S3     |
| D3   | S4     | IN2[0] | IN2[1] | IN2[2] | IN2[3] | IN2[4] | IN2[5] |
| D2   | IN2[6] | IN2[7] | IN2[8] | IN2[9] | IN3[0] | IN3[1] | IN3[2] |
| D1   | IN3[3] | IN3[4] | IN3[5] | IN3[6] | IN3[7] | IN3[8] | IN3[9] |
| DCLK | H      | H      | L      | L      | L      | H      | H      |

## Channel ID Setting Limitation

There are some notices to assign channel ID. It's depending on LVDS output format (refer to OUTPUT DATA FORMAT).

### 1) 10-bit 5pair mode LVDS output

In this mode, channel ID will be IN1 only.

ID indicate IN1

| A    |        |        |        |        |        |        |        |
|------|--------|--------|--------|--------|--------|--------|--------|
| D5   | S0     | S1     | S2     | IN1[0] | IN1[1] | IN1[2] | IN1[3] |
| D4   | IN1[4] | IN1[5] | IN1[6] | IN1[7] | IN1[8] | IN1[9] | S3     |
| D3   | S4     | IN2[0] | IN2[1] | IN2[2] | IN2[3] | IN2[4] | IN2[5] |
| D2   | IN2[6] | IN2[7] | IN2[8] | IN2[9] | IN3[0] | IN3[1] | IN3[2] |
| D1   | IN3[3] | IN3[4] | IN3[5] | IN3[6] | IN3[7] | IN3[8] | IN3[9] |
| DCLK | H      | H      | L      | L      | L      | H      | H      |

### 2) 16-bit 5pair mode LVDS output

In this mode, channel ID will be IN1, IN2 and IN3.

| A    |         |         |         |         |         |         |         |
|------|---------|---------|---------|---------|---------|---------|---------|
| D5   | S0      | S1      | S2      | IN1[0]  | IN1[1]  | IN1[2]  | IN1[3]  |
| D4   | IN1[4]  | IN1[5]  | IN1[6]  | IN1[7]  | IN1[8]  | IN1[9]  | IN1[10] |
| D3   | IN1[11] | IN1[12] | IN1[13] | IN1[14] | IN1[15] | IN2[0]  | IN2[1]  |
| D2   | IN2[2]  | IN2[3]  | IN2[4]  | IN2[5]  | IN2[6]  | IN2[7]  | IN2[8]  |
| D1   | IN2[9]  | IN2[10] | IN2[11] | IN2[12] | IN2[13] | IN2[14] | IN2[15] |
| DCLK | H       | H       | L       | L       | L       | H       | H       |

| B    |          |          |          |          |          |          |          |
|------|----------|----------|----------|----------|----------|----------|----------|
| D5   | S0       | S1       | S2       | INP3[0]  | INP3[1]  | INP3[2]  | INP3[3]  |
| D4   | INP3[4]  | INP3[5]  | INP3[6]  | INP3[7]  | INP3[8]  | INP3[9]  | INP3[10] |
| D3   | INP3[11] | INP3[12] | INP3[13] | INP3[14] | INP3[15] | INP1[0]  | INP1[1]  |
| D2   | INP1[2]  | INP1[3]  | INP1[4]  | INP1[5]  | INP1[6]  | INP1[7]  | INP1[8]  |
| D1   | INP1[9]  | INP1[10] | INP1[11] | INP1[12] | INP1[13] | INP1[14] | INP1[15] |
| DCLK | H        | H        | L        | L        | L        | H        | H        |

| C    |          |          |          |          |          |          |          |
|------|----------|----------|----------|----------|----------|----------|----------|
| D5   | S0       | S1       | S2       | INP2[0]  | INP2[1]  | INP2[2]  | INP2[3]  |
| D4   | INP2[4]  | INP2[5]  | INP2[6]  | INP2[7]  | INP2[8]  | INP2[9]  | INP2[10] |
| D3   | INP2[11] | INP2[12] | INP2[13] | INP2[14] | INP2[15] | INP3[0]  | INP3[1]  |
| D2   | INP3[2]  | INP3[3]  | INP3[4]  | INP3[5]  | INP3[6]  | INP3[7]  | INP3[8]  |
| D1   | INP3[9]  | INP3[10] | INP3[11] | INP3[12] | INP3[13] | INP3[14] | INP3[15] |
| DCLK | H        | H        | L        | L        | L        | H        | H        |

| REGISTER ADDRESS             | BIT | LABEL         | DEFAULT   | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------|-----|---------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R171 (ABh)<br>- R175 (AFh)   |     | SEL_PCK*      | 000       | pulse mapping control for CLK*<br>000 = PO1, 001 = PO2, 010 = PO3, 011 = PO4<br>100 = PO5, 101 = PO6, 110 = PO7, 111 = PO8                                                                                                                                                                                                                                       |
|                              |     | SEL_CLK*      | 0         | mapping control<br>0 = output clock, 1 = output pulse                                                                                                                                                                                                                                                                                                            |
| R208 (D0h)<br>- R270 (10Eh)  | 7   | EN_TP*        | 0         | enable toggle point<br>0 = disable and subsequent toggle point<br>1 = enable toggle point                                                                                                                                                                                                                                                                        |
|                              | 6:0 | TP*           |           | pixel count of toggle point                                                                                                                                                                                                                                                                                                                                      |
| R271 (10Fh)<br>- R310 (136h) |     | POL*_PO*      |           | polarity of PO* pulse at TP*                                                                                                                                                                                                                                                                                                                                     |
| R163 (A3h)                   | 7:0 | FLAGPIX[7:0]  | 0000_0000 | flag pixel                                                                                                                                                                                                                                                                                                                                                       |
| R164 (A4h)                   | 6:0 | FLAGPIX[6:0]  | 000_0000  | flag pixel                                                                                                                                                                                                                                                                                                                                                       |
| R180 (B4h)                   | 3:0 | SEL_FLAG[3:0] | 0000      | select signal to be output as datatrig<br>0xxx = flagpix, 1000 = PO0, 1001 = PO1, 1010 = PO2,<br>1011 = PO3, 1100 = PO4, 1101 = PO5, 1110 = PO6<br>1111 = PO7                                                                                                                                                                                                    |
| R10 (0Ah)                    | 7:4 | FLAG_S1[3:0]  | 0001      | output dataflag as S1<br>(valid only LVDS mode)<br>0000 = always low, 0001 = start flag<br>0010 = reserved, 0011 = reserved, 0100 = reserved<br>0101 = channel ID[0], 0110 = channel ID[1],<br>0111 = reserved, 1000 = reserved<br>1001 = reserved, 1010 = reserved, 1011 = reserved,<br>1100 = reserved, 1101 = reserved, 1110 = reserved<br>1111 = always high |
|                              | 3:0 | FLAG_S0[3:0]  | 0000      | output dataflag as S0<br>(valid only LVDS mode)<br>0000 = always low, 0001 = start flag<br>0010 = reserved, 0011 = reserved, 0100 = reserved<br>0101 = channel ID[0], 0110 = channel ID[1],<br>0111 = reserved, 1000 = reserved<br>1001 = reserved, 1010 = reserved, 1011 = reserved,<br>1100 = reserved, 1101 = reserved, 1110 = reserved<br>1111 = always high |
| R11 (0Bh)                    | 7:4 | FLAG_S3[3:0]  | 0001      | output dataflag as S3<br>(valid only LVDS mode)<br>0000 = always low, 0001 = start flag<br>0010 = reserved, 0011 = reserved, 0100 = reserved<br>0101 = channel ID[0], 0110 = channel ID[1],<br>0111 = reserved, 1000 = reserved<br>1001 = reserved, 1010 = reserved, 1011 = reserved,<br>1100 = reserved, 1101 = reserved, 1110 = reserved<br>1111 = always high |
|                              | 3:0 | FLAG_S2[3:0]  | 0000      | output dataflag as S2<br>(valid only LVDS mode)<br>0000 = always low, 0001 = start flag<br>0010 = reserved, 0011 = reserved, 0100 = reserved<br>0101 = channel ID[0], 0110 = channel ID[1],<br>0111 = reserved, 1000 = reserved<br>1001 = reserved, 1010 = reserved, 1011 = reserved,<br>1100 = reserved, 1101 = reserved, 1110 = reserved                       |

| REGISTER ADDRESS | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                      |
|------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  |     |              |         | 1111 = always high                                                                                                                                                                                                                                                                                                                                               |
| R12 (0Ch)        | 3:0 | FLAG_S4[3:0] | 0000    | output dataflag as S4<br>(valid only LVDS mode)<br>0000 = always low, 0001 = start flag<br>0010 = reserved, 0011 = reserved, 0100 = reserved<br>0101 = channel ID[0], 0110 = channel ID[1],<br>0111 = reserved, 1000 = reserved<br>1001 = reserved, 1010 = reserved, 1011 = reserved,<br>1100 = reserved, 1101 = reserved, 1110 = reserved<br>1111 = always high |

## TG MASK TIMING

The WM8231 has a TG clock mask function. M1, M2 and M3 pulses specify the mask period; T1 and T2 pulses are used for changing the signal polarity during the mask period. C\_CHK1 and C\_CHK2 are applied to the M pulse only; they cannot be applied to the T pulse. C\_CHK3 and C\_CHK4 are applied to M1 and T1; C\_CHK5 and C\_CHK6 are applied to M2 and T2. The mask timing is synchronized with TGCKO rise edge.

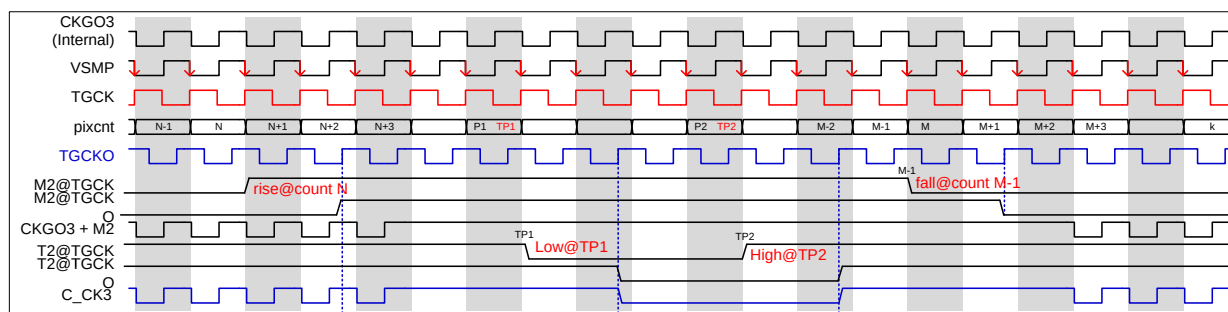


Figure 25 TG Mask Timing

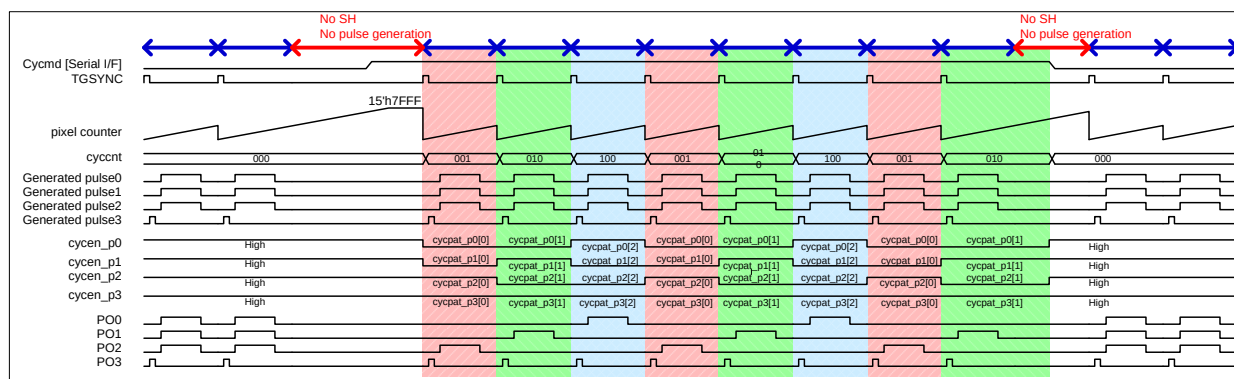
| TG CLOCK         | APPLIED "M" PULSE | APPLIED "T" PULSE |
|------------------|-------------------|-------------------|
| C_CHK1<br>C_CHK2 | M3                | none              |
| C_CHK3<br>C_CHK4 | M1                | T1                |
| C_CHK5<br>C_CHK6 | M2                | T2                |



| REGISTER ADDRESS | BIT | LABEL        | DEFAULT   | DESCRIPTION                      |
|------------------|-----|--------------|-----------|----------------------------------|
| R195 (C3h)       | 7:0 | M1_RISE[7:0] | 0000_0000 | M1 pulse rise count (mask start) |
| R196 (C4h)       | 6:0 | M1_RISE[6:0] | 000_0000  | M1 pulse rise count (mask start) |
| R197 (C5h)       | 7:0 | M1_FALL[7:0] | 0000_0000 | M1 pulse fall count (mask end)   |
| R198 (C6h)       | 6:0 | M1_FALL[6:0] | 000_0000  | M1 pulse fall count (mask end)   |
| R199 (C7h)       | 7:0 | M2_RISE[7:0] | 0000_0000 | M2 pulse rise count (mask start) |
| R200 (C8h)       | 6:0 | M2_RISE[6:0] | 000_0000  | M2 pulse rise count (mask start) |
| R201 (C9h)       | 7:0 | M2_FALL[7:0] | 0000_0000 | M2 pulse fall count (mask end)   |
| R202 (CAh)       | 6:0 | M2_FALL[6:0] | 000_0000  | M2 pulse fall count (mask end)   |
| R203 (CBh)       | 7:0 | M3_RISE[7:0] | 0000_0000 | M3 pulse rise count (mask start) |
| R204 (CCh)       | 6:0 | M3_RISE[6:0] | 000_0000  | M3 pulse rise count (mask start) |
| R205 (CDh)       | 7:0 | M3_FALL[7:0] | 0000_0000 | M3 pulse fall count (mask end)   |
| R206 (CEh)       | 6:0 | M3_FALL[6:0] | 000_0000  | M3 pulse fall count (mask end)   |
| R271 (010Fh)     | 7:0 | POL*_T1      | 1111_1111 | polarity of T1 pulse at TP*      |
| – R278 (116h)    | 7:0 | POL*_T2      | 1111_1111 | polarity of T2 pulse at TP*      |

### TG CYCLE MODE

The TG cycle mode can set a different TG pulse line by line. This mode can only be used in slave mode.



**Figure 26 TG Cycle Mode**

| REGISTER ADDRESS           | BIT | LABEL           | DEFAULT | DESCRIPTION                                                                                                               |
|----------------------------|-----|-----------------|---------|---------------------------------------------------------------------------------------------------------------------------|
| R160 (A0h)                 | 3   | CYCMD           | 0       | cycle mode enable<br>0 = normal (same operation at every line)<br>1 = cycle mode                                          |
| R181 (B5h)<br>– R184 (B8h) |     | CYCPAT_PO*[2:0] | 000     | PO* cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |

## TG DIVIDE MODE

Some CCD sensors require TG clocking as half of pixel rate. The WM8231 supports this operation using TG divide mode (TGDIVMD=1). TG divide mode is applied to CLK3,4,5 and 6. CLK1 and 2 are not affected by this mode. To operate TG divide mode correctly, the mask period and reset period must be configured for CLK3,4,5 and 6. Reset period can be set by SEL\_PO\* and POL\*\_PO\* register setting. Reset period should be set as inside of mask period. During the mask period, signal polarity can be changed by T1 and T2 register settings; Also, output signal polarity can be changed using the INV\_CK\* bits.

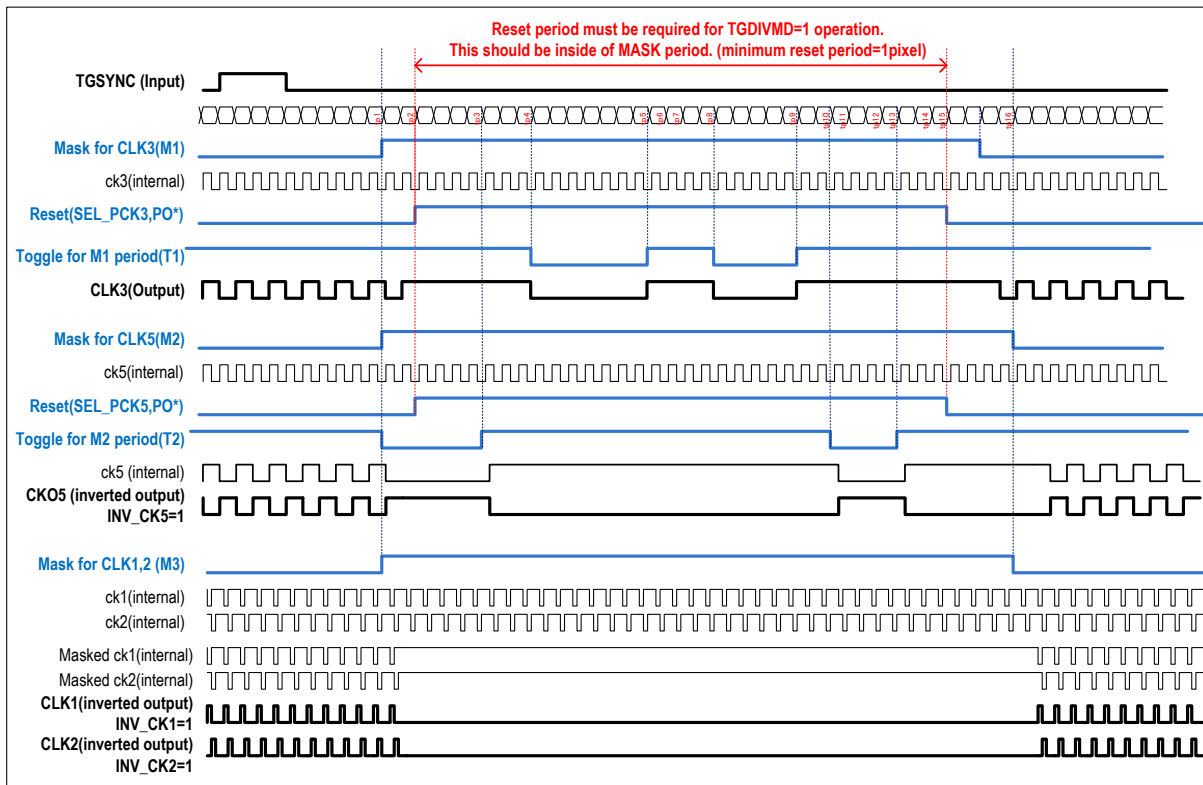
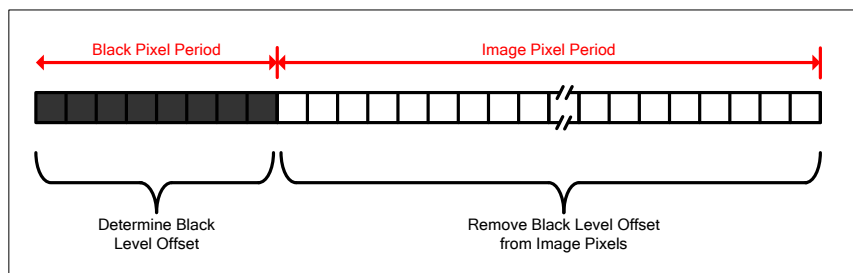


Figure 27 TG Divide Mode

| REGISTER ADDRESS             | BIT | LABEL        | DEFAULT   | DESCRIPTION                                                                                                                                                  |
|------------------------------|-----|--------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R4 (04h)                     | 4   | TGDIVMD      | 0         | enable TG clock divide mode<br>0 = normal (TG clock rate = MCLK clock rate)<br>1 = enable TG clock divide mode<br>(TG clock rate is half of MCLK clock rate) |
| R167 (A7h)                   |     | INV_CLK*     | 0         | invert signal output assigned to CLK*<br>0 = non-inverted, 1 = inverted                                                                                      |
| R169 (A9h)                   |     | EN_CLK*      | 0         | enable signal output CLK*<br>0 = disable, 1 = enable                                                                                                         |
| R171 (ABh)<br>- R175 (AFh)   |     | SEL_PCK*     | 000       | pulse mapping control for CLK*<br>000 = PO1, 001 = PO2, 010 = PO3, 011 = PO4<br>100 = PO5, 101 = PO6, 110 = PO7, 111 = PO8                                   |
|                              |     | SEL_CLK*     | 0         | mapping control<br>0 = output clock, 1 = output pulse                                                                                                        |
| R195 (C3h)                   | 7:0 | M1_RISE[7:0] | 0000_0000 | M1 pulse rise count (mask start)                                                                                                                             |
| R196 (C4h)                   | 6:0 | M1_RISE[6:0] | 000_0000  | M1 pulse rise count (mask start)                                                                                                                             |
| R197 (C5h)                   | 7:0 | M1_FALL[7:0] | 0000_0000 | M1 pulse fall count (mask end)                                                                                                                               |
| R198 (C6h)                   | 6:0 | M1_FALL[6:0] | 000_0000  | M1 pulse fall count (mask end)                                                                                                                               |
| R199 (C7h)                   | 7:0 | M2_RISE[7:0] | 0000_0000 | M2 pulse rise count (mask start)                                                                                                                             |
| R200 (C8h)                   | 6:0 | M2_RISE[6:0] | 000_0000  | M2 pulse rise count (mask start)                                                                                                                             |
| R201 (C9h)                   | 7:0 | M2_FALL[7:0] | 0000_0000 | M2 pulse fall count (mask end)                                                                                                                               |
| R202 (CAh)                   | 6:0 | M2_FALL[6:0] | 000_0000  | M2 pulse fall count (mask end)                                                                                                                               |
| R203 (CBh)                   | 7:0 | M3_RISE[7:0] | 0000_0000 | M3 pulse rise count (mask start)                                                                                                                             |
| R204 (CCh)                   | 6:0 | M3_RISE[6:0] | 000_0000  | M3 pulse rise count (mask start)                                                                                                                             |
| R205 (CDh)                   | 7:0 | M3_FALL[7:0] | 0000_0000 | M3 pulse fall count (mask end)                                                                                                                               |
| R206 (CEh)                   | 6:0 | M3_FALL[6:0] | 000_0000  | M3 pulse fall count (mask end)                                                                                                                               |
| R208 (D0h)<br>- R270 (10Eh)  | 7   | EN_TP*       | 0         | enable toggle point<br>0 = disable and subsequent toggle point<br>1 = enable toggle point                                                                    |
|                              | 6:0 | TP*          |           | pixel count of toggle point                                                                                                                                  |
| R271 (10Fh)<br>- R278 (116h) |     | POL*_T1      | 1111_1111 | polarity of T* pulse at TP*                                                                                                                                  |
| R279 (117h)<br>- R310 (136h) |     | POL*_PO*     | 0000_0000 | polarity of TPO* pulse at TP*                                                                                                                                |

## PROGRAMMABLE AUTOMATIC BLACK LEVEL CALIBRATION (BLC)

The Programmable Automatic Black-Level Calibration (BLC) function is to adjust the D.C. offset of the output data such that the digital output level code for black pixels is calibrated to a target black level value. The D.C. offset is determined during the optically-black pixels at the beginning of the linear sensor and removed during the image-pixels as shown in Figure 28.

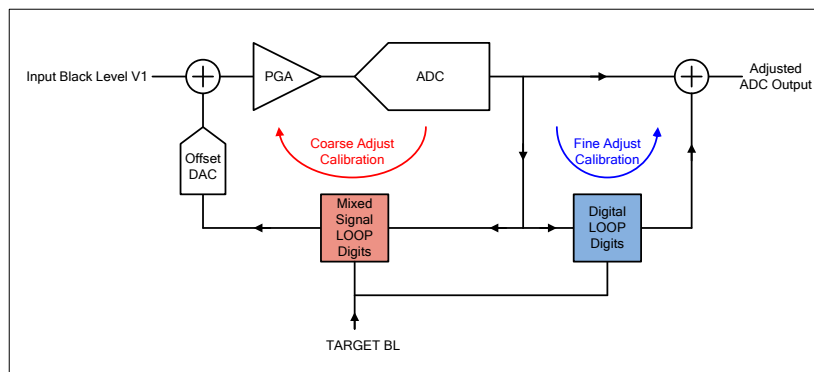


**Figure 28 Linear Sensor Model**

The automatic black level calibration operates assuming 12 bits ADC resolution. Adjustments to calculations must be made for different ADC resolutions.

The black level calibration process occurs in two stages as shown in Figure 29 below:

- **Coarse Adjust Calibration** - This is a mixed signal loop which removes the coarse offset by adjusting the offset DAC.
- **Fine Adjust Calibration** - This is a digital loop which removes the remaining offset with better noise tolerance, utilising ADC over-range to improve the dynamic range of the system.



**Figure 29 BLC Top-Level Circuitry**

### TARGET CODES

The user must specify a target black level for each channel through the registers TARGETINP\*. If, during the black-pixel period, the average ADC output code was, for example, 100 and the user specified the target black level code to be 10, the BLC circuitry would determine 90 codes should be subtracted from the ADC output. These 90 codes will then be subtracted from every image-pixel code output from the ADC.

Note – changing the PGA gain affects the black-level through the device; the gain should therefore not be changed during a BLC procedure. If the PGA gain changes, then the BLC routine should be re-run.

The automatic black level calibration feature operates with the assumption of a 12-bit ADC resolution. The register settings for Target Codes (TARGETINP\*) should be set differently depending on the ADC

resolution being used. As TARGETINP\* is an 8 bit register, the 4 MSBs of a data output code cannot be changed.

## 16-bit ADC Resolution

For 16bit resolution the target code entered into TARGETINP\* will ignore the 4 MSBs and 4 LSBs of the 16-bit data output. For example if the desired code out is 0000111111110001, the value entered into TARGETINP\* would be 11111111.

## 10-bit ADC Resolution

For 10bit resolution the 4 MSBs of the 10bit data output code will be ignored. The 2 LSBs of the target code should be set to '00'. For example if the desired code out is 0000111111, the value entered into TARGETINP\* would be 11111100.

## BLC SCENARIOS OF OPERATION

The BLC can be used in various ways to suit the application, for example calibration can be done once per page or once per line. Three potential scenarios of operation are suggested below.

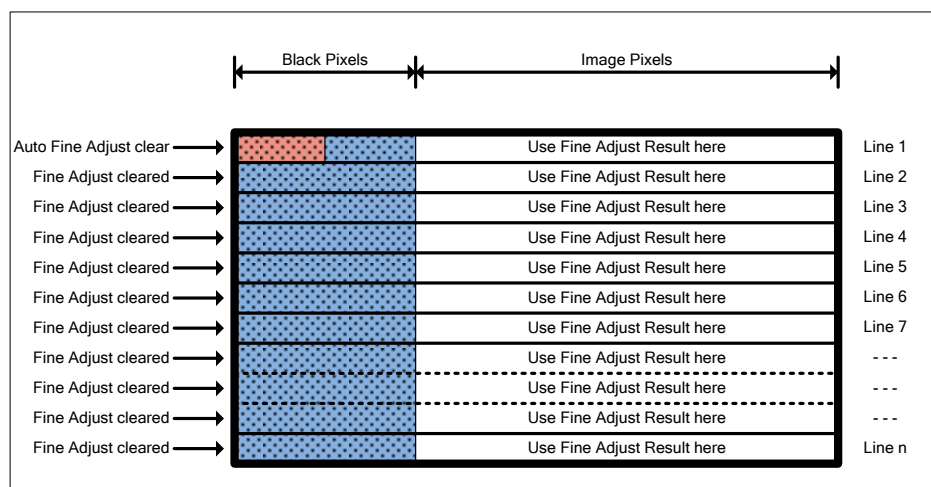
Note: The registers FRAME\_START and SEQ\_START when set high by the user will automatically be set low by the device.

### SCENARIO 1

In this scenario, Coarse Adjust Calibration is enabled for the 1<sup>st</sup> line; Fine Adjust Calibration is enabled for every line, with the Fine Adjust Calibration result recalculated every line. This scenario is suitable for dealing with large amounts of D.C. drift throughout a frame; but this is at a cost of potential line-by-line variation in the Fine Adjust result (dependent on sensor noise and the PGA gain). Table 14 shows which registers are required for this scenario with example settings.

| SETUP REGISTER | BPIX_AVAIL | CADUR | FRAME_START | FA_EVERYLINE |
|----------------|------------|-------|-------------|--------------|
| Value          | 50         | 2     | 1           | 1            |

**Table 14 Example Register Settings for Scenario 1**



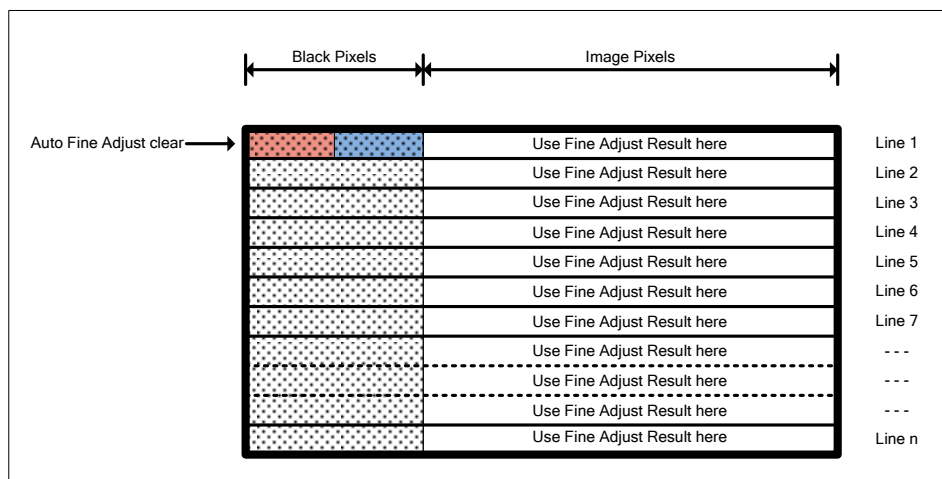
**Figure 30 Scenario 1**

## SCENARIO 2

In this scenario, Coarse Adjust and Fine Adjust Calibration is enabled for the 1<sup>st</sup> line, with the Fine Adjust result updated on the 1<sup>st</sup> line only. This scenario is suitable for adjusting for black-level D.C. drift on a frame-by-frame basis; there will be no line-by-line variation in the black-level from the BLC circuitry. Table 15 shows which registers are required for this scenario with example settings.

| SETUP REGISTER | BPIX_AVAIL | CADUR | FRAME_START |
|----------------|------------|-------|-------------|
| Value          | 50         | 2     | 1           |

**Table 15 Example Register Settings for Scenario 2**



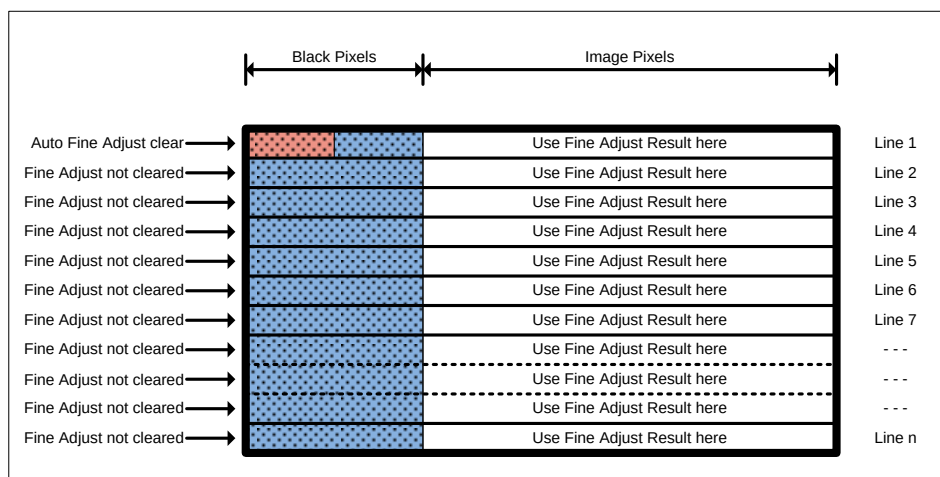
**Figure 31 Scenario 2**

## SCENARIO 3

In this scenario, Coarse Adjust Calibration is enabled for the 1<sup>st</sup> line; Fine Adjust Calibration is enabled for every line, with the Fine Adjust result accumulated throughout frame and used every line. This scenario allows any variation in the black-level to be tracked throughout the frame by accumulating the Fine Adjust result over multiple lines. This method does not deal with as large amounts of D.C. drift throughout the frame as scenario 1, but it will produce less line-by-line variation. Table 16 shows which registers are required for this scenario with example settings.

| SETUP REGISTER | BPIX_AVAIL | CADUR | FRAME_START | FA_EVERYLINE | FA_ACCUM |
|----------------|------------|-------|-------------|--------------|----------|
| Value          | 50         | 2     | 1           | 1            | 1        |

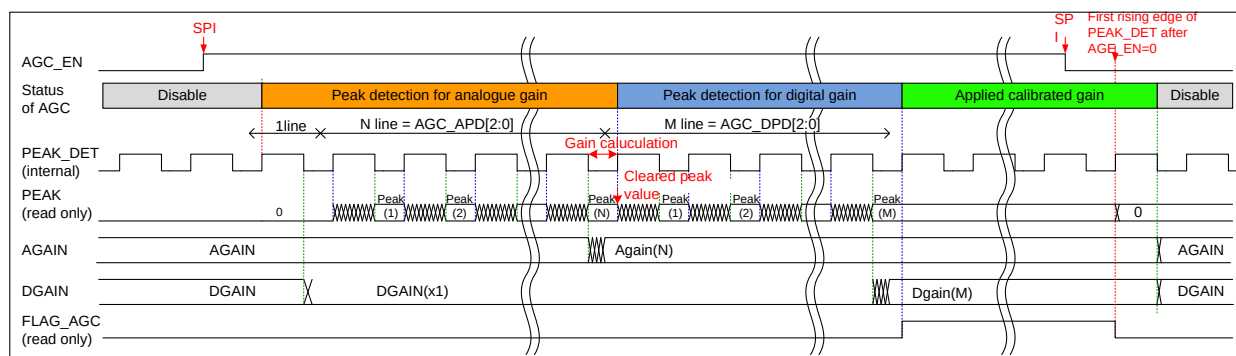
**Table 16 Example Register Settings for Scenario 3**



**Figure 32 Scenario 3**

## AUTOMATIC GAIN CONTROL (AGC)

The Automatic Gain Control (AGC) function is to adjust the gain to an appropriate level for a range of input signal levels. The AGC function is enabled by AGC\_EN register set to 1. The gain control process has three stages as shown in Figure 33 below:



**Figure 33 Automatic Gain Control**

### Analogue Gain Calibration

The analogue gain is kept to the previous setting for (AGAIN), and the digital gain is set to x1 (DGAIN=12'd2048) automatically. During the PEAK\_DET=high period, peak detection is executed and then calculates an appropriate analogue gain (Again(N)) while PEAK\_DET=low period. This period requires at least 200 pixels. The number of peak detection cycle is selectable by the AGC\_APD register. The minimum cycle is 0 (In this case the analogue gain calibration is not executed), and the maximum cycle is 7 lines. The peak value is cleared when the analogue peak detection finished.

### Digital Gain Calibration

The analogue gain is set to the calibrated value (Again(N)), and the digital gain is set to x1 (DGAIN=12'd2048) automatically. The peak detection and digital gain calibration functions are then executed. The number of peak detection lines is selectable by the AGC\_DPD register. The minimum cycle is 0 (In this case the digital gain calibration is not executed), and the maximum cycle is 7 lines.

### Applied Calibrated Analogue and Digital Gain

The analogue and digital gain are holding calibrated value until AGC\_EN register set to 0.

$$\text{Again}(N) = \text{AGC\_TARGETINP}^* / \text{peak}(n) \times \text{AGAIN}$$

$$\text{Dgain}(M) = (\text{AGC\_TARGETINP}^* - \text{TARGETINP}^*) / (\text{peak}(M) - \text{TARGETINP}^*)$$



| REGISTER ADDRESS | BIT | LABEL               | DEFAULT   | DESCRIPTION                                                                                                                                              |
|------------------|-----|---------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| R74 (4Ah)        | 7:0 | TARGETIN1[7:0]      | 0000_0000 | target black level for IN1[7:0]                                                                                                                          |
| R77 (4Dh)        | 7:0 | TARGETIN2[7:0]      | 0000_0000 | target black level for IN2[7:0]                                                                                                                          |
| R80 (50h)        | 7:0 | TARGETIN3[7:0]      | 0000_0000 | target black level for IN3[7:0]                                                                                                                          |
| R87 (57h)        | 7:4 | AGCAVE[3:0]         | 0000      | averaging factor before peak detection<br>0000 = no average, 0001 = 2, 0010 = 4, 0011 = 8 ..., 1010 = 1024 (1011 = 1100 = 1101 = 1110 = 1111 = reserved) |
|                  | 2   | AGC_ERRFLAG         | 0         | AGC error flag<br>0 = no error detected, 1 = AGC finish with error                                                                                       |
|                  | 1   | AGC_ENDFLAG         | 0         | AGC end flag<br>0 = not end or not run, 1 = AGC sequence was done                                                                                        |
|                  | 0   | AGC_EN              | 0         | AGC enable<br>0 = disable, 1 = enable                                                                                                                    |
| R88 (58h)        | 6:4 | AGC_DPD[2:0]        | 000       | the number of peak detection iterations to calculate digital gain                                                                                        |
|                  | 2:0 | AGC_APD[2:0]        | 000       | the number of peak detection iterations to calculate analogue gain                                                                                       |
| R93 (5Dh)        | 7:0 | AGC_TARGETIN1 [7:0] | 0000_0000 | LSB of AGC target level for IN1                                                                                                                          |
| R94 (5Eh)        | 1:0 | AGC_TARGETIN1 [9:8] | 00        | MSB of AGC target level for IN1                                                                                                                          |
| R99 (63h)        | 7:0 | AGC_TARGETIN2 [7:0] | 0000_0000 | LSB of AGC target level for IN2                                                                                                                          |
| R100 (64h)       | 1:0 | AGC_TARGETIN2 [9:8] | 00        | MSB of AGC target level for IN2                                                                                                                          |
| R105 (69h)       | 7:0 | AGC_TARGETIN3 [7:0] | 0000_0000 | LSB of AGC target level for IN3                                                                                                                          |
| R106 (6Ah)       | 1:0 | AGC_TARGETIN3 [9:8] | 00        | MSB of AGC target level for IN3                                                                                                                          |
| R191 (BFh)       | 7:0 | PEAKDET_RISE [7:0]  | 0000_0000 | LSB of PEAKDET_RISE[14:0]<br>peak detection start pixel count                                                                                            |
| R192 (C0h)       | 6:0 | PEAKDET_RISE [14:8] | 000_0000  | MSB of PEAKDET_RISE[14:0]<br>peak detection start pixel count                                                                                            |
| R193 (C1h)       | 7:0 | PEAKDET_FALL [7:0]  | 0000_0000 | LSB of PEAKDET_FALL[14:0]<br>peak detection start pixel count                                                                                            |
| R194 (C2h)       | 6:0 | PEAKDET_FALL [14:8] | 000_0000  | MSB of PEAKDET_FALL[14:0]<br>peak detection start pixel count                                                                                            |



## TEST PATTERN GENERATOR

WM8231 has test pattern generator which can be used for interface verification between AFE data output and back-end devices without sensor signal input. This function can be presented in several different patterns by PGPAT[1:0] and PGMARCH registers as shown below. The PGLEVEL, PGWIDTH1 and PGWIDTH2 are the parameter to define the pattern level and width. The PGLEVEL register has 16bit length, PGWIDTH1 and PGWIDTH2 has 8bit length.

Note that test pattern generator is required TGSYNC input. (i.e. this can be used under TG slave mode operation only.)

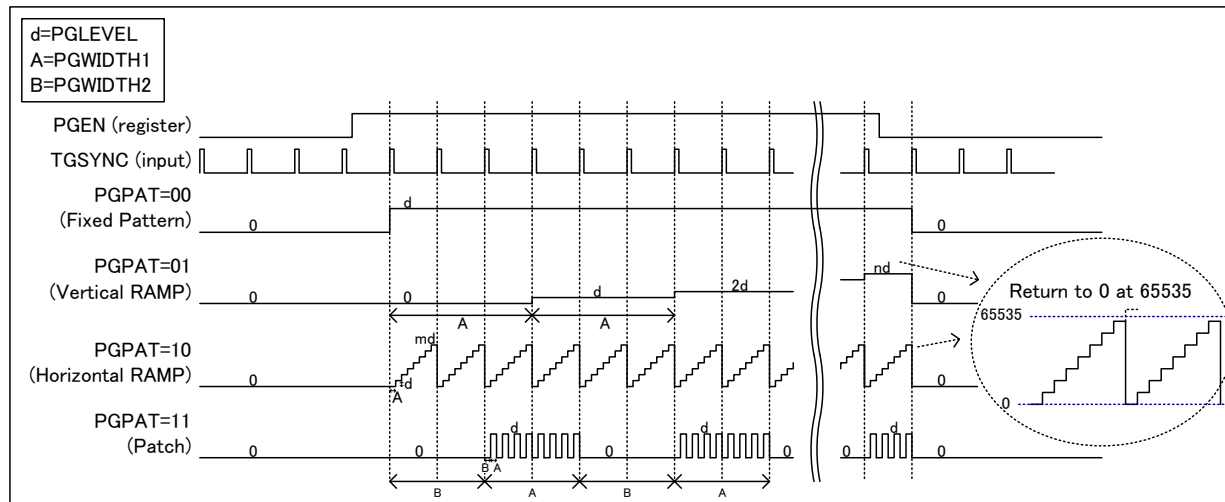


Figure 36 Test Pattern Output Data Formats

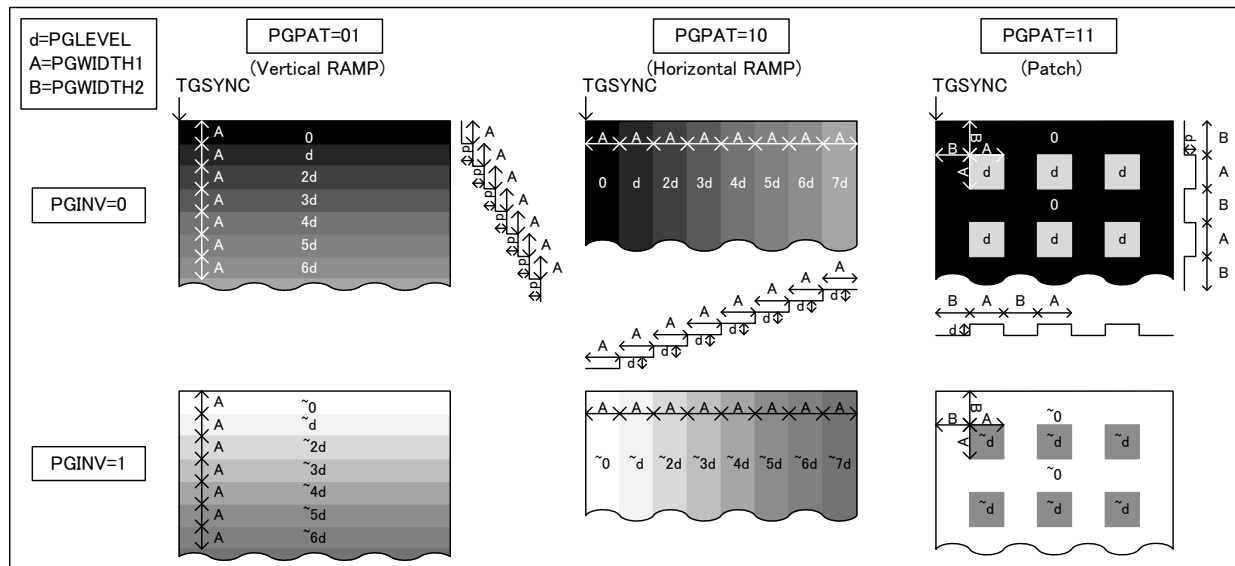
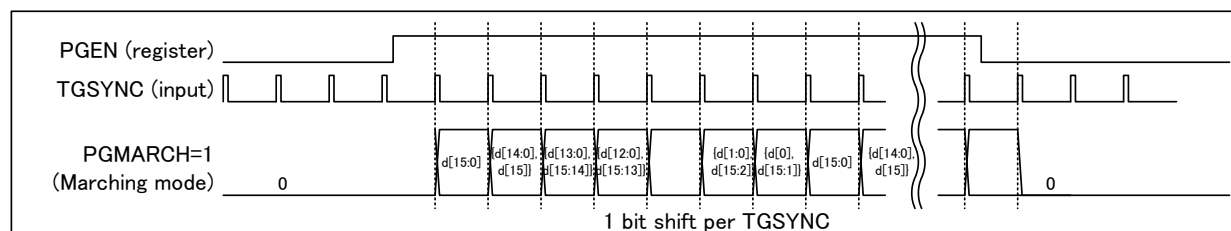


Figure 37 Test Pattern Output image



**Figure 38 Test Pattern Output Data Formats (Marching mode)**

| REGISTER ADDRESS    | BIT | LABEL      | DEFAULT | DESCRIPTION                                                                                                                  |
|---------------------|-----|------------|---------|------------------------------------------------------------------------------------------------------------------------------|
| R20 (14h) PG config | 7   | PGMARCH    | 0       | pattern generator marching mode enable<br>0 = controlled by PGPAT<br>1 = marching pattern                                    |
|                     | 6:5 | PGPAT[1:0] | 00      | select pattern generator output<br>00 = fixed value<br>01 = vertical ramp<br>10 = horizontal ramp<br>11 = patch              |
|                     | 4   | PGINV      | 0       | invert pattern generator output<br>0 = normal<br>1 = invert                                                                  |
|                     | 3   | SEL_PGZ    | 0       | select output of pattern generator (IN3)<br>0 = normal output<br>1 = output generated digital pattern instead of ADC outputs |
|                     | 2   | SEL_PGY    | 0       | select output of pattern generator (IN2)<br>0 = normal output<br>1 = output generated digital pattern instead of ADC outputs |
|                     | 1   | SEL_PGX    | 0       | select output of pattern generator (IN1)<br>0 = normal output<br>1 = output generated digital pattern instead of ADC outputs |
|                     | 0   | PGEN       | 0       | enable pattern generator<br>0 = disable<br>1 = enable                                                                        |

| REGISTER ADDRESS     | BIT | LABEL        | DEFAULT   | DESCRIPTION                    |
|----------------------|-----|--------------|-----------|--------------------------------|
| R21 (15h) PGCODE LSB | 7:0 | PGLEVEL[7:0] | 0000_0000 | parameter of pattern generator |

| REGISTER ADDRESS     | BIT | LABEL        | DEFAULT   | DESCRIPTION                    |
|----------------------|-----|--------------|-----------|--------------------------------|
| R22 (16h) PGCODE MSB | 7:0 | PGLEVEL[7:0] | 0000_0000 | parameter of pattern generator |

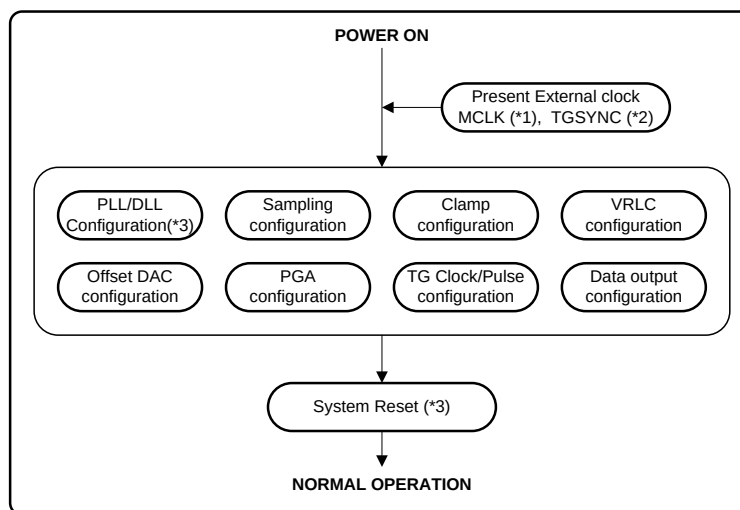
| REGISTER ADDRESS     | BIT | LABEL         | DEFAULT   | DESCRIPTION                    |
|----------------------|-----|---------------|-----------|--------------------------------|
| R23 (17h) PG width 1 | 7:0 | PGWIDTH1[7:0] | 0000_0000 | parameter of pattern generator |

| REGISTER ADDRESS     | BIT | LABEL         | DEFAULT   | DESCRIPTION                    |
|----------------------|-----|---------------|-----------|--------------------------------|
| R24 (18h) PG width 2 | 7:0 | PGWIDTH2[7:0] | 0000_0000 | parameter of pattern generator |

## REGISTER SETTING PROCEDURE

### OVERALL

Figure 39 shows the overall procedure for WM8231 register setting. Every register can be configured without MCLK and TGSYNC input, but the following Note1~3 must be followed before starting normal operation.



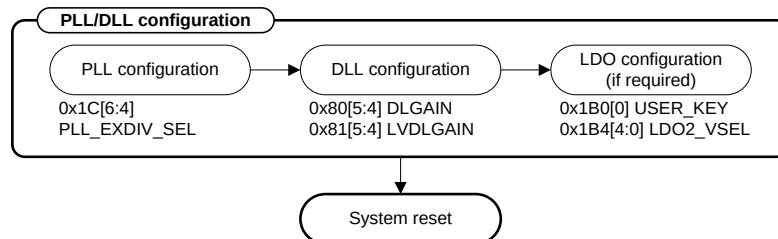
**Figure 39 Overall Procedure**

#### Notes:

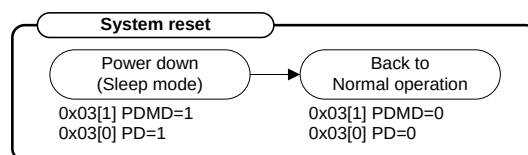
1. MCLK must be present before System Reset. Also, System Reset must be done when MCLK is interrupted during normal operation.
2. TGSYNC input is required in TG slave mode. Also, this must be present before normal operation.
3. System Reset must be done after PLL/DLL configuration.

## PLL/DLL CONFIGURATION

PLL and DLL registers must be configured depending on the MCLK frequency and data output format. See “PLL DLL Setup” section for details of configuring PLL/DLL registers. The device must be reset after PLL/DLL configuration as shown in Figure 40.



**Figure 40 PLL/DLL Configuration**



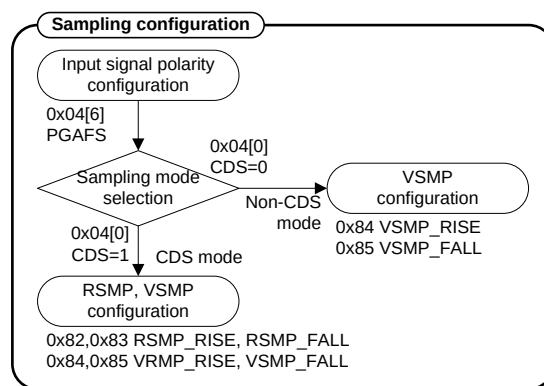
**Figure 41 System Reset**

## SAMPLING CONFIGURATION

Sampling configuration is the setting for input signal polarity and sampling timing. See “CDS/Non-CDS Processing” section for details of configuring this register.

**Non-CDS mode (S/H mode):** RSMP configuration is not required.

**CDS mode:** RSMP and VSMP configurations are required.



**Figure 42 Sampling Configuration**

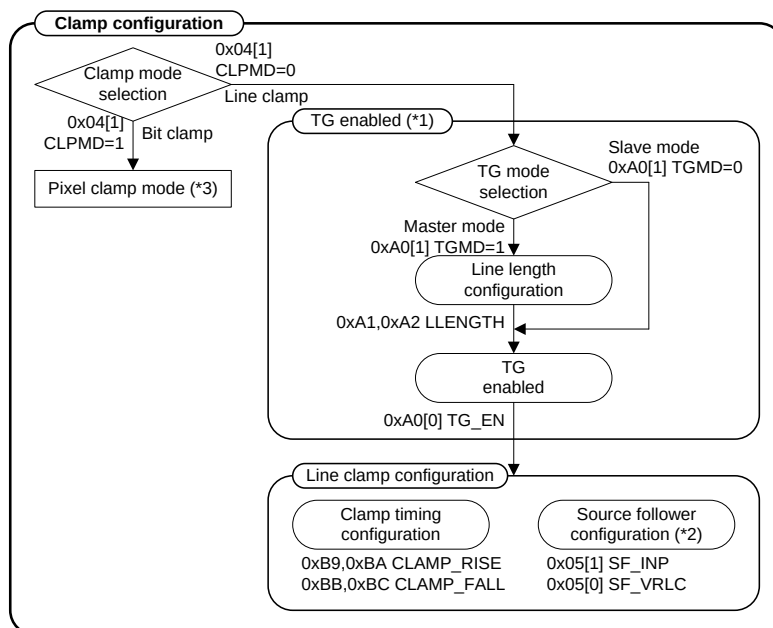
## CLAMP CONFIGURATION

Clamp configuration is the setting for clamp modes and clamp timing configuration in line clamp mode. See "Reset Level Clamping (RLC)" section and "CDS/Non-CDS Processing" section for details of configuring this register.

**TG enabled:** This must be enabled when AGC function is used.

**Line clamp configuration:** Line clamp operation is enabled during CLAMP\_RISE ~ CLAMP\_FALL period. Also, the source follower should be set to prevent clamp voltage drop in line clamp mode.

**Pixel clamp (Bit clamp) mode:** The pixel clamping is enabled during RSMP = high period. This mode can be used in CDS operation only.



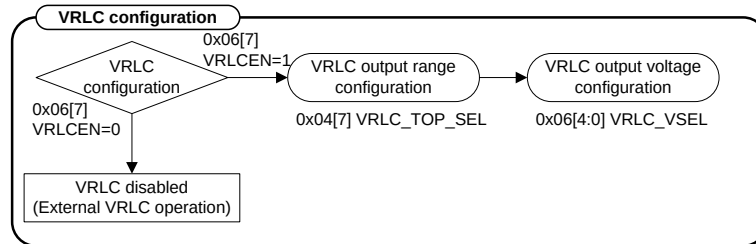
**Figure 43 Clamp Configuration**

### Notes:

1. This must be set when Line clamp is used.
2. SF\_INP and SF\_VRLC must be set both when source follower enabled
3. Pixel clamp can be used in CDS operation only.

## VRCL CONFIGURATION

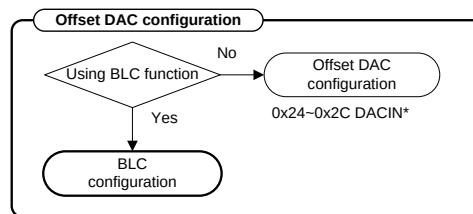
VRCL configuration is the setting for VRCL voltage which, is used for input signal clamp voltage at line clamp operation. The VRCL voltage is also used as the reference level of non-CDS (S/H) operation. See “Reset Level Clamping (RLC)” section and “CDS/Non-CDS Processing” section for details of configuring this register.



**Figure 44 VRCL Configuration**

## OFFSET DAC CONFIGURATION

The offset DAC is used for black level offset compensation. WM8231 has BLC function to calibrate black level. In this mode, the offset DAC will be configured automatically. When this function is not needed, the offset DAC can be configured manually. See “Overall Signal Flow Summary” section for details of offset DAC configuration, and see “BLC Scenarios of Operation” for details of BLC sequence.



**Figure 45 Offset DAC Configuration**

## BLC Configuration

**TG enabled:** This must be enabled when AGC function is used.

**BLC start pixel configuration:** This is start pixel configuration for BLC.

**BLC period configuration:** BLC will operate while this period from BLC start pixel.

**BLC target level configuration:** This is configuration for the target level of black pixel.

### Coarse adjust configuration:

**CADUR:** This is the coarse adjust iteration setting during BLC period.

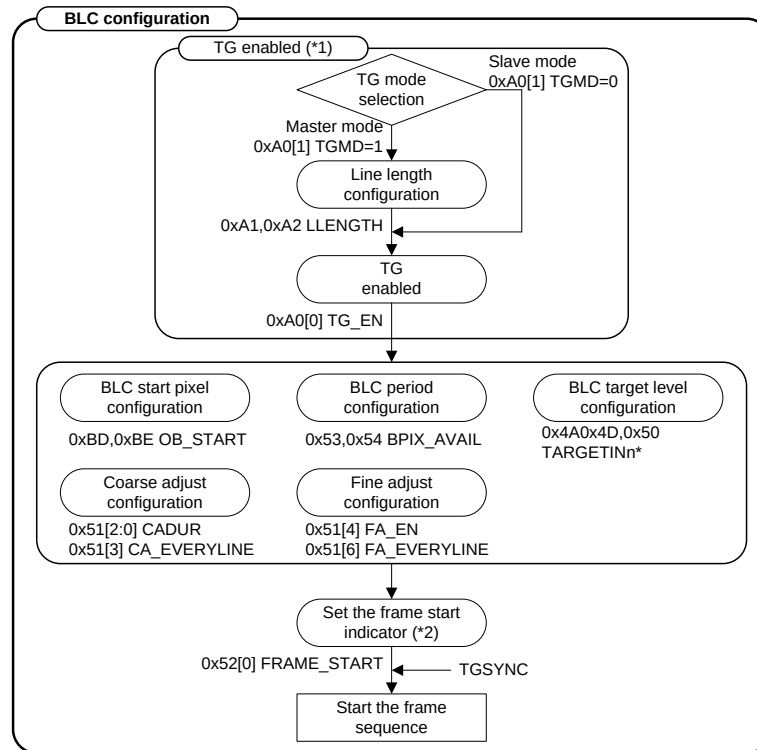
**CA\_EVERYLINE:** When this register set, coarse adjust will operate on every line.

### Fine adjust configuration:

**FA\_EN:** When this register set, fine adjust will operate during BLC period.

**FA\_EVERYLINE:** When this register set, fine adjust will operate on every line.





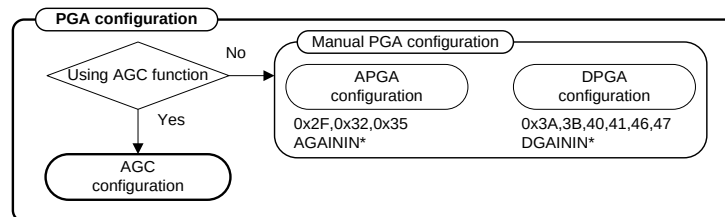
**Figure 46 BLC Configuration**

**Notes:**

1. This must be set when BLC is used.
2. With this register set, frame sequence will be started after TGSYNC is recognized. Therefore this should be set within the last line of previous frame.

**PGA CONFIGURATION**

The WM8231 provides an Automatic Gain Control (AGC) function. The output code is calibrated to target level by this automatic gain control function. See "Automatic Gain Control (AGC)" section for details of AGC sequence. Also, see the following instruction to configure AGC related registers. The analogue PGA (APGA) and digital PGA (DPGA) can be configured manually when AGC is not required. See "Offset Adjust and Programmable Gain" section for details of PGA configuration.



**Figure 47 PGA Configuration**

## AGC CONFIGURATION

Figure 48 shows the procedure for AGC Configuration.

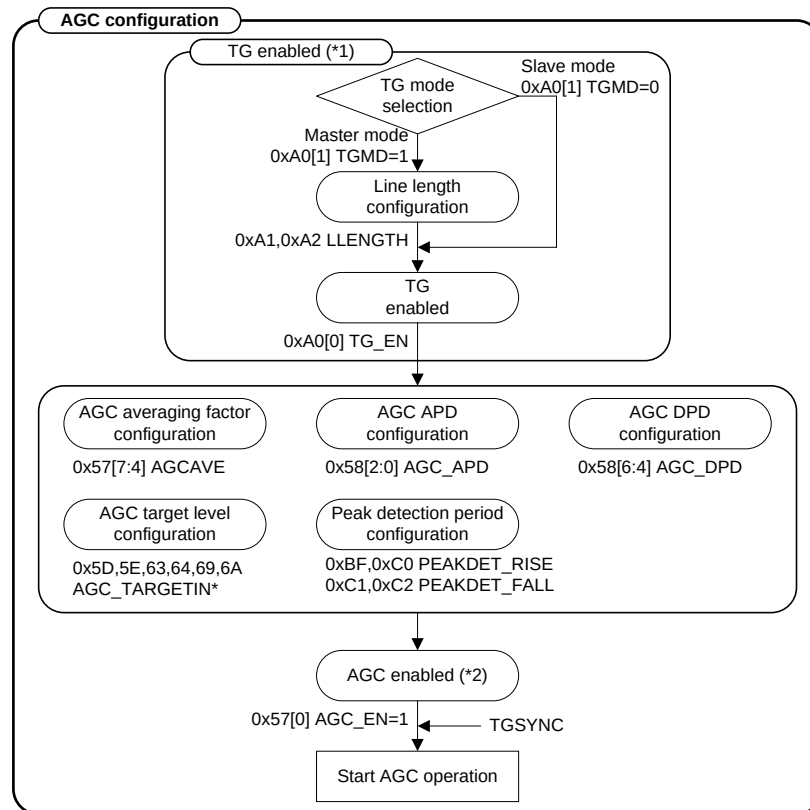
**TG enabled:** This must be enabled when AGC function is used.

**AGC averaging factor configuration:** This is averaging factor for peak level detection.

**AGC APD/DPD configuration:** This is line iteration setting for peak level detection.

**AGC target level configuration:** The output code will be calibrated to this target level after APGA and DPGA calibration. APGA and DPGA keep calibrated gain value while AGC is enabled. (AGC\_EN=1)

**Peak detection period configuration:** This is the setting for peak detection period.



**Figure 48 AGC Configuration**

### Notes:

1. This must be set when AGC is used.
2. With this register set, AGC sequence will be started after TGSYNC is recognized.

## TG CLOCK CONFIGURATION

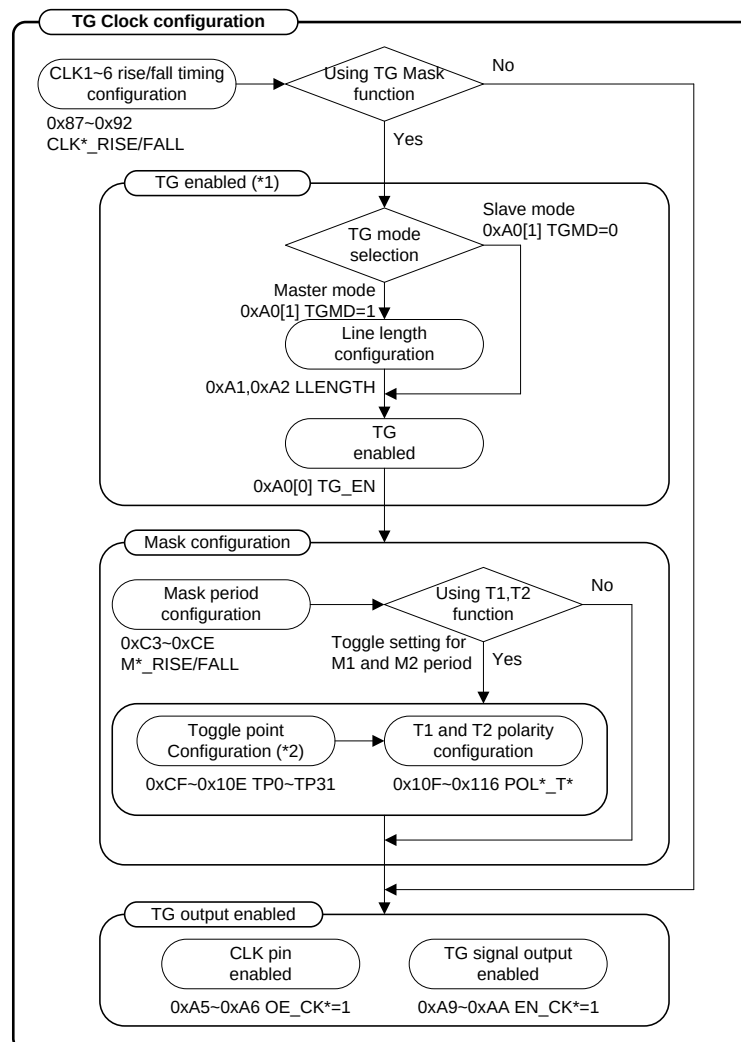
Figure 49 shows the procedure for TG Clock Timing and Mask Configuration. CLK1~CLK6 can be configured as clock type output. See “Sensor Timing Generation” section for details of TG function.

**TG enabled:** This must be enabled when TG mask function is used.

**Mask period configuration:** TG clock will be masked while mask signal is high. The rising and falling timing is configured by M\*\_RISE/FALL register. See “TG Mask Timing” section for details of this function.

**Toggle point configuration:** Pulse toggle timing is configured by toggle point setting (TP0~TP31). TP\* register consists of toggle point setting bit (TP value bit) and enable bit. The enable bit must be set when TP is used. Unused TP can be disabled, but it must be followed Note-2 as described below.

**T1 and T2 polarity configuration:** T1 and T2 are internal signal to set the TG signal polarity during mask period. See “TG Mask Timing” section for details of this function.



**Figure 49 TG Clock Configuration**

**Notes:**

1. This must be set when the TG-MASK function is used.
2. When configure Toggle point (TP), it must be used from TP0 in ascending order. Also, TP pixel counter value must be set as TP0<TP1<TP2 .....

## TG PULSE CONFIGURATION

Figure 50 shows the procedure for TG Pulse Configuration. CLK2~CLK11 can be configured as pulse type output. See "Sensor Timing Generation" section for details of TG function.

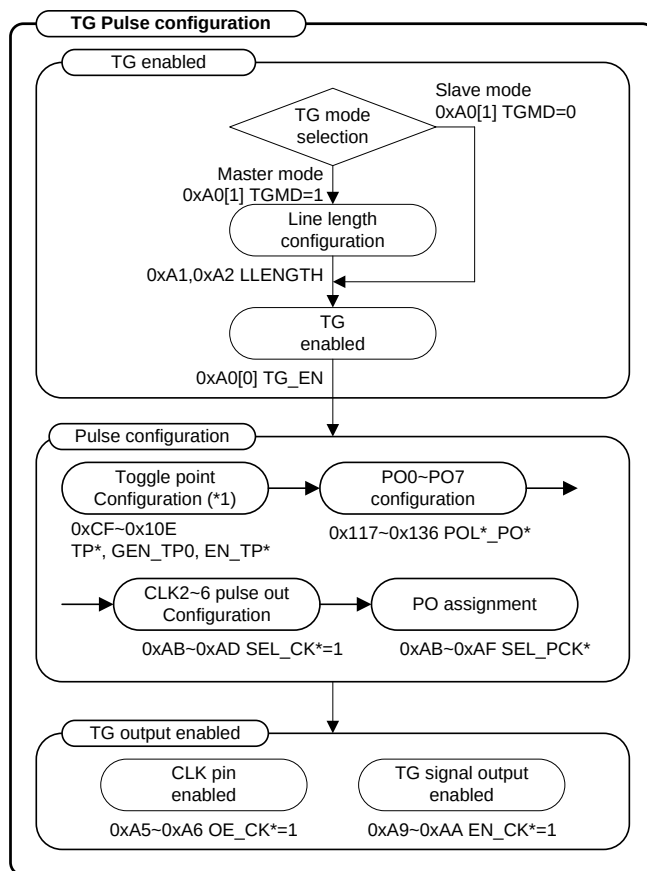
**TG enabled:** This must be enabled when TG pulse function is used.

**Toggle point configuration:** Pulse toggle timing is configured by toggle point setting (TP0~TP31). TP\* register consists of toggle point setting bit (TP pixel counter value bit) and enable bit. The enable bit must be set when TP is used. Unused TP can be disabled, but this must be followed Note-1 as described below.

**PO0~PO7 configuration:** PO0~PO7 are internal pulse for CLK pulse output. Pulse toggle timing is configured by polarity setting register (0x117~0x136 POL\*\_PO\*).

**CLK2~6 pulse out configuration:** CLK2~CLK6 can select output signal type, clock type or pulse type by SEL\_CLK\* register bit. This register must be set when pulse output is required.

**PO assignment:** Internal PO\* pulse will be assigned to CLK2~CLK11 pin with this register.



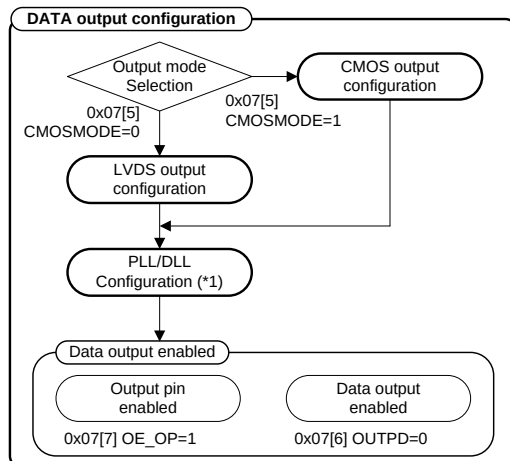
**Figure 50 TG Pulse Configuration**

### Notes:

- When configure Toggle point (TP), it must be used from TP0 in ascending order. Also, TP pixel counter value must be set as TP0<TP1<TP2

## DATA OUTPUT CONFIGURATION

Figure 51 shows the procedure for Data Output Configuration. WM8231 provides 10-bit CMOS output and various LVDS output formats. See “Output Data Format” section for details of LVDS and CMOS output format.

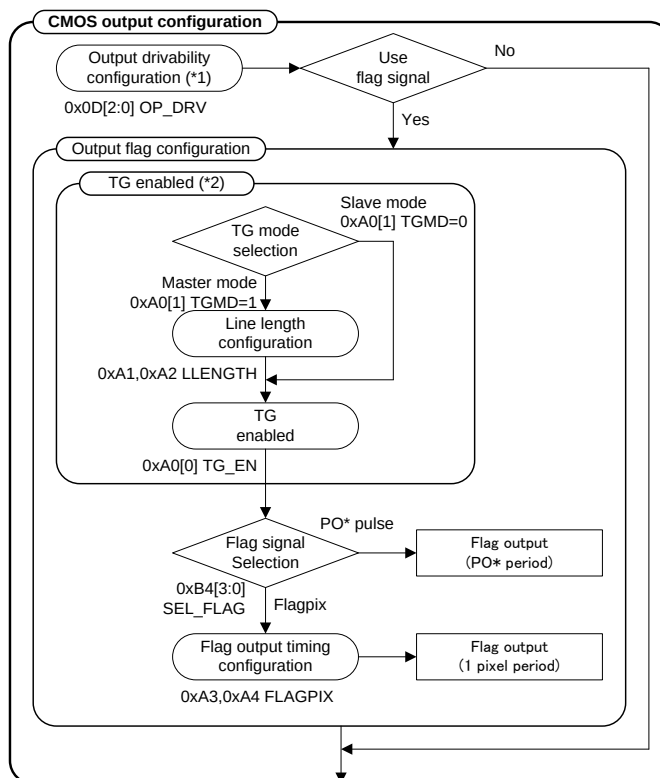


**Figure 51 Data Output Configuration**

**Notes:** 1. For details, see “PLL/DLL Configuration” section.

## CMOS Output Configuration

Figure 52 shows the procedure for CMOS Output Configuration. Output drivability must be set when CMOS output is selected. In CMOS output mode, flag signal will be output from DCLKN/OC[2] pin.



**Figure 52 CMOS Output Configuration**

**Notes:**

1. OP\_DRV is valid when 0x0D[3] DRV\_CTRL set to 0. When DRV\_CTRL set to 1, OP\_DRV is invalid, and drivability of output pin can be configured individually by 0x0E~0x13 OP\*\_DRV and OC\*\_DRV.
2. This must be set when flag is used.

**LVDS Output Configuration**

Figure 53 shows the procedure for LVDS Output Configuration.

**LVDS format configuration:** LVDS format can be configured by this register. See “Output Data Format” section for details of each format.

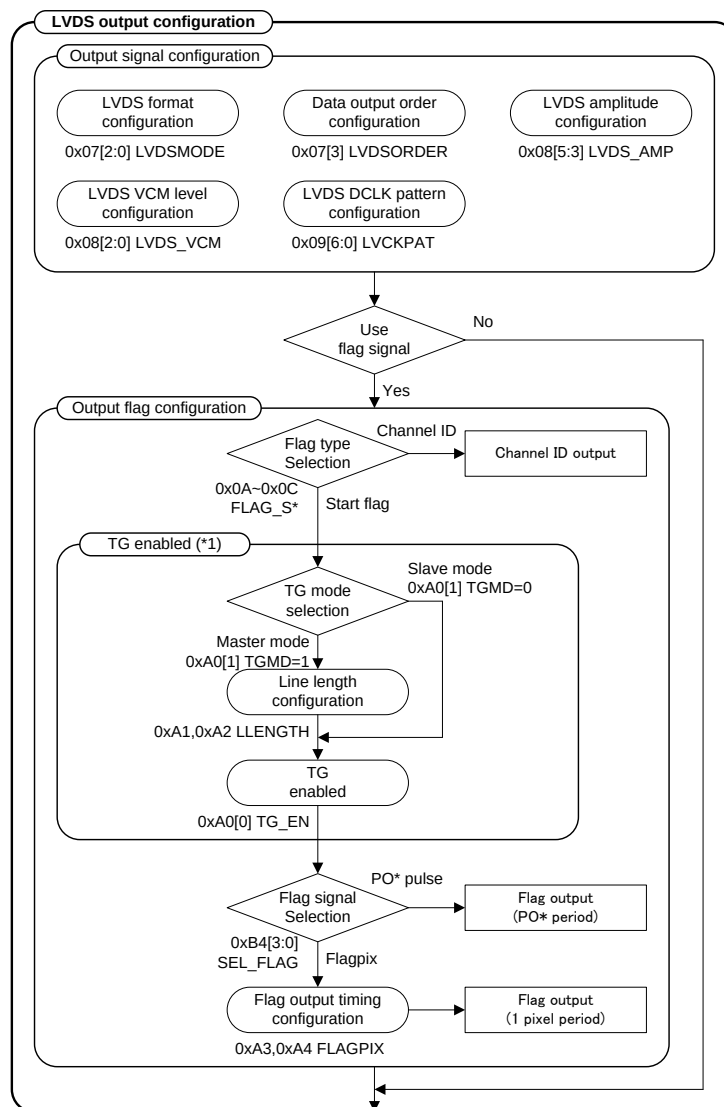
**Data output order configuration:** Data output order can be set by this register. See “LVDS Data Output Order” section for details of output order.

**LVDS amplitude configuration:** This is LVDS signal amplitude configuration. The LVDS amplitude is configured using the LVDS\_AMP register field. Selections in the range 50mV to 200mV are supported. Note that the default code (110) should not be used.

**LVDS VCM level configuration:** This is LVDS common mode voltage configuration.

**LVDS DCLK pattern configuration:** This is DCLK output pattern configuration.

**Output flag configuration:** Flag type can be selected from start flag or channel ID. See “Trigger Data” and “Channel ID” section for details of output flag. When this is not used, flag data (S~S4) will be always 0.



**Figure 53 LVDS Output Configuration**

**Notes:**

1. This must be set when start flag is used.

## REGISTER MAP

The following table describes the location of each control bit used to determine the operation of the WM8231. Not all registers are used and any registers not listed should be set to zero.

| REG       | NAME                       | 7                     | 6                  | 5                     | 4                | 3                     | 2             | 1                | 0          | DEFAULT |
|-----------|----------------------------|-----------------------|--------------------|-----------------------|------------------|-----------------------|---------------|------------------|------------|---------|
| R0 (0h)   | Software Reset/Chip ID 1   | SW_RESET_CHIP_ID[7:0] |                    |                       |                  |                       |               |                  |            | 32h     |
| R1 (1h)   | Chip ID 2                  | CHIP_ID[7:0]          |                    |                       |                  |                       |               |                  |            | 82h     |
| R2 (2h)   | Chip Rev                   | 0                     | 0                  | 0                     | 0                | CHIP_REV[3:0]         |               |                  |            | 00h     |
| R3 (3h)   | Setup Reg 1                | 0                     | 0                  | 0                     | CHZPD            | CHYPD                 | CHXPD         | PDMD             | PD         | 00h     |
| R4 (4h)   | Setup Reg 2                | VVRLC_TOP_SEL         | PGAFS              | ADCFS                 | TGDIVMD          | 0                     | 0             | CLPMD            | CDS        | 00h     |
| R5 (5h)   | Setup Reg 3                | 0                     | 0                  | 0                     | SF_BYPLS         | PT_SF[1:0]            |               | SF_INP           | SF_VRLC    | 1Ch     |
| R6 (6h)   | VRLC control               | VRLCEN                | VRLC_ISEL[1:0]     |                       | VRLC_VSEL[4:0]   |                       |               |                  |            | 8Ah     |
| R7 (7h)   | output control             | OE_OP                 | OUTPD              | CMOSMODE              | OUTSYNC          | LVDSORDER             | LVDSMODE[2:0] |                  |            | 40h     |
| R8 (8h)   | LVDS control               | 0                     | LVDS_POL           | LVDS_AMP[2:0]         |                  |                       | LVDS_VCM[2:0] |                  |            | 35h     |
| R9 (9h)   | LVDS clock pattern         | 0                     | LVCKPAT[6:0]       |                       |                  |                       |               |                  |            | 63h     |
| R10 (Ah)  | flag control 1             | FLAG_S1[3:0]          |                    |                       |                  | FLAG_S0[3:0]          |               |                  |            | 10h     |
| R11 (Bh)  | flag control 2             | FLAG_S3[3:0]          |                    |                       |                  | FLAG_S2[3:0]          |               |                  |            | 00h     |
| R12 (Ch)  | flag control 3             | 0                     | 0                  | 0                     | 0                | FLAG_S4[3:0]          |               |                  |            | 00h     |
| R13 (Dh)  | CMOS drivability control 1 | 0                     | 0                  | 0                     | 0                | DRV_CTRL              | OP_DRV[2:0]   |                  |            | 00h     |
| R14 (Eh)  | CMOS drivability control 2 | 0                     | OP1_DRV[2:0]       |                       |                  | 0                     | OP0_DRV[2:0]  |                  |            | 00h     |
| R15 (Fh)  | CMOS drivability control 3 | 0                     | OP3_DRV[2:0]       |                       |                  | 0                     | OP2_DRV[2:0]  |                  |            | 00h     |
| R16 (10h) | CMOS drivability control 4 | 0                     | OP5_DRV[2:0]       |                       |                  | 0                     | OP4_DRV[2:0]  |                  |            | 00h     |
| R17 (11h) | CMOS drivability control 5 | 0                     | OP7_DRV[2:0]       |                       |                  | 0                     | OP6_DRV[2:0]  |                  |            | 00h     |
| R18 (12h) | CMOS drivability control 6 | 0                     | OP9_DRV[2:0]       |                       |                  | 0                     | OP8_DRV[2:0]  |                  |            | 00h     |
| R19 (13h) | CMOS drivability control 7 | 0                     | OC2_DRV[2:0]       |                       |                  | 0                     | OC1_DRV[2:0]  |                  |            | 00h     |
| R20 (14h) | PG config                  | PGMARCH               | PGPAT[1:0]         |                       | PGINV            | SEL_PGZ               | SEL_PGY       | SEL_PGX          | PGEN       | 00h     |
| R21 (15h) | PGCODE LSB                 | PGLEVEL[7:0]          |                    |                       |                  |                       |               |                  |            | 00h     |
| R22 (16h) | PGCODE MSB                 | PGLEVEL[7:0]          |                    |                       |                  |                       |               |                  |            | 00h     |
| R23 (17h) | PG width 1                 | PGWIDTH1[7:0]         |                    |                       |                  |                       |               |                  |            | 00h     |
| R24 (18h) | PG width 2                 | PGWIDTH2[7:0]         |                    |                       |                  |                       |               |                  |            | 00h     |
| R25 (19h) | clock monitor              | 0                     | 0                  | 0                     | 0                | 0                     | MONCLK[2:0]   |                  |            | 00h     |
| R26 (1Ah) | PLL control 1              | 0                     | 0                  | 0                     | 0                | 0                     | PLL_LPF_RST   | PLL_CP_PD        | PLL_VCO_PD | 00h     |
| R27 (1Bh) | PLL control 2              | 0                     | PLL_LPF_SEL        | 0                     | 0                | PLL_PFD_CTRL[1:0]     |               | PLL_CP_GAIN[1:0] |            | 09h     |
| R28 (1Ch) | PLL divider control 1      | 0                     | PLL_EXDIV_SEL[2:0] |                       |                  | PLL_FBDIV_SEL[3:0]    |               |                  |            | 11h     |
| R29 (1Dh) | PLL divider control 2      | 0                     | 0                  | PLL_POSTDIV2_SEL[1:0] |                  | PLL_POSTDIV1_SEL[3:0] |               |                  |            | 11h     |
| R35 (23h) | Cycle mode control         | 0                     | 0                  | 0                     | 0                | INTM[1:0]             |               | ACYC             | LINBYLINE  | 00h     |
| R38 (26h) | DAC IN1                    | DACIN1[7:0]           |                    |                       |                  |                       |               |                  |            | 80h     |
| R41 (29h) | DAC IN2IN2                 | DACIN2IN2[7:0]        |                    |                       |                  |                       |               |                  |            | 80h     |
| R44 (2Ch) | DAC INP3                   | DACINP3[7:0]          |                    |                       |                  |                       |               |                  |            | 80h     |
| R47 (2Fh) | AGAIN IN1                  | 0                     | 0                  | 0                     | AGAININ1[4:0]    |                       |               |                  |            | 01h     |
| R50 (32h) | AGAIN IN2IN2               | 0                     | 0                  | 0                     | AGAININ2IN2[4:0] |                       |               |                  |            | 01h     |
| R53 (35h) | AGAIN INP3                 | 0                     | 0                  | 0                     | AGAININP3[4:0]   |                       |               |                  |            | 01h     |
| R58 (3Ah) | DGAIN IN1 LSB              | DGAININ1[3:0]         |                    |                       |                  | 0                     | 0             | 0                | 0          | 00h     |
| R59 (3Bh) | DGAIN IN1 MSB              | DGAININ1[11:4]        |                    |                       |                  |                       |               |                  |            | 80h     |
| R64 (40h) | DGAIN IN2IN2 LSB           | DGAININ2IN2[3:0]      |                    |                       |                  | 0                     | 0             | 0                | 0          | 00h     |
| R65 (41h) | DGAIN IN2IN2 MSB           | DGAININ2IN2[11:4]     |                    |                       |                  |                       |               |                  |            | 80h     |
| R70 (46h) | DGAIN INP3 LSB             | DGAININP3[3:0]        |                    |                       |                  | 0                     | 0             | 0                | 0          | 00h     |
| R71 (47h) | DGAIN INP3 MSB             | DGAININP3[11:4]       |                    |                       |                  |                       |               |                  |            | 80h     |
| R74 (4Ah) | BLC IN1 target             | TARGETIN1[7:0]        |                    |                       |                  |                       |               |                  |            | 00h     |
| R77 (4Dh) | BLC IN2IN2 target          | TARGETIN2IN2[7:0]     |                    |                       |                  |                       |               |                  |            | 00h     |



| REG        | NAME                   | 7                     | 6             | 5               | 4        | 3            | 2            | 1                  | 0           | DEFAULT |     |
|------------|------------------------|-----------------------|---------------|-----------------|----------|--------------|--------------|--------------------|-------------|---------|-----|
| R80 (50h)  | BLC INP3 target        | TARGETINP3[7:0]       |               |                 |          |              |              |                    |             | 00h     |     |
| R81 (51h)  | BLC control 1          | FRAME_SEQ             | FA_EVERYLINE  | FA_ACCUM        | FA_EN    | FA_EVERYLINE | CADUR[2:0]   |                    |             | 00h     |     |
| R82 (52h)  | BLC control 2          | 0                     | 0             | 0               | 0        | 0            | 0            | SEQ_START          | FRAME_START | 00h     |     |
| R83 (53h)  | BLC control 3          | BPIX_AVAIL[7:0]       |               |                 |          |              |              |                    |             | 00h     |     |
| R84 (54h)  | BLC control 4          | 0                     | 0             | 0               | 0        | 0            | 0            | BPIX_AVAIL[9:8]    |             | 00h     |     |
| R85 (55h)  | BLC control 5          | LINE_DEL[7:0]         |               |                 |          |              |              |                    |             | 00h     |     |
| R86 (56h)  | BLC control 6          | 0                     | 0             | 0               | 0        | 0            | 0            | 0                  | LINE_DEL[8] | 00h     |     |
| R87 (57h)  | AGC config 1           | AGCAVE[3:0]           |               |                 |          | 0            | AGC_ERRFLAG  | AGC_ENDFLAG        | AGC_EN      | 00h     |     |
| R88 (58h)  | AGC config 2           | 0                     | AGC_DPD[2:0]  |                 |          | 0            | AGC_APD[2:0] |                    |             | 00h     |     |
| R93 (5Dh)  | AGC target IN1 LSB     | AGC_TARGETIN1[7:0]    |               |                 |          |              |              |                    |             | 00h     |     |
| R94 (5Eh)  | AGC target IN1 MSB     | 0                     | 0             | 0               | 0        | 0            | 0            | AGC_TARGETIN1[9:8] |             | 00h     |     |
| R99 (63h)  | AGC target IN2IN2 LSB  | AGC_TARGETIN2IN2[7:0] |               |                 |          |              |              |                    |             | 00h     |     |
| R100 (64h) | AGC target IN2IN2 MSB  | 0                     | 0             | 0               | 0        | 0            | 0            | AGC_TARGETIN2[9:8] |             | 00h     |     |
| R105 (69h) | AGC target IN3 LSB     | AGC_TARGETIN3[7:0]    |               |                 |          |              |              |                    |             | 00h     |     |
| R106 (6Ah) | AGC target IN3 MSB     | 0                     | 0             | 0               | 0        | 0            | 0            | AGC_TARGETIN3[9:8] |             | 00h     |     |
| R111 (6Fh) | AGC peak level IN1 LSB | PEAK_IN1[7:0]         |               |                 |          |              |              |                    |             | 00h     |     |
| R112 (70h) | AGC peak level IN1 MSB | 0                     | 0             | 0               | 0        | 0            | 0            | PEAK_IN1[9:8]      |             | 00h     |     |
| R117 (75h) | AGC peak level IN2 LSB | PEAK_IN2[7:0]         |               |                 |          |              |              |                    |             | 00h     |     |
| R118 (76h) | AGC peak level IN2 MSB | 0                     | 0             | 0               | 0        | 0            | 0            | PEAK_IN2[9:8]      |             | 00h     |     |
| R123 (7Bh) | AGC peak level IN3 LSB | PEAK_IN3[7:0]         |               |                 |          |              |              |                    |             | 00h     |     |
| R124 (7Ch) | AGC peak level IN3 MSB | 0                     | 0             | 0               | 0        | 0            | 0            | PEAK_IN3[9:8]      |             | 00h     |     |
| R128 (80h) | DLL config 1           | 0                     | 0             | DLGAIN[1:0]     |          | 0            | DLLRST       | CKOSTB             | AFECKSTB    | 10h     |     |
| R129 (81h) | DLL config 2           | 0                     | 0             | LVDLGAIN[1:0]   |          | 0            | 0            | LVDLLRST           | LVDLLSTB    | 10h     |     |
| R130 (82h) | RSMP rise              | 0                     | 0             | RSMP_RISE[5:0]  |          |              |              |                    |             | 1Ch     |     |
| R131 (83h) | RSMP fall              | 0                     | 0             | RSMP_FALL[5:0]  |          |              |              |                    |             | 26h     |     |
| R132 (84h) | VSMP rise              | 0                     | 0             | VSMP_RISE[5:0]  |          |              |              |                    |             | 28h     |     |
| R133 (85h) | VSMP fall              | 0                     | 0             | VSMP_FALL[5:0]  |          |              |              |                    |             | 08h     |     |
| R134 (86h) | TGCKO rise             | 0                     | 0             | TCLKO_RISE[5:0] |          |              |              |                    |             | 37h     |     |
| R135 (87h) | CLK1 rise              | 0                     | 0             | CLK1_RISE[5:0]  |          |              |              |                    |             | 0Ah     |     |
| R136 (88h) | CLK1 fall              | 0                     | 0             | CLK1_FALL[5:0]  |          |              |              |                    |             | 19h     |     |
| R137 (89h) | CLK2 rise              | 0                     | 0             | CLK2_RISE[5:0]  |          |              |              |                    |             | 19h     |     |
| R138 (8Ah) | CLK2fall               | 0                     | 0             | CLK2_FALL[5:0]  |          |              |              |                    |             | 28h     |     |
| R139 (8Bh) | CLK3 rise              | 0                     | 0             | CLK3_RISE[5:0]  |          |              |              |                    |             | 28h     |     |
| R140 (8Ch) | CLK3 fall              | 0                     | 0             | CLK3_FALL[5:0]  |          |              |              |                    |             | 0Ah     |     |
| R141 (8Dh) | CLK4 rise              | 0                     | 0             | CLK4_RISE[5:0]  |          |              |              |                    |             | 00h     |     |
| R142 (8Eh) | CLK4 fall              | 0                     | 0             | CLK4_FALL[5:0]  |          |              |              |                    |             | 00h     |     |
| R143 (8Fh) | CLK5 rise              | 0                     | 0             | CLK5_RISE[5:0]  |          |              |              |                    |             | 0Ah     |     |
| R144 (90h) | CLK5 fall              | 0                     | 0             | CLK5_FALL[5:0]  |          |              |              |                    |             | 28h     |     |
| R145 (91h) | CLK6 rise              | 0                     | 0             | CLK6_RISE[5:0]  |          |              |              |                    |             | 0Ah     |     |
| R146 (92h) | CLK6 fall              | 0                     | 0             | CLK6_FALL[5:0]  |          |              |              |                    |             | 28h     |     |
| R160 (A0h) | TG config 1            | OFFSET[3:0]           |               |                 |          | CYCMD        |              | POLSYNC            | TGMD        | TG_EN   | 00h |
| R161 (A1h) | TG config 2            | LLENGTH[7:0]          |               |                 |          |              |              |                    |             | 00h     |     |
| R162 (A2h) | TG config 3            | 0                     | LLENGTH[14:8] |                 |          |              |              |                    |             | 00h     |     |
| R163 (A3h) | TG config 4            | FLAGPIX[7:0]          |               |                 |          |              |              |                    |             | 00h     |     |
| R164 (A4h) | TG config 5            | 0                     | FLAGPIX[14:8] |                 |          |              |              |                    |             | 00h     |     |
| R165 (A5h) | TG config 6            | OE_CLK8               | OE_CLK7       | OE_CLK6         | OE_CLK5  | OE_CLK4      | OE_CLK3      | OE_CLK2            | OE_CLK1     | FFh     |     |
| R166 (A6h) | TG config 7            | 0                     | 0             | 0               | 0        | 0            | OE_CLK11     | OE_CLK10           | OE_CLK9     | 07h     |     |
| R167 (A7h) | TG config 8            | INV_CLK8              | INV_CLK7      | INV_CLK6        | INV_CLK5 | INV_CLK4     | INV_CLK3     | INV_CLK2           | INV_CLK1    | 00h     |     |
| R168 (A8h) | TG config 9            | 0                     | 0             | 0               | 0        | 0            | INV_CLK11    | INV_CLK10          | INV_CLK9    | 00h     |     |

| REG        | NAME                  | 7                 | 6                  | 5             | 4       | 3              | 2               | 1              | 0       | DEFAULT |
|------------|-----------------------|-------------------|--------------------|---------------|---------|----------------|-----------------|----------------|---------|---------|
| R169 (A9h) | TG config 10          | EN_CLK8           | EN_CLK7            | EN_CLK6       | EN_CLK5 | EN_CLK4        | EN_CLK3         | EN_CLK2        | EN_CLK1 | 00h     |
| R170 (AAh) | TG config 11          | 0                 | 0                  | 0             | 0       | 0              | EN_CLK11        | EN_CLK10       | EN_CLK9 | 00h     |
| R171 (ABh) | TG config 12          | SEL_CLK3          | SEL_PCK3[2:0]      |               |         | SEL_CLK2       | SEL_PCK2[2:0]   |                |         | 00h     |
| R172 (ACh) | TG config 13          | SEL_CLK5          | SEL_PCK5[2:0]      |               |         | SEL_CLK4       | SEL_PCK4[2:0]   |                |         | 00h     |
| R173 (ADh) | TG config 14          | 0                 | SEL_PCK7[2:0]      |               |         | SEL_CLK6       | SEL_PCK6[2:0]   |                |         | 00h     |
| R174 (AEh) | TG config 15          | 0                 | SEL_PCK9[2:0]      |               |         | 0              | SEL_PCK8[2:0]   |                |         | 00h     |
| R175 (AFh) | TG config 16          | 0                 | SEL_PCK11[2:0]     |               |         | 0              | SEL_PCK10[2:0]  |                |         | 00h     |
| R176 (B0h) | TG config 17          | DEL_PCK5[1:0]     |                    | DEL_PCK4[1:0] |         | DEL_PCK3[1:0]  |                 | DEL_PCK2[1:0]  |         | 00h     |
| R177 (B1h) | TG config 18          | DEL_PCK9[1:0]     |                    | DEL_PCK8[1:0] |         | DEL_PCK7[1:0]  |                 | DEL_PCK6[1:0]  |         | 00h     |
| R178 (B2h) | TG config 19          | 0                 | 0                  | 0             | 0       | DEL_PCK11[1:0] |                 | DEL_PCK10[1:0] |         | 00h     |
| R179 (B3h) | TG config 20          | 0                 | 0                  | 0             | INV_M3  | INV_M2         | INV_M1          | INV_T2         | INV_T1  | 00h     |
| R180 (B4h) | TG config 21          | 0                 | 0                  | 0             | 0       | SEL_FLAG[3:0]  |                 |                |         | 00h     |
| R181 (B5h) | TG config 22          | 0                 | CYCPAT_PO1[2:0]    |               |         | 0              | CYCPAT_PO0[2:0] |                |         | 00h     |
| R182 (B6h) | TG config 23          | 0                 | CYCPAT_PO3[2:0]    |               |         | 0              | CYCPAT_PO2[2:0] |                |         | 00h     |
| R183 (B7h) | TG config 24          | 0                 | CYCPAT_PO5[2:0]    |               |         | 0              | CYCPAT_PO4[2:0] |                |         | 00h     |
| R184 (B8h) | TG config 25          | 0                 | CYCPAT_PO7[2:0]    |               |         | 0              | CYCPAT_PO6[2:0] |                |         | 00h     |
| R185 (B9h) | clamp enable rise LSB | CLAMP_RISE[7:0]   |                    |               |         |                |                 |                |         | 00h     |
| R186 (BAh) | clamp enable rise MSB | 0                 | CLAMP_RISE[14:8]   |               |         |                |                 |                |         | 00h     |
| R187 (BBh) | clamp enable fall LSB | CLAMP_FALL[7:0]   |                    |               |         |                |                 |                |         | 00h     |
| R188 (BCh) | clamp enable fall MSB | 0                 | CLAMP_FALL[14:8]   |               |         |                |                 |                |         | 00h     |
| R189 (BDh) | OB start LSB          | OB_START[7:0]     |                    |               |         |                |                 |                |         | 00h     |
| R190 (BEh) | OB start MSB          | 0                 | OB_START[14:8]     |               |         |                |                 |                |         | 00h     |
| R191 (BFh) | peak_det rise LSB     | PEAKDET_RISE[7:0] |                    |               |         |                |                 |                |         | 00h     |
| R192 (C0h) | peak_det rise MSB     | 0                 | PEAKDET_RISE[14:8] |               |         |                |                 |                |         | 00h     |
| R193 (C1h) | peak_det fall LSB     | PEAKDET_FALL[7:0] |                    |               |         |                |                 |                |         | 00h     |
| R194 (C2h) | peak_det fall MSB     | 0                 | PEAKDET_FALL[14:8] |               |         |                |                 |                |         | 00h     |
| R195 (C3h) | Mask pulse 1 rise LSB | M1_RISE[7:0]      |                    |               |         |                |                 |                |         | 00h     |
| R196 (C4h) | Mask pulse 1 rise MSB | 0                 | M1_RISE[14:8]      |               |         |                |                 |                |         | 00h     |
| R197 (C5h) | Mask pulse 1 fall LSB | M1_FALL[7:0]      |                    |               |         |                |                 |                |         | 00h     |
| R198 (C6h) | Mask pulse 1 fall MSB | 0                 | M1_FALL[14:8]      |               |         |                |                 |                |         | 00h     |
| R199 (C7h) | Mask pulse 2 rise LSB | M2_RISE[7:0]      |                    |               |         |                |                 |                |         | 00h     |
| R200 (C8h) | Mask pulse 2 rise MSB | 0                 | M2_RISE[14:8]      |               |         |                |                 |                |         | 00h     |
| R201 (C9h) | Mask pulse 2 fall LSB | M2_FALL[7:0]      |                    |               |         |                |                 |                |         | 00h     |
| R202 (CAh) | Mask pulse 2 fall MSB | 0                 | M2_FALL[14:8]      |               |         |                |                 |                |         | 00h     |
| R203 (CBh) | Mask pulse 3 rise LSB | M3_RISE[7:0]      |                    |               |         |                |                 |                |         | 00h     |
| R204 (CCh) | Mask pulse 3 rise MSB | 0                 | M3_RISE[14:8]      |               |         |                |                 |                |         | 00h     |
| R205 (CDh) | Mask pulse 3 fall LSB | M3_FALL[7:0]      |                    |               |         |                |                 |                |         | 00h     |
| R206 (CEh) | Mask pulse 3 fall MSB | 0                 | M3_FALL[14:8]      |               |         |                |                 |                |         | 00h     |
| R207 (CFh) | Toggle point 0 LSB    | TP0[7:0]          |                    |               |         |                |                 |                |         | 00h     |
| R208 (D0h) | Toggle point 0 MSB    | GEN_TP0           | TP0[14:8]          |               |         |                |                 |                |         | 00h     |
| R209 (D1h) | Toggle point 1 LSB    | TP1[7:0]          |                    |               |         |                |                 |                |         | 00h     |
| R210 (D2h) | Toggle point 1 MSB    | EN_TP1            | TP1[14:8]          |               |         |                |                 |                |         | 00h     |
| R211 (D3h) | Toggle point 2 LSB    | TP2[7:0]          |                    |               |         |                |                 |                |         | 00h     |
| R212 (D4h) | Toggle point 2 MSB    | EN_TP2            | TP2[14:8]          |               |         |                |                 |                |         | 00h     |
| R213 (D5h) | Toggle point 3 LSB    | TP3[7:0]          |                    |               |         |                |                 |                |         | 00h     |
| R214 (D6h) | Toggle point 3 MSB    | EN_TP3            | TP3[14:8]          |               |         |                |                 |                |         | 00h     |
| R215 (D7h) | Toggle point 4 LSB    | TP4[7:0]          |                    |               |         |                |                 |                |         | 00h     |
| R216 (D8h) | Toggle point 4 MSB    | EN_TP4            | TP4[14:8]          |               |         |                |                 |                |         | 00h     |
| R217 (D9h) | Toggle point 5 LSB    | TP5[7:0]          |                    |               |         |                |                 |                |         | 00h     |

| REG         | NAME                | 7         | 6          | 5 | 4 | 3 | 2 | 1 | 0 | DEFAULT |
|-------------|---------------------|-----------|------------|---|---|---|---|---|---|---------|
| R218 (DAh)  | Toggle point 5 MSB  | EN_TP5    | TP5[14:8]  |   |   |   |   |   |   | 00h     |
| R219 (DBh)  | Toggle point 6 LSB  | TP6[7:0]  |            |   |   |   |   |   |   | 00h     |
| R220 (DCh)  | Toggle point 6 MSB  | EN_TP6    | TP6[14:8]  |   |   |   |   |   |   | 00h     |
| R221 (DDh)  | Toggle point 7 LSB  | TP7[7:0]  |            |   |   |   |   |   |   | 00h     |
| R222 (DEh)  | Toggle point 7 MSB  | EN_TP7    | TP7[14:8]  |   |   |   |   |   |   | 00h     |
| R223 (DFh)  | Toggle point 8 LSB  | TP8[7:0]  |            |   |   |   |   |   |   | 00h     |
| R224 (E0h)  | Toggle point 8 MSB  | EN_TP8    | TP8[14:8]  |   |   |   |   |   |   | 00h     |
| R225 (E1h)  | Toggle point 9 LSB  | TP9[7:0]  |            |   |   |   |   |   |   | 00h     |
| R226 (E2h)  | Toggle point 9 MSB  | EN_TP9    | TP9[14:8]  |   |   |   |   |   |   | 00h     |
| R227 (E3h)  | Toggle point 10 LSB | TP10[7:0] |            |   |   |   |   |   |   | 00h     |
| R228 (E4h)  | Toggle point 10 MSB | EN_TP10   | TP10[14:8] |   |   |   |   |   |   | 00h     |
| R229 (E5h)  | Toggle point 11 LSB | TP11[7:0] |            |   |   |   |   |   |   | 00h     |
| R230 (E6h)  | Toggle point 11 MSB | EN_TP11   | TP11[14:8] |   |   |   |   |   |   | 00h     |
| R231 (E7h)  | Toggle point 12 LSB | TP12[7:0] |            |   |   |   |   |   |   | 00h     |
| R232 (E8h)  | Toggle point 12 MSB | EN_TP12   | TP12[14:8] |   |   |   |   |   |   | 00h     |
| R233 (E9h)  | Toggle point 13 LSB | TP13[7:0] |            |   |   |   |   |   |   | 00h     |
| R234 (EAh)  | Toggle point 13 MSB | EN_TP13   | TP13[14:8] |   |   |   |   |   |   | 00h     |
| R235 (EBh)  | Toggle point 14 LSB | TP14[7:0] |            |   |   |   |   |   |   | 00h     |
| R236 (ECh)  | Toggle point 14 MSB | EN_TP14   | TP14[14:8] |   |   |   |   |   |   | 00h     |
| R237 (EDh)  | Toggle point 15 LSB | TP15[7:0] |            |   |   |   |   |   |   | 00h     |
| R238 (EEh)  | Toggle point 15 MSB | EN_TP15   | TP15[14:8] |   |   |   |   |   |   | 00h     |
| R239 (EFh)  | Toggle point 16 LSB | TP16[7:0] |            |   |   |   |   |   |   | 00h     |
| R240 (F0h)  | Toggle point 16 MSB | EN_TP16   | TP16[14:8] |   |   |   |   |   |   | 00h     |
| R241 (F1h)  | Toggle point 17 LSB | TP17[7:0] |            |   |   |   |   |   |   | 00h     |
| R242 (F2h)  | Toggle point 17 MSB | EN_TP17   | TP17[14:8] |   |   |   |   |   |   | 00h     |
| R243 (F3h)  | Toggle point 18 LSB | TP18[7:0] |            |   |   |   |   |   |   | 00h     |
| R244 (F4h)  | Toggle point 18 MSB | EN_TP18   | TP18[14:8] |   |   |   |   |   |   | 00h     |
| R245 (F5h)  | Toggle point 19 LSB | TP19[7:0] |            |   |   |   |   |   |   | 00h     |
| R246 (F6h)  | Toggle point 19 MSB | EN_TP19   | TP19[14:8] |   |   |   |   |   |   | 00h     |
| R247 (F7h)  | Toggle point 20 LSB | TP20[7:0] |            |   |   |   |   |   |   | 00h     |
| R248 (F8h)  | Toggle point 20 MSB | EN_TP20   | TP20[14:8] |   |   |   |   |   |   | 00h     |
| R249 (F9h)  | Toggle point 21 LSB | TP21[7:0] |            |   |   |   |   |   |   | 00h     |
| R250 (FAh)  | Toggle point 21 MSB | EN_TP21   | TP21[14:8] |   |   |   |   |   |   | 00h     |
| R251 (FBh)  | Toggle point 22 LSB | TP22[7:0] |            |   |   |   |   |   |   | 00h     |
| R252 (FCh)  | Toggle point 22 MSB | EN_TP22   | TP22[14:8] |   |   |   |   |   |   | 00h     |
| R253 (FDh)  | Toggle point 23 LSB | TP23[7:0] |            |   |   |   |   |   |   | 00h     |
| R254 (FEh)  | Toggle point 23 MSB | EN_TP23   | TP23[14:8] |   |   |   |   |   |   | 00h     |
| R255 (FFh)  | Toggle point 24 LSB | TP24[7:0] |            |   |   |   |   |   |   | 00h     |
| R256 (100h) | Toggle point 24 MSB | EN_TP24   | TP24[14:8] |   |   |   |   |   |   | 00h     |
| R257 (101h) | Toggle point 25 LSB | TP25[7:0] |            |   |   |   |   |   |   | 00h     |
| R258 (102h) | Toggle point 25 MSB | EN_TP25   | TP25[14:8] |   |   |   |   |   |   | 00h     |
| R259 (103h) | Toggle point 26 LSB | TP26[7:0] |            |   |   |   |   |   |   | 00h     |
| R260 (104h) | Toggle point 26 MSB | EN_TP26   | TP26[14:8] |   |   |   |   |   |   | 00h     |
| R261 (105h) | Toggle point 27 LSB | TP27[7:0] |            |   |   |   |   |   |   | 00h     |
| R262 (106h) | Toggle point 27 MSB | EN_TP27   | TP27[14:8] |   |   |   |   |   |   | 00h     |
| R263 (107h) | Toggle point 28 LSB | TP28[7:0] |            |   |   |   |   |   |   | 00h     |
| R264 (108h) | Toggle point 28 MSB | EN_TP28   | TP28[14:8] |   |   |   |   |   |   | 00h     |
| R265 (109h) | Toggle point 29 LSB | TP29[7:0] |            |   |   |   |   |   |   | 00h     |
| R266 (10Ah) | Toggle point 29 MSB | EN_TP29   | TP29[14:8] |   |   |   |   |   |   | 00h     |

| REG         | NAME                     | 7         | 6          | 5         | 4         | 3         | 2         | 1         | 0         | DEFAULT |
|-------------|--------------------------|-----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|---------|
| R267 (10Bh) | Toggle point 30 LSB      | TP30[7:0] |            |           |           |           |           |           |           | 00h     |
| R268 (10Ch) | Toggle point 30 MSB      | EN_TP30   | TP30[14:8] |           |           |           |           |           |           | 00h     |
| R269 (10Dh) | Toggle point 31 LSB      | TP31[7:0] |            |           |           |           |           |           |           | 00h     |
| R270 (10Eh) | Toggle point 31 MSB      | EN_TP31   | TP31[14:8] |           |           |           |           |           |           | 00h     |
| R271 (10Fh) | Polarity setting of T1 1 | POL7_T1   | POL6_T1    | POL5_T1   | POL4_T1   | POL3_T1   | POL2_T1   | POL1_T1   | POL0_T1   | FFh     |
| R272 (110h) | Polarity setting of T1 2 | POL15_T1  | POL14_T1   | POL13_T1  | POL12_T1  | POL11_T1  | POL10_T1  | POL9_T1   | POL8_T1   | FFh     |
| R273 (111h) | Polarity setting of T1 3 | POL23_T1  | POL22_T1   | POL21_T1  | POL20_T1  | POL19_T1  | POL18_T1  | POL17_T1  | POL16_T1  | FFh     |
| R274 (112h) | Polarity setting of T1 4 | POL31_T1  | POL30_T1   | POL29_T1  | POL28_T1  | POL27_T1  | POL26_T1  | POL25_T1  | POL24_T1  | FFh     |
| R275 (113h) | Polarity setting of T2 1 | POL7_T2   | POL6_T2    | POL5_T2   | POL4_T2   | POL3_T2   | POL2_T2   | POL1_T2   | POL0_T2   | FFh     |
| R276 (114h) | Polarity setting of T2 2 | POL15_T2  | POL14_T2   | POL13_T2  | POL12_T2  | POL11_T2  | POL10_T2  | POL9_T2   | POL8_T2   | FFh     |
| R277 (115h) | Polarity setting of T2 3 | POL23_T2  | POL22_T2   | POL21_T2  | POL20_T2  | POL19_T2  | POL18_T2  | POL17_T2  | POL16_T2  | FFh     |
| R278 (116h) | Polarity setting of T2 4 | POL31_T2  | POL30_T2   | POL29_T2  | POL28_T2  | POL27_T2  | POL26_T2  | POL25_T2  | POL24_T2  | FFh     |
| R279 (117h) | Polarity setting of P0 1 | POL7_P00  | POL6_P00   | POL5_P00  | POL4_P00  | POL3_P00  | POL2_P00  | POL1_P00  | POL0_P00  | 00h     |
| R280 (118h) | Polarity setting of P0 2 | POL15_P00 | POL14_P00  | POL13_P00 | POL12_P00 | POL11_P00 | POL10_P00 | POL9_P00  | POL8_P00  | 00h     |
| R281 (119h) | Polarity setting of P0 3 | POL23_P00 | POL22_P00  | POL21_P00 | POL20_P00 | POL19_P00 | POL18_P00 | POL17_P00 | POL16_P00 | 00h     |
| R282 (11Ah) | Polarity setting of P0 4 | POL31_P00 | POL30_P00  | POL29_P00 | POL28_P00 | POL27_P00 | POL26_P00 | POL25_P00 | POL24_P00 | 00h     |
| R283 (11Bh) | Polarity setting of P1 1 | POL7_P01  | POL6_P01   | POL5_P01  | POL4_P01  | POL3_P01  | POL2_P01  | POL1_P01  | POL0_P01  | 00h     |
| R284 (11Ch) | Polarity setting of P1 2 | POL15_P01 | POL14_P01  | POL13_P01 | POL12_P01 | POL11_P01 | POL10_P01 | POL9_P01  | POL8_P01  | 00h     |
| R285 (11Dh) | Polarity setting of P1 3 | POL23_P01 | POL22_P01  | POL21_P01 | POL20_P01 | POL19_P01 | POL18_P01 | POL17_P01 | POL16_P01 | 00h     |
| R286 (11Eh) | Polarity setting of P1 4 | POL31_P01 | POL30_P01  | POL29_P01 | POL28_P01 | POL27_P01 | POL26_P01 | POL25_P01 | POL24_P01 | 00h     |
| R287 (11Fh) | Polarity setting of P2 1 | POL7_P02  | POL6_P02   | POL5_P02  | POL4_P02  | POL3_P02  | POL2_P02  | POL1_P02  | POL0_P02  | 00h     |
| R288 (120h) | Polarity setting of P2 2 | POL15_P02 | POL14_P02  | POL13_P02 | POL12_P02 | POL11_P02 | POL10_P02 | POL9_P02  | POL8_P02  | 00h     |
| R289 (121h) | Polarity setting of P2 3 | POL23_P02 | POL22_P02  | POL21_P02 | POL20_P02 | POL19_P02 | POL18_P02 | POL17_P02 | POL16_P02 | 00h     |
| R290 (122h) | Polarity setting of P2 4 | POL31_P02 | POL30_P02  | POL29_P02 | POL28_P02 | POL27_P02 | POL26_P02 | POL25_P02 | POL24_P02 | 00h     |
| R291 (123h) | Polarity setting of P3 1 | POL7_P03  | POL6_P03   | POL5_P03  | POL4_P03  | POL3_P03  | POL2_P03  | POL1_P03  | POL0_P03  | 00h     |
| R292 (124h) | Polarity setting of P3 2 | POL15_P03 | POL14_P03  | POL13_P03 | POL12_P03 | POL11_P03 | POL10_P03 | POL9_P03  | POL8_P03  | 00h     |
| R293 (125h) | Polarity setting of P3 3 | POL23_P03 | POL22_P03  | POL21_P03 | POL20_P03 | POL19_P03 | POL18_P03 | POL17_P03 | POL16_P03 | 00h     |
| R294 (126h) | Polarity setting of P3 4 | POL31_P03 | POL30_P03  | POL29_P03 | POL28_P03 | POL27_P03 | POL26_P03 | POL25_P03 | POL24_P03 | 00h     |
| R295 (127h) | Polarity setting of P4 1 | POL7_P04  | POL6_P04   | POL5_P04  | POL4_P04  | POL3_P04  | POL2_P04  | POL1_P04  | POL0_P04  | 00h     |
| R296 (128h) | Polarity setting of P4 2 | POL15_P04 | POL14_P04  | POL13_P04 | POL12_P04 | POL11_P04 | POL10_P04 | POL9_P04  | POL8_P04  | 00h     |
| R297 (129h) | Polarity setting of P4 3 | POL23_P04 | POL22_P04  | POL21_P04 | POL20_P04 | POL19_P04 | POL18_P04 | POL17_P04 | POL16_P04 | 00h     |
| R298 (12Ah) | Polarity setting of P4 4 | POL31_P04 | POL30_P04  | POL29_P04 | POL28_P04 | POL27_P04 | POL26_P04 | POL25_P04 | POL24_P04 | 00h     |
| R299 (12Bh) | Polarity setting of P5 1 | POL7_P05  | POL6_P05   | POL5_P05  | POL4_P05  | POL3_P05  | POL2_P05  | POL1_P05  | POL0_P05  | 00h     |
| R300 (12Ch) | Polarity setting of P5 2 | POL15_P05 | POL14_P05  | POL13_P05 | POL12_P05 | POL11_P05 | POL10_P05 | POL9_P05  | POL8_P05  | 00h     |
| R301 (12Dh) | Polarity setting of P5 3 | POL23_P05 | POL22_P05  | POL21_P05 | POL20_P05 | POL19_P05 | POL18_P05 | POL17_P05 | POL16_P05 | 00h     |
| R302 (12Eh) | Polarity setting of P5 4 | POL31_P05 | POL30_P05  | POL29_P05 | POL28_P05 | POL27_P05 | POL26_P05 | POL25_P05 | POL24_P05 | 00h     |
| R303 (12Fh) | Polarity setting of P6 1 | POL7_P06  | POL6_P06   | POL5_P06  | POL4_P06  | POL3_P06  | POL2_P06  | POL1_P06  | POL0_P06  | 00h     |
| R304 (130h) | Polarity setting of P6 2 | POL15_P06 | POL14_P06  | POL13_P06 | POL12_P06 | POL11_P06 | POL10_P06 | POL9_P06  | POL8_P06  | 00h     |
| R305 (131h) | Polarity setting of P6 3 | POL23_P06 | POL22_P06  | POL21_P06 | POL20_P06 | POL19_P06 | POL18_P06 | POL17_P06 | POL16_P06 | 00h     |
| R306 (132h) | Polarity setting of P6 4 | POL31_P06 | POL30_P06  | POL29_P06 | POL28_P06 | POL27_P06 | POL26_P06 | POL25_P06 | POL24_P06 | 00h     |
| R307 (133h) | Polarity setting of P7 1 | POL7_P07  | POL6_P07   | POL5_P07  | POL4_P07  | POL3_P07  | POL2_P07  | POL1_P07  | POL0_P07  | 00h     |
| R308 (134h) | Polarity setting of P7 2 | POL15_P07 | POL14_P07  | POL13_P07 | POL12_P07 | POL11_P07 | POL10_P07 | POL9_P07  | POL8_P07  | 00h     |
| R309 (135h) | Polarity setting of P7 3 | POL23_P07 | POL22_P07  | POL21_P07 | POL20_P07 | POL19_P07 | POL18_P07 | POL17_P07 | POL16_P07 | 00h     |
| R310 (136h) | Polarity setting of P7 4 | POL31_P07 | POL30_P07  | POL29_P07 | POL28_P07 | POL27_P07 | POL26_P07 | POL25_P07 | POL24_P07 | 00h     |

## EXTENDED PAGE REGISTERS

|             |                     |   |   |   |           |   |   |              |           |     |
|-------------|---------------------|---|---|---|-----------|---|---|--------------|-----------|-----|
| R432 (1B0h) | User access control | 0 | 0 | 0 | 0         | 0 | 0 | 0            | USER_KEY  | 00h |
| R436 (1B4h) | LDO2 control        | 0 | 0 | 0 | LDO2 VSEL |   |   |              |           | 10h |
| R448 (1C0h) | USER_KEY2           | 0 | 0 | 0 | 0         | 0 | 0 | 0            | USER_KEY2 | 00h |
| R459 (1CBh) | Comp control        | 0 | 0 | 0 | 0         | 0 | 0 | PT_COMP[1:0] |           | 01h |

### Notes:

1. To change the LDO2 control, the USER\_KEY bit must be set to '1'.
2. If it's not required to change this register, it must be set as default.
3. To change the Comp control, the USER\_KEY2 bit must be set to '1'.
4. If it's not required to change this register, must be set as default.

## REGISTER BITS BY ADDRESS

| REGISTER ADDRESS                     | BIT | LABEL                 | DEFAULT   | DESCRIPTION                                                                                                                               | REFER TO |
|--------------------------------------|-----|-----------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R0 (00h)<br>Software Reset/Chip ID 1 | 7:0 | SW_RESET_CHIP_ID[7:0] | 0011_0010 | A write issues a software reset, and returns all control registers to their default values.<br>A read returns lower bits of the device ID |          |

**Register 00h** Software Reset/Chip ID 1

| REGISTER ADDRESS      | BIT | LABEL        | DEFAULT   | DESCRIPTION                                | REFER TO |
|-----------------------|-----|--------------|-----------|--------------------------------------------|----------|
| R1 (01h)<br>Chip ID 2 | 7:0 | CHIP_ID[7:0] | 1000_0010 | A read returns upper bits of the device ID |          |

**Register 01h** Chip ID 2

| REGISTER ADDRESS     | BIT | LABEL         | DEFAULT | DESCRIPTION                               | REFER TO |
|----------------------|-----|---------------|---------|-------------------------------------------|----------|
| R2 (02h)<br>Chip Rev | 3:0 | CHIP_REV[3:0] | 0000    | A read returns the device revision number |          |

**Register 02h** Chip Rev

| REGISTER ADDRESS        | BIT | LABEL  | DEFAULT | DESCRIPTION                                                                                                               | REFER TO |
|-------------------------|-----|--------|---------|---------------------------------------------------------------------------------------------------------------------------|----------|
| R3 (03h)<br>Setup Reg 1 | 4   | CHZPD  | 0       | ADC powerdown control for channel 3<br>(related PGA and digits goes power down)<br>0 = normal operation<br>1 = power down |          |
|                         | 3   | CHYPD  | 0       | ADC powerdown control for channel 2<br>(related PGA and digits goes power down)<br>0 = normal operation<br>1 = power down |          |
|                         | 2   | CHXPDP | 0       | ADC powerdown control for channel 1<br>(related PGA and digits goes power down)<br>0 = normal operation<br>1 = power down |          |
|                         | 1   | PDMD   | 0       | power down mode<br>0 : standby<br>1 : sleep                                                                               |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION                                          | REFER TO |
|------------------|-----|-------|---------|------------------------------------------------------|----------|
|                  | 0   | PD    | 0       | power down<br>0 : normal operation<br>1 : power down |          |

**Register 03h** Setup Reg 1

| REGISTER ADDRESS        | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                  | REFER TO |
|-------------------------|-----|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R4 (04h)<br>Setup Reg 2 | 7   | VRLC_TOP_SEL | 0       | selects output range of VRLCDAC<br>0 = AVDD<br>1 = 1.6V                                                                                                      |          |
|                         | 6   | PGAFS        | 0       | control PGA input polarity<br>0 = negative<br>1 = positive                                                                                                   |          |
|                         | 5   | ADCFS        | 0       | control ADC full scale range<br>0 = 1.2V<br>1 = 1.8V                                                                                                         |          |
|                         | 4   | TGDIVMD      | 0       | enable TG clock divide mode<br>0 = normal (TG clock rate = MCLK clock rate)<br>1 = enable TG clock divide mode<br>(TG clock rate is half of MCLK clock rate) |          |
|                         | 1   | CLPMD        | 0       | select clamp mode<br>0 = line clamp<br>1 = bit clamp                                                                                                         |          |
|                         | 0   | CDS          | 0       | CDS mode control<br>0 = S/H mode<br>1 = CDS mode                                                                                                             |          |

**Register 04h** Setup Reg 2

| REGISTER ADDRESS        | BIT | LABEL      | DEFAULT | DESCRIPTION                                                                                     | REFER TO |
|-------------------------|-----|------------|---------|-------------------------------------------------------------------------------------------------|----------|
| R5 (05h)<br>Setup Reg 3 | 4   | SF_BYPLS   | 1       | bypass level shift of VRLC source follower<br>0 = use level shifter<br>1 = bypass level shifter |          |
|                         | 3:2 | PT_SF[1:0] | 11      | source follower power trim<br>00 = 1mA<br>01 = 2mA<br>10 = 3mA<br>11 = 4mA                      |          |
|                         | 1   | SF_INP     | 0       | control source follower on signal inputs INP*<br>0 = disabled<br>1 = enabled                    |          |
|                         | 0   | SF_VRLC    | 0       | control source follower on VRLC<br>0 = disabled<br>1 = enabled                                  |          |

**Register 05h** Setup Reg 3

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|------------------|-----|-------|---------|-------------|----------|
|------------------|-----|-------|---------|-------------|----------|

| REGISTER ADDRESS         | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                                                   | REFER TO |
|--------------------------|-----|----------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R6 (06h)<br>VRLC control | 7   | VRLCEN         | 1       | enable for VRLC DAC<br>0 = disabled<br>1 = enabled                                                                                                                                            |          |
|                          | 6:5 | VRLC_ISEL[1:0] | 00      | selects output current capability<br>00 = Up to 2mA<br>01 = Up to 3mA<br>10 = Up to 4mA<br>11 = reserved (Up to 2mA)                                                                          |          |
|                          | 4:0 | VRLC_VSEL[4:0] | 0_1010  | VRLC output voltage setting<br><br>when VRLC_TOP_SEL=0 (AVDD)<br>$3.3/AVDD * (0.2 + 0.09 \times VRLC\_VSEL[4:0])$<br><br>when VRLC_TOP_SEL=1 (1.6V)<br>$1.6 - 0.048 * (31 - VRLC\_VSEL[4:0])$ |          |

**Register 06h** VRLC control

| REGISTER ADDRESS           | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                                               | REFER TO |
|----------------------------|-----|----------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R7 (07h)<br>output control | 7   | OE_OP          | 0       | output enable of dataout (CMOS/LVDS)<br>when HIZCTRL=0<br>0= Hi-Z<br>1= enable dataout<br>when HIZCTRL=1<br>OE_OP state is neglected and enable dataout                                   |          |
|                            | 6   | OUTPD          | 1       | control data output<br>0 = enable data output<br>1 = mask data output (data out=0)                                                                                                        |          |
|                            | 5   | CMOSMODE       | 0       | enable CMOS output mode<br>0 = LVDS output mode based on LVDSMODE[2:0]<br>1 = CMOS output mode                                                                                            |          |
|                            | 4   | OUTSYNC        | 0       | enable synchronous output mode<br>0 = continuous<br>1 = synchronized dataout with LineStart signal                                                                                        |          |
|                            | 3   | LVDSORDER      | 0       | control LVDS data output order<br>0 = descending order<br>1 = ascending order                                                                                                             |          |
|                            | 2:0 | LVDSMODE [2:0] | 000     | select LVDS dataoutput format<br>000 = 10bit 5pair + clk<br>001 = 10bit 3pair + clk<br>011 = 12bit 4pair + clk<br>101 = 16bit 5pair + clk<br>110 = 16bit 3pair + clk<br>Others = reserved |          |

**Register 07h** output control

| REGISTER ADDRESS         | BIT | LABEL    | DEFAULT | DESCRIPTION                                | REFER TO |
|--------------------------|-----|----------|---------|--------------------------------------------|----------|
| R8 (08h)<br>LVDS control | 6   | LVDS_POL | 0       | invert LVDS outputs polarity<br>0 = normal |          |

| REGISTER ADDRESS | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                               | REFER TO |
|------------------|-----|---------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|                  |     |               |         | 1 = inverted                                                                                                                                                              |          |
|                  | 5:3 | LVDS_AMP[2:0] | 110     | LVDS amplitude select<br>000 = 50mV<br>001 = 100mV<br>010 = 150mV<br>011 = 200mV<br>All other codes are Reserved.<br>Note that the default code (110) should not be used. |          |
|                  | 2:0 | LVDS_VCM[2:0] | 101     | LVDS common mode select<br>000 = 0.70V<br>001 = 0.80V<br>010 = 0.90V<br>011 = 1.00V<br>100 = 1.15V<br>101 = 1.25V<br>110 = 1.35V<br>111 = 1.45V                           |          |

**Register 08h** LVDS control

| REGISTER ADDRESS               | BIT | LABEL        | DEFAULT  | DESCRIPTION                              | REFER TO |
|--------------------------------|-----|--------------|----------|------------------------------------------|----------|
| R9 (09h)<br>LVDS clock pattern | 6:0 | LVCKPAT[6:0] | 110_0011 | LVDS clock pattern<br>(output MSB first) |          |

**Register 09h** LVDS clock pattern

| REGISTER ADDRESS            | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                | REFER TO |
|-----------------------------|-----|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R10 (0Ah)<br>flag control 1 | 7:4 | FLAG_S1[3:0] | 0001    | output dataflag as S1<br>(valid only LVDS mode)<br>0000 = always low<br>0001 = start flag<br>0010 = reserved<br>0011 = reserved<br>0100 = reserved<br>0101 = channel ID[0]<br>0110 = channel ID[1]<br>0111 = channel ID[2]<br>1000 = channel ID[3]<br>1001 = reserved<br>1010 = reserved<br>1011 = reserved<br>1100 = reserved<br>1101 = reserved<br>1110 = reserved<br>1111 = always high |          |



| REGISTER ADDRESS | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                | REFER TO |
|------------------|-----|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|                  | 3:0 | FLAG_S0[3:0] | 0000    | output dataflag as S0<br>(valid only LVDS mode)<br>0000 = always low<br>0001 = start flag<br>0010 = reserved<br>0011 = reserved<br>0100 = reserved<br>0101 = channel ID[0]<br>0110 = channel ID[1]<br>0111 = channel ID[2]<br>1000 = channel ID[3]<br>1001 = reserved<br>1010 = reserved<br>1011 = reserved<br>1100 = reserved<br>1101 = reserved<br>1110 = reserved<br>1111 = always high |          |

**Register 0Ah** flag control 1

| REGISTER ADDRESS            | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                | REFER TO |
|-----------------------------|-----|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R11 (0Bh)<br>flag control 2 | 7:4 | FLAG_S3[3:0] | 0000    | output dataflag as S3<br>(valid only LVDS mode)<br>0000 = always low<br>0001 = start flag<br>0010 = reserved<br>0011 = reserved<br>0100 = reserved<br>0101 = channel ID[0]<br>0110 = channel ID[1]<br>0111 = channel ID[2]<br>1000 = channel ID[3]<br>1001 = reserved<br>1010 = reserved<br>1011 = reserved<br>1100 = reserved<br>1101 = reserved<br>1110 = reserved<br>1111 = always high |          |
|                             | 3:0 | FLAG_S2[3:0] | 0000    | output dataflag as S2<br>(valid only LVDS mode)<br>0000 = always low<br>0001 = start flag<br>0010 = reserved<br>0011 = reserved<br>0100 = reserved<br>0101 = channel ID[0]<br>0110 = channel ID[1]<br>0111 = channel ID[2]<br>1000 = channel ID[3]<br>1001 = reserved                                                                                                                      |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION                                                                                                       | REFER TO |
|------------------|-----|-------|---------|-------------------------------------------------------------------------------------------------------------------|----------|
|                  |     |       |         | 1010 = reserved<br>1011 = reserved<br>1100 = reserved<br>1101 = reserved<br>1110 = reserved<br>1111 = always high |          |

**Register 0Bh** flag control 2

| REGISTER ADDRESS            | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                | REFER TO |
|-----------------------------|-----|--------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R12 (0Ch)<br>flag control 3 | 3:0 | FLAG_S4[3:0] | 0000    | output dataflag as S4<br>(valid only LVDS mode)<br>0000 = always low<br>0001 = start flag<br>0010 = reserved<br>0011 = reserved<br>0100 = reserved<br>0101 = channel ID[0]<br>0110 = channel ID[1]<br>0111 = channel ID[2]<br>1000 = channel ID[3]<br>1001 = reserved<br>1010 = reserved<br>1011 = reserved<br>1100 = reserved<br>1101 = reserved<br>1110 = reserved<br>1111 = always high |          |

**Register 0Ch** flag control 3

| REGISTER ADDRESS                        | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                                                                                | REFER TO |
|-----------------------------------------|-----|-------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R13 (0Dh)<br>CMOS drivability control 1 | 3   | DRV_CTRL    | 0       | CMOS output drivability control mode<br>0 = OP_DRV controls drivability of all output pins OP*<br>1 = OP_DRV is invalid, and OP*_DRV control drivability of output pin OP* |          |
|                                         | 2:0 | OP_DRV[2:0] | 000     | CMOS output drivability control when DRV_CTRL=0<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA                                   |          |

**Register 0Dh** CMOS drivability control 1

| REGISTER ADDRESS | BIT | LABEL        | DEFAULT | DESCRIPTION                   | REFER TO |
|------------------|-----|--------------|---------|-------------------------------|----------|
| R14 (0Eh)        | 6:4 | OP1_DRV[2:0] | 000     | CMOS output (OP2) drivability |          |

| REGISTER ADDRESS           | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                            | REFER TO |
|----------------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------|----------|
| CMOS drivability control 2 |     |              |         | 000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA                                  |          |
|                            | 2:0 | OP0_DRV[2:0] | 000     | CMOS output (OP1) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |

**Register 0Eh** CMOS drivability control 2

| REGISTER ADDRESS                        | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                            | REFER TO |
|-----------------------------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------|----------|
| R15 (0Fh)<br>CMOS drivability control 3 | 6:4 | OP3_DRV[2:0] | 000     | CMOS output (OP4) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |
|                                         | 2:0 | OP2_DRV[2:0] | 000     | CMOS output (OP3) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |

**Register 0Fh** CMOS drivability control 3

| REGISTER ADDRESS                        | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                            | REFER TO |
|-----------------------------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------|----------|
| R16 (10h)<br>CMOS drivability control 4 | 6:4 | OP5_DRV[2:0] | 000     | CMOS output (OP6) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |

| REGISTER ADDRESS | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                            | REFER TO |
|------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------|----------|
|                  | 2:0 | OP4_DRV[2:0] | 000     | CMOS output (OP5) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |

**Register 10h** CMOS drivability control 4

| REGISTER ADDRESS                              | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                            | REFER TO |
|-----------------------------------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------|----------|
| R17 (11h)<br>CMOS<br>drivability<br>control 5 | 6:4 | OP7_DRV[2:0] | 000     | CMOS output (OP8) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |
|                                               | 2:0 | OP6_DRV[2:0] | 000     | CMOS output (OP7) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |

**Register 11h** CMOS drivability control 5

| REGISTER ADDRESS                              | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                             | REFER TO |
|-----------------------------------------------|-----|--------------|---------|-------------------------------------------------------------------------------------------------------------------------|----------|
| R18 (12h)<br>CMOS<br>drivability<br>control 6 | 6:4 | OP9_DRV[2:0] | 000     | CMOS output (OP10) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |
|                                               | 2:0 | OP8_DRV[2:0] | 000     | CMOS output (OP9) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA  |          |

**Register 12h** CMOS drivability control 6

| REGISTER ADDRESS                        | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                            | REFER TO |
|-----------------------------------------|-----|--------------|---------|------------------------------------------------------------------------------------------------------------------------|----------|
| R19 (13h)<br>CMOS drivability control 7 | 6:4 | OC2_DRV[2:0] | 000     | CMOS output (OC2) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |
|                                         | 2:0 | OC1_DRV[2:0] | 000     | CMOS output (OC1) drivability<br>000: Hi-Z<br>001: 1mA<br>010: 2mA<br>011: 3mA<br>100: 4mA<br>101: 5mA<br>110/111: 6mA |          |

**Register 13h** CMOS drivability control 7

| REGISTER ADDRESS       | BIT | LABEL      | DEFAULT | DESCRIPTION                                                                                                                  | REFER TO |
|------------------------|-----|------------|---------|------------------------------------------------------------------------------------------------------------------------------|----------|
| R20 (14h)<br>PG config | 7   | PGMARCH    | 0       | pattern generator marching mode enable<br>0 = controlled by PGPAT<br>1 = marching pattern                                    |          |
|                        | 6:5 | PGPAT[1:0] | 00      | select pattern generator output<br>00 = fixed value<br>01 = vertical ramp<br>10 = horizontal ramp<br>11 = patch              |          |
|                        | 4   | PGINV      | 0       | invert pattern generator output<br>0 = normal<br>1 = invert                                                                  |          |
|                        | 3   | SEL_PGZ    | 0       | select output of pattern generator (IN3)<br>0 = normal output<br>1 = output generated digital pattern instead of ADC outputs |          |
|                        | 2   | SEL_PGY    | 0       | select output of pattern generator (IN2)<br>0 = normal output<br>1 = output generated digital pattern instead of ADC outputs |          |
|                        | 1   | SEL_PGX    | 0       | select output of pattern generator (IN1)<br>0 = normal output<br>1 = output generated digital pattern instead of ADC outputs |          |
|                        | 0   | PGEN       | 0       | enable pattern generator<br>0 = disable<br>1 = enable                                                                        |          |

**Register 14h** PG config

| REGISTER ADDRESS    | BIT | LABEL        | DEFAULT   | DESCRIPTION                    | REFER TO |
|---------------------|-----|--------------|-----------|--------------------------------|----------|
| R21 (15h)<br>PGCODE | 7:0 | PGLEVEL[7:0] | 0000_0000 | parameter of pattern generator |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|------------------|-----|-------|---------|-------------|----------|
| LSB              |     |       |         |             |          |

**Register 15h** PGCODE LSB

| REGISTER ADDRESS           | BIT | LABEL        | DEFAULT   | DESCRIPTION                    | REFER TO |
|----------------------------|-----|--------------|-----------|--------------------------------|----------|
| R22 (16h)<br>PGCODE<br>MSB | 7:0 | PGLEVEL[7:0] | 0000_0000 | parameter of pattern generator |          |

**Register 16h** PGCODE MSB

| REGISTER ADDRESS        | BIT | LABEL         | DEFAULT   | DESCRIPTION                    | REFER TO |
|-------------------------|-----|---------------|-----------|--------------------------------|----------|
| R23 (17h)<br>PG width 1 | 7:0 | PGWIDTH1[7:0] | 0000_0000 | parameter of pattern generator |          |

**Register 17h** PG width 1

| REGISTER ADDRESS        | BIT | LABEL         | DEFAULT   | DESCRIPTION                    | REFER TO |
|-------------------------|-----|---------------|-----------|--------------------------------|----------|
| R24 (18h)<br>PG width 2 | 7:0 | PGWIDTH2[7:0] | 0000_0000 | parameter of pattern generator |          |

**Register 18h** PG width 2

| REGISTER ADDRESS           | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                   | REFER TO |
|----------------------------|-----|-------------|---------|---------------------------------------------------------------------------------------------------------------|----------|
| R25 (19h)<br>clock monitor | 2:0 | MONCLK[2:0] | 000     | select monitor output<br>0xx = Low (monitor disabled)<br>100 = RSMP<br>101 = VSMP<br>110 = ACLK<br>111 = OCLK |          |

**Register 19h** clock monitor

| REGISTER ADDRESS           | BIT | LABEL       | DEFAULT | DESCRIPTION                                             | REFER TO |
|----------------------------|-----|-------------|---------|---------------------------------------------------------|----------|
| R26 (1Ah)<br>PLL control 1 | 2   | PLL_LPF_RST | 0       | Reset Loop Filter.<br>0 = normal<br>1 = reset           |          |
|                            | 1   | PLL_CP_PD   | 0       | power down Charge Pump.<br>0 = normal<br>1 = power down |          |
|                            | 0   | PLL_VCO_PD  | 0       | power down VCO<br>0 = normal<br>1 = power down          |          |

**Register 1Ah** PLL control 1

| REGISTER ADDRESS           | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                                                          | REFER TO |
|----------------------------|-----|--------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R27 (1Bh)<br>PLL control 2 | 6   | PLL_LPF_SEL        | 0       | Control Loop Filter to improve the performance.<br>Note: these settings are applicable for the specific conditions.<br>0 = normal filter<br>1 = larger resistor to improve PLL cutoff freq (for SSC) |          |
|                            | 3:2 | PLL_PFD_CTRL [1:0] | 10      | Control reset delay to improve PFD sensitivity.<br>00 = 1ns delay<br>01 = 2.2ns delay<br>10 = 3.4ns delay (default)<br>11 = 5.8ns delay                                                              |          |
|                            | 1:0 | PLL_CP_GAIN [1:0]  | 01      | Control Charge Pump current.<br>00 = 0.5uA<br>01 = 1uA (default)<br>10 = 2uA<br>11 = 4uA                                                                                                             |          |

**Register 1Bh** PLL control 2

| REGISTER ADDRESS                   | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                                        | REFER TO |
|------------------------------------|-----|--------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R28 (1Ch)<br>PLL divider control 1 | 6:4 | PLL_EXDIV_SEL[2:0] | 001     | Select EX DIV ratio.<br>Need to set according to input frequency. See details in "PLL DLL Setup"<br>000 = 1<br>001 = 2<br>010 = 4<br>011 = 8<br>100 = 16<br>101 to 111 = reserved. |          |
|                                    | 3:0 | PLL_FBDIV_SEL[3:0] | 0001    | Select FB DIV ratio. (ReadOnly)<br>0000 = 1<br>0001 = 2<br>0010 = 3<br>0011 = 4<br>0100 = 6<br>0101 = 8<br>0110 = 9<br>0111 = 12<br>1000 = 18<br>1001 to 1111 = reserved.          |          |

**Register 1Ch** PLL divider control 1

| REGISTER ADDRESS                   | BIT | LABEL                 | DEFAULT | DESCRIPTION                                                                    | REFER TO |
|------------------------------------|-----|-----------------------|---------|--------------------------------------------------------------------------------|----------|
| R29 (1Dh)<br>PLL divider control 2 | 5:4 | PLL_POSTDIV2_SEL[1:0] | 01      | Select POST DIV2 ratio.<br>(Read Only)<br>00 = 1<br>01 = 2<br>10 = 4<br>11 = 6 |          |

| REGISTER ADDRESS | BIT | LABEL                 | DEFAULT | DESCRIPTION                                                                                                                                                                   | REFER TO |
|------------------|-----|-----------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|                  | 3:0 | PLL_POSTDIV1_SEL[3:0] | 0001    | Select POST DIV1 ratio. (Read Only)<br>0000 = 1<br>0001 = 2<br>0010 = 3<br>0011 = 4<br>0100 = 6<br>0101 = 8<br>0110 = 9<br>0111 = 12<br>1000 = 18<br>1001 to 1111 = reserved. |          |

**Register 1Dh** PLL divider control 2

| REGISTER ADDRESS                | BIT | LABEL      | DEFAULT | DESCRIPTION                                                                                                                | REFER TO |
|---------------------------------|-----|------------|---------|----------------------------------------------------------------------------------------------------------------------------|----------|
| R35 (23h)<br>Cycle mode control | 3:2 | INTM[1:0]  | 00      | When LINEBYLINE=1, controls the GAIN and DAC mux selector when ACYC=0<br>00 = IN1<br>01 = IN2<br>10 = IN3<br>11 = reserved |          |
|                                 | 1   | ACYC       | 0       | when LINEBYLINE=1, determines the function of the MUX control<br>0 = decided by INTM register<br>1= auto-cycling enabled   |          |
|                                 | 0   | LINEBYLINE | 0       | select line by line operation<br>0=normal operation<br>1=Line by Line operation                                            |          |

**Register 23h** cycle mode control

| REGISTER ADDRESS     | BIT | LABEL       | DEFAULT   | DESCRIPTION                                                      | REFER TO |
|----------------------|-----|-------------|-----------|------------------------------------------------------------------|----------|
| R38 (26h)<br>DAC IN1 | 7:0 | DACIN1[7:0] | 1000_0000 | DACIN1offset value<br>$250 * (DACIN1[7:0] - 127.5) / 127.5$ [mV] |          |

**Register 26h** DAC IN1

| REGISTER ADDRESS     | BIT | LABEL       | DEFAULT   | DESCRIPTION                                                       | REFER TO |
|----------------------|-----|-------------|-----------|-------------------------------------------------------------------|----------|
| R41 (29h)<br>DAC IN2 | 7:0 | DACIN2[7:0] | 1000_0000 | DACIN2 offset value<br>$250 * (DACIN2[7:0] - 127.5) / 127.5$ [mV] |          |

**Register 29h** DAC IN2

| REGISTER ADDRESS     | BIT | LABEL       | DEFAULT   | DESCRIPTION                                                      | REFER TO |
|----------------------|-----|-------------|-----------|------------------------------------------------------------------|----------|
| R44 (2Ch)<br>DAC IN3 | 7:0 | DACIN3[7:0] | 1000_0000 | DACIN3offset value<br>$250 * (DACIN3[7:0] - 127.5) / 127.5$ [mV] |          |

**Register 2Ch** DAC IN3



| REGISTER ADDRESS       | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                 | REFER TO |
|------------------------|-----|---------------|---------|-----------------------------------------------------------------------------|----------|
| R47 (2Fh)<br>AGAIN IN1 | 4:0 | AGAININ1[4:0] | 0_0001  | PGA IN1 gain code<br>$\text{gain(V/V)} = 0.6 + 0.3 \cdot \text{AGAIN}[4:0]$ |          |

**Register 2Fh** AGAIN IN1

| REGISTER ADDRESS       | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                 | REFER TO |
|------------------------|-----|---------------|---------|-----------------------------------------------------------------------------|----------|
| R50 (32h)<br>AGAIN IN2 | 4:0 | AGAININ2[4:0] | 0_0001  | PGA IN2 gain code<br>$\text{gain(V/V)} = 0.6 + 0.3 \cdot \text{AGAIN}[4:0]$ |          |

**Register 32h** AGAIN IN2

| REGISTER ADDRESS       | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                 | REFER TO |
|------------------------|-----|---------------|---------|-----------------------------------------------------------------------------|----------|
| R53 (35h)<br>AGAIN IN3 | 4:0 | AGAININ3[4:0] | 0_0001  | PGA IN3 gain code<br>$\text{gain(V/V)} = 0.6 + 0.3 \cdot \text{AGAIN}[4:0]$ |          |

**Register 35h** AGAIN IN3

| REGISTER ADDRESS              | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                                                                                    | REFER TO |
|-------------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R58 (3Ah)<br>DGAIN IN1<br>LSB | 7:4 | DGAININ1[3:0] | 0000    | lower bits of digital gain IN1<br>1111_1111_1111_1111 = 1.99[V/V]<br>...<br>1000_0000_0000_0000 = 1.0[V/V]<br>...<br>0100_0000_0000_0000 = 0.5[V/V]<br>0011_1111_1111_1111 = reserved<br>...<br>0000_0000_0000_0000 = reserved |          |

**Register 3Ah** DGAIN IN1 LSB

| REGISTER ADDRESS              | BIT | LABEL          | DEFAULT   | DESCRIPTION                                                                                                                                                                                                                    | REFER TO |
|-------------------------------|-----|----------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R59 (3Bh)<br>DGAIN IN1<br>MSB | 7:0 | DGAININ1[11:4] | 1000_0000 | upper bits of digital gain IN1<br>1111_1111_1111_1111 = 1.99[V/V]<br>...<br>1000_0000_0000_0000 = 1.0[V/V]<br>...<br>0100_0000_0000_0000 = 0.5[V/V]<br>0011_1111_1111_1111 = reserved<br>...<br>0000_0000_0000_0000 = reserved |          |

**Register 3Bh** DGAIN IN1 MSB

| REGISTER ADDRESS       | BIT | LABEL         | DEFAULT | DESCRIPTION                                                       | REFER TO |
|------------------------|-----|---------------|---------|-------------------------------------------------------------------|----------|
| R64 (40h)<br>DGAIN IN2 | 7:4 | DGAININ2[3:0] | 0000    | lower bits of digital gain IN2<br>1111_1111_1111_1111 = 1.99[V/V] |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION                                                                                                                                               | REFER TO |
|------------------|-----|-------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| LSB              |     |       |         | ...<br>1000_0000_0000_0000 = 1.0[V/V]<br>...<br>0100_0000_0000_0000 = 0.5[V/V]<br>0011_1111_1111_1111 = reserved<br>...<br>0000_0000_0000_0000 = reserved |          |

**Register 40h** DGAIN IN2 LSB

| REGISTER ADDRESS              | BIT | LABEL          | DEFAULT   | DESCRIPTION                                                                                                                                                                                                                    | REFER TO |
|-------------------------------|-----|----------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R65 (41h)<br>DGAIN IN2<br>MSB | 7:0 | DGAININ2[11:4] | 1000_0000 | upper bits of digital gain IN2<br>1111_1111_1111_1111 = 1.99[V/V]<br>...<br>1000_0000_0000_0000 = 1.0[V/V]<br>...<br>0100_0000_0000_0000 = 0.5[V/V]<br>0011_1111_1111_1111 = reserved<br>...<br>0000_0000_0000_0000 = reserved |          |

**Register 41h** DGAIN IN2 MSB

| REGISTER ADDRESS              | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                                                                                    | REFER TO |
|-------------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R70 (46h)<br>DGAIN IN3<br>LSB | 7:4 | DGAININ3[3:0] | 0000    | lower bits of digital gain IN3<br>1111_1111_1111_1111 = 1.99[V/V]<br>...<br>1000_0000_0000_0000 = 1.0[V/V]<br>...<br>0100_0000_0000_0000 = 0.5[V/V]<br>0011_1111_1111_1111 = reserved<br>...<br>0000_0000_0000_0000 = reserved |          |

**Register 46h** DGAIN IN3 LSB

| REGISTER ADDRESS              | BIT | LABEL          | DEFAULT   | DESCRIPTION                                                                                                                                                                                                                    | REFER TO |
|-------------------------------|-----|----------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R71 (47h)<br>DGAIN IN3<br>MSB | 7:0 | DGAININ3[11:4] | 1000_0000 | upper bits of digital gain IN3<br>1111_1111_1111_1111 = 1.99[V/V]<br>...<br>1000_0000_0000_0000 = 1.0[V/V]<br>...<br>0100_0000_0000_0000 = 0.5[V/V]<br>0011_1111_1111_1111 = reserved<br>...<br>0000_0000_0000_0000 = reserved |          |

**Register 47h** DGAIN IN3 MSB

| REGISTER ADDRESS            | BIT | LABEL          | DEFAULT   | DESCRIPTION                | REFER TO |
|-----------------------------|-----|----------------|-----------|----------------------------|----------|
| R74 (4Ah)<br>BLC IN1 target | 7:0 | TARGETIN1[7:0] | 0000_0000 | target black level for IN1 |          |

**Register 4Ah** BLC IN1 target

| REGISTER ADDRESS            | BIT | LABEL          | DEFAULT   | DESCRIPTION                | REFER TO |
|-----------------------------|-----|----------------|-----------|----------------------------|----------|
| R77 (4Dh)<br>BLC IN2 target | 7:0 | TARGETIN2[7:0] | 0000_0000 | target black level for IN2 |          |

**Register 4Dh** BLC IN2 target

| REGISTER ADDRESS            | BIT | LABEL          | DEFAULT   | DESCRIPTION                | REFER TO |
|-----------------------------|-----|----------------|-----------|----------------------------|----------|
| R80 (50h)<br>BLC IN3 target | 7:0 | TARGETIN3[7:0] | 0000_0000 | target black level for IN3 |          |

**Register 50h** BLC IN3 target

| REGISTER ADDRESS           | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                         | REFER TO |
|----------------------------|-----|--------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R81 (51h)<br>BLC control 1 | 7   | FRAME_SEQ    | 0       | control frame sequence mode<br>0 = line by line<br>1 = frame sequence mode                                                                          |          |
|                            | 6   | FA_EVERYLINE | 0       | control fine adjustment<br>0 = Fine adjust only used on the 1st line of a frame<br>1 = Fine adjust used on every line of a frame                    |          |
|                            | 5   | FA_ACCUM     | 0       | makes the fine adjust calibration accumulate a result over multiple lines<br>0 = not accumulate<br>1 = accumulate                                   |          |
|                            | 4   | FA_EN        | 0       | enables the fine adjust operation<br>0 = disable<br>1 = enable                                                                                      |          |
|                            | 3   | CA_EVERYLINE | 0       | control coarse adjustment<br>0 = Coarse adjust only used on the 1st line of a frame<br>1 = Coarse adjust used on every line of a frame              |          |
|                            | 2:0 | CADUR[2:0]   | 000     | controls the number of coarse adjust iterations to be performed<br>000 = disable<br>001 = 1time<br>010 = 2time<br>011 = 3time<br>...<br>111 = 7time |          |

**Register 51h** BLC control 1

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|------------------|-----|-------|---------|-------------|----------|
|------------------|-----|-------|---------|-------------|----------|

| REGISTER ADDRESS           | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                                                                                                                                                                                       | REFER TO |
|----------------------------|-----|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R82 (52h)<br>BLC control 2 | 1   | SEQ_START   | 0       | register flag to indicate that the next start-of-line indicator is the first line of the first frame in a frame-sequence. This register is automatically set to zero at the end of the BLC operation on the first line<br>0 = no effect<br>1 = first frame of frame-sequence mode |          |
|                            | 0   | FRAME_START | 0       | Register flag to indicate that the next start-of-line indicator is the first line in a frame. This register is automatically set to zero at the end of the BLC operation on the first line<br>0 = no effect<br>1 = start of line                                                  |          |

**Register 52h** BLC control 2

| REGISTER ADDRESS           | BIT | LABEL                | DEFAULT   | DESCRIPTION                                                                                                                                                                     | REFER TO |
|----------------------------|-----|----------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R83 (53h)<br>BLC control 3 | 7:0 | BPIX_AVAIL[7:0]<br>] | 0000_0000 | LSBs of the number of black-pixels available over which to perform the coarse and/or fine adjust calibration<br>00_0000_0000 = no pixel available<br>11_1111_1111 = 1023 pixels |          |

**Register 53h** BLC control 3

| REGISTER ADDRESS           | BIT | LABEL                | DEFAULT | DESCRIPTION                                                                                                                                                                     | REFER TO |
|----------------------------|-----|----------------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R84 (54h)<br>BLC control 4 | 1:0 | BPIX_AVAIL[9:8]<br>] | 00      | MSBs of the number of black-pixels available over which to perform the coarse and/or fine adjust calibration<br>00_0000_0000 = no pixel available<br>11_1111_1111 = 1023 pixels |          |

**Register 54h** BLC control 4

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT   | DESCRIPTION                                                                                                                                   | REFER TO |
|----------------------------|-----|---------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R85 (55h)<br>BLC control 5 | 7:0 | LINE_DEL[7:0] | 0000_0000 | LSBs of the number of lines from the start of a frame to delay the start of BLC operation<br>0_0000_0000 = no delay<br>1_1111_1111 = 511 line |          |

**Register 55h** BLC control 5

| REGISTER ADDRESS           | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                                                   | REFER TO |
|----------------------------|-----|-------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R86 (56h)<br>BLC control 6 | 0   | LINE_DEL[8] | 0       | MSBs of the number of lines from the start of a frame to delay the start of BLC operation<br>0_0000_0000 = no delay<br>1_1111_1111 = 511 line |          |

**Register 56h** BLC control 6

| REGISTER ADDRESS | BIT | LABEL       | DEFAULT | DESCRIPTION                            | REFER TO |
|------------------|-----|-------------|---------|----------------------------------------|----------|
| R87 (57h)        | 7:4 | AGCAVE[3:0] | 0000    | averaging factor before peak detection |          |

| REGISTER ADDRESS | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                                                                                | REFER TO |
|------------------|-----|-------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| AGC config 1     |     |             |         | 0000 = no average<br>0001 = 2<br>0010 = 4<br>0011 = 8<br>...<br>1010 = 1024<br>1011 = reserved<br>1100 = reserved<br>1101 = reserved<br>1110 = reserved<br>1111 = reserved |          |
|                  | 2   | AGC_ERRFLAG | 0       | AGC error flag<br>0 = no error detected<br>1 = AGC finish with error                                                                                                       |          |
|                  | 1   | AGC_ENDFLAG | 0       | AGC end flag<br>0 = not end or not run<br>1 = AGC sequence was done                                                                                                        |          |
|                  | 0   | AGC_EN      | 0       | AGC enable<br>0 = disable<br>1 = enable                                                                                                                                    |          |

**Register 57h** AGC config 1

| REGISTER ADDRESS          | BIT | LABEL        | DEFAULT | DESCRIPTION                                                                                                                                                 | REFER TO |
|---------------------------|-----|--------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R88 (58h)<br>AGC config 2 | 6:4 | AGC_DPD[2:0] | 000     | the number of peak detection iterations to calculate digital gain<br>000 = no digital gain adjustment<br>001 = 1line<br>010 = 2line<br>...<br>111 = 7line   |          |
|                           | 2:0 | AGC_APD[2:0] | 000     | the number of peak detection iterations to calculate analogue gain<br>000 = no analogue gain adjustment<br>001 = 1line<br>010 = 2line<br>...<br>111 = 7line |          |

**Register 58h** AGC config 2

| REGISTER ADDRESS                   | BIT | LABEL                  | DEFAULT   | DESCRIPTION                      | REFER TO |
|------------------------------------|-----|------------------------|-----------|----------------------------------|----------|
| R93 (5Dh)<br>AGC target<br>IN1 LSB | 7:0 | AGC_TARGET<br>IN1[7:0] | 0000_0000 | LSBs of AGC target level for IN1 |          |

**Register 5Dh** AGC target IN1 LSB

| REGISTER ADDRESS | BIT | LABEL      | DEFAULT | DESCRIPTION                      | REFER TO |
|------------------|-----|------------|---------|----------------------------------|----------|
| R94 (5Eh)        | 1:0 | AGC_TARGET | 00      | MSBs of AGC target level for IN1 |          |

| REGISTER ADDRESS   | BIT | LABEL    | DEFAULT | DESCRIPTION | REFER TO |
|--------------------|-----|----------|---------|-------------|----------|
| AGC target IN1 MSB |     | IN1[9:8] |         |             |          |

**Register 5Eh** AGC target IN1 MSB

| REGISTER ADDRESS                | BIT | LABEL               | DEFAULT   | DESCRIPTION                      | REFER TO |
|---------------------------------|-----|---------------------|-----------|----------------------------------|----------|
| R99 (63h)<br>AGC target IN2 LSB | 7:0 | AGC_TARGET IN2[7:0] | 0000_0000 | LSBs of AGC target level for IN2 |          |

**Register 63h** AGC target IN2 LSB

| REGISTER ADDRESS                 | BIT | LABEL               | DEFAULT | DESCRIPTION                      | REFER TO |
|----------------------------------|-----|---------------------|---------|----------------------------------|----------|
| R100 (64h)<br>AGC target IN2 MSB | 1:0 | AGC_TARGET IN2[9:8] | 00      | MSBs of AGC target level for IN2 |          |

**Register 64h** AGC target IN2 MSB

| REGISTER ADDRESS                 | BIT | LABEL               | DEFAULT   | DESCRIPTION                      | REFER TO |
|----------------------------------|-----|---------------------|-----------|----------------------------------|----------|
| R105 (69h)<br>AGC target IN3 LSB | 7:0 | AGC_TARGET IN3[7:0] | 0000_0000 | LSBs of AGC target level for IN3 |          |

**Register 69h** AGC target IN3 LSB

| REGISTER ADDRESS                 | BIT | LABEL               | DEFAULT | DESCRIPTION                      | REFER TO |
|----------------------------------|-----|---------------------|---------|----------------------------------|----------|
| R106 (6Ah)<br>AGC target IN3 MSB | 1:0 | AGC_TARGET IN3[9:8] | 00      | MSBs of AGC target level for IN3 |          |

**Register 6Ah** AGC target IN3 MSB

| REGISTER ADDRESS                     | BIT | LABEL         | DEFAULT   | DESCRIPTION                                    | REFER TO |
|--------------------------------------|-----|---------------|-----------|------------------------------------------------|----------|
| R111 (6Fh)<br>AGC peak level IN1 LSB | 7:0 | PEAK_IN1[7:0] | 0000_0000 | LSBs of detected peak level of IN1 (Read Only) |          |

**Register 6Fh** AGC peak level IN1 LSB

| REGISTER ADDRESS                     | BIT | LABEL         | DEFAULT | DESCRIPTION                                    | REFER TO |
|--------------------------------------|-----|---------------|---------|------------------------------------------------|----------|
| R112 (70h)<br>AGC peak level IN1 MSB | 1:0 | PEAK_IN1[9:8] | 00      | MSBs of detected peak level of IN1 (Read Only) |          |

**Register 70h** AGC peak level IN1 MSB

| REGISTER ADDRESS                     | BIT | LABEL         | DEFAULT   | DESCRIPTION                                    | REFER TO |
|--------------------------------------|-----|---------------|-----------|------------------------------------------------|----------|
| R117 (75h)<br>AGC peak level IN2 LSB | 7:0 | PEAK_IN2[7:0] | 0000_0000 | LSBs of detected peak level of IN2 (Read Only) |          |

**Register 75h** AGC peak level IN2 LSB

| REGISTER ADDRESS                     | BIT | LABEL         | DEFAULT | DESCRIPTION                                    | REFER TO |
|--------------------------------------|-----|---------------|---------|------------------------------------------------|----------|
| R118 (76h)<br>AGC peak level IN2 MSB | 1:0 | PEAK_IN2[9:8] | 00      | MSBs of detected peak level of IN2 (Read Only) |          |

**Register 76h** AGC peak level IN2 MSB

| REGISTER ADDRESS                     | BIT | LABEL         | DEFAULT   | DESCRIPTION                                    | REFER TO |
|--------------------------------------|-----|---------------|-----------|------------------------------------------------|----------|
| R123 (7Bh)<br>AGC peak level IN3 LSB | 7:0 | PEAK_IN3[7:0] | 0000_0000 | LSBs of detected peak level of IN3 (Read Only) |          |

**Register 7Bh** AGC peak level IN3 LSB

| REGISTER ADDRESS                     | BIT | LABEL         | DEFAULT | DESCRIPTION                                    | REFER TO |
|--------------------------------------|-----|---------------|---------|------------------------------------------------|----------|
| R124 (7Ch)<br>AGC peak level IN3 MSB | 1:0 | PEAK_IN3[9:8] | 00      | MSBs of detected peak level of IN3 (Read Only) |          |

**Register 7Ch** AGC peak level IN3 MSB

| REGISTER ADDRESS           | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                | REFER TO |
|----------------------------|-----|-------------|---------|------------------------------------------------------------------------------------------------------------|----------|
| R128 (80h)<br>DLL config 1 | 5:4 | DLGAIN[1:0] | 01      | gain control of DLL delay line<br>Need to set according to input frequency. See details in "PLL DLL Setup" |          |
|                            | 2   | DLLRST      | 0       | reset DLL delay line<br>0 = normal<br>1 = reset DLL                                                        |          |
|                            | 1   | CKOSTB      | 0       | standby TG clock output<br>0 = generate TG clock<br>1 = stop generation of TG clock                        |          |
|                            | 0   | AFECKSTB    | 0       | standby AFE clock (VSMP/RSMP/ADCK) output<br>0 = generate AFE clock<br>1 = stop generation of AFE clock    |          |

**Register 80h** DLL config 1

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------|-----|---------------|---------|-----------------------------------------------------------------------------------------------------------------|----------|
| R129 (81h)<br>DLL config 2 | 5:4 | LVDLGAIN[1:0] | 01      | gain control of LVDS DLL delay line<br>Need to set according to input frequency. See details in "PLL DLL Setup" |          |

| REGISTER ADDRESS | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                                                                    | REFER TO |
|------------------|-----|----------|---------|--------------------------------------------------------------------------------------------------------------------------------|----------|
|                  | 1   | LVDLLRST | 0       | reset LVDS DLL delay line<br>0 = normal<br>1 = reset LVDS DLL                                                                  |          |
|                  | 0   | LVDLLSTB | 0       | standby LVDS serializer clock generation<br>0 = generate LVDS serializer clock<br>1 = stop generation of LVDS serializer clock |          |

**Register 81h** DLL config 2

| REGISTER ADDRESS        | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|--------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R130 (82h)<br>RSMP rise | 5:0 | RSMP_RISE<br>[5:0] | 01_1100 | RSMP rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 82h** RSMP rise

| REGISTER ADDRESS        | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|--------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R131 (83h)<br>RSMP fall | 5:0 | RSMP_FALL<br>[5:0] | 10_0110 | RSMP fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 83h** RSMP fall

| REGISTER ADDRESS        | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|--------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R132 (84h)<br>VSMP rise | 5:0 | VSMP_RISE<br>[5:0] | 10_1000 | VSMP rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 84h** VSMP rise



| REGISTER ADDRESS        | BIT | LABEL              | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|--------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R133 (85h)<br>VSMP fall | 5:0 | VSMP_FALL<br>[5:0] | 00_1000 | VSMP fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 85h** VSMP fall

| REGISTER ADDRESS         | BIT | LABEL               | DEFAULT | DESCRIPTION                                                                                                                                                           | REFER TO |
|--------------------------|-----|---------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R134 (86h)<br>TGCKO rise | 5:0 | TCLKO_RISE<br>[5:0] | 11_0111 | TCLKO rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 86h** TGCKO rise

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R135 (87h)<br>CLK1 rise | 5:0 | CLK1_RISE[5:0] | 00_1010 | CLK1 rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 87h** CLK1 rise

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R136 (88h)<br>CLK1 fall | 5:0 | CLK1_FALL[5:0] | 01_1001 | CLK1 fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 88h** CLK1 fall

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R137 (89h)<br>CLK2 rise | 5:0 | CLK2_RISE[5:0] | 01_1001 | CLK2 rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 89h** CLK2 rise

| REGISTER ADDRESS       | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R138 (8Ah)<br>CLK2fall | 5:0 | CLK2_FALL[5:0] | 10_1000 | CLK2 fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 8Ah** CLK2fall

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R139 (8Bh)<br>CLK3 rise | 5:0 | CLK3_RISE[5:0] | 10_1000 | CLK3 rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 8Bh** CLK3 rise

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R140 (8Ch)<br>CLK3 fall | 5:0 | CLK3_FALL[5:0] | 00_1010 | CLK3 fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 8Ch CLK3 fall**

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R141 (8Dh)<br>CLK4 rise | 5:0 | CLK4_RISE[5:0] | 00_0000 | CLK4 rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 8Dh CLK4 rise**

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R142 (8Eh)<br>CLK4 fall | 5:0 | CLK4_FALL[5:0] | 00_0000 | CLK4 fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 8Eh CLK4 fall**

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R143 (8Fh)<br>CLK5 rise | 5:0 | CLK5_RISE[5:0] | 00_1010 | CLK5 rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 8Fh CLK5 rise**

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                              | REFER TO |
|-------------------------|-----|----------------|---------|--------------------------------------------------------------------------------------------------------------------------|----------|
| R144 (90h)<br>CLK5 fall | 5:0 | CLK5_FALL[5:0] | 10_1000 | CLK5 fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION                              | REFER TO |
|------------------|-----|-------|---------|------------------------------------------|----------|
|                  |     |       |         | 11_1110 = reserved<br>11_1111 = reserved |          |

**Register 90h** CLK5 fall

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R145 (91h)<br>CLK6 rise | 5:0 | CLK6_RISE[5:0] | 00_1010 | CLK6 rise edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 91h** CLK6 rise

| REGISTER ADDRESS        | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                                                          | REFER TO |
|-------------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R146 (92h)<br>CLK6 fall | 5:0 | CLK6_FALL[5:0] | 10_1000 | CLK6 fall edge<br>00_0000 = tap0<br>00_0001 = tap1<br>...<br>11_1011 = tap59<br>11_1100 = reserved<br>11_1101 = reserved<br>11_1110 = reserved<br>11_1111 = reserved |          |

**Register 92h** CLK6 fall

| REGISTER ADDRESS          | BIT | LABEL       | DEFAULT | DESCRIPTION                                                                                                                          | REFER TO |
|---------------------------|-----|-------------|---------|--------------------------------------------------------------------------------------------------------------------------------------|----------|
| R160 (A0h)<br>TG config 1 | 7:4 | OFFSET[3:0] | 0000    | pixel counter offset (valid only in slave mode)                                                                                      |          |
|                           | 3   | CYCMD       | 0       | cycle mode enable<br>0 = normal (same operation at everyline)<br>1 = cycle mode                                                      |          |
|                           | 2   | POLSYNC     | 0       | polarity of tgync signal<br>0 = reset pixel counter at positive edge of tgsync<br>1 = reset pixel counter at negative edge of tgsync |          |
|                           | 1   | TGMD        | 0       | TG operation mode<br>0 = slave<br>1 = master                                                                                         |          |
|                           | 0   | TG_EN       | 0       | TG enable<br>0 = disable<br>1 = enable                                                                                               |          |

**Register A0h** TG config 1

| REGISTER ADDRESS          | BIT | LABEL        | DEFAULT   | DESCRIPTION                                                                         | REFER TO |
|---------------------------|-----|--------------|-----------|-------------------------------------------------------------------------------------|----------|
| R161 (A1h)<br>TG config 2 | 7:0 | LLENGTH[7:0] | 0000_0000 | LSBs of LLENGTH[14:0]<br>the number of pixels in a line (valid only in master mode) |          |

**Register A1h** TG config 2

| REGISTER ADDRESS          | BIT | LABEL         | DEFAULT  | DESCRIPTION                                                                   | REFER TO |
|---------------------------|-----|---------------|----------|-------------------------------------------------------------------------------|----------|
| R162 (A2h)<br>TG config 3 | 6:0 | LLENGTH[14:8] | 000_0000 | MSBs of LLENGTH<br>the number of pixels in a line (valid only in master mode) |          |

**Register A2h** TG config 3

| REGISTER ADDRESS          | BIT | LABEL        | DEFAULT   | DESCRIPTION                                                                                                        | REFER TO |
|---------------------------|-----|--------------|-----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R163 (A3h)<br>TG config 4 | 7:0 | FLAGPIX[7:0] | 0000_0000 | LSBs of FLAGPIX[14:0]<br>flag pixel control<br>pulse flagpix is high<br>when pixel counter equals to flagpix[14:0] |          |

**Register A3h** TG config 4

| REGISTER ADDRESS          | BIT | LABEL         | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|---------------------------|-----|---------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R164 (A4h)<br>TG config 5 | 6:0 | FLAGPIX[14:8] | 000_0000 | MSBs of FLAGPIX[14:0]<br>flag pixel control<br>pulse flagpix is high<br>when pixel counter equals to flagpix[14:0] |          |

**Register A4h** TG config 5

| REGISTER ADDRESS          | BIT | LABEL   | DEFAULT | DESCRIPTION                                       | REFER TO |
|---------------------------|-----|---------|---------|---------------------------------------------------|----------|
| R165 (A5h)<br>TG config 6 | 7   | OE_CLK8 | 1       | output enable of "CLK8"<br>0 = Hi-Z<br>1 = output |          |
|                           | 6   | OE_CLK7 | 1       | output enable of "CLK7"<br>0 = Hi-Z<br>1 = output |          |
|                           | 5   | OE_CLK6 | 1       | output enable of "CLK6"<br>0 = Hi-Z<br>1 = output |          |
|                           | 4   | OE_CLK5 | 1       | output enable of "CLK5"<br>0 = Hi-Z<br>1 = output |          |
|                           | 3   | OE_CLK4 | 1       | output enable of "CLK4"<br>0 = Hi-Z<br>1 = output |          |
|                           | 2   | OE_CLK3 | 1       | output enable of "CLK3"<br>0 = Hi-Z<br>1 = output |          |
|                           | 1   | OE_CLK2 | 1       | output enable of "CLK2"<br>0 = Hi-Z               |          |

| REGISTER ADDRESS | BIT | LABEL   | DEFAULT | DESCRIPTION                                       | REFER TO |
|------------------|-----|---------|---------|---------------------------------------------------|----------|
|                  |     |         |         | 1 = output                                        |          |
|                  | 0   | OE_CLK1 | 1       | output enable of "CLK1"<br>0 = Hi-Z<br>1 = output |          |

**Register A5h** TG config 6

| REGISTER ADDRESS          | BIT | LABEL    | DEFAULT | DESCRIPTION                                        | REFER TO |
|---------------------------|-----|----------|---------|----------------------------------------------------|----------|
| R166 (A6h)<br>TG config 7 | 2   | OE_CLK11 | 1       | output enable of "CLK11"<br>0 = Hi-Z<br>1 = output |          |
|                           | 1   | OE_CLK10 | 1       | output enable of "CLK10"<br>0 = Hi-Z<br>1 = output |          |
|                           | 0   | OE_CLK9  | 1       | output enable of "CLK9"<br>0 = Hi-Z<br>1 = output  |          |

**Register A6h** TG config 7

| REGISTER ADDRESS          | BIT | LABEL    | DEFAULT | DESCRIPTION                                                               | REFER TO |
|---------------------------|-----|----------|---------|---------------------------------------------------------------------------|----------|
| R167 (A7h)<br>TG config 8 | 7   | INV_CLK8 | 0       | invert signal output assigned to CLK8<br>0 = non-inverted<br>1 = inverted |          |
|                           | 6   | INV_CLK7 | 0       | invert signal output assigned to CLK7<br>0 = non-inverted<br>1 = inverted |          |
|                           | 5   | INV_CLK6 | 0       | invert signal output assigned to CLK6<br>0 = non-inverted<br>1 = inverted |          |
|                           | 4   | INV_CLK5 | 0       | invert signal output assigned to CLK5<br>0 = non-inverted<br>1 = inverted |          |
|                           | 3   | INV_CLK4 | 0       | invert signal output assigned to CLK4<br>0 = non-inverted<br>1 = inverted |          |
|                           | 2   | INV_CLK3 | 0       | invert signal output assigned to CLK3<br>0 = non-inverted<br>1 = inverted |          |
|                           | 1   | INV_CLK2 | 0       | invert signal output assigned to CLK2<br>0 = non-inverted<br>1 = inverted |          |
|                           | 0   | INV_CLK1 | 0       | invert signal output assigned to CLK1<br>0 = non-inverted<br>1 = inverted |          |

**Register A7h** TG config 8

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|------------------|-----|-------|---------|-------------|----------|
|------------------|-----|-------|---------|-------------|----------|

| REGISTER ADDRESS          | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                | REFER TO |
|---------------------------|-----|-----------|---------|----------------------------------------------------------------------------|----------|
| R168 (A8h)<br>TG config 9 | 2   | INV_CLK11 | 0       | invert signal output assigned to CLK11<br>0 = non-inverted<br>1 = inverted |          |
|                           | 1   | INV_CLK10 | 0       | invert signal output assigned to CLK10<br>0 = non-inverted<br>1 = inverted |          |
|                           | 0   | INV_CLK9  | 0       | invert signal output assigned to CLK9<br>0 = non-inverted<br>1 = inverted  |          |

**Register A8h** TG config 9

| REGISTER ADDRESS           | BIT | LABEL   | DEFAULT | DESCRIPTION                                            | REFER TO |
|----------------------------|-----|---------|---------|--------------------------------------------------------|----------|
| R169 (A9h)<br>TG config 10 | 7   | EN_CLK8 | 0       | enable signal output CLK8<br>0 = disable<br>1 = enable |          |
|                            | 6   | EN_CLK7 | 0       | enable signal output CLK7<br>0 = disable<br>1 = enable |          |
|                            | 5   | EN_CLK6 | 0       | enable signal output CLK6<br>0 = disable<br>1 = enable |          |
|                            | 4   | EN_CLK5 | 0       | enable signal output CLK5<br>0 = disable<br>1 = enable |          |
|                            | 3   | EN_CLK4 | 0       | enable signal output CLK4<br>0 = disable<br>1 = enable |          |
|                            | 2   | EN_CLK3 | 0       | enable signal output CLK3<br>0 = disable<br>1 = enable |          |
|                            | 1   | EN_CLK2 | 0       | enable signal output CLK2<br>0 = disable<br>1 = enable |          |
|                            | 0   | EN_CLK1 | 0       | enable signal output CLK1<br>0 = disable<br>1 = enable |          |

**Register A9h** TG config 10

| REGISTER ADDRESS           | BIT | LABEL    | DEFAULT | DESCRIPTION                                             | REFER TO |
|----------------------------|-----|----------|---------|---------------------------------------------------------|----------|
| R170 (AAh)<br>TG config 11 | 2   | EN_CLK11 | 0       | enable signal output CLK11<br>0 = disable<br>1 = enable |          |
|                            | 1   | EN_CLK10 | 0       | enable signal output CLK10<br>0 = disable<br>1 = enable |          |
|                            | 0   | EN_CLK9  | 0       | enable signal output CLK9<br>0 = disable<br>1 = enable  |          |

**Register AAh TG config 11**

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                        | REFER TO |
|----------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R171 (ABh)<br>TG config 12 | 7   | SEL_CLK3      | 0       | select signal for CLK3<br>0 = output clock<br>1 = output pulse (select by SEL_PCK3[2:0])                                                                           |          |
|                            | 6:4 | SEL_PCK3[2:0] | 000     | select pulse assigned to CLK3 (valid only when SEL_CLK3=1)<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |
|                            | 3   | SEL_CLK2      | 0       | select signal for CLK2<br>0 = output clock<br>1 = output pulse (select by SEL_PCK2[2:0])                                                                           |          |
|                            | 2:0 | SEL_PCK2[2:0] | 000     | select pulse assigned to CLK2 (valid only when SEL_CLK2=1)<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |

**Register ABh TG config 12**

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                        | REFER TO |
|----------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R172 (ACh)<br>TG config 13 | 7   | SEL_CLK5      | 0       | select signal for CLK5<br>0 = output clock<br>1 = output pulse (select by SEL_PCK5[2:0])                                                                           |          |
|                            | 6:4 | SEL_PCK5[2:0] | 000     | select pulse assigned to CLK5 (valid only when SEL_CLK5=1)<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |
|                            | 3   | SEL_CLK4      | 0       | select signal for CLK4<br>0 = output clock<br>1 = output pulse (select by SEL_PCK4[2:0])                                                                           |          |
|                            | 2:0 | SEL_PCK4[2:0] | 000     | select pulse assigned to CLK4 (valid only when SEL_CLK4=1)<br>000 = PO0                                                                                            |          |



| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION                                                                             | REFER TO |
|------------------|-----|-------|---------|-----------------------------------------------------------------------------------------|----------|
|                  |     |       |         | 001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |

**Register ACh** TG config 13

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                        | REFER TO |
|----------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R173 (ADh)<br>TG config 14 | 6:4 | SEL_PCK7[2:0] | 000     | select pulse assigned to CLK7<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7                              |          |
|                            | 3   | SEL_CLK6      | 0       | select signal for CLK6<br>0 = output clock<br>1 = output pulse (select by SEL_PCK6[2:0])                                                                           |          |
|                            | 2:0 | SEL_PCK6[2:0] | 000     | select pulse assigned to CLK6 (valid only when SEL_CLK6=1)<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |

**Register ADh** TG config 14

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                           | REFER TO |
|----------------------------|-----|---------------|---------|---------------------------------------------------------------------------------------------------------------------------------------|----------|
| R174 (AEh)<br>TG config 15 | 6:4 | SEL_PCK9[2:0] | 000     | select pulse assigned to CLK9<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |
|                            | 2:0 | SEL_PCK8[2:0] | 000     | select pulse assigned to CLK8<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |

**Register AEh** TG config 15

| REGISTER ADDRESS | BIT | LABEL          | DEFAULT | DESCRIPTION                    | REFER TO |
|------------------|-----|----------------|---------|--------------------------------|----------|
| R175 (AFh)       | 6:4 | SEL_PCK11[2:0] | 000     | select pulse assigned to CLK11 |          |

| REGISTER ADDRESS | BIT | LABEL          | DEFAULT | DESCRIPTION                                                                                                                            | REFER TO |
|------------------|-----|----------------|---------|----------------------------------------------------------------------------------------------------------------------------------------|----------|
| TG config 16     |     |                |         | 000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7                                   |          |
|                  | 2:0 | SEL_PCK10[2:0] | 000     | select pulse assigned to CLK10<br>000 = PO0<br>001 = PO1<br>010 = PO2<br>011 = PO3<br>100 = PO4<br>101 = PO5<br>110 = PO6<br>111 = PO7 |          |

**Register AFh** TG config 16

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                            | REFER TO |
|----------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------|----------|
| R176 (B0h)<br>TG config 17 | 7:6 | DEL_PCK5[1:0] | 00      | control delay of pulse output assigned to CLK5<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |
|                            | 5:4 | DEL_PCK4[1:0] | 00      | control delay of pulse output assigned to CLK4<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |
|                            | 3:2 | DEL_PCK3[1:0] | 00      | control delay of pulse output assigned to CLK3<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |
|                            | 1:0 | DEL_PCK2[1:0] | 00      | control delay of pulse output assigned to CLK2<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |

**Register B0h** TG config 17

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                            | REFER TO |
|----------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------|----------|
| R177 (B1h)<br>TG config 18 | 7:6 | DEL_PCK9[1:0] | 00      | control delay of pulse output assigned to CLK9<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |

| REGISTER ADDRESS | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                            | REFER TO |
|------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------|----------|
|                  | 5:4 | DEL_PCK8[1:0] | 00      | control delay of pulse output assigned to CLK8<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |
|                  | 3:2 | DEL_PCK7[1:0] | 00      | control delay of pulse output assigned to CLK7<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |
|                  | 1:0 | DEL_PCK6[1:0] | 00      | control delay of pulse output assigned to CLK6<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |

**Register B1h** TG config 18

| REGISTER ADDRESS           | BIT | LABEL               | DEFAULT | DESCRIPTION                                                                                             | REFER TO |
|----------------------------|-----|---------------------|---------|---------------------------------------------------------------------------------------------------------|----------|
| R178 (B2h)<br>TG config 19 | 3:2 | DEL_PCK11[1:0]<br>] | 00      | control delay of pulse output assigned to CLK11<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |
|                            | 1:0 | DEL_PCK10[1:0]<br>] | 00      | control delay of pulse output assigned to CLK10<br>00 = 0nsec<br>01 = 1nsec<br>10 = 2nsec<br>11 = 3nsec |          |

**Register B2h** TG config 19

| REGISTER ADDRESS           | BIT | LABEL  | DEFAULT | DESCRIPTION                                                  | REFER TO |
|----------------------------|-----|--------|---------|--------------------------------------------------------------|----------|
| R179 (B3h)<br>TG config 20 | 4   | INV_M3 | 0       | invert mask pulse "M3"<br>0 = non-inverted<br>1 = inverted   |          |
|                            | 3   | INV_M2 | 0       | invert mask pulse "M2"<br>0 = non-inverted<br>1 = inverted   |          |
|                            | 2   | INV_M1 | 0       | invert mask pulse "M1"<br>0 = non-inverted<br>1 = inverted   |          |
|                            | 1   | INV_T2 | 0       | invert toggle pulse "T2"<br>0 = non-inverted<br>1 = inverted |          |
|                            | 0   | INV_T1 | 0       | invert toggle pulse "T1"<br>0 = non-inverted<br>1 = inverted |          |

**Register B3h** TG config 20

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT | DESCRIPTION                                                                                                                                                              | REFER TO |
|----------------------------|-----|---------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| R180 (B4h)<br>TG config 21 | 3:0 | SEL_FLAG[3:0] | 0000    | select signal to be output as datatrig<br>0xxx = flagpix<br>1000 = PO0<br>1001 = PO1<br>1010 = PO2<br>1011 = PO3<br>1100 = PO4<br>1101 = PO5<br>1110 = PO6<br>1111 = PO7 |          |

**Register B4h** TG config 21

| REGISTER ADDRESS           | BIT | LABEL               | DEFAULT | DESCRIPTION                                                                                                               | REFER TO |
|----------------------------|-----|---------------------|---------|---------------------------------------------------------------------------------------------------------------------------|----------|
| R181 (B5h)<br>TG config 22 | 6:4 | CYCPAT_PO1<br>[2:0] | 000     | PO1 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |
|                            | 2:0 | CYCPAT_PO0<br>[2:0] | 000     | PO0 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |

**Register B5h** TG config 22

| REGISTER ADDRESS           | BIT | LABEL               | DEFAULT | DESCRIPTION                                                                                                               | REFER TO |
|----------------------------|-----|---------------------|---------|---------------------------------------------------------------------------------------------------------------------------|----------|
| R182 (B6h)<br>TG config 23 | 6:4 | CYCPAT_PO3<br>[2:0] | 000     | PO3 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |
|                            | 2:0 | CYCPAT_PO2<br>[2:0] | 000     | PO2 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |

**Register B6h** TG config 23

| REGISTER ADDRESS           | BIT | LABEL               | DEFAULT | DESCRIPTION                                                                                                               | REFER TO |
|----------------------------|-----|---------------------|---------|---------------------------------------------------------------------------------------------------------------------------|----------|
| R183 (B7h)<br>TG config 24 | 6:4 | CYCPAT_PO5<br>[2:0] | 000     | PO5 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |
|                            | 2:0 | CYCPAT_PO4<br>[2:0] | 000     | PO4 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |

**Register B7h** TG config 24

| REGISTER ADDRESS           | BIT | LABEL               | DEFAULT | DESCRIPTION                                                                                                               | REFER TO |
|----------------------------|-----|---------------------|---------|---------------------------------------------------------------------------------------------------------------------------|----------|
| R184 (B8h)<br>TG config 25 | 6:4 | CYCPAT_PO7<br>[2:0] | 000     | PO7 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |
|                            | 2:0 | CYCPAT_PO6<br>[2:0] | 000     | PO6 cycle mode control<br>[0] = pulse enable at cycle-1<br>[1] = pulse enable at cycle-2<br>[2] = pulse enable at cycle-3 |          |

**Register B8h** TG config 25

| REGISTER ADDRESS                    | BIT | LABEL               | DEFAULT   | DESCRIPTION                                         | REFER TO |
|-------------------------------------|-----|---------------------|-----------|-----------------------------------------------------|----------|
| R185 (B9h)<br>clamp enable rise LSB | 7:0 | CLAMP_RISE<br>[7:0] | 0000_0000 | LSBs of CLAMP_RISE<br>clamp enable pulse rise pixel |          |

**Register B9h** clamp enable rise LSB

| REGISTER ADDRESS                    | BIT | LABEL                | DEFAULT  | DESCRIPTION                                         | REFER TO |
|-------------------------------------|-----|----------------------|----------|-----------------------------------------------------|----------|
| R186 (BAh)<br>clamp enable rise MSB | 6:0 | CLAMP_RISE<br>[14:8] | 000_0000 | MSBs of CLAMP_RISE<br>clamp enable pulse rise pixel |          |

**Register BAh** clamp enable rise MSB

| REGISTER ADDRESS                    | BIT | LABEL               | DEFAULT   | DESCRIPTION                                         | REFER TO |
|-------------------------------------|-----|---------------------|-----------|-----------------------------------------------------|----------|
| R187 (BBh)<br>clamp enable fall LSB | 7:0 | CLAMP_FALL<br>[7:0] | 0000_0000 | LSBs of CLAMP_FALL<br>clamp enable pulse fall pixel |          |

**Register BBh** clamp enable fall LSB

| REGISTER ADDRESS                    | BIT | LABEL                | DEFAULT  | DESCRIPTION                                         | REFER TO |
|-------------------------------------|-----|----------------------|----------|-----------------------------------------------------|----------|
| R188 (BCh)<br>clamp enable fall MSB | 6:0 | CLAMP_FALL<br>[14:8] | 000_0000 | MSBs of CLAMP_FALL<br>clamp enable pulse fall pixel |          |

**Register BCh** clamp enable fall MSB

| REGISTER ADDRESS           | BIT | LABEL         | DEFAULT   | DESCRIPTION                                                     | REFER TO |
|----------------------------|-----|---------------|-----------|-----------------------------------------------------------------|----------|
| R189 (BDh)<br>OB start LSB | 7:0 | OB_START[7:0] | 0000_0000 | LSBs of OB_START<br>optical black caribration start pixel count |          |

**Register BDh** OB start LSB

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|------------------|-----|-------|---------|-------------|----------|
|------------------|-----|-------|---------|-------------|----------|

| REGISTER ADDRESS           | BIT | LABEL               | DEFAULT  | DESCRIPTION                                                     | REFER TO |
|----------------------------|-----|---------------------|----------|-----------------------------------------------------------------|----------|
| R190 (BEh)<br>OB start MSB | 6:0 | OB_START[14:8]<br>] | 000_0000 | MSBs of OB_START<br>optical black caribration start pixel count |          |

**Register BEh** OB start MSB

| REGISTER ADDRESS                   | BIT | LABEL                      | DEFAULT   | DESCRIPTION                                                    | REFER TO |
|------------------------------------|-----|----------------------------|-----------|----------------------------------------------------------------|----------|
| R191 (BFh)<br>peak_det rise<br>LSB | 7:0 | PEAKDET_RISE<br>E<br>[7:0] | 0000_0000 | LSBs of PEAKDET_RISE[14:0]<br>peak detection start pixel count |          |

**Register BFh** peak\_det rise LSB

| REGISTER ADDRESS                   | BIT | LABEL                       | DEFAULT  | DESCRIPTION                                                    | REFER TO |
|------------------------------------|-----|-----------------------------|----------|----------------------------------------------------------------|----------|
| R192 (C0h)<br>peak_det rise<br>MSB | 6:0 | PEAKDET_RISE<br>E<br>[14:8] | 000_0000 | MSBs of PEAKDET_RISE[14:0]<br>peak detection start pixel count |          |

**Register C0h** peak\_det rise MSB

| REGISTER ADDRESS                   | BIT | LABEL                      | DEFAULT   | DESCRIPTION                                                  | REFER TO |
|------------------------------------|-----|----------------------------|-----------|--------------------------------------------------------------|----------|
| R193 (C1h)<br>peak_det fall<br>LSB | 7:0 | PEAKDET_FALL<br>L<br>[7:0] | 0000_0000 | LSBs of PEAKDET_FALL[14:0]<br>peak detection end pixel count |          |

**Register C1h** peak\_det fall LSB

| REGISTER ADDRESS                   | BIT | LABEL                       | DEFAULT  | DESCRIPTION                                                  | REFER TO |
|------------------------------------|-----|-----------------------------|----------|--------------------------------------------------------------|----------|
| R194 (C2h)<br>peak_det fall<br>MSB | 6:0 | PEAKDET_FALL<br>L<br>[14:8] | 000_0000 | MSBs of PEAKDET_FALL[14:0]<br>peak detection end pixel count |          |

**Register C2h** peak\_det fall MSB

| REGISTER ADDRESS                       | BIT | LABEL        | DEFAULT   | DESCRIPTION                                              | REFER TO |
|----------------------------------------|-----|--------------|-----------|----------------------------------------------------------|----------|
| R195 (C3h)<br>Mask pulse 1<br>rise LSB | 7:0 | M1_RISE[7:0] | 0000_0000 | LSBs of M1_RISE[14:0]<br>mask puse "M1" rise pixel count |          |

**Register C3h** Mask pulse 1 rise LSB

| REGISTER ADDRESS                       | BIT | LABEL         | DEFAULT  | DESCRIPTION                                              | REFER TO |
|----------------------------------------|-----|---------------|----------|----------------------------------------------------------|----------|
| R196 (C4h)<br>Mask pulse 1<br>rise MSB | 6:0 | M1_RISE[14:8] | 000_0000 | MSBs of M1_RISE[14:0]<br>mask puse "M1" rise pixel count |          |

**Register C4h** Mask pulse 1 rise MSB

| REGISTER ADDRESS                    | BIT | LABEL        | DEFAULT   | DESCRIPTION                                               | REFER TO |
|-------------------------------------|-----|--------------|-----------|-----------------------------------------------------------|----------|
| R197 (C5h)<br>Mask pulse 1 fall LSB | 7:0 | M1_FALL[7:0] | 0000_0000 | LSBs of M1_FALL[14:0]<br>mask pulse "M1" fall pixel count |          |

**Register C5h** Mask pulse 1 fall LSB

| REGISTER ADDRESS                    | BIT | LABEL         | DEFAULT  | DESCRIPTION                                               | REFER TO |
|-------------------------------------|-----|---------------|----------|-----------------------------------------------------------|----------|
| R198 (C6h)<br>Mask pulse 1 fall MSB | 6:0 | M1_FALL[14:8] | 000_0000 | MSBs of M1_FALL[14:0]<br>mask pulse "M1" fall pixel count |          |

**Register C6h** Mask pulse 1 fall MSB

| REGISTER ADDRESS                    | BIT | LABEL        | DEFAULT   | DESCRIPTION                                               | REFER TO |
|-------------------------------------|-----|--------------|-----------|-----------------------------------------------------------|----------|
| R199 (C7h)<br>Mask pulse 2 rise LSB | 7:0 | M2_RISE[7:0] | 0000_0000 | LSBs of M2_RISE[14:0]<br>mask pulse "M2" rise pixel count |          |

**Register C7h** Mask pulse 2 rise LSB

| REGISTER ADDRESS                    | BIT | LABEL         | DEFAULT  | DESCRIPTION                                               | REFER TO |
|-------------------------------------|-----|---------------|----------|-----------------------------------------------------------|----------|
| R200 (C8h)<br>Mask pulse 2 rise MSB | 6:0 | M2_RISE[14:8] | 000_0000 | MSBs of M2_RISE[14:0]<br>mask pulse "M2" rise pixel count |          |

**Register C8h** Mask pulse 2 rise MSB

| REGISTER ADDRESS                    | BIT | LABEL        | DEFAULT   | DESCRIPTION                                               | REFER TO |
|-------------------------------------|-----|--------------|-----------|-----------------------------------------------------------|----------|
| R201 (C9h)<br>Mask pulse 2 fall LSB | 7:0 | M2_FALL[7:0] | 0000_0000 | LSBs of M2_FALL[14:0]<br>mask pulse "M2" fall pixel count |          |

**Register C9h** Mask pulse 2 fall LSB

| REGISTER ADDRESS                    | BIT | LABEL         | DEFAULT  | DESCRIPTION                                               | REFER TO |
|-------------------------------------|-----|---------------|----------|-----------------------------------------------------------|----------|
| R202 (CAh)<br>Mask pulse 2 fall MSB | 6:0 | M2_FALL[14:8] | 000_0000 | MSBs of M2_FALL[14:0]<br>mask pulse "M2" fall pixel count |          |

**Register CAh** Mask pulse 2 fall MSB

| REGISTER ADDRESS                    | BIT | LABEL        | DEFAULT   | DESCRIPTION                                         | REFER TO |
|-------------------------------------|-----|--------------|-----------|-----------------------------------------------------|----------|
| R203 (CBh)<br>Mask pulse 3 rise LSB | 7:0 | M3_RISE[7:0] | 0000_0000 | LSBs of M3_RISE<br>mask pulse "M3" rise pixel count |          |

**Register CBh** Mask pulse 3 rise LSB



| REGISTER ADDRESS                       | BIT | LABEL         | DEFAULT  | DESCRIPTION                                         | REFER TO |
|----------------------------------------|-----|---------------|----------|-----------------------------------------------------|----------|
| R204 (CCh)<br>Mask pulse 3<br>rise MSB | 6:0 | M3_RISE[14:8] | 000_0000 | MSBs of M3_RISE<br>mask pulse "M3" rise pixel count |          |

**Register CCh** Mask pulse 3 rise MSB

| REGISTER ADDRESS                       | BIT | LABEL        | DEFAULT   | DESCRIPTION                                         | REFER TO |
|----------------------------------------|-----|--------------|-----------|-----------------------------------------------------|----------|
| R205 (CDh)<br>Mask pulse 3<br>fall LSB | 7:0 | M3_FALL[7:0] | 0000_0000 | LSBs of M3_FALL<br>mask pulse "M3" fall pixel count |          |

**Register CDh** Mask pulse 3 fall LSB

| REGISTER ADDRESS                       | BIT | LABEL         | DEFAULT  | DESCRIPTION                                         | REFER TO |
|----------------------------------------|-----|---------------|----------|-----------------------------------------------------|----------|
| R206 (CEh)<br>Mask pulse 3<br>fall MSB | 6:0 | M3_FALL[14:8] | 000_0000 | MSBs of M3_FALL<br>mask pulse "M3" fall pixel count |          |

**Register CEh** Mask pulse 3 fall MSB

| REGISTER ADDRESS                    | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|-------------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R207 (CFh)<br>Toggle point<br>0 LSB | 7:0 | TP0[7:0] | 0000_0000 | pixel count of toggle point "TP0" |          |

**Register CFh** Toggle point 0 LSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                    | REFER TO |
|-------------------------------------|-----|-----------|----------|------------------------------------------------------------------------------------------------|----------|
| R208 (D0h)<br>Toggle point<br>0 MSB | 7   | GEN_TP0   | 0        | global enable of toggle point<br>0 = disable all toggle point<br>1 = enable toggle point "TP0" |          |
|                                     | 6:0 | TP0[14:8] | 000_0000 | pixel count of toggle point "TP0"                                                              |          |

**Register D0h** Toggle point 0 MSB

| REGISTER ADDRESS                    | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|-------------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R209 (D1h)<br>Toggle point<br>1 LSB | 7:0 | TP1[7:0] | 0000_0000 | pixel count of toggle point "TP1" |          |

**Register D1h** Toggle point 1 LSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|-------------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R210 (D2h)<br>Toggle point<br>1 MSB | 7   | EN_TP1    | 0        | enable toggle point "TP1"<br>0 = disable "TP1" and all subsequent toggle point<br>1 = enable toggle point "TP1" |          |
|                                     | 6:0 | TP1[14:8] | 000_0000 | pixel count of toggle point "TP1"                                                                               |          |

**Register D2h Toggle point 1 MSB**

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R211 (D3h)<br>Toggle point 2 LSB | 7:0 | TP2[7:0] | 0000_0000 | pixel count of toggle point "TP2" |          |

**Register D3h Toggle point 2 LSB**

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R212 (D4h)<br>Toggle point 2 MSB | 7   | EN_TP2    | 0        | enable toggle point "TP2"<br>0 = disable "TP2" and all subsequent toggle point<br>1 = enable toggle point "TP2" |          |
|                                  | 6:0 | TP2[14:8] | 000_0000 | pixel count of toggle point "TP2"                                                                               |          |

**Register D4h Toggle point 2 MSB**

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R213 (D5h)<br>Toggle point 3 LSB | 7:0 | TP3[7:0] | 0000_0000 | pixel count of toggle point "TP3" |          |

**Register D5h Toggle point 3 LSB**

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R214 (D6h)<br>Toggle point 3 MSB | 7   | EN_TP3    | 0        | enable toggle point "TP3"<br>0 = disable "TP3" and all subsequent toggle point<br>1 = enable toggle point "TP3" |          |
|                                  | 6:0 | TP3[14:8] | 000_0000 | pixel count of toggle point "TP3"                                                                               |          |

**Register D6h Toggle point 3 MSB**

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R215 (D7h)<br>Toggle point 4 LSB | 7:0 | TP4[7:0] | 0000_0000 | pixel count of toggle point "TP4" |          |

**Register D7h Toggle point 4 LSB**

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R216 (D8h)<br>Toggle point 4 MSB | 7   | EN_TP4    | 0        | enable toggle point "TP4"<br>0 = disable "TP4" and all subsequent toggle point<br>1 = enable toggle point "TP4" |          |
|                                  | 6:0 | TP4[14:8] | 000_0000 | pixel count of toggle point "TP4"                                                                               |          |

**Register D8h Toggle point 4 MSB**

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R217 (D9h)<br>Toggle point 5 LSB | 7:0 | TP5[7:0] | 0000_0000 | pixel count of toggle point "TP5" |          |

**Register D9h** Toggle point 5 LSB

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R218 (DAh)<br>Toggle point 5 MSB | 7   | EN_TP5    | 0        | enable toggle point "TP5"<br>0 = disable "TP5" and all subsequent toggle point<br>1 = enable toggle point "TP5" |          |
|                                  | 6:0 | TP5[14:8] | 000_0000 | pixel count of toggle point "TP5"                                                                               |          |

**Register DAh** Toggle point 5 MSB

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R219 (DBh)<br>Toggle point 6 LSB | 7:0 | TP6[7:0] | 0000_0000 | pixel count of toggle point "TP1" |          |

**Register DBh** Toggle point 6 LSB

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R220 (DCh)<br>Toggle point 6 MSB | 7   | EN_TP6    | 0        | enable toggle point "TP6"<br>0 = disable "TP6" and all subsequent toggle point<br>1 = enable toggle point "TP6" |          |
|                                  | 6:0 | TP6[14:8] | 000_0000 | pixel count of toggle point "TP6"                                                                               |          |

**Register DCh** Toggle point 6 MSB

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R221 (DDh)<br>Toggle point 7 LSB | 7:0 | TP7[7:0] | 0000_0000 | pixel count of toggle point "TP7" |          |

**Register DDh** Toggle point 7 LSB

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R222 (DEh)<br>Toggle point 7 MSB | 7   | EN_TP7    | 0        | enable toggle point "TP7"<br>0 = disable "TP7" and all subsequent toggle point<br>1 = enable toggle point "TP7" |          |
|                                  | 6:0 | TP7[14:8] | 000_0000 | pixel count of toggle point "TP7"                                                                               |          |

**Register DEh** Toggle point 7 MSB

| REGISTER ADDRESS | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|------------------|-----|----------|-----------|-----------------------------------|----------|
| R223 (DFh)       | 7:0 | TP8[7:0] | 0000_0000 | pixel count of toggle point "TP8" |          |

| REGISTER ADDRESS   | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|--------------------|-----|-------|---------|-------------|----------|
| Toggle point 8 LSB |     |       |         |             |          |

**Register DFh** Toggle point 8 LSB

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R224 (E0h)<br>Toggle point 8 MSB | 7   | EN_TP8    | 0        | enable toggle point "TP8"<br>0 = disable "TP8" and all subsequent toggle point<br>1 = enable toggle point "TP8" |          |
|                                  | 6:0 | TP8[14:8] | 000_0000 | pixel count of toggle point "TP8"                                                                               |          |

**Register E0h** Toggle point 8 MSB

| REGISTER ADDRESS                 | BIT | LABEL    | DEFAULT   | DESCRIPTION                       | REFER TO |
|----------------------------------|-----|----------|-----------|-----------------------------------|----------|
| R225 (E1h)<br>Toggle point 9 LSB | 7:0 | TP9[7:0] | 0000_0000 | pixel count of toggle point "TP9" |          |

**Register E1h** Toggle point 9 LSB

| REGISTER ADDRESS                 | BIT | LABEL     | DEFAULT  | DESCRIPTION                                                                                                     | REFER TO |
|----------------------------------|-----|-----------|----------|-----------------------------------------------------------------------------------------------------------------|----------|
| R226 (E2h)<br>Toggle point 9 MSB | 7   | EN_TP9    | 0        | enable toggle point "TP9"<br>0 = disable "TP9" and all subsequent toggle point<br>1 = enable toggle point "TP9" |          |
|                                  | 6:0 | TP9[14:8] | 000_0000 | pixel count of toggle point "TP9"                                                                               |          |

**Register E2h** Toggle point 9 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R227 (E3h)<br>Toggle point 10 LSB | 7:0 | TP10[7:0] | 0000_0000 | pixel count of toggle point "TP10" |          |

**Register E3h** Toggle point 10 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R228 (E4h)<br>Toggle point 10 MSB | 7   | EN_TP10    | 0        | enable toggle point "TP10"<br>0 = disable "TP10" and all subsequent toggle point<br>1 = enable toggle point "TP10" |          |
|                                   | 6:0 | TP10[14:8] | 000_0000 | pixel count of toggle point "TP10"                                                                                 |          |

**Register E4h** Toggle point 10 MSB

| REGISTER ADDRESS           | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|----------------------------|-----|-----------|-----------|------------------------------------|----------|
| R229 (E5h)<br>Toggle point | 7:0 | TP11[7:0] | 0000_0000 | pixel count of toggle point "TP11" |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION | REFER TO |
|------------------|-----|-------|---------|-------------|----------|
| 11 LSB           |     |       |         |             |          |

**Register E5h** Toggle point 11 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R230 (E6h)<br>Toggle point 11 MSB | 7   | EN_TP11    | 0        | enable toggle point "TP11"<br>0 = disable "TP11" and all subsequent toggle point<br>1 = enable toggle point "TP11" |          |
|                                   | 6:0 | TP11[14:8] | 000_0000 | pixel count of toggle point "TP11"                                                                                 |          |

**Register E6h** Toggle point 11 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R231 (E7h)<br>Toggle point 12 LSB | 7:0 | TP12[7:0] | 0000_0000 | pixel count of toggle point "TP12" |          |

**Register E7h** Toggle point 12 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R232 (E8h)<br>Toggle point 12 MSB | 7   | EN_TP12    | 0        | enable toggle point "TP12"<br>0 = disable "TP12" and all subsequent toggle point<br>1 = enable toggle point "TP12" |          |
|                                   | 6:0 | TP12[14:8] | 000_0000 | pixel count of toggle point "TP12"                                                                                 |          |

**Register E8h** Toggle point 12 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R233 (E9h)<br>Toggle point 13 LSB | 7:0 | TP13[7:0] | 0000_0000 | pixel count of toggle point "TP13" |          |

**Register E9h** Toggle point 13 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R234 (EAh)<br>Toggle point 13 MSB | 7   | EN_TP13    | 0        | enable toggle point "TP13"<br>0 = disable "TP13" and all subsequent toggle point<br>1 = enable toggle point "TP13" |          |
|                                   | 6:0 | TP13[14:8] | 000_0000 | pixel count of toggle point "TP13"                                                                                 |          |

**Register EAh** Toggle point 13 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R235 (EBh)<br>Toggle point 14 LSB | 7:0 | TP14[7:0] | 0000_0000 | pixel count of toggle point "TP14" |          |

## Register EBh Toggle point 14 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R236 (ECh)<br>Toggle point 14 MSB | 7   | EN_TP14    | 0        | enable toggle point "TP14"<br>0 = disable "TP14" and all subsequent toggle point<br>1 = enable toggle point "TP14" |          |
|                                   | 6:0 | TP14[14:8] | 000_0000 | pixel count of toggle point "TP14"                                                                                 |          |

## Register ECh Toggle point 14 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R237 (EDh)<br>Toggle point 15 LSB | 7:0 | TP15[7:0] | 0000_0000 | pixel count of toggle point "TP15" |          |

## Register EDh Toggle point 15 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R238 (EEh)<br>Toggle point 15 MSB | 7   | EN_TP15    | 0        | enable toggle point "TP15"<br>0 = disable "TP15" and all subsequent toggle point<br>1 = enable toggle point "TP15" |          |
|                                   | 6:0 | TP15[14:8] | 000_0000 | pixel count of toggle point "TP15"                                                                                 |          |

## Register EEh Toggle point 15 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R239 (EFh)<br>Toggle point 16 LSB | 7:0 | TP16[7:0] | 0000_0000 | pixel count of toggle point "TP16" |          |

## Register EFh Toggle point 16 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R240 (F0h)<br>Toggle point 16 MSB | 7   | EN_TP16    | 0        | enable toggle point "TP16"<br>0 = disable "TP16" and all subsequent toggle point<br>1 = enable toggle point "TP16" |          |
|                                   | 6:0 | TP16[14:8] | 000_0000 | pixel count of toggle point "TP16"                                                                                 |          |

## Register F0h Toggle point 16 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R241 (F1h)<br>Toggle point 17 LSB | 7:0 | TP17[7:0] | 0000_0000 | pixel count of toggle point "TP17" |          |

## Register F1h Toggle point 17 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R242 (F2h)<br>Toggle point 17 MSB | 7   | EN_TP17    | 0        | enable toggle point "TP17"<br>0 = disable "TP17" and all subsequent toggle point<br>1 = enable toggle point "TP17" |          |
|                                   | 6:0 | TP17[14:8] | 000_0000 | pixel count of toggle point "TP17"                                                                                 |          |

**Register F2h** Toggle point 17 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R243 (F3h)<br>Toggle point 18 LSB | 7:0 | TP18[7:0] | 0000_0000 | pixel count of toggle point "TP18" |          |

**Register F3h** Toggle point 18 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R244 (F4h)<br>Toggle point 18 MSB | 7   | EN_TP18    | 0        | enable toggle point "TP18"<br>0 = disable "TP18" and all subsequent toggle point<br>1 = enable toggle point "TP18" |          |
|                                   | 6:0 | TP18[14:8] | 000_0000 | pixel count of toggle point "TP18"                                                                                 |          |

**Register F4h** Toggle point 18 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R245 (F5h)<br>Toggle point 19 LSB | 7:0 | TP19[7:0] | 0000_0000 | pixel count of toggle point "TP19" |          |

**Register F5h** Toggle point 19 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R246 (F6h)<br>Toggle point 19 MSB | 7   | EN_TP19    | 0        | enable toggle point "TP19"<br>0 = disable "TP19" and all subsequent toggle point<br>1 = enable toggle point "TP19" |          |
|                                   | 6:0 | TP19[14:8] | 000_0000 | pixel count of toggle point "TP19"                                                                                 |          |

**Register F6h** Toggle point 19 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R247 (F7h)<br>Toggle point 20 LSB | 7:0 | TP20[7:0] | 0000_0000 | pixel count of toggle point "TP20" |          |

**Register F7h** Toggle point 20 LSB

| REGISTER ADDRESS | BIT | LABEL   | DEFAULT | DESCRIPTION                | REFER TO |
|------------------|-----|---------|---------|----------------------------|----------|
| R248 (F8h)       | 7   | EN_TP20 | 0       | enable toggle point "TP20" |          |

| REGISTER ADDRESS    | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                          | REFER TO |
|---------------------|-----|------------|----------|--------------------------------------------------------------------------------------|----------|
| Toggle point 20 MSB |     |            |          | 0 = disable "TP20" and all subsequent toggle point<br>1 = enable toggle point "TP20" |          |
|                     | 6:0 | TP20[14:8] | 000_0000 | pixel count of toggle point "TP20"                                                   |          |

**Register F8h** Toggle point 20 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R249 (F9h)<br>Toggle point 21 LSB | 7:0 | TP21[7:0] | 0000_0000 | pixel count of toggle point "TP21" |          |

**Register F9h** Toggle point 21 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R250 (FAh)<br>Toggle point 21 MSB | 7   | EN_TP21    | 0        | enable toggle point "TP21"<br>0 = disable "TP21" and all subsequent toggle point<br>1 = enable toggle point "TP21" |          |
|                                   | 6:0 | TP21[14:8] | 000_0000 | pixel count of toggle point "TP21"                                                                                 |          |

**Register FAh** Toggle point 21 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R251 (FBh)<br>Toggle point 22 LSB | 7:0 | TP22[7:0] | 0000_0000 | pixel count of toggle point "TP22" |          |

**Register FBh** Toggle point 22 LSB

| REGISTER ADDRESS                  | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-----------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R252 (FCh)<br>Toggle point 22 MSB | 7   | EN_TP22    | 0        | enable toggle point "TP22"<br>0 = disable "TP22" and all subsequent toggle point<br>1 = enable toggle point "TP22" |          |
|                                   | 6:0 | TP22[14:8] | 000_0000 | pixel count of toggle point "TP22"                                                                                 |          |

**Register FCh** Toggle point 22 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R253 (FDh)<br>Toggle point 23 LSB | 7:0 | TP23[7:0] | 0000_0000 | pixel count of toggle point "TP23" |          |

**Register FDh** Toggle point 23 LSB

| REGISTER ADDRESS           | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                      | REFER TO |
|----------------------------|-----|---------|---------|----------------------------------------------------------------------------------|----------|
| R254 (FEh)<br>Toggle point | 7   | EN_TP23 | 0       | enable toggle point "TP23"<br>0 = disable "TP23" and all subsequent toggle point |          |



| REGISTER ADDRESS | BIT | LABEL      | DEFAULT  | DESCRIPTION                        | REFER TO |
|------------------|-----|------------|----------|------------------------------------|----------|
| 23 MSB           |     |            |          | 1 = enable toggle point "TP23"     |          |
|                  | 6:0 | TP23[14:8] | 000_0000 | pixel count of toggle point "TP23" |          |

**Register FEh** Toggle point 23 MSB

| REGISTER ADDRESS                  | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-----------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R255 (FFh)<br>Toggle point 24 LSB | 7:0 | TP24[7:0] | 0000_0000 | pixel count of toggle point "TP24" |          |

**Register FFh** Toggle point 24 LSB

| REGISTER ADDRESS                    | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R256 (0100h)<br>Toggle point 24 MSB | 7   | EN_TP24    | 0        | enable toggle point "TP24"<br>0 = disable "TP24" and all subsequent toggle point<br>1 = enable toggle point "TP24" |          |
|                                     | 6:0 | TP24[14:8] | 000_0000 | pixel count of toggle point "TP24"                                                                                 |          |

**Register 0100h** Toggle point 24 MSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R257 (0101h)<br>Toggle point 25 LSB | 7:0 | TP25[7:0] | 0000_0000 | pixel count of toggle point "TP25" |          |

**Register 0101h** Toggle point 25 LSB

| REGISTER ADDRESS                    | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R258 (0102h)<br>Toggle point 25 MSB | 7   | EN_TP25    | 0        | enable toggle point "TP25"<br>0 = disable "TP25" and all subsequent toggle point<br>1 = enable toggle point "TP25" |          |
|                                     | 6:0 | TP25[14:8] | 000_0000 | pixel count of toggle point "TP25"                                                                                 |          |

**Register 0102h** Toggle point 25 MSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R259 (0103h)<br>Toggle point 26 LSB | 7:0 | TP26[7:0] | 0000_0000 | pixel count of toggle point "TP26" |          |

**Register 0103h** Toggle point 26 LSB

| REGISTER ADDRESS                    | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------|-----|---------|---------|--------------------------------------------------------------------------------------------------------------------|----------|
| R260 (0104h)<br>Toggle point 26 MSB | 7   | EN_TP26 | 0       | enable toggle point "TP26"<br>0 = disable "TP26" and all subsequent toggle point<br>1 = enable toggle point "TP26" |          |

| REGISTER ADDRESS | BIT | LABEL      | DEFAULT  | DESCRIPTION                        | REFER TO |
|------------------|-----|------------|----------|------------------------------------|----------|
|                  | 6:0 | TP26[14:8] | 000_0000 | pixel count of toggle point "TP26" |          |

**Register 0104h** Toggle point 26 MSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R261 (0105h)<br>Toggle point 27 LSB | 7:0 | TP27[7:0] | 0000_0000 | pixel count of toggle point "TP27" |          |

**Register 0105h** Toggle point 27 LSB

| REGISTER ADDRESS                    | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R262 (0106h)<br>Toggle point 27 MSB | 7   | EN_TP27    | 0        | enable toggle point "TP27"<br>0 = disable "TP27" and all subsequent toggle point<br>1 = enable toggle point "TP27" |          |
|                                     | 6:0 | TP27[14:8] | 000_0000 | pixel count of toggle point "TP27"                                                                                 |          |

**Register 0106h** Toggle point 27 MSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R263 (0107h)<br>Toggle point 28 LSB | 7:0 | TP28[7:0] | 0000_0000 | pixel count of toggle point "TP28" |          |

**Register 0107h** Toggle point 28 LSB

| REGISTER ADDRESS                    | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R264 (0108h)<br>Toggle point 28 MSB | 7   | EN_TP28    | 0        | enable toggle point "TP28"<br>0 = disable "TP28" and all subsequent toggle point<br>1 = enable toggle point "TP28" |          |
|                                     | 6:0 | TP28[14:8] | 000_0000 | pixel count of toggle point "TP28"                                                                                 |          |

**Register 0108h** Toggle point 28 MSB

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R265 (0109h)<br>Toggle point 29 LSB | 7:0 | TP29[7:0] | 0000_0000 | pixel count of toggle point "TP29" |          |

**Register 0109h** Toggle point 29 LSB

| REGISTER ADDRESS                    | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R266 (010Ah)<br>Toggle point 29 MSB | 7   | EN_TP29    | 0        | enable toggle point "TP29"<br>0 = disable "TP29" and all subsequent toggle point<br>1 = enable toggle point "TP29" |          |
|                                     | 6:0 | TP29[14:8] | 000_0000 | pixel count of toggle point "TP29"                                                                                 |          |

**Register 010Ah** Toggle point 29 MSB

| REGISTER ADDRESS                          | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R267<br>(010Bh)<br>Toggle point<br>30 LSB | 7:0 | TP30[7:0] | 0000_0000 | pixel count of toggle point "TP30" |          |

**Register 010Bh** Toggle point 30 LSB

| REGISTER ADDRESS                          | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                                                        | REFER TO |
|-------------------------------------------|-----|------------|----------|--------------------------------------------------------------------------------------------------------------------|----------|
| R268<br>(010Ch)<br>Toggle point<br>30 MSB | 7   | EN_TP30    | 0        | enable toggle point "TP30"<br>0 = disable "TP30" and all subsequent toggle point<br>1 = enable toggle point "TP30" |          |
|                                           | 6:0 | TP30[14:8] | 000_0000 | pixel count of toggle point "TP30"                                                                                 |          |

**Register 010Ch** Toggle point 30 MSB

| REGISTER ADDRESS                          | BIT | LABEL     | DEFAULT   | DESCRIPTION                        | REFER TO |
|-------------------------------------------|-----|-----------|-----------|------------------------------------|----------|
| R269<br>(010Dh)<br>Toggle point<br>31 LSB | 7:0 | TP31[7:0] | 0000_0000 | pixel count of toggle point "TP31" |          |

**Register 010Dh** Toggle point 31 LSB

| REGISTER ADDRESS                          | BIT | LABEL      | DEFAULT  | DESCRIPTION                                                                        | REFER TO |
|-------------------------------------------|-----|------------|----------|------------------------------------------------------------------------------------|----------|
| R270<br>(010Eh)<br>Toggle point<br>31 MSB | 7   | EN_TP31    | 0        | enable toggle point "TP31"<br>0 = disable "TP31"<br>1 = enable toggle point "TP31" |          |
|                                           | 6:0 | TP31[14:8] | 000_0000 | pixel count of toggle point "TP31"                                                 |          |

**Register 010Eh** Toggle point 31 MSB

| REGISTER ADDRESS                                  | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                      | REFER TO |
|---------------------------------------------------|-----|---------|---------|----------------------------------------------------------------------------------|----------|
| R271<br>(010Fh)<br>Polarity<br>setting of<br>T1 1 | 7   | POL7_T1 | 1       | logic level of T1 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                                   | 6   | POL6_T1 | 1       | logic level of T1 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                                   | 5   | POL5_T1 | 1       | logic level of T1 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                                   | 4   | POL4_T1 | 1       | logic level of T1 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                                   | 3   | POL3_T1 | 1       | logic level of T1 pulse at toggle point TP3<br>0 = low at TP3                    |          |

| REGISTER ADDRESS | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                      | REFER TO |
|------------------|-----|---------|---------|----------------------------------------------------------------------------------|----------|
|                  |     |         |         | 1 = high at TP3                                                                  |          |
|                  | 2   | POL2_T1 | 1       | logic level of T1 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                  | 1   | POL1_T1 | 1       | logic level of T1 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                  | 0   | POL0_T1 | 1       | logic level of T1 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 010Fh** Polarity setting of T1 1

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------------------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
| R272 (0110h)<br>Polarity setting of T1 2 | 7   | POL15_T1 | 1       | logic level of T1 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_T1 | 1       | logic level of T1 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_T1 | 1       | logic level of T1 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_T1 | 1       | logic level of T1 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_T1 | 1       | logic level of T1 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_T1 | 1       | logic level of T1 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_T1  | 1       | logic level of T1 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_T1  | 1       | logic level of T1 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 0110h** Polarity setting of T1 2

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------------------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
| R273 (0111h)<br>Polarity setting of T1 3 | 7   | POL23_T1 | 1       | logic level of T1 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_T1 | 1       | logic level of T1 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_T1 | 1       | logic level of T1 pulse at toggle point TP21<br>0 = low at TP21                     |          |

| REGISTER ADDRESS | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
|                  |     |          |         | 1 = high at TP21                                                                    |          |
|                  | 4   | POL20_T1 | 1       | logic level of T1 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                  | 3   | POL19_T1 | 1       | logic level of T1 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                  | 2   | POL18_T1 | 1       | logic level of T1 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                  | 1   | POL17_T1 | 1       | logic level of T1 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                  | 0   | POL16_T1 | 1       | logic level of T1 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0111h** Polarity setting of T1 3

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------------------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
| R274 (0112h)<br>Polarity setting of T1 4 | 7   | POL31_T1 | 1       | logic level of T1 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_T1 | 1       | logic level of T1 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_T1 | 1       | logic level of T1 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_T1 | 1       | logic level of T1 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_T1 | 1       | logic level of T1 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_T1 | 1       | logic level of T1 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                          | 1   | POL25_T1 | 1       | logic level of T1 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                          | 0   | POL24_T1 | 1       | logic level of T1 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 0112h** Polarity setting of T1 4

| REGISTER ADDRESS         | BIT | LABEL   | DEFAULT | DESCRIPTION                                                   | REFER TO |
|--------------------------|-----|---------|---------|---------------------------------------------------------------|----------|
| R275 (0113h)<br>Polarity | 7   | POL7_T2 | 1       | logic level of T2 pulse at toggle point TP7<br>0 = low at TP7 |          |

| REGISTER ADDRESS | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                      | REFER TO |
|------------------|-----|---------|---------|----------------------------------------------------------------------------------|----------|
| setting of T2 1  |     |         |         | 1 = high at TP7                                                                  |          |
|                  | 6   | POL6_T2 | 1       | logic level of T2 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                  | 5   | POL5_T2 | 1       | logic level of T2 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                  | 4   | POL4_T2 | 1       | logic level of T2 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                  | 3   | POL3_T2 | 1       | logic level of T2 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                  | 2   | POL2_T2 | 1       | logic level of T2 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                  | 1   | POL1_T2 | 1       | logic level of T2 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                  | 0   | POL0_T2 | 1       | logic level of T2 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 0113h** Polarity setting of T2 1

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------------------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
| R276 (0114h)<br>Polarity setting of T2 2 | 7   | POL15_T2 | 1       | logic level of T2 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_T2 | 1       | logic level of T2 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_T2 | 1       | logic level of T2 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_T2 | 1       | logic level of T2 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_T2 | 1       | logic level of T2 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_T2 | 1       | logic level of T2 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_T2  | 1       | logic level of T2 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_T2  | 1       | logic level of T2 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 0114h** Polarity setting of T2 2

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------------------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
| R277 (0115h)<br>Polarity setting of T2 3 | 7   | POL23_T2 | 1       | logic level of T2 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_T2 | 1       | logic level of T2 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_T2 | 1       | logic level of T2 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                          | 4   | POL20_T2 | 1       | logic level of T2 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                          | 3   | POL19_T2 | 1       | logic level of T2 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                          | 2   | POL18_T2 | 1       | logic level of T2 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                                          | 1   | POL17_T2 | 1       | logic level of T2 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                                          | 0   | POL16_T2 | 1       | logic level of T2 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0115h** Polarity setting of T2 3

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                         | REFER TO |
|------------------------------------------|-----|----------|---------|-------------------------------------------------------------------------------------|----------|
| R278 (0116h)<br>Polarity setting of T2 4 | 7   | POL31_T2 | 1       | logic level of T2 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_T2 | 1       | logic level of T2 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_T2 | 1       | logic level of T2 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_T2 | 1       | logic level of T2 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_T2 | 1       | logic level of T2 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_T2 | 1       | logic level of T2 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                          | 1   | POL25_T2 | 1       | logic level of T2 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                          | 0   | POL24_T2 | 1       | logic level of T2 pulse at toggle point TP24                                        |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION                         | REFER TO |
|------------------|-----|-------|---------|-------------------------------------|----------|
|                  |     |       |         | 0 = low at TP24<br>1 = high at TP24 |          |

**Register 0116h** Polarity setting of T2 4

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R279 (0117h)<br>Polarity setting of P0 1 | 7   | POL7_PO0 | 0       | logic level of PO0 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                          | 6   | POL6_PO0 | 0       | logic level of PO0 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                          | 5   | POL5_PO0 | 0       | logic level of PO0 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                          | 4   | POL4_PO0 | 0       | logic level of PO0 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                          | 3   | POL3_PO0 | 0       | logic level of PO0 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                          | 2   | POL2_PO0 | 0       | logic level of PO0 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                                          | 1   | POL1_PO0 | 0       | logic level of PO0 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                                          | 0   | POL0_PO0 | 0       | logic level of PO0 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 0117h** Polarity setting of P0 1

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R280 (0118h)<br>Polarity setting of P0 2 | 7   | POL15_PO0 | 0       | logic level of PO0 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_PO0 | 0       | logic level of PO0 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_PO0 | 0       | logic level of PO0 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_PO0 | 0       | logic level of PO0 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_PO0 | 0       | logic level of PO0 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_PO0 | 0       | logic level of PO0 pulse at toggle point TP10                                        |          |



| REGISTER ADDRESS | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
|                  |     |          |         | 0 = low at TP10<br>1 = high at TP10                                               |          |
|                  | 1   | POL9_PO0 | 0       | logic level of PO0 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9 |          |
|                  | 0   | POL8_PO0 | 0       | logic level of PO0 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8 |          |

**Register 0118h** Polarity setting of P0 2

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R281 (0119h)<br>Polarity setting of P0 3 | 7   | POL23_PO0 | 0       | logic level of PO0 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_PO0 | 0       | logic level of PO0 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_PO0 | 0       | logic level of PO0 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                          | 4   | POL20_PO0 | 0       | logic level of PO0 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                          | 3   | POL19_PO0 | 0       | logic level of PO0 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                          | 2   | POL18_PO0 | 0       | logic level of PO0 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                                          | 1   | POL17_PO0 | 0       | logic level of PO0 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                                          | 0   | POL16_PO0 | 0       | logic level of PO0 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0119h** Polarity setting of P0 3

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R282 (011Ah)<br>Polarity setting of P0 4 | 7   | POL31_PO0 | 0       | logic level of PO0 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_PO0 | 0       | logic level of PO0 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_PO0 | 0       | logic level of PO0 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_PO0 | 0       | logic level of PO0 pulse at toggle point TP28                                        |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 0 = low at TP28<br>1 = high at TP28                                                  |          |
|                  | 3   | POL27_PO0 | 0       | logic level of PO0 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                  | 2   | POL26_PO0 | 0       | logic level of PO0 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                  | 1   | POL25_PO0 | 0       | logic level of PO0 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                  | 0   | POL24_PO0 | 0       | logic level of PO0 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 011Ah** Polarity setting of P0 4

| REGISTER ADDRESS                                  | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|---------------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R283<br>(011Bh)<br>Polarity<br>setting of<br>P1 1 | 7   | POL7_PO1 | 0       | logic level of PO1 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                                   | 6   | POL6_PO1 | 0       | logic level of PO1 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                                   | 5   | POL5_PO1 | 0       | logic level of PO1 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                                   | 4   | POL4_PO1 | 0       | logic level of PO1 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                                   | 3   | POL3_PO1 | 0       | logic level of PO1 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                                   | 2   | POL2_PO1 | 0       | logic level of PO1 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                                                   | 1   | POL1_PO1 | 0       | logic level of PO1 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                                                   | 0   | POL0_PO1 | 0       | logic level of PO1 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 011Bh** Polarity setting of P1 1

| REGISTER ADDRESS                          | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|-------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R284<br>(011Ch)<br>Polarity<br>setting of | 7   | POL15_PO1 | 0       | logic level of PO1 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                           | 6   | POL14_PO1 | 0       | logic level of PO1 pulse at toggle point TP14                                        |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| P1 2             |     |           |         | 0 = low at TP14<br>1 = high at TP14                                                  |          |
|                  | 5   | POL13_PO1 | 0       | logic level of PO1 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                  | 4   | POL12_PO1 | 0       | logic level of PO1 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                  | 3   | POL11_PO1 | 0       | logic level of PO1 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                  | 2   | POL10_PO1 | 0       | logic level of PO1 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                  | 1   | POL9_PO1  | 0       | logic level of PO1 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                  | 0   | POL8_PO1  | 0       | logic level of PO1 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 011Ch** Polarity setting of P1 2

| REGISTER ADDRESS                                  | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|---------------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R285<br>(011Dh)<br>Polarity<br>setting of<br>P1 3 | 7   | POL23_PO1 | 0       | logic level of PO1 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                                   | 6   | POL22_PO1 | 0       | logic level of PO1 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                                   | 5   | POL21_PO1 | 0       | logic level of PO1 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                                   | 4   | POL20_PO1 | 0       | logic level of PO1 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                                   | 3   | POL19_PO1 | 0       | logic level of PO1 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                                   | 2   | POL18_PO1 | 0       | logic level of PO1 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                                                   | 1   | POL17_PO1 | 0       | logic level of PO1 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                                                   | 0   | POL16_PO1 | 0       | logic level of PO1 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 011Dh** Polarity setting of P1 3

| REGISTER ADDRESS                                  | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|---------------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R286<br>(011Eh)<br>Polarity<br>setting of<br>P1 4 | 7   | POL31_PO1 | 0       | logic level of PO1 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                                   | 6   | POL30_PO1 | 0       | logic level of PO1 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                                   | 5   | POL29_PO1 | 0       | logic level of PO1 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                                   | 4   | POL28_PO1 | 0       | logic level of PO1 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                                   | 3   | POL27_PO1 | 0       | logic level of PO1 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                                   | 2   | POL26_PO1 | 0       | logic level of PO1 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                                   | 1   | POL25_PO1 | 0       | logic level of PO1 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                                   | 0   | POL24_PO1 | 0       | logic level of PO1 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 011Eh** Polarity setting of P1 4

| REGISTER ADDRESS                                  | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|---------------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R287<br>(011Fh)<br>Polarity<br>setting of<br>P2 1 | 7   | POL7_PO2 | 0       | logic level of PO2 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                                   | 6   | POL6_PO2 | 0       | logic level of PO2 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                                   | 5   | POL5_PO2 | 0       | logic level of PO2 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                                   | 4   | POL4_PO2 | 0       | logic level of PO2 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                                   | 3   | POL3_PO2 | 0       | logic level of PO2 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                                   | 2   | POL2_PO2 | 0       | logic level of PO2 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                                                   | 1   | POL1_PO2 | 0       | logic level of PO2 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                                                   | 0   | POL0_PO2 | 0       | logic level of PO2 pulse at toggle point TP0<br>0 = low at TP0                    |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION     | REFER TO |
|------------------|-----|-------|---------|-----------------|----------|
|                  |     |       |         | 1 = high at TP0 |          |

**Register 011Fh** Polarity setting of P2 1

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R288 (0120h)<br>Polarity setting of P2 2 | 7   | POL15_PO2 | 0       | logic level of PO2 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_PO2 | 0       | logic level of PO2 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_PO2 | 0       | logic level of PO2 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_PO2 | 0       | logic level of PO2 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_PO2 | 0       | logic level of PO2 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_PO2 | 0       | logic level of PO2 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_PO2  | 0       | logic level of PO2 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_PO2  | 0       | logic level of PO2 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 0120h** Polarity setting of P2 2

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R289 (0121h)<br>Polarity setting of P2 3 | 7   | POL23_PO2 | 0       | logic level of PO2 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_PO2 | 0       | logic level of PO2 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_PO2 | 0       | logic level of PO2 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                          | 4   | POL20_PO2 | 0       | logic level of PO2 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                          | 3   | POL19_PO2 | 0       | logic level of PO2 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                          | 2   | POL18_PO2 | 0       | logic level of PO2 pulse at toggle point TP18<br>0 = low at TP18                     |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 1 = high at TP18                                                                     |          |
|                  | 1   | POL17_PO2 | 0       | logic level of PO2 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                  | 0   | POL16_PO2 | 0       | logic level of PO2 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0121h** Polarity setting of P2 3

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R290 (0122h)<br>Polarity setting of P2 4 | 7   | POL31_PO2 | 0       | logic level of PO2 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_PO2 | 0       | logic level of PO2 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_PO2 | 0       | logic level of PO2 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_PO2 | 0       | logic level of PO2 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_PO2 | 0       | logic level of PO2 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_PO2 | 0       | logic level of PO2 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                          | 1   | POL25_PO2 | 0       | logic level of PO2 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                          | 0   | POL24_PO2 | 0       | logic level of PO2 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 0122h** Polarity setting of P2 4

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R291 (0123h)<br>Polarity setting of P3 1 | 7   | POL7_PO3 | 0       | logic level of PO3 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                          | 6   | POL6_PO3 | 0       | logic level of PO3 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                          | 5   | POL5_PO3 | 0       | logic level of PO3 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                          | 4   | POL4_PO3 | 0       | logic level of PO3 pulse at toggle point TP4<br>0 = low at TP4                    |          |

| REGISTER ADDRESS | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
|                  |     |          |         | 1 = high at TP4                                                                   |          |
|                  | 3   | POL3_PO3 | 0       | logic level of PO3 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                  | 2   | POL2_PO3 | 0       | logic level of PO3 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                  | 1   | POL1_PO3 | 0       | logic level of PO3 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                  | 0   | POL0_PO3 | 0       | logic level of PO3 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 0123h** Polarity setting of P3 1

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R292 (0124h)<br>Polarity setting of P3 2 | 7   | POL15_PO3 | 0       | logic level of PO3 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_PO3 | 0       | logic level of PO3 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_PO3 | 0       | logic level of PO3 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_PO3 | 0       | logic level of PO3 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_PO3 | 0       | logic level of PO3 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_PO3 | 0       | logic level of PO3 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_PO3  | 0       | logic level of PO3 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_PO3  | 0       | logic level of PO3 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 0124h** Polarity setting of P3 2

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R293 (0125h)<br>Polarity setting of P3 3 | 7   | POL23_PO3 | 0       | logic level of PO3 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_PO3 | 0       | logic level of PO3 pulse at toggle point TP22<br>0 = low at TP22                     |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 1 = high at TP22                                                                     |          |
|                  | 5   | POL21_PO3 | 0       | logic level of PO3 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                  | 4   | POL20_PO3 | 0       | logic level of PO3 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                  | 3   | POL19_PO3 | 0       | logic level of PO3 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                  | 2   | POL18_PO3 | 0       | logic level of PO3 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                  | 1   | POL17_PO3 | 0       | logic level of PO3 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                  | 0   | POL16_PO3 | 0       | logic level of PO3 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0125h** Polarity setting of P3 3

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R294 (0126h)<br>Polarity setting of P3 4 | 7   | POL31_PO3 | 0       | logic level of PO3 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_PO3 | 0       | logic level of PO3 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_PO3 | 0       | logic level of PO3 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_PO3 | 0       | logic level of PO3 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_PO3 | 0       | logic level of PO3 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_PO3 | 0       | logic level of PO3 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                          | 1   | POL25_PO3 | 0       | logic level of PO3 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                          | 0   | POL24_PO3 | 0       | logic level of PO3 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 0126h** Polarity setting of P3 4



| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R295 (0127h)<br>Polarity setting of P4 1 | 7   | POL7_PO4 | 0       | logic level of PO4 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                          | 6   | POL6_PO4 | 0       | logic level of PO4 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                          | 5   | POL5_PO4 | 0       | logic level of PO4 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                          | 4   | POL4_PO4 | 0       | logic level of PO4 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                          | 3   | POL3_PO4 | 0       | logic level of PO4 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                          | 2   | POL2_PO4 | 0       | logic level of PO4 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                                          | 1   | POL1_PO4 | 0       | logic level of PO4 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                                          | 0   | POL0_PO4 | 0       | logic level of PO4 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 0127h** Polarity setting of P4 1

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R296 (0128h)<br>Polarity setting of P4 2 | 7   | POL15_PO4 | 0       | logic level of PO4 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_PO4 | 0       | logic level of PO4 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_PO4 | 0       | logic level of PO4 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_PO4 | 0       | logic level of PO4 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_PO4 | 0       | logic level of PO4 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_PO4 | 0       | logic level of PO4 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_PO4  | 0       | logic level of PO4 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_PO4  | 0       | logic level of PO4 pulse at toggle point TP8<br>0 = low at TP8                       |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION     | REFER TO |
|------------------|-----|-------|---------|-----------------|----------|
|                  |     |       |         | 1 = high at TP8 |          |

**Register 0128h** Polarity setting of P4 2

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R297 (0129h)<br>Polarity setting of P4 3 | 7   | POL23_PO4 | 0       | logic level of PO4 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_PO4 | 0       | logic level of PO4 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_PO4 | 0       | logic level of PO4 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                          | 4   | POL20_PO4 | 0       | logic level of PO4 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                          | 3   | POL19_PO4 | 0       | logic level of PO4 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                          | 2   | POL18_PO4 | 0       | logic level of PO4 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                                          | 1   | POL17_PO4 | 0       | logic level of PO4 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                                          | 0   | POL16_PO4 | 0       | logic level of PO4 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0129h** Polarity setting of P4 3

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R298 (012Ah)<br>Polarity setting of P4 4 | 7   | POL31_PO4 | 0       | logic level of PO4 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_PO4 | 0       | logic level of PO4 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_PO4 | 0       | logic level of PO4 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_PO4 | 0       | logic level of PO4 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_PO4 | 0       | logic level of PO4 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_PO4 | 0       | logic level of PO4 pulse at toggle point TP26<br>0 = low at TP26                     |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 1 = high at TP26                                                                     |          |
|                  | 1   | POL25_PO4 | 0       | logic level of PO4 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                  | 0   | POL24_PO4 | 0       | logic level of PO4 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 012Ah** Polarity setting of P4 4

| REGISTER ADDRESS                                  | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|---------------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R299<br>(012Bh)<br>Polarity<br>setting of<br>P5 1 | 7   | POL7_PO5 | 0       | logic level of PO5 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                                   | 6   | POL6_PO5 | 0       | logic level of PO5 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                                   | 5   | POL5_PO5 | 0       | logic level of PO5 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                                   | 4   | POL4_PO5 | 0       | logic level of PO5 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                                   | 3   | POL3_PO5 | 0       | logic level of PO5 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                                   | 2   | POL2_PO5 | 0       | logic level of PO5 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                                                   | 1   | POL1_PO5 | 0       | logic level of PO5 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                                                   | 0   | POL0_PO5 | 0       | logic level of PO5 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 012Bh** Polarity setting of P5 1

| REGISTER ADDRESS                                  | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|---------------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R300<br>(012Ch)<br>Polarity<br>setting of<br>P5 2 | 7   | POL15_PO5 | 0       | logic level of PO5 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                                   | 6   | POL14_PO5 | 0       | logic level of PO5 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                                   | 5   | POL13_PO5 | 0       | logic level of PO5 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                                   | 4   | POL12_PO5 | 0       | logic level of PO5 pulse at toggle point TP12<br>0 = low at TP12                     |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 1 = high at TP12                                                                     |          |
|                  | 3   | POL11_PO5 | 0       | logic level of PO5 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                  | 2   | POL10_PO5 | 0       | logic level of PO5 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                  | 1   | POL9_PO5  | 0       | logic level of PO5 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                  | 0   | POL8_PO5  | 0       | logic level of PO5 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 012Ch** Polarity setting of P5 2

| REGISTER ADDRESS                                  | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|---------------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R301<br>(012Dh)<br>Polarity<br>setting of<br>P5 3 | 7   | POL23_PO5 | 0       | logic level of PO5 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                                   | 6   | POL22_PO5 | 0       | logic level of PO5 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                                   | 5   | POL21_PO5 | 0       | logic level of PO5 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                                   | 4   | POL20_PO5 | 0       | logic level of PO5 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                                   | 3   | POL19_PO5 | 0       | logic level of PO5 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                                   | 2   | POL18_PO5 | 0       | logic level of PO5 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                                                   | 1   | POL17_PO5 | 0       | logic level of PO5 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                                                   | 0   | POL16_PO5 | 0       | logic level of PO5 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 012Dh** Polarity setting of P5 3

| REGISTER ADDRESS                                  | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|---------------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R302<br>(012Eh)<br>Polarity<br>setting of<br>P5 4 | 7   | POL31_PO5 | 0       | logic level of PO5 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                                   | 6   | POL30_PO5 | 0       | logic level of PO5 pulse at toggle point TP30<br>0 = low at TP30                     |          |

| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 1 = high at TP30                                                                     |          |
|                  | 5   | POL29_PO5 | 0       | logic level of PO5 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                  | 4   | POL28_PO5 | 0       | logic level of PO5 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                  | 3   | POL27_PO5 | 0       | logic level of PO5 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                  | 2   | POL26_PO5 | 0       | logic level of PO5 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                  | 1   | POL25_PO5 | 0       | logic level of PO5 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                  | 0   | POL24_PO5 | 0       | logic level of PO5 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 012Eh** Polarity setting of P5 4

| REGISTER ADDRESS                                  | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|---------------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R303<br>(012Fh)<br>Polarity<br>setting of<br>P6 1 | 7   | POL7_PO6 | 0       | logic level of PO6 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                                   | 6   | POL6_PO6 | 0       | logic level of PO6 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                                   | 5   | POL5_PO6 | 0       | logic level of PO6 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                                   | 4   | POL4_PO6 | 0       | logic level of PO6 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                                   | 3   | POL3_PO6 | 0       | logic level of PO6 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                                   | 2   | POL2_PO6 | 0       | logic level of PO6 pulse at toggle point TP2<br>0 = low at TP2<br>1 = high at TP2 |          |
|                                                   | 1   | POL1_PO6 | 0       | logic level of PO6 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                                                   | 0   | POL0_PO6 | 0       | logic level of PO6 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 012Fh** Polarity setting of P6 1

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R304 (0130h)<br>Polarity setting of P6 2 | 7   | POL15_PO6 | 0       | logic level of PO6 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_PO6 | 0       | logic level of PO6 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_PO6 | 0       | logic level of PO6 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_PO6 | 0       | logic level of PO6 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_PO6 | 0       | logic level of PO6 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_PO6 | 0       | logic level of PO6 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_PO6  | 0       | logic level of PO6 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_PO6  | 0       | logic level of PO6 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 0130h** Polarity setting of P6 2

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R305 (0131h)<br>Polarity setting of P6 3 | 7   | POL23_PO6 | 0       | logic level of PO6 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_PO6 | 0       | logic level of PO6 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_PO6 | 0       | logic level of PO6 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                          | 4   | POL20_PO6 | 0       | logic level of PO6 pulse at toggle point TP20<br>0 = low at TP20<br>1 = high at TP20 |          |
|                                          | 3   | POL19_PO6 | 0       | logic level of PO6 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                                          | 2   | POL18_PO6 | 0       | logic level of PO6 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                                          | 1   | POL17_PO6 | 0       | logic level of PO6 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                                          | 0   | POL16_PO6 | 0       | logic level of PO6 pulse at toggle point TP16<br>0 = low at TP16                     |          |

| REGISTER ADDRESS | BIT | LABEL | DEFAULT | DESCRIPTION      | REFER TO |
|------------------|-----|-------|---------|------------------|----------|
|                  |     |       |         | 1 = high at TP16 |          |

**Register 0131h** Polarity setting of P6 3

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R306 (0132h)<br>Polarity setting of P6 4 | 7   | POL31_PO6 | 0       | logic level of PO6 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_PO6 | 0       | logic level of PO6 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_PO6 | 0       | logic level of PO6 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_PO6 | 0       | logic level of PO6 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_PO6 | 0       | logic level of PO6 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_PO6 | 0       | logic level of PO6 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                          | 1   | POL25_PO6 | 0       | logic level of PO6 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                          | 0   | POL24_PO6 | 0       | logic level of PO6 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 0132h** Polarity setting of P6 4

| REGISTER ADDRESS                         | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------------------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
| R307 (0133h)<br>Polarity setting of P7 1 | 7   | POL7_PO7 | 0       | logic level of PO7 pulse at toggle point TP7<br>0 = low at TP7<br>1 = high at TP7 |          |
|                                          | 6   | POL6_PO7 | 0       | logic level of PO7 pulse at toggle point TP6<br>0 = low at TP6<br>1 = high at TP6 |          |
|                                          | 5   | POL5_PO7 | 0       | logic level of PO7 pulse at toggle point TP5<br>0 = low at TP5<br>1 = high at TP5 |          |
|                                          | 4   | POL4_PO7 | 0       | logic level of PO7 pulse at toggle point TP4<br>0 = low at TP4<br>1 = high at TP4 |          |
|                                          | 3   | POL3_PO7 | 0       | logic level of PO7 pulse at toggle point TP3<br>0 = low at TP3<br>1 = high at TP3 |          |
|                                          | 2   | POL2_PO7 | 0       | logic level of PO7 pulse at toggle point TP2<br>0 = low at TP2                    |          |

| REGISTER ADDRESS | BIT | LABEL    | DEFAULT | DESCRIPTION                                                                       | REFER TO |
|------------------|-----|----------|---------|-----------------------------------------------------------------------------------|----------|
|                  |     |          |         | 1 = high at TP2                                                                   |          |
|                  | 1   | POL1_PO7 | 0       | logic level of PO7 pulse at toggle point TP1<br>0 = low at TP1<br>1 = high at TP1 |          |
|                  | 0   | POL0_PO7 | 0       | logic level of PO7 pulse at toggle point TP0<br>0 = low at TP0<br>1 = high at TP0 |          |

**Register 0133h** Polarity setting of P7 1

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R308 (0134h)<br>Polarity setting of P7 2 | 7   | POL15_PO7 | 0       | logic level of PO7 pulse at toggle point TP15<br>0 = low at TP15<br>1 = high at TP15 |          |
|                                          | 6   | POL14_PO7 | 0       | logic level of PO7 pulse at toggle point TP14<br>0 = low at TP14<br>1 = high at TP14 |          |
|                                          | 5   | POL13_PO7 | 0       | logic level of PO7 pulse at toggle point TP13<br>0 = low at TP13<br>1 = high at TP13 |          |
|                                          | 4   | POL12_PO7 | 0       | logic level of PO7 pulse at toggle point TP12<br>0 = low at TP12<br>1 = high at TP12 |          |
|                                          | 3   | POL11_PO7 | 0       | logic level of PO7 pulse at toggle point TP11<br>0 = low at TP11<br>1 = high at TP11 |          |
|                                          | 2   | POL10_PO7 | 0       | logic level of PO7 pulse at toggle point TP10<br>0 = low at TP10<br>1 = high at TP10 |          |
|                                          | 1   | POL9_PO7  | 0       | logic level of PO7 pulse at toggle point TP9<br>0 = low at TP9<br>1 = high at TP9    |          |
|                                          | 0   | POL8_PO7  | 0       | logic level of PO7 pulse at toggle point TP8<br>0 = low at TP8<br>1 = high at TP8    |          |

**Register 0134h** Polarity setting of P7 2

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R309 (0135h)<br>Polarity setting of P7 3 | 7   | POL23_PO7 | 0       | logic level of PO7 pulse at toggle point TP23<br>0 = low at TP23<br>1 = high at TP23 |          |
|                                          | 6   | POL22_PO7 | 0       | logic level of PO7 pulse at toggle point TP22<br>0 = low at TP22<br>1 = high at TP22 |          |
|                                          | 5   | POL21_PO7 | 0       | logic level of PO7 pulse at toggle point TP21<br>0 = low at TP21<br>1 = high at TP21 |          |
|                                          | 4   | POL20_PO7 | 0       | logic level of PO7 pulse at toggle point TP20<br>0 = low at TP20                     |          |



| REGISTER ADDRESS | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
|                  |     |           |         | 1 = high at TP20                                                                     |          |
|                  | 3   | POL19_PO7 | 0       | logic level of PO7 pulse at toggle point TP19<br>0 = low at TP19<br>1 = high at TP19 |          |
|                  | 2   | POL18_PO7 | 0       | logic level of PO7 pulse at toggle point TP18<br>0 = low at TP18<br>1 = high at TP18 |          |
|                  | 1   | POL17_PO7 | 0       | logic level of PO7 pulse at toggle point TP17<br>0 = low at TP17<br>1 = high at TP17 |          |
|                  | 0   | POL16_PO7 | 0       | logic level of PO7 pulse at toggle point TP16<br>0 = low at TP16<br>1 = high at TP16 |          |

**Register 0135h** Polarity setting of P7 3

| REGISTER ADDRESS                         | BIT | LABEL     | DEFAULT | DESCRIPTION                                                                          | REFER TO |
|------------------------------------------|-----|-----------|---------|--------------------------------------------------------------------------------------|----------|
| R310 (0136h)<br>Polarity setting of P7 4 | 7   | POL31_PO7 | 0       | logic level of PO7 pulse at toggle point TP31<br>0 = low at TP31<br>1 = high at TP31 |          |
|                                          | 6   | POL30_PO7 | 0       | logic level of PO7 pulse at toggle point TP30<br>0 = low at TP30<br>1 = high at TP30 |          |
|                                          | 5   | POL29_PO7 | 0       | logic level of PO7 pulse at toggle point TP29<br>0 = low at TP29<br>1 = high at TP29 |          |
|                                          | 4   | POL28_PO7 | 0       | logic level of PO7 pulse at toggle point TP28<br>0 = low at TP28<br>1 = high at TP28 |          |
|                                          | 3   | POL27_PO7 | 0       | logic level of PO7 pulse at toggle point TP27<br>0 = low at TP27<br>1 = high at TP27 |          |
|                                          | 2   | POL26_PO7 | 0       | logic level of PO7 pulse at toggle point TP26<br>0 = low at TP26<br>1 = high at TP26 |          |
|                                          | 1   | POL25_PO7 | 0       | logic level of PO7 pulse at toggle point TP25<br>0 = low at TP25<br>1 = high at TP25 |          |
|                                          | 0   | POL24_PO7 | 0       | logic level of PO7 pulse at toggle point TP24<br>0 = low at TP24<br>1 = high at TP24 |          |

**Register 0136h** Polarity setting of P7 4

| REGISTER ADDRESS                   | BIT | LABEL    | DEFAULT | DESCRIPTION                                         | REFER TO |
|------------------------------------|-----|----------|---------|-----------------------------------------------------|----------|
| R432 (1B0h)<br>User access control | 0   | USER_KEY | 0       | 0 = User access disabled<br>1 = User access enabled |          |

**Register 01B0h** User access control

| REGISTER ADDRESS            | BIT | LABEL     | DEFAULT | DESCRIPTION                    | REFER TO |
|-----------------------------|-----|-----------|---------|--------------------------------|----------|
| R436 (1B4h)<br>LDO2 control | 4:0 | LDO2 VSEL | 1_0000  | 1_0000 = 1.8V<br>1_0010 = 2.0V |          |

**Register 01B4h** LDO2 control

| REGISTER ADDRESS                    | BIT | LABEL     | DEFAULT | DESCRIPTION                                           | REFER TO |
|-------------------------------------|-----|-----------|---------|-------------------------------------------------------|----------|
| R448 (1C0h)<br>User access control2 | 0   | User_KEY2 | 0       | 0 = User access2 disabled<br>1 = User access2 enabled |          |

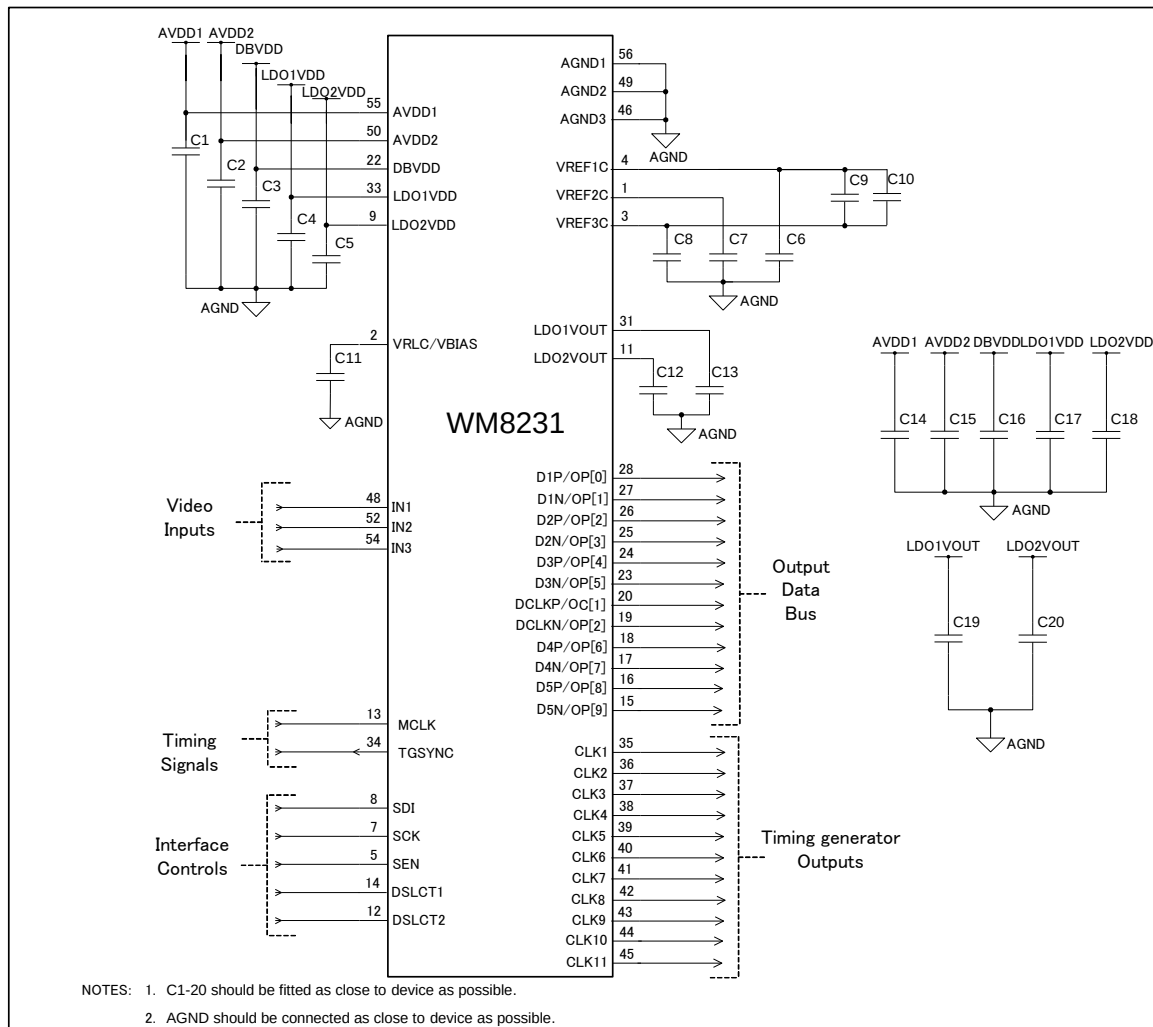
**Register 1C0h** User access control2

| REGISTER ADDRESS            | BIT | LABEL   | DEFAULT | DESCRIPTION                                                                    | REFER TO |
|-----------------------------|-----|---------|---------|--------------------------------------------------------------------------------|----------|
| R459 (1CBh)<br>Comp control | 1:0 | PT_COMP | 01      | 01 = Standard operation<br>11 = High performance operation<br>Other = Inhibit. |          |

**Register 1CBh** Comp control

## APPLICATIONS INFORMATION

### RECOMMENDED EXTERNAL COMPONENTS

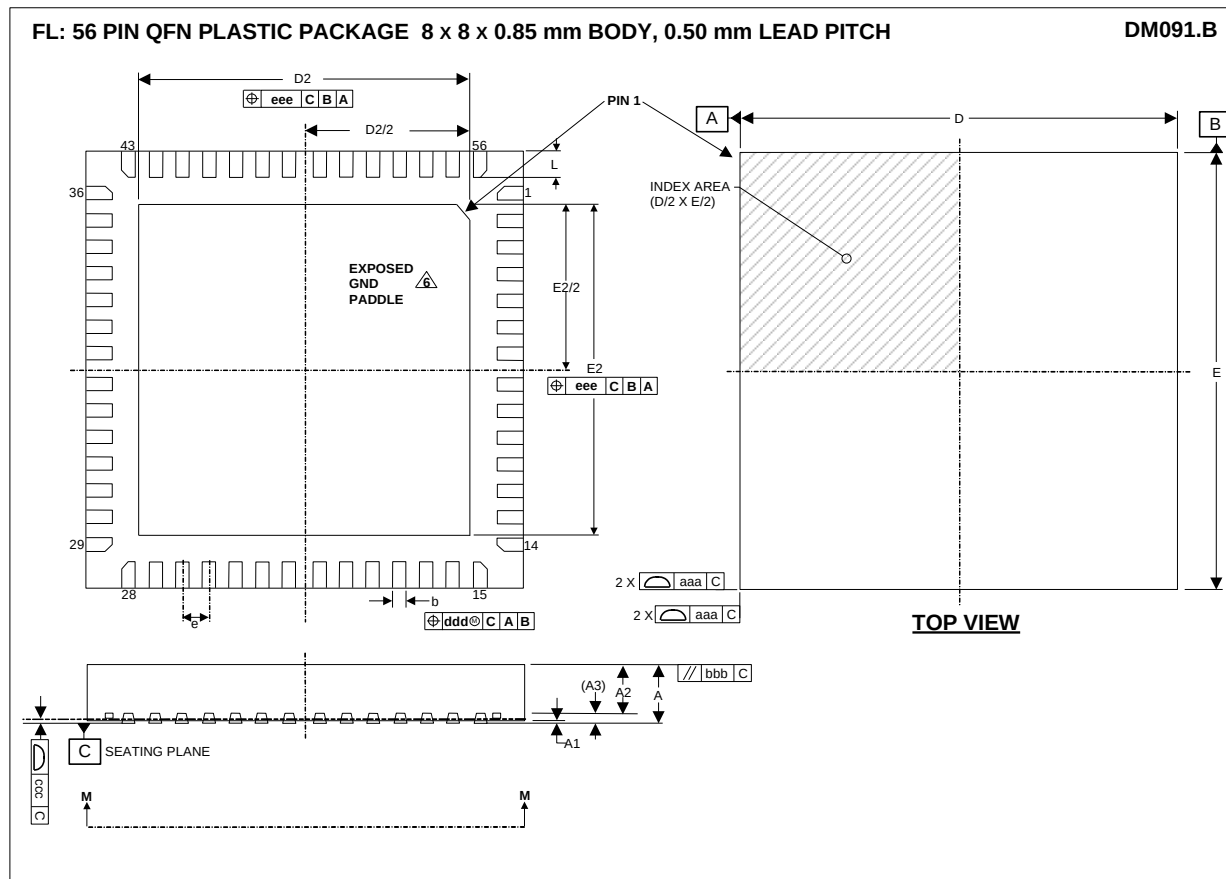


**Figure 54 External Components Diagram**

**RECOMMENDED EXTERNAL COMPONENT DESCRIPTION**

| COMPONENT REFERENCE | SUGGESTED VALUE | DESCRIPTION                                         |
|---------------------|-----------------|-----------------------------------------------------|
| C1                  | 0.1uF           | De-coupling for AVDD1                               |
| C2                  | 0.1uF           | De-coupling for AVDD2                               |
| C3                  | 0.1uF           | De-coupling for DBVDD                               |
| C4                  | 0.1uF           | De-coupling for LDO1VDD                             |
| C5                  | 0.1uF           | De-coupling for LDO2VDD                             |
| C6                  | 0.1uF           | De-coupling for VREF1C                              |
| C7                  | 0.1uF           | De-coupling for VREF2C                              |
| C8                  | 0.1uF           | De-coupling for VREF3C                              |
| C9                  | 0.01uF          | High frequency decoupling between VREF1C and VREF3C |
| C10                 | 10uF            | Low frequency decoupling between VREF1C and VREF3C  |
| C11                 | 1uF             | De-coupling for VRLC/VBIAS                          |
| C12                 | 1uF             | De-coupling for LDO1VOUT                            |
| C13                 | 1uF             | De-coupling for LDO2VOUT                            |
| C14                 | 10uF            | Reservoir capacitor for AVDD1                       |
| C15                 | 10uF            | Reservoir capacitor for AVDD2                       |
| C16                 | 10uF            | Reservoir capacitor for DBVDD                       |
| C17                 | 10uF            | Reservoir capacitor for LDO1VDD                     |
| C18                 | 10uF            | Reservoir capacitor for LDO2VDD                     |
| C19                 | 10uF            | Reservoir capacitor for LDOOUT                      |
| C20                 | 10uF            | Reservoir capacitor for LDOOUT                      |

**Table 17 External Components Descriptions**

**PACKAGE DIMENSIONS**


| Symbols                                | Dimensions (mm)                 |           |      | NOTE |
|----------------------------------------|---------------------------------|-----------|------|------|
|                                        | MIN                             | NOM       | MAX  |      |
| <b>A</b>                               | 0.8                             | 0.85      | 0.9  |      |
| <b>A1</b>                              | 0                               | 0.035     | 0.05 |      |
| <b>A2</b>                              | -                               | 0.65      | 0.67 |      |
| <b>A3</b>                              |                                 | 0.203 REF |      |      |
| <b>b</b>                               | 0.20                            | 0.25      | 0.30 | 1    |
| <b>D</b>                               |                                 | 8.00 BSC  |      |      |
| <b>D2</b>                              | 5.95                            | 6.05      | 6.15 |      |
| <b>E</b>                               |                                 | 8.00 BSC  |      |      |
| <b>E2</b>                              | 5.95                            | 6.05      | 6.15 |      |
| <b>e</b>                               |                                 | 0.5 BSC   |      |      |
| <b>L</b>                               | 0.35                            | 0.4       | 0.45 |      |
| <b>Tolerances of Form and Position</b> |                                 |           |      |      |
| <b>aaa</b>                             | 0.10                            |           |      |      |
| <b>bbb</b>                             | 0.10                            |           |      |      |
| <b>ccc</b>                             | 0.08                            |           |      |      |
| <b>ddd</b>                             | 0.10                            |           |      |      |
| <b>eee</b>                             | 0.10                            |           |      |      |
| <b>REF</b>                             | JEDEC, MO-220, VARIATION VLLD-2 |           |      |      |

**NOTES:**

1. DIMENSION b APPLIED TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 mm AND 0.30 mm FROM TERMINAL TIP.
2. ALL DIMENSIONS ARE IN MILLIMETRES
3. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-002.
4. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
5. THIS DRAWING IS SUBJECT TO CHANGE WITHOUT NOTICE.
6. REFER TO APPLICATIONS NOTE WAN\_0118 FOR FURTHER INFORMATION.

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**IMPORTANT NOTICE**

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**REVISION HISTORY**

| DATE     | REV | ORIGINATOR | CHANGES                                                     | PAGE          |
|----------|-----|------------|-------------------------------------------------------------|---------------|
| 14/12/12 | 4.0 | AA         | Added channel to channel offset matching specification      | 9             |
|          |     |            | Corrected offset DAC INL DNL spec                           | 10            |
|          |     |            | Corrected supply current for full power down mode           | 11            |
|          |     |            | Updated timing specification                                | 15,17,33-35   |
|          |     |            | Corrected figure for ADC INPUT BLACK LEVEL ADJUST           | 21            |
|          |     |            | Corrected figure for overall signal flow                    | 22            |
|          |     |            | Added description for ADC, PGA Bias Current Control.        | 22            |
|          |     |            | Added description for PLL DLL setup                         | 23            |
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| 20/10/15 | 4.4 | PH         | Test limit (min/max) conditions added in Elec Chars         | 8-10          |
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| 27/03/18 | 4.7 | PH         | Formatting update – no change in content                    | ALL           |
| 04/10/18 | 4.8 | PH         | Supported operating frequencies (MCLK, sample rate) updated | 1, 16, 23, 25 |

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