



OV7910/OV7410/OV7411

OV7910P SINGLE-CHIP CMOS COLOR PAL CAMERA OV7410P/OV7411P SINGLE-CHIP CMOS B&W PAL CAMERA

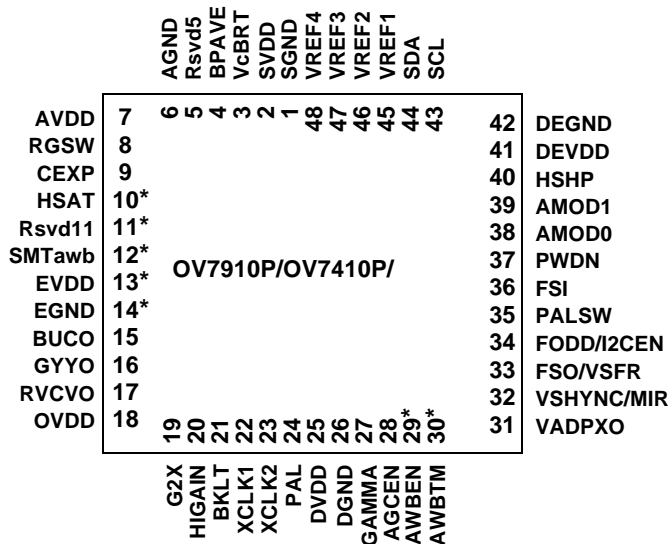
Features

- Single-chip 1/3 inch format video camera
 - High-sensitivity version (OV7411P)
- Composite video: PAL or S-Video
- Component video: RGB or YUV
- Sensitivity boost (+18 dB) /AGC on-off
- Automatic exposure/gain/white balance
- External frame sync capability
- Aperture correction
- I²C programmable:
 - color sat., brightness, contrast, white balance, exposure time, gain
- Gamma correction (0.45)-On/Off
- Low power consumption
- +5 volt-only power supply

General Description

The OV7910P (color) and OV7410P/OV7411P (black and white) Single-chip CMOS camera devices are designed to provide a high level of functionality in a single small-footprint package. Both devices support composite video and S-Video. The OV7910P imager also provides RGB and YCrCb video signals, and each device directly interfaces with a VCR TV monitor or other 75 ohm terminated input. A minimum of external components are required to complete a fully functional camera subsystem. The OV7910P/OV7410P/OV7411P video cameras require only a single 5-volt DC supply and have been designed for very low power operation. These products are ideal for all applications requiring a small footprint, low voltage, low power and low cost color or black and white video camera.

- Video Conferencing
- Video Phones
- Video e-mail
- PC Multimedia
- Toys
- Security
- Surveillance



* NOTE: These pins are "no connect" in OV7410P/OV7411P sensor.

OV7910P/OV7410P/OV7411P PIN ASSIGNMENT

| | |
|---------------------------|---|
| Array Size | PAL: 628 x 582 pixels |
| Image Area | PAL: 5.78 x 4.19 mm |
| Auto Electronic Exposure | 1/60 - 1/15000 sec. |
| Min. Illumination (3000K) | OV7910P: < 3 lux @ f1.2 OV7410P: < 0.5 lux @ f1.2 OV7411P: < 0.2 lux @ f1.2 |
| S/N Ratio | > 48 dB |
| Fixed Pattern Noise (FPN) | < 0.03% V _{P-P} |
| Dark Current | < 0.2 nA/cm ² |
| Dynamic Range | > 72 dB |
| Power Supply | 5VDC, ±5% |
| Power Requirements | 200 mW |
| Package Type | 48-pin LCC |

Table 1. Pin Description*(Pins designated with "*" are "no connect" in OV7410P/OV7411P sensor.)*

| Pin No. | Name | Pin Type | Function/Description | | | | | | | | | | | | | | | | | | | | |
|---------|--------|---|---|-------|-------|------------------|--------|---|---|--------------------|-----------|---|---|----------------|-----|---|---|--------------|------------|---|---|----------------|-----|
| 01 | SGND | V _{in} | Analog ground | | | | | | | | | | | | | | | | | | | | |
| 02 | SVDD | V _{in} | Analog power (+5VDC) | | | | | | | | | | | | | | | | | | | | |
| 03 | VcBRT | 1.2V | Image brightness adjustment. Default set by internal resistor (~50K). Default may be changed by applying external bias to this pin. | | | | | | | | | | | | | | | | | | | | |
| 04 | BPAVE | Function (Default = 0) | Internal 3-point average selection "0" - Use internal 3-point averaging "1" - Bypass internal 3-point averaging | | | | | | | | | | | | | | | | | | | | |
| 05 | Rsvd5 | V _{ref} | Internal reference | | | | | | | | | | | | | | | | | | | | |
| 06 | AGND | V _{in} | Analog ground | | | | | | | | | | | | | | | | | | | | |
| 07 | AVDD | V _{in} | Analog power (+5VDC) | | | | | | | | | | | | | | | | | | | | |
| 08 | RGSW | Function (Default = 0) | "Raw" data pixel selection "0" - select non- "raw" pixel data "1" - select "raw" pixel data | | | | | | | | | | | | | | | | | | | | |
| 09 | CEXP | Function (Default = 0) | Central exposure selection "0" - select normal mode "1" - select central exposure mode | | | | | | | | | | | | | | | | | | | | |
| 10* | HSAT | Function (Default = 0) <i>(N/C on OV7410P/ OV7411P)</i> | Color Saturation selection "0" - select normal color saturation "1" - select increase color saturation by 25% Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". | | | | | | | | | | | | | | | | | | | | |
| 11* | Rsvd11 | N/C | Pin reserved | | | | | | | | | | | | | | | | | | | | |
| 12* | SMTawb | Function (Default = 0) <i>(N/C on OV7410P/ OV7411P)</i> | Automatic White Balance (AWB) Smart mode selection "0" - Disable smart mode "1" - Enable smart mode. Count pixels which contain a luminance signal between 10-80% of max. value. Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". | | | | | | | | | | | | | | | | | | | | |
| 13* | EVDD | V _{in} <i>(N/C on OV7410P/ OV7411P)</i> | Analog power (+5VDC) Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". | | | | | | | | | | | | | | | | | | | | |
| 14* | EGND | V _{in} <i>(N/C on OV7410P/ OV7411P)</i> | Analog ground Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". | | | | | | | | | | | | | | | | | | | | |
| 15 | BUCO | Output | Video Output: Output format determined by pins 38 and 39 (AMOD1, AMOD0) <table border="1"> <thead> <tr> <th>AMOD1</th> <th>AMOD0</th> <th>Output Component</th> <th>Format</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>S-Video CO channel</td> <td>Composite</td> </tr> <tr> <td>0</td> <td>1</td> <td>Blue component</td> <td>RGB</td> </tr> <tr> <td>1</td> <td>0</td> <td>Cb component</td> <td>YUV or B/W</td> </tr> <tr> <td>1</td> <td>1</td> <td>Blue component</td> <td>RGB</td> </tr> </tbody> </table> Note: Modes (AMOD1, AMOD0) = 00, 01, 11 are not available for OV7410P Image Sensor | AMOD1 | AMOD0 | Output Component | Format | 0 | 0 | S-Video CO channel | Composite | 0 | 1 | Blue component | RGB | 1 | 0 | Cb component | YUV or B/W | 1 | 1 | Blue component | RGB |
| AMOD1 | AMOD0 | Output Component | Format | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | S-Video CO channel | Composite | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | Blue component | RGB | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | Cb component | YUV or B/W | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | Blue component | RGB | | | | | | | | | | | | | | | | | | | | |

Table 1. Pin Description*(Pins designated with "*" are "no connect" in OV7410P/OV7411P sensor.)*

| Pin No. | Name | Pin Type | Function/Description | | | | | | | | | | | | | | | | | | | | |
|---------|-------|---|--|-------|-------|------------------|--------|---|-----------|--------------------|-----------|-----------|---|-----------------|-----------|---|---|--------------|------------|---|---|-----------------|-----|
| 16 | GYO | Output | Video Output: Output format determined by pins 38 and 39 (AMOD1, AMOD0) <table border="1"> <thead> <tr> <th>AMOD1</th> <th>AMOD0</th> <th>Output Component</th> <th>Format</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>S-Video YO channel</td> <td>Composite</td> </tr> <tr> <td>0</td> <td>1</td> <td>Green component</td> <td>RGB</td> </tr> <tr> <td>1</td> <td>0</td> <td>Y component</td> <td>YUV or B/W</td> </tr> <tr> <td>1</td> <td>1</td> <td>Green component</td> <td>RGB</td> </tr> </tbody> </table> <p>Note: Modes (AMOD1, AMOD0) = 00, 01, 11 are not available for OV7410P Image Sensor</p> | AMOD1 | AMOD0 | Output Component | Format | 0 | 0 | S-Video YO channel | Composite | 0 | 1 | Green component | RGB | 1 | 0 | Y component | YUV or B/W | 1 | 1 | Green component | RGB |
| AMOD1 | AMOD0 | Output Component | Format | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | S-Video YO channel | Composite | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | Green component | RGB | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | Y component | YUV or B/W | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | Green component | RGB | | | | | | | | | | | | | | | | | | | | |
| 17 | RVCVO | Output | Video Output: Output format determined by pins 38 and 39 (AMOD1, AMOD0) <table border="1"> <thead> <tr> <th>AMOD1</th> <th>AMOD0</th> <th>Output Component</th> <th>Format</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>CVBS signal</td> <td>Composite</td> </tr> <tr> <td>0</td> <td>1</td> <td>Red component</td> <td>RGB</td> </tr> <tr> <td>1</td> <td>0</td> <td>Cr component</td> <td>YUV or B/W</td> </tr> <tr> <td>1</td> <td>1</td> <td>Red component</td> <td>RGB</td> </tr> </tbody> </table> <p>Note: Modes (AMOD1, AMOD0) = 00, 01, 11 are not available for OV7410P Image Sensor</p> | AMOD1 | AMOD0 | Output Component | Format | 0 | 0 | CVBS signal | Composite | 0 | 1 | Red component | RGB | 1 | 0 | Cr component | YUV or B/W | 1 | 1 | Red component | RGB |
| AMOD1 | AMOD0 | Output Component | Format | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | CVBS signal | Composite | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | Red component | RGB | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | Cr component | YUV or B/W | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | Red component | RGB | | | | | | | | | | | | | | | | | | | | |
| 18 | OVDD | V _{in} | Analog power for video output (+5VDC) | | | | | | | | | | | | | | | | | | | | |
| 19 | G2X | Function (Default = 0) | Automatic Gain Control (AGC) gain selection. Affects range selected by HGAIN (p20). See HGAIN below. "0" - select normal AGC gain (1X) "1" - select enhanced AGC gain (2X) | | | | | | | | | | | | | | | | | | | | |
| 20 | HGAIN | Function (Default = 0) | Automatic Gain Control (AGC) gain range selection "0" - select normal AGC range (1X <-> 4X) "1" - select expanded AGC range (1X -> 8X) <table border="1"> <thead> <tr> <th>HGAIN</th> <th>G2X</th> <th>AGC Range</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1X <-> 4X</td> </tr> <tr> <td>0</td> <td>1</td> <td>2X <-> 8X</td> </tr> <tr> <td>1</td> <td>0</td> <td>1X <-> 8X</td> </tr> <tr> <td>1</td> <td>1</td> <td>2X <-> 16X</td> </tr> </tbody> </table> | HGAIN | G2X | AGC Range | 0 | 0 | 1X <-> 4X | 0 | 1 | 2X <-> 8X | 1 | 0 | 1X <-> 8X | 1 | 1 | 2X <-> 16X | | | | | |
| HGAIN | G2X | AGC Range | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 1X <-> 4X | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | 2X <-> 8X | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | 1X <-> 8X | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 2X <-> 16X | | | | | | | | | | | | | | | | | | | | | |
| 21 | BKLT | Function (Default = 0) | Backlight selection "0" - Disable backlight compensation "1" - Enable backlight compensation | | | | | | | | | | | | | | | | | | | | |
| 22 | XCLK1 | CLK | Crystal clock input. Frequency is 4 x F _{sc} to meet PAL subcarrier standards | | | | | | | | | | | | | | | | | | | | |
| 23 | XCLK2 | CLK | Crystal clock output (4 x F _{sc} for PAL = 17.73265 MHz) | | | | | | | | | | | | | | | | | | | | |
| 24 | PAL | Function (Default = 1) | | | | | | | | | | | | | | | | | | | | | |
| 25 | DVDD | V _{in} | Digital power | | | | | | | | | | | | | | | | | | | | |
| 26 | DGND | V _{in} | Digital ground | | | | | | | | | | | | | | | | | | | | |
| 27 | GAMMA | Function (Default = 1) | GAMMA selection "0" - Disable GAMMA correction "1" - Enable GAMMA correction | | | | | | | | | | | | | | | | | | | | |
| 28 | AGCEN | Function (Default = 1) | Automatic Gain Control (AGC) selection "0" - Disable AGC "1" - Enable AGC | | | | | | | | | | | | | | | | | | | | |
| 29* | AWBEN | Function (Default = 1) (N/C on OV7410P/ OV7411P) | Automatic White Balance selection "0" - Disable AWB "1" - Enable AWB <p>Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect".</p> | | | | | | | | | | | | | | | | | | | | |

Table 1. Pin Description

(Pins designated with "*" are "no connect" in OV7410P/OV7411P sensor.)

| Pin No. | Name | Pin Type | Function/Description |
|---------|------------|---|---|
| 30* | AWBTM | Function (Default = 0) (N/C on OV7410P/ OV7411P) | Automatic White Balance speed selection "0" - Select normal AWB "1" - Select "fast" AWB Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". |
| 31 | VAXPXO | Output | Valid pixel detect output. CLK is asserted on this pin during active image period. |
| 32 | VHSYNC/MIR | Output/Function (Default = 0) | Vertical/horizontal sync output. Adding a pullup resistor on this pin enables mirror image |
| 33 | FSO/VSFR | Output/Function (Default = 0) | Vertical field/frame sync output, default to field sync. Adding a pullup resistor on this pin enables frame sync. |
| 34 | FODD/I2CEN | Output/Function (Default = 0) | Even/Odd field flag. Adding a pullup resistor on this pin enables I ² C control. |
| 35 | PALSW | Output | PAL switch clock output |
| 36 | FSI | Input | Field sync input |
| 37 | PWDN | Function | Power Down mode selection "0" - Disable power down mode "1" - Enable power down mode |
| 38 | AMOD0 | Function | AMOD0 (w/AMOD1) selects output mode. Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". |
| 39 | AMOD1 | Function | AMOD1 (w/AMOD0) selects output mode. Note: This function is not available on OV7410P/OV7411P Image Sensor. This pin is "no connect". |
| 40 | HSHP | Function | Sharpness level selection "0" - select normal sharpness "1" - select x2 sharpness |
| 41 | DEVDD | V _{in} | Analog power |
| 42 | DEGNZD | V _{in} | Analog ground |
| 43 | SCL | Input/Output | I ² C control |
| 44 | SDA | Input/Output | I ² C data/address |
| 45 | VREF1 | V _{ref} | Internal reference. Must be decoupled with 0.1 μF capacitor to analog ground. |
| 46 | VREF2 | V _{ref} | Internal reference. Must be decoupled with 0.1 μF capacitor to analog ground. |
| 47 | VREF3 | V _{ref} | Internal reference. Must be decoupled with 0.1 μF capacitor to analog ground. |
| 48 | VREF4 | V _{ref} | Internal reference. Must be decoupled with 0.1 μF capacitor to analog ground. |

1. Functional Description

(Note: All references to color functions apply only to OV7910P image sensor)

1.1 Video Standards

Two TV standards are implemented and available as output in the OV7910P/OV7410P/OV7411P imaging devices: PAL (B). Table 2 below shows how to configure the standard of choice. Please note

that the accuracy and stability of the crystal clock frequency is important to avoid unwanted color shift in TV/video systems.

Table 2. Standard Configuration

| Standard | PAL (pin 24) | Clock | Comments |
|----------|-----------------|---------------|--------------------|
| PAL | 1 | 17.734475 MHz | clock in = 4 x Fsc |

1.2 Video Formats

The OV7910P/OV7410P/OV7411P image sensors support a variety of formats including Composite (CVBS), S-Video (YO/CO), RGB components, YUV components, and B/W. Composite and S-Video signals are generated from the internal TV encoder and the RGB/YUV/BW outputs are generated from the color matrix prior to entering the encoder.

The image sensor utilizes the RG/BG Bayer pattern sending raw pixel data through the color matrix, creating RGB or YUV component signals. At the same time, YUV signals are also processed to generate both composite and S-Video signals. (Note: Color format configuration is valid only for the OV7910P image sensor)

configuration for the OV7910P/OV7410P/OV7411P image sensors. Pins AMOD0/AMOD1 (pins 38 and 39) select composite and S-Video formats. In this configuration, RVCVO (pin 17) outputs CVBS, GYYO (pin 16) outputs

1.2.1 Composite and S-Video

The Composite/S-Video format is the power-up default

the YO component of the S-Video signal, and BUCO (pin 15) outputs the CO component. Table 3 below summarizes the formats available and the settings required on the appropriate pins.

1.2.2 RGB

Setting AMOD0 = 1 (w/AMOD1 = x) selects the RGB format. In this configuration, RVCVO outputs the

Red component, GYYO outputs the Green component, and BUCO provides the Blue component.

1.2.3 YUV

Setting AMOD0=0 and AMOD1=1 configures the OV7910P/OV7410P/OV7411P sensors to operate in YUV or B/W mode. In this configuration, GYYO outputs the Y component, RVCVO provides the Cr component,

and BUCO outputs the Cb component. On the OV7410P image sensor, only the GYYO (Y component) output is valid.

Table 3. Video Format Selection

| Format Type | RVCVO Output (pin 17) | GYVO Output (pin 16) | BUCO Output (pin 15) | Pin Settings |
|---------------------|-----------------------|----------------------|----------------------|--|
| Composite + S-Video | CVBS | YO | CO | AMOD0 = 0, AMOD1 = 0 |
| RGB Components | Red | Green | Blue | AMOD0 = 1, AMOD1 = x |
| YUV Components | Cr | Y | Cb | AMOD0 = 0, AMOD1 = 1 |
| Black and White | — | Y | — | AMOD0 = 0, AMOD1 = 1 (Pins 15 & 17 are undefined on the OV7410P sensor) |

1.3 Configuring the OV7910P/OV7410P/OV7411P Image Sensors for Operation

The OV7910P/OV7410P/OV7411P sensors have been designed for easy-of-use in many stand-alone applications. Most of the on-chip functions are configurable by connecting appropriate pins high (logic “1”) or low (logic “0”) through a 10k Ohm resistor. The image sensor reads the input pins at power up, which enables user-defined default configurations.

The OV7910P/OV7410P/OV7411P imaging devices also contain an I²C interface for programmatic access. When the image sensors will enable the I²C port for access.

1.4 White Balance

The function of white balance in the OV7910P image sensor is to adjust and calibrate the image devices sensitivity on the primary (RGB) colors to match the color cast of the light source. The Auto White Balance (AWB) can be enabled or disabled either through an external pin (AWBEN, pin 29) or through the I²C port. If

able only through the I²C port. This function enables the user to define a “cooler” or “warmer” background for image capture.

1.5 Additional Picture Control

A number of functions/registers are available which enable the user to configure OV7910P/OV7410P/OV7411P image capturing parameters. These functions include Automatic Gain Control (AGC), AGC Gain, Automatic Exposure Control (AEC), GAMMA,

to all

register functions (For further details on I²C, see Section 2. “I²C Bus” on page 11). By default, the I²C port is disabled. To enable the I²C for controlling the sensors, a 10K Ohm pull-up resistor must be connected to FODD/I2CEN. With FODD/I2CEN pulled high at power-up, the OV7910P/OV7410P/OV7411P image

AWB is enabled, the image sensors continuously perform white balancing. A fast or slow mode of white balancing may be user-selected (AWBTM, pin 30). Fast AWB updates color every 2 fields while slow

white balancing updates every 16 fields.

By using the I²C port, the color temperature may be further fine tuned to the requirement of the application. Note that the “blue” (Blue and Blue bias registers) and “red” (Red and Red bias registers) bias control is available and Backlight control.

HGAIN (pin 20) may be used to set the range of AGC Gain. A “0” on HGAIN sets AGC Gain range for 1X <-> 4X, while a “1” sets the range for 1X <-> 8X. G2X (pin 19) can then be used to enhance the AGC gain range.

A “0” on G2X sets AGC gain at normal. A “1” enhances the AGC gain by 2 (Refer to Table 1, “Pin Description,” on page 2, pins 19 and 20 for further details). This function may be configured through the I²C port, as

well. GAMMA (pin 27) can be used to set the GAMMA correction. BKLT (pin 21) controls how the OV7910P/OV7410P/OV7411P image sensors manage backlight conditions. These functions may also be controlled through the I²C interface.

At power up, AGC and AEC are enabled. AGC can be disabled at power up by configuring the AGCEN pin (pin 28) as required. AEC cannot be enabled/disabled externally and must be reprogrammed through the I²C port.

1.6 Other Image Sensor Control Functions

Additional programmable functions for the OV7910P/

OV7410P/OV7411P image sensors include sharpness adjustment, brightness level fine tune, color saturation adjustment, mirror image control, and power down. All of these functions (except power down) can be configured either by an external pin or through the I²C interface.

Specifications

Table 4. Electrical parameters (0°C to 70 °C, all voltages referenced to GND)

| Symbol | Descriptions | Max | Typ | Min | Units |
|---|---|------|------|--------------------------|-------|
| Supply | | | | | |
| V _{DD} | Supply voltage (VDD, DVDD) | 5.25 | 5.0 | 4.75 | V |
| I _{DD} | Supply Current in VDDs | 40 | - | - | mA |
| I²C | | | | | |
| f _{scl} | SCL clock frequency | 400 | - | - | kHz |
| t _f | SDA fall time | 300 | - | 20 + 0.1C _{sda} | ns |
| t _{idle} | Bus idle time | - | - | 1.3 | us |
| t _{hdsta} | START hold time | - | - | 0.6 | us |
| t _{stps} | STOP set up time | - | - | 0.6 | us |
| t _{ds} | SDA set up time | - | - | 100 | us |
| t _{dh} | SDA hold time | - | - | 0 | us |
| Clock input / Crystal Oscillator | | | | | |
| f _{osc} | Resonator frequency | 10 | - | 20 | MHz |
| | Load capacitor | - | 10 | - | pF |
| | Parallel resistance | | 1M | | W |
| | Rise/fall time for external clock input | - | 5 | - | ns |
| | Duty cycle for external clock input | 60 | | 40 | % |
| Misc. timing | | | | | |
| t _{SYNC} | External FSI cycle time | - | 2 | - | frame |
| t _{PU} | Chip power up time | 100 | - | - | us |
| t _{PD} | Power up delay time | - | 10 | - | us |
| t _{PZ} | Power up low-z delay | - | 1000 | - | ns |
| VTO analog video output parameters | | | | | |

| V _{TO} analog video output parameters | | | | | | |
|--|----------------------------|-----|----------------|-------------------------|-----|-------|
| Symbol | Descriptions | Max | Type (OV7910P) | Type (OV7410P/ OV7411P) | Min | Units |
| V _{TO-P} | Video peak signal level | - | 2.3 | 2.4 | - | V |
| V _{TO-B} | Video black signal level | - | 0.7 | 1.2 | - | V |
| V _{SYNC} | Video sync pulse amplitude | - | 0.7 | 0.4 | - | V |
| R _o | Video output load | | 75 | 75 | | Ohm |

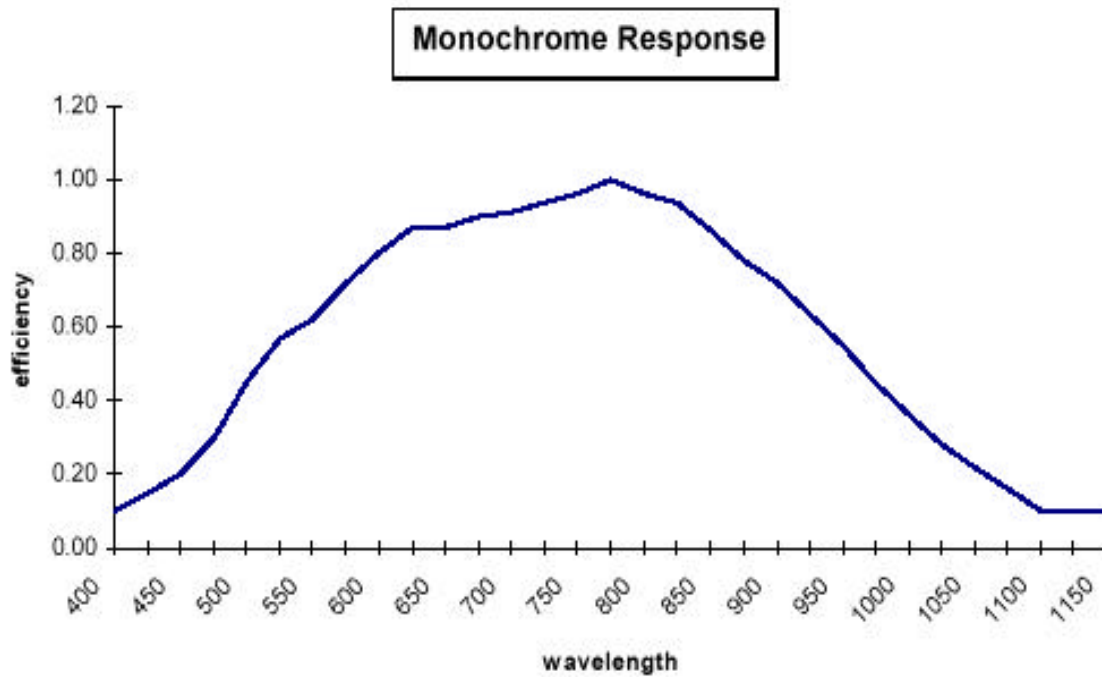
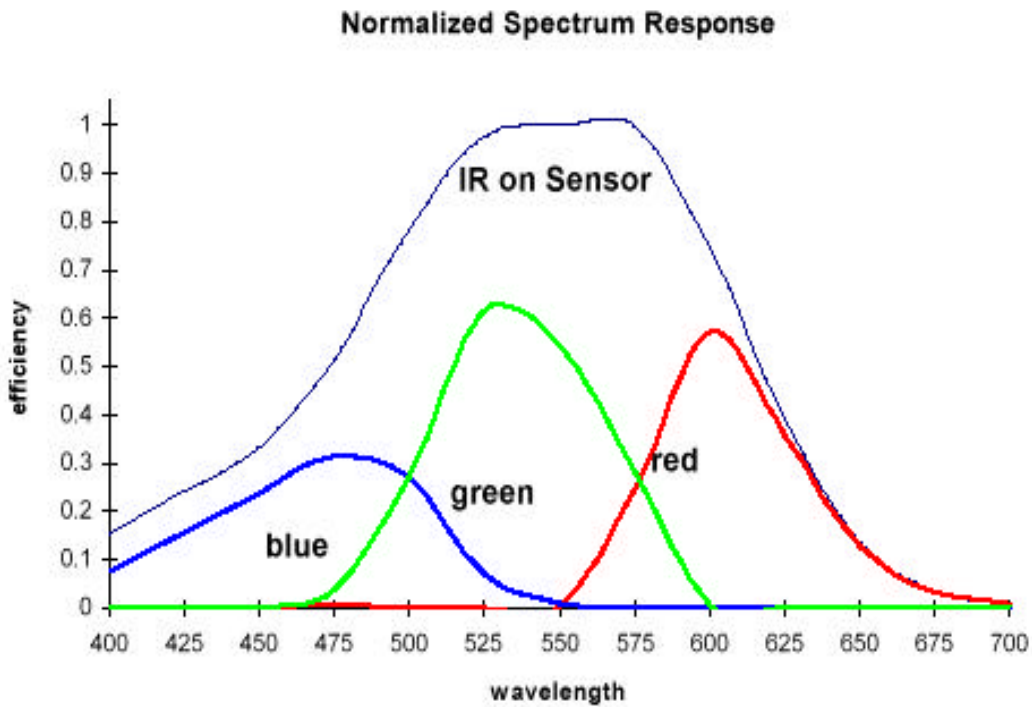


Figure 1. Spectrum Response

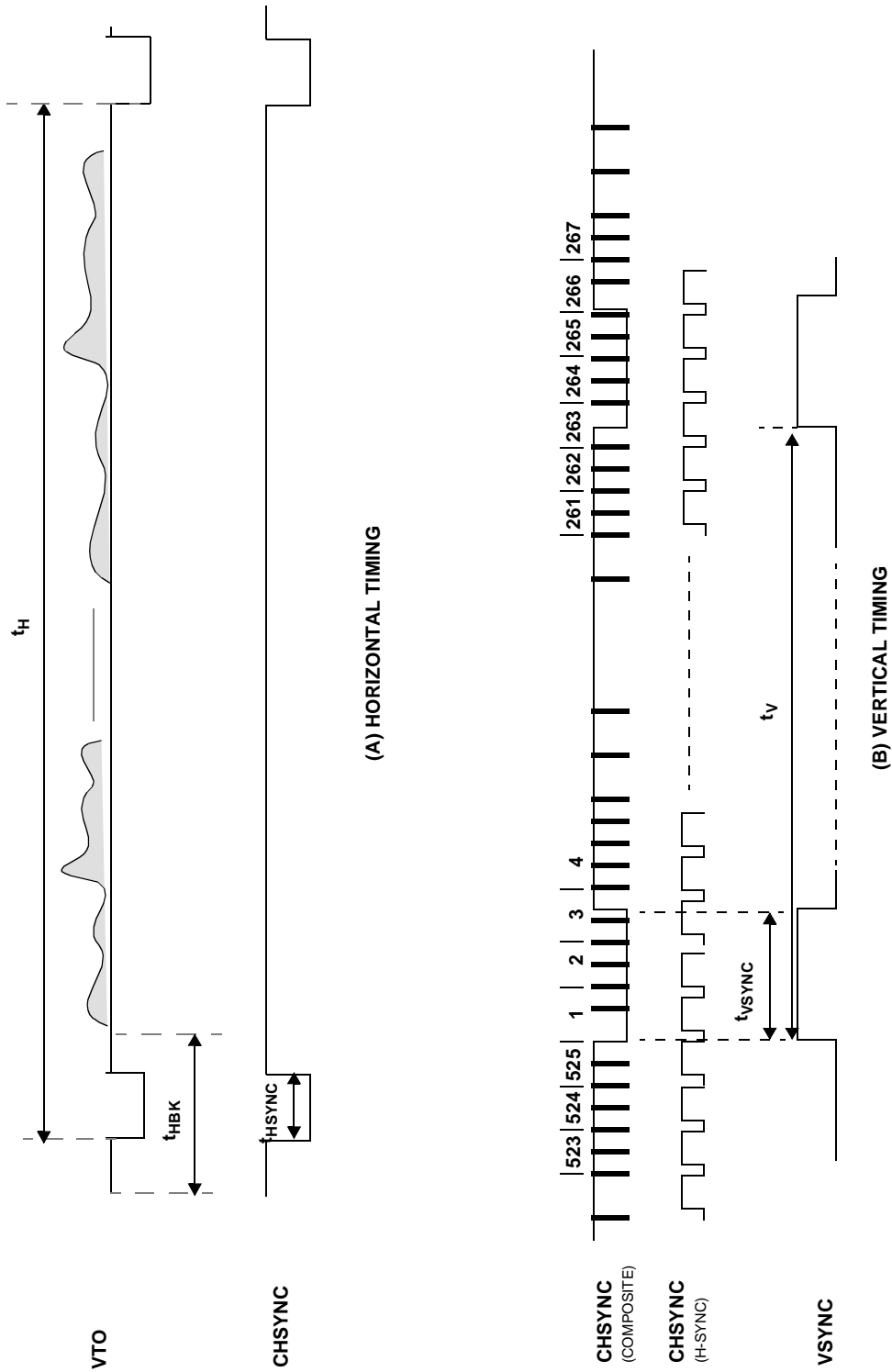


Figure 2. Video Timing Diagram

2. I²C Bus

I²C

Many of the functions and configuration registers in the OV7910P/OV7410P/OV7411P image sensors are available through the I²C high-speed serial interface. The I²C port is enabled by asserting the I2CEN line (pin 34) through a 10K ohm resistor to V_{DD}. When the rate using a 7-bit address/data transfer protocol .

capability is enabled (I2CEN = 1), the OV7910P/OV7410P/OV7411P imager operates as a slave device that supports up to 400 kbps serial transfer

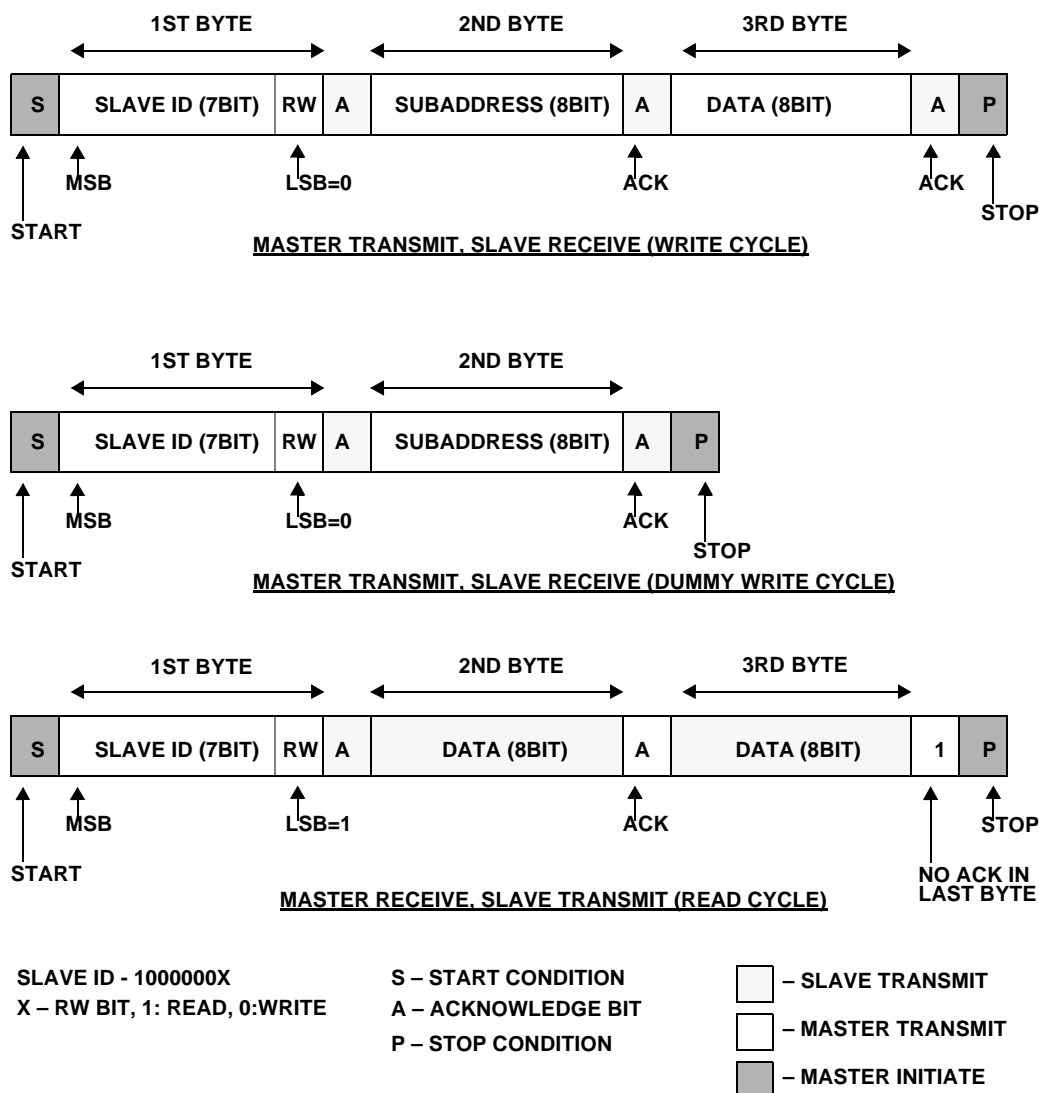


Figure 3. I²C Bus Protocol Format

that the read cycle can be terminated. Note that the restart feature is not supported here.

2.1 I²C Bus Protocol Format

In I²C operation, the master must perform the following operations:

- **Generate the start/stop condition**
- **Provide the serial clock on SCL**
- **Place the 7-bit slave address, the RW bit, and the 8-bit subaddress on SDA**

The receiver must pull down SDA during the acknowledge bit time. During the write cycle, the OV7910P/OV7410P/OV7411P device returns the acknowledgment and, during read cycle, the master returns the acknowledgment except when the read data is the last byte. If the read data is the last byte, the master does not perform an acknowledge, indicating to the slave below).

Within each byte, MSB is always transferred first. Read/write control bit is the LSB of the first byte. Standard I²C communications require only two pins: SCL and SDA. SDA is configured as open drain for bidirectional purpose. A HIGH to LOW transition on the SDA while SCL is HIGH indicates a START condition. A LOW to HIGH transition on the SDA while SCL is HIGH indicates a STOP condition. Only a master can generate START/STOP conditions.

Except for these two special conditions, the protocol that SDA remain stable during the HIGH period of the clock, SCL. Each bit is allowed to change state only when SCL is LOW (See Figure 4. Bit Transfer on the I²C Bus and Figure 5. Data Transfer on the I²C Bus

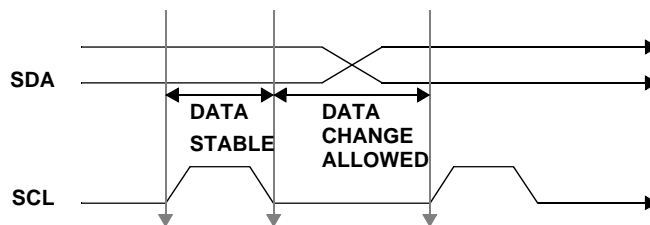
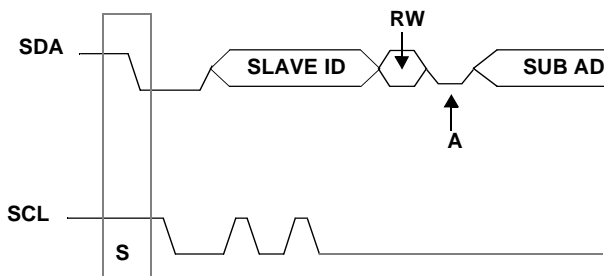


Figure 4. Bit Transfer on the I²C Bus

Figure 5. Data Transfer on the I²C Bus



The OV7910P/OV7410P/OV7411P I²C supports multi-byte write and multi-byte read. The master must supply the subaddress. in the write cycle, but not in the read cycle. Therefore, the OV7910P/OV7410P/OV7411P takes the read subaddress from the previous write cycle. In multi-byte write or multi-byte read cycles, the subaddress is automatically increment after the first data byte so that continuous locations can be accessed

in one bus cycle. A multi-byte cycle overwrites its original subaddress; therefore, if a read cycle immediately follows a multi-byte cycle, you must insert a single-byte write cycle that provides a new subaddress.

The OV7910P/OV7410P/OV7411P supports a single slave ID. The ID is preset to 80 write and 81 for read.

In the write cycle, the second byte in I²C bus is the subaddress for selecting the individual on-chip registers, and the third byte is the data associated with this register. Writing to an undefined subaddress is ignored.

In the read cycle, the second byte is the data associated with the previous stored subaddress. Reading of undefined subaddresses returns unknown data.

2.2 Register Set

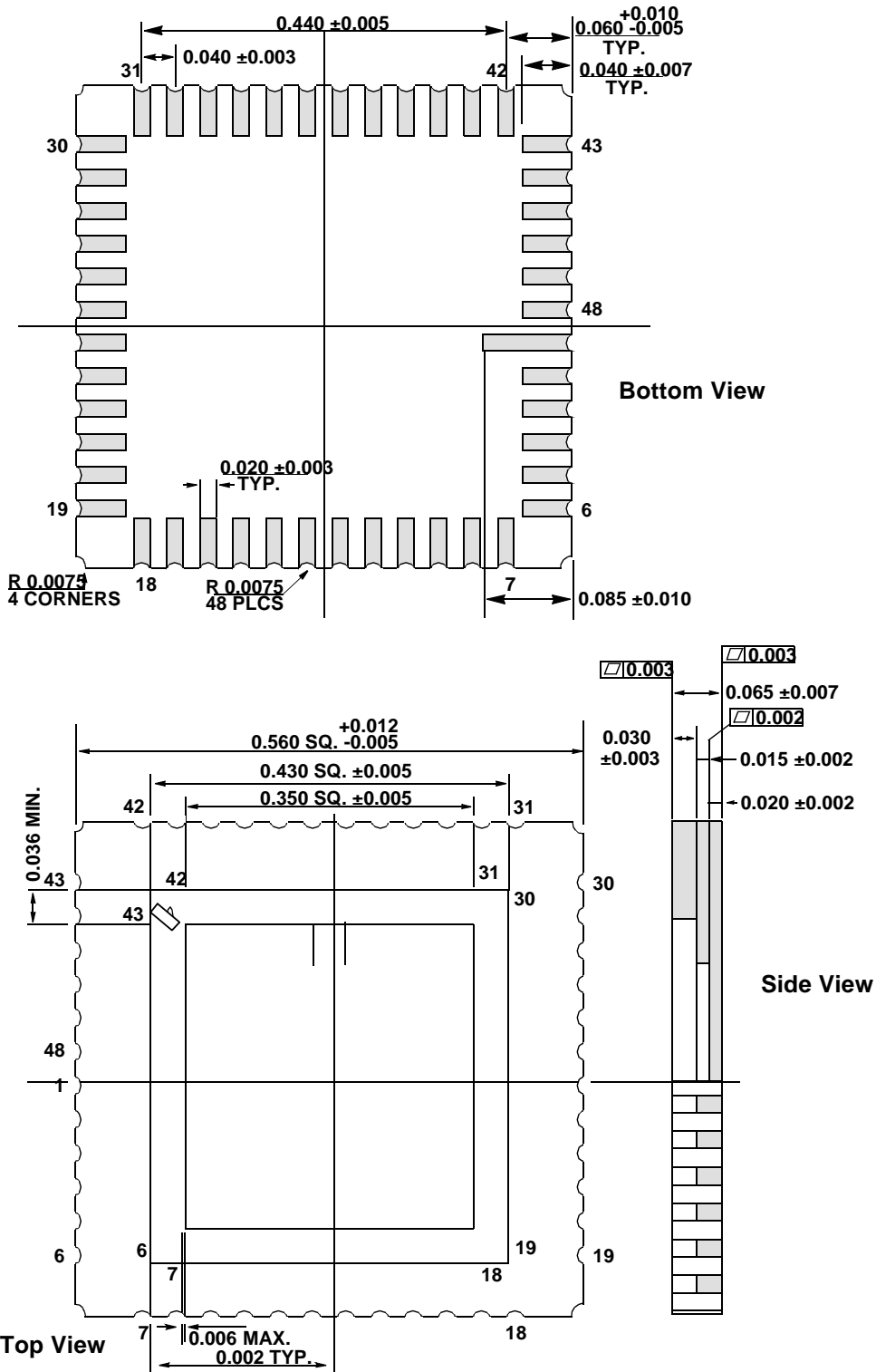
The table below provides a list and description of available I²C registers contained in the OV7910P/OV7410P/OV7411P image sensor.

Table 5. I²C Registers

| Subad- dress (hex) | Register | Default (hex) | Read/ Write | Descriptions |
|--------------------------|-----------|------------------|----------------|--|
| 00 | Gain[6:0] | 00 | RW | GC[7] - unimplemented bit, returns 'X' when read. GC[6:0] - Storage for the current AGC Gain setting. This register is updated automatically. If AGC is enabled, the internal control stores the optimal gain value in this register. IF AGC is not enabled, a "00" is stored in this register. |
| 01 | Blue[7:0] | 80 | RW | Storage for the current blue channel setting for white balance control. BLU[7] - "0" decrease gain, "1" increase gain. BLU[6:0] - blue channel gain balance value. Note: This function is not available on the OV7410P/OV7411P Image Sensor. |
| 02 | Red[7:0] | 80 | RW | Storage for the current red channel setting for white balance control. RED[7] - "0" decrease gain, "1" increase gain. RED[6:0] - red channel balance value. Note: This function is not available on the OV7410P/OV7411P Image Sensor. |
| 03 | Sat | D0 | RW | SAT[7:0] - saturation adjustment. "FFh"- highest, "00h"-lowest Note: This function is not available on the OV7410P/OV7411P Image Sensor. |
| 04 | Cnt | 00 | RW | CTR[7:0] - contrast adjustment. "FFh"-highest, "00h"-lowest |
| 05 | Brt | 80 | RW | BRT[7:0] - brightness adjustment. "FFh"-highest,"00h"-lowest |
| 06 | Rsvd06 | B2 | RW | reserved |
| 07 | Blue Bias | 20 | RW | BBS[7:6] - rsvd (BBS[7:6] = 00) BBS[5:0] - blue channel bias value. This value defines the fine tune adjustment for the blue tint in the white balance control. This register is the manual control portion of the AWB control Note: This function is not available on the OV7410P/OV7411P Image Sensor. |

| Subaddress (hex) | Register | Default (hex) | Read/Write | Descriptions | | | | | | | | | | | | | | | |
|------------------|--------------------|---------------|------------|--|-------|-----|-----------|---|---|-----------|---|---|-----------|---|---|-----------|---|---|------------|
| 08 | Red Bias | 20 | RW | RBS[7:6] – rsvd (RBS[7:6] = 01) RBS[5:0] – red channel bias value. This value defines the fine tune adjustment for the red tint in the white balance control. This register is the manual control portion of the AWB control Note: This function is not available on the OV7410P/OV7411P Image Sensor. | | | | | | | | | | | | | | | |
| 09 | Rsvd09 | B7 | RW | reserved | | | | | | | | | | | | | | | |
| 0A | Rsvd0A | 45 | RW | reserved | | | | | | | | | | | | | | | |
| 0B | Rsvd0B | — | W | reserved | | | | | | | | | | | | | | | |
| 0C | Rsvd0C | — | W | reserved | | | | | | | | | | | | | | | |
| 0D | Rsvd0D | 4E | RW | reserved | | | | | | | | | | | | | | | |
| 0E | Rsvd0E | 32 | RW | reserved | | | | | | | | | | | | | | | |
| 0F | Rsvd0F | 7A | RW | reserved | | | | | | | | | | | | | | | |
| 10 | version | 03 | R | Version | | | | | | | | | | | | | | | |
| 11 | Manufacture ID (H) | 7F | R | MIDH[7:0] – manufacture ID high byte | | | | | | | | | | | | | | | |
| 12 | Manufacture ID (L) | A2 | R | MIDL[7:0] – manufacture ID low byte | | | | | | | | | | | | | | | |
| 13 | AEC | 82 | RW | AEC[7:0] – Manual exposure setting. “00” = lowest, 82 = Highest | | | | | | | | | | | | | | | |
| 14 | Common A | 9F | RW | COMA[7] - CEXP, “0” selects central exposure COMA[6:4] - rsvd COMA[3] - GAMMA, “1” selects gamma = 0.45, “0” select gamma=1.0 COMA[2] - AGCEN, “1” enables auto gain control COMA[1] - AWBEN “1” enables auto white balance* COMA[0] - AEC enable. If AEC is enabled, the AEC register (Reg. 13) is updated automatically. If AEC is disabled, AEC register remains unchanged. *Note: COMA[1], AWBEN is not available on the OV7410P/OV7411P Image Sensor. | | | | | | | | | | | | | | | |
| 15 | Common B | 00 | RW | COMB[7] - SRST, “1” initiates soft reset. Initiate soft reset. All registers are set to default values and chip is reset to known state and resumes normal operation. This bit is automatically cleared after reset. COMB[6] - MIRR, “1” selects mirror image COMB[5] - VSFR, “1” enables frame sync output to VSYNC (pin 32), “0” enables field sync output to VSYNC COMB[4] - BKLT, “1” selects backlight exposure mode COMB[3] - FREX, “1” disables the update of exposure and gain value COMB[2] - HGAIN. Automatic Gain Control (AGC) gain range selection. See COME[6] (G2X), below. “0” - select normal AGC range (1X <-> 4X) “1” - select expanded AGC range (1X -> 8X) <table border="1"> <thead> <tr> <th>HGAIN</th> <th>G2X</th> <th>AGC Range</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1X <-> 4X</td> </tr> <tr> <td>0</td> <td>1</td> <td>2X <-> 8X</td> </tr> <tr> <td>1</td> <td>0</td> <td>1X <-> 8X</td> </tr> <tr> <td>1</td> <td>1</td> <td>2X <-> 16X</td> </tr> </tbody> </table> COMB[1:0] - AMOD, select video output modes 00 - S-video and CVBS* 01 - RGB* 10 - YUV 11 - RGB* *Note: COMB[1:0] = 00, 01, 11 are not available on the OV7410P/OV7411P Image Sensor. | HGAIN | G2X | AGC Range | 0 | 0 | 1X <-> 4X | 0 | 1 | 2X <-> 8X | 1 | 0 | 1X <-> 8X | 1 | 1 | 2X <-> 16X |
| HGAIN | G2X | AGC Range | | | | | | | | | | | | | | | | | |
| 0 | 0 | 1X <-> 4X | | | | | | | | | | | | | | | | | |
| 0 | 1 | 2X <-> 8X | | | | | | | | | | | | | | | | | |
| 1 | 0 | 1X <-> 8X | | | | | | | | | | | | | | | | | |
| 1 | 1 | 2X <-> 16X | | | | | | | | | | | | | | | | | |
| 16 | Common C | 20 | RW | COMC[7] - Smart AWB. “0” disables SMTawb, “1” enables SMTawb COMC[6] - rsvd COMC[5] - Automatic Level Control. “0” disables ALC, “1” enables ALCauto level control COMC[4:0] - rsvd | | | | | | | | | | | | | | | |
| 17 | Common D | 34 | RW | COMD[7:4] - rsvd COMD[3] - BPSHP. “0” enables sharpness control, “1” disables sharpness control COMD[2] - rsvd COMD[1] - AWBTM, “1” selects fast AWB update* COMD[0] - rsvd *Note: COMD[1], AWBTM is not available on the OV7410P/OV7411P Image Sensor. | | | | | | | | | | | | | | | |
| 18 | Rsvd18 | A2 | RW | reserved | | | | | | | | | | | | | | | |
| 19 | Rsvd19 | 66 | RW | reserved | | | | | | | | | | | | | | | |

| Subaddress (hex) | Register | Default (hex) | Read/Write | Descriptions |
|------------------|----------|---------------|------------|---|
| 1A | Rsvd1A | 73 | RW | reserved |
| 1B | Rsvd1B | D0 | RW | reserved |
| 1C | Rsvd1C | 15 | RW | reserved |
| 1D | Common E | 20 | RW | COME[7] - rsvd COME[6] - G2XA. Automatic Gain Control (AGC) gain selection. Affects range selected by HGAIN. See COMB[2] (HGAIN), above. "0" - select normal AGC gain (1X) "1" - select enhanced AGC gain (2X) COME[5:0] - rsvd |
| 1E | Rsvd1F | 30 | RW | reserved |
| 1F | Rsvd20 | 28 | RW | reserved |
| 20 - 2F | Rsvd2X | N/A | RW | reserved |
| 30 | Rsvd30 | 80 | RW | reserved |
| 31 | Rsvd31 | 80 | RW | reserved |
| 32 | Rsvd32 | 80 | RW | reserved |
| 33 | Rsvd33 | 40 | RW | reserved |
| 34 | Rsvd34 | 80 | RW | reserved |
| 35 | Rsvd35 | 20 | RW | reserved |
| 36 | Rsvd36 | 20 | RW | reserved |
| 37 | Rsvd37 | 80 | RW | reserved |
| 38 | Rsvd38 | 80 | RW | reserved |
| 39 | Rsvd39 | 80 | RW | reserved |
| 3A | Rsvd3A | 80 | RW | reserved |
| 3B | Rsvd3B | 80 | RW | reserved |



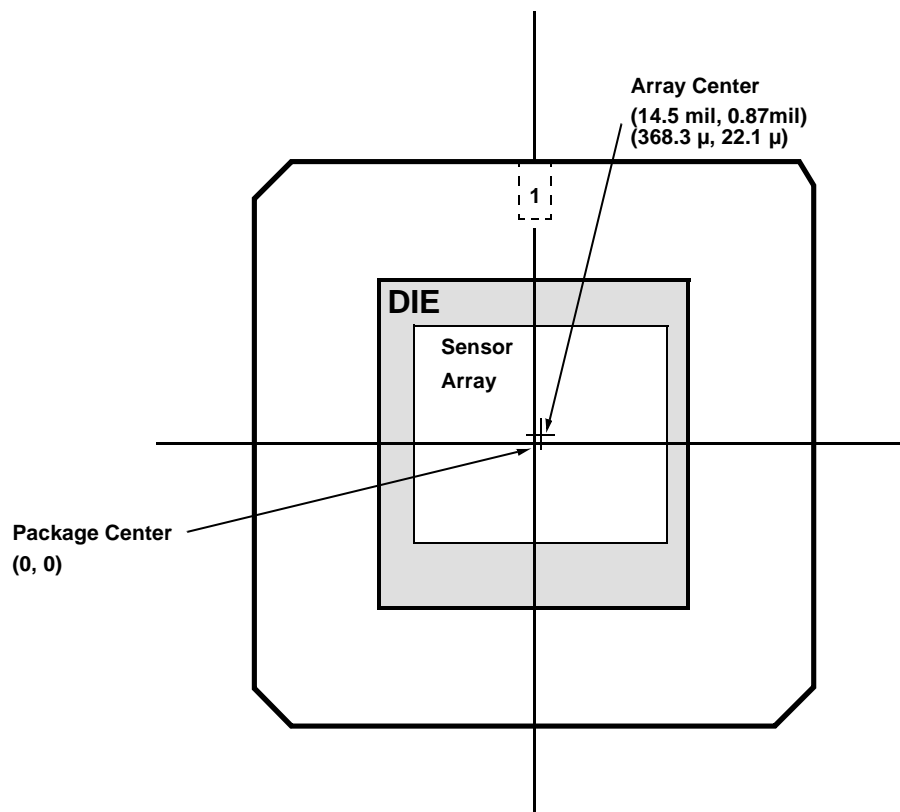


Figure 6. OV7910P/OV7410P/OV7411P Package Outline

Table 6. Ordering Information

| Part Number | Description | Package |
|-------------|--|------------|
| OV7910P | Color Image Sensor, PAL Analog, I ² C Bus Control | 48 pin LCC |
| OV7410P | B/W Image Sensor, PAL Analog, I ² C Bus Control | 48 pin LCC |
| OV7411P | High sensitivity B/W Image Sensor w/micro lenses, PAL Analog, I ² C Bus Control | 48 pin LCC |

OmniVision Technologies, Inc. reserves the right to make changes without further notice to any product herein to improve reliability, function, or design. OmniVision Technologies, Inc. does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others. No part of this publication may be copied or reproduced, in any form without the prior written consent of OmniVision Technologies, Inc.

Revision History

| Product | Product Version | Description | Date |
|-----------------------------|------------------------|--|-------------|
| OV7910P/OV7410P | AA | Product Release | 10/1/98 |
| OV7910P/OV7410P | AI | Process/performance change enhancements | 1/1/99 |
| OV7910P/OV7410P | AJ | Process/performance change enhancements, I2C register changes: Regs. 03, 06, 08, x10 | 2/11/99 |
| OV7910P/OV7410P | AK | Performance/manufacturability improvements | 2/22/99 |
| OV7910P/OV7410P | AK | Miscellaneous corrections | 6/6/99 |
| OV7910P/OV7410P/ OV7411P | AK | Add OV7411P release | 6/17/99 |