

# AS7261

## XYZ Chromatic White Color Sensor + NIR with Electronic Shutter and Smart Interface

### General Description

The AS7261 is a chromatic white color sensor providing direct XYZ color coordinates consistent with the CIE 1931 2° Standard Observer color coordinates. It also maps the XYZ coordinates to the x, y (Y) of the 2-dimensional color gamut and scales the coordinates to the CIE 1976 u'v' coordinate system.

The device provides accurate Correlated Color Temperature (CCT) measurements and provides color point deviation from the black body curve for white light color in the delta u' v' coordinate system. It also integrates a Near-IR channel for other applications. LED drivers with programmable currents are provided for electronic shutter applications.

The AS7261 integrates Gaussian filters into standard CMOS silicon via Nano-optic deposited interference filter technology and is packaged in an LGA package that provides a built in aperture to control the light entering the sensor array.

Control and spectral data access is implemented through either the I<sup>2</sup>C register set, or with a high level AT Spectral Command set via a serial UART.

*Ordering Information and Content Guide appear at end of datasheet.*

### Key Benefits & Features

The benefits and features of AS7261, XYZ Chromatic White Color Sensor + NIR with Electronic Shutter and Smart Interface are listed below:

**Figure 1:**  
**AS7261 Benefits and Features**

| Benefits                                                                                                                                                                                    | Features                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Calibrated Chromatic white data</li> </ul>                                                                                                         | <ul style="list-style-type: none"> <li>• XYZ</li> <li>• xy data (CIE 1931)</li> <li>• DUV, u'v', uv (CIE 1976)</li> <li>• CCT, LUX</li> </ul> |
| <ul style="list-style-type: none"> <li>• Simple text-based command interface via UART, or direct register read and write with interrupt on sensor ready option on I<sup>2</sup>C</li> </ul> | <ul style="list-style-type: none"> <li>• UART or I<sup>2</sup>C slave digital Interface</li> </ul>                                            |
| <ul style="list-style-type: none"> <li>• Lifetime-calibrated sensing with minimal drift over time or temperature</li> </ul>                                                                 | <ul style="list-style-type: none"> <li>• Filter set realized by silicon interference filters</li> </ul>                                       |
| <ul style="list-style-type: none"> <li>• No additional signal conditioning required</li> </ul>                                                                                              | <ul style="list-style-type: none"> <li>• 16-bit ADC with digital access</li> </ul>                                                            |

| Benefits                                                                                          | Features                                                                                                                                |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Electronic shutter control/synchronization</li> </ul>    | <ul style="list-style-type: none"> <li>• Programmable LED drivers</li> </ul>                                                            |
| <ul style="list-style-type: none"> <li>• Low voltage operation</li> </ul>                         | <ul style="list-style-type: none"> <li>• 2.7V to 3.6V with I<sup>2</sup>C interface</li> </ul>                                          |
| <ul style="list-style-type: none"> <li>• Small, robust package, with built-in aperture</li> </ul> | <ul style="list-style-type: none"> <li>• 20-pin LGA package 4.5mm x 4.7mm x 2.5mm</li> <li>• -40°C to 85°C temperature range</li> </ul> |

### Applications

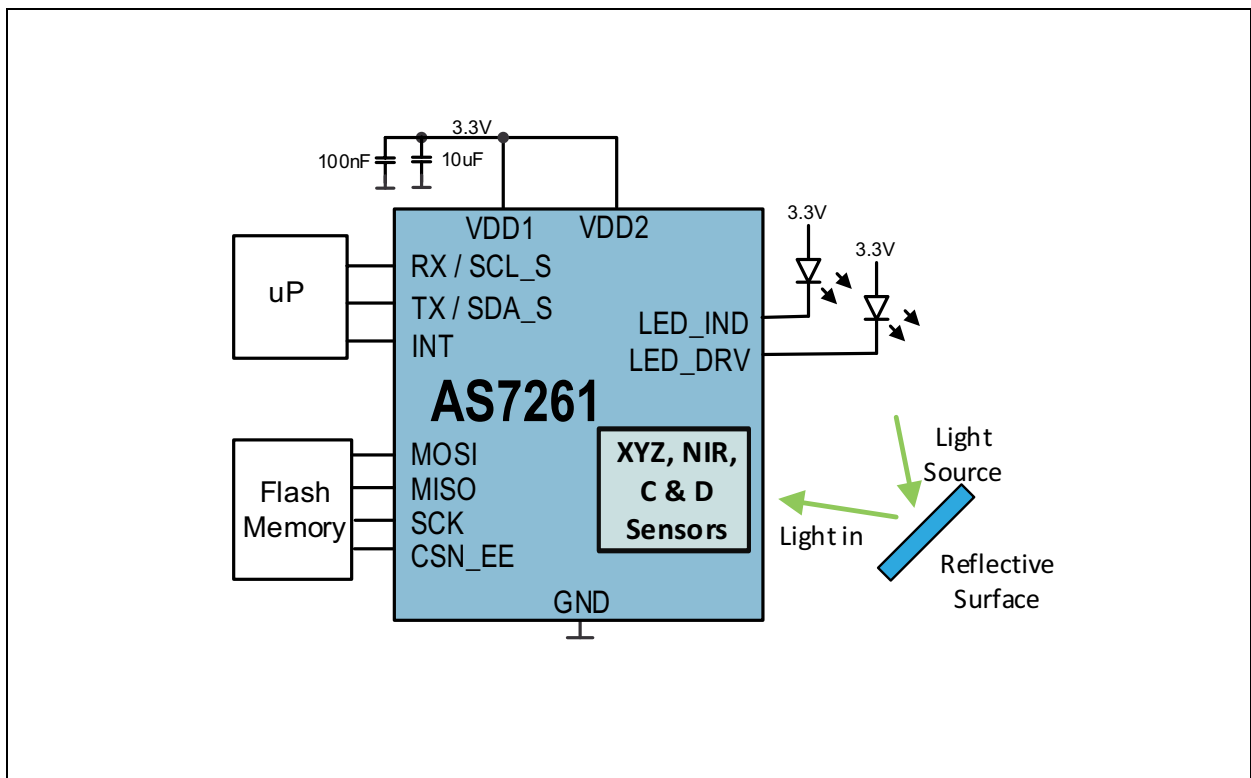
The AS7261 applications include:

- Color measurement and absorbance
- Color matching and identification
- Precision color tuning/calibration

### Block Diagram

The functional blocks of this device are shown below:

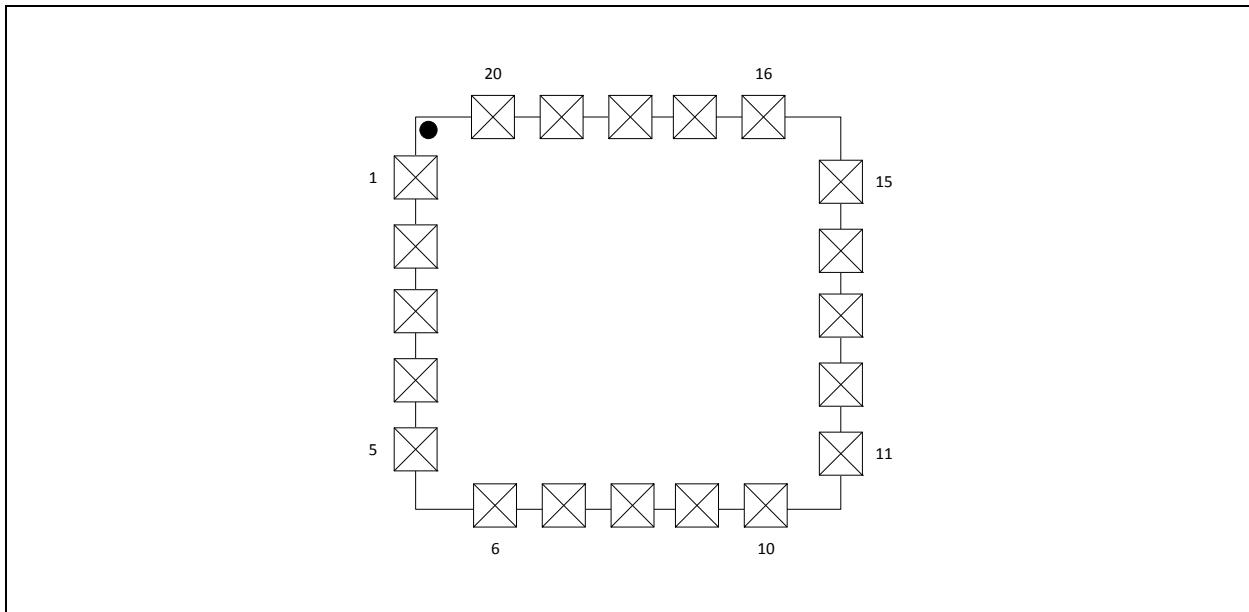
**Figure 2:**  
AS7261 Chromatic White Color System



## Pin Assignments

The device pin assignments are described below.

**Figure 3:**  
AS7261 Pin Diagram (Top View)



**Figure 4:**  
AS7261 Pin Description

| Pin # | Pin Name | Description                                              |
|-------|----------|----------------------------------------------------------|
| 1     | NC       | Not functional. Do not connect                           |
| 2     | RESN     | Reset, active LOW                                        |
| 3     | SCK      | SPI serial clock                                         |
| 4     | MOSI     | SPI master out slave in                                  |
| 5     | MISO     | SPI master in slave out                                  |
| 6     | CSN_EE   | Chip Select for external serial Flash memory, Active LOW |
| 7     | CSN_SD   | Chip Select for SD Card Interface, Active LOW            |
| 8     | I2C_ENB  | Select UART (Low) or I <sup>2</sup> C (High) Operation   |
| 9     | NF       | Not Functional. Do not connect.                          |

| Pin # | Pin Name | Description                                                      |
|-------|----------|------------------------------------------------------------------|
| 10    | NF       | Not Functional. Do not connect.                                  |
| 11    | RX/SCL_S | RX (UART) or SCL_S (I <sup>2</sup> C Slave) Depending on I2C_ENB |
| 12    | TX/SDA_S | TX (UART) or SDA_S (I <sup>2</sup> C Slave) Depending on I2C_ENB |
| 13    | INT      | Interrupt, Active LOW                                            |
| 14    | VDD2     | Voltage Supply                                                   |
| 15    | LED_DRV  | LED Driver Output for Driving LED, Current Sink                  |
| 16    | GND      | Ground                                                           |
| 17    | VDD1     | Voltage Supply                                                   |
| 18    | LED_IND  | LED Driver Output for Indicator LED, Current Sink                |
| 19    | NF       | Not Functional. Do not connect.                                  |
| 20    | NF       | Not Functional. Do not connect.                                  |

## Absolute Maximum Ratings

Stresses beyond those listed under [Absolute Maximum Ratings](#) may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under [Electrical Characteristics](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Figure 5:**  
Absolute Maximum Ratings

| Symbol                                           | Parameter                         | Min        | Max       | Units | Comments                                                                                                                                                                                                                 |
|--------------------------------------------------|-----------------------------------|------------|-----------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Electrical Parameters</b>                     |                                   |            |           |       |                                                                                                                                                                                                                          |
| $V_{DD1\_MAX}$                                   | Supply voltage VDD1               | -0.3       | 5         | V     | Pin VDD1 to GND                                                                                                                                                                                                          |
| $V_{DD2\_MAX}$                                   | Supply voltage VDD2               | -0.3       | 5         | V     | Pin VDD2 to GND                                                                                                                                                                                                          |
| $V_{DD\_IO}$                                     | Input/output pin voltage          | -0.3       | VDD + 0.3 | V     | Input/output pin to GND                                                                                                                                                                                                  |
| $I_{scr}$                                        | Input current (latch-up immunity) | $\pm 100$  |           | mA    | JESD78D                                                                                                                                                                                                                  |
| <b>Electrostatic Discharge</b>                   |                                   |            |           |       |                                                                                                                                                                                                                          |
| $ESD_{HBM}$                                      | Electrostatic discharge HBM       | $\pm 1000$ |           | V     | JS-001-2014                                                                                                                                                                                                              |
| $ESD_{CDM}$                                      | Electrostatic discharge CDM       | $\pm 500$  |           | V     | JSD22-C101F                                                                                                                                                                                                              |
| <b>Temperature Ranges and Storage Conditions</b> |                                   |            |           |       |                                                                                                                                                                                                                          |
| $T_{strg}$                                       | Storage temperature range         | -40        | 85        | °C    |                                                                                                                                                                                                                          |
| $T_{body}$                                       | Package body temperature          |            | 260       | °C    | IPC/JEDEC J-STD-020. The reflow peak soldering temperature (body temperature) is specified according IPC/JEDEC J-STD-020 "Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices" |
| $RH_{NC}$                                        | Relative humidity non-condensing  | 5          | 85        | %     |                                                                                                                                                                                                                          |
| MSL                                              | Moisture sensitivity level        | 3          |           |       | Represents a 168 hours max. floor life time                                                                                                                                                                              |

## Electrical Characteristics

All limits are guaranteed with  $V_{DD} = V_{DD1} = V_{DD2} = 3.3V$ ,  $T_{AMB} = 25^{\circ}C$ . The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.  $V_{DD1}$  and  $V_{DD2}$  must be sourced from the same power supply.

Figure 6:  
AS7261 Electrical Characteristics

| Symbol                              | Parameter                                                 | Conditions                      | Min  | Typ | Max             | Unit |
|-------------------------------------|-----------------------------------------------------------|---------------------------------|------|-----|-----------------|------|
| <b>General Operating Conditions</b> |                                                           |                                 |      |     |                 |      |
| $V_{DD1} / V_{DD2}$                 | Voltage operating supply                                  | UART interface                  | 2.97 | 3.3 | 3.6             | V    |
| $V_{DD1} / V_{DD2}$                 | Voltage operating supply                                  | I <sup>2</sup> C interface      | 2.7  | 3.3 | 3.6             | V    |
| $T_{AMB}$                           | Operating temperature                                     |                                 | -40  | 25  | 85              | °C   |
| $I_{VDD}$                           | Operating current                                         |                                 |      |     | 5               | mA   |
| <b>Internal RC Oscillator</b>       |                                                           |                                 |      |     |                 |      |
| $F_{OSC}$                           | Internal RC oscillator frequency                          |                                 | 15.7 | 16  | 16.3            | MHz  |
| $t_{JITTER}$                        | Internal clock jitter                                     | @25°C                           |      |     | 1.2             | ns   |
| <b>Temperature Sensor</b>           |                                                           |                                 |      |     |                 |      |
| $D_{TEMP}$                          | Absolute accuracy of the internal temperature measurement |                                 | -8.5 |     | 8.5             | °C   |
| <b>Indicator LED</b>                |                                                           |                                 |      |     |                 |      |
| $I_{IND}$                           | LED current                                               |                                 | 1    |     | 8               | mA   |
| $I_{ACC}$                           | Accuracy of current                                       |                                 | -30  |     | 30              | %    |
| $V_{LED}$                           | Voltage range of connected LED                            | V <sub>ds</sub> of current sink | 0.3  |     | V <sub>DD</sub> | V    |
| <b>LED_DRV</b>                      |                                                           |                                 |      |     |                 |      |
| $I_{LED1}$                          | LED current                                               |                                 | 12.5 |     | 100             | mA   |
| $I_{ACC}$                           | Accuracy of current                                       |                                 | -10  |     | 10              | %    |
| $V_{LED}$                           | Voltage range of connected LED                            | V <sub>ds</sub> of current sink | 0.3  |     | V <sub>DD</sub> | V    |

| Symbol                            | Parameter                      | Conditions    | Min            | Typ | Max            | Unit |
|-----------------------------------|--------------------------------|---------------|----------------|-----|----------------|------|
| <b>Digital Inputs and Outputs</b> |                                |               |                |     |                |      |
| $I_{IL\ RESN}$                    | Logic input current (RESN pin) | $V_{in}=0V$   | -1             |     | -0.2           | mA   |
| $V_{IH}$                          | CMOS logic high input          |               | $0.7 * V_{DD}$ |     | VDD            | V    |
| $V_{IL}$                          | CMOS logic low input           |               | 0              |     | $0.3 * V_{DD}$ | V    |
| $V_{OH}$                          | CMOS logic high output         | $I=1mA$       |                |     | $V_{DD}-0.4$   | V    |
| $V_{OL}$                          | CMOS logic low output          | $I=1mA$       |                |     | 0.4            | V    |
| $t_{RISE}^{(1)}$                  | Current rise time              | $C(Pad)=30pF$ |                |     | 5              | ns   |
| $t_{FALL}^{(1)}$                  | Current fall time              | $C(Pad)=30pF$ |                |     | 5              | ns   |

**Note(s):**

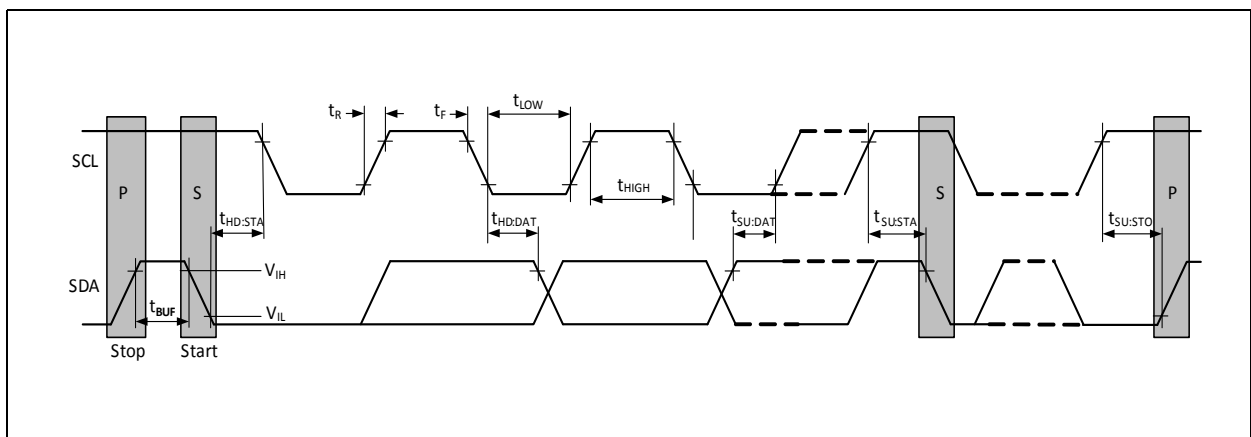
1. Guaranteed, not tested in production.

### Timing Characteristics

Figure 7:  
AS7261 I<sup>2</sup>C Slave Timing Characteristics

| Symbol                          | Parameter                              | Conditions                                   | Min | Typ | Max | Unit |
|---------------------------------|----------------------------------------|----------------------------------------------|-----|-----|-----|------|
| <b>I<sup>2</sup>C Interface</b> |                                        |                                              |     |     |     |      |
| f <sub>SCLK</sub>               | SCL Clock Frequency                    |                                              | 0   |     | 400 | kHz  |
| t <sub>BUF</sub>                | Bus Free Time Between a STOP and START |                                              | 1.3 |     |     | μs   |
| t <sub>HD:STA</sub>             | Hold Time (Repeated) START             |                                              | 0.6 |     |     | μs   |
| t <sub>LOW</sub>                | LOW Period of SCL Clock                |                                              | 1.3 |     |     | μs   |
| t <sub>HIGH</sub>               | HIGH Period of SCL Clock               |                                              | 0.6 |     |     | μs   |
| t <sub>SU:STA</sub>             | Setup Time for a Repeated START        |                                              | 0.6 |     |     | μs   |
| t <sub>HD:DAT</sub>             | Data Hold Time                         |                                              | 0   |     | 0.9 | μs   |
| t <sub>SU:DAT</sub>             | Data Setup Time                        |                                              | 100 |     |     | ns   |
| t <sub>R</sub>                  | Rise Time of Both SDA and SCL          |                                              | 20  |     | 300 | ns   |
| t <sub>F</sub>                  | Fall Time of Both SDA and SCL          |                                              | 20  |     | 300 | ns   |
| t <sub>SU:STO</sub>             | Setup Time for STOP Condition          |                                              | 0.6 |     |     | μs   |
| C <sub>B</sub>                  | Capacitive Load for Each Bus Line      | CB — total capacitance of one bus line in pF |     |     | 400 | pF   |
| C <sub>I/O</sub>                | I/O Capacitance (SDA, SCL)             |                                              |     |     | 10  | pF   |

Figure 8:  
I<sup>2</sup>C Slave Timing Diagram





**Figure 9:**  
AS7261 SPI Slave Timing Characteristics

| Symbol               | Parameter           | Conditions                                                        | Min | Typ | Max | Unit |
|----------------------|---------------------|-------------------------------------------------------------------|-----|-----|-----|------|
| <b>SPI Interface</b> |                     |                                                                   |     |     |     |      |
| $f_{SCLK}$           | Clock Frequency     |                                                                   | 0   |     | 16  | MHz  |
| $t_{SCK\_H}$         | Clock high time     |                                                                   | 40  |     |     | ns   |
| $t_{SCK\_L}$         | Clock low time      |                                                                   | 40  |     |     | ns   |
| $t_{SCK\_RISE}$      | SCK rise time       |                                                                   | 5   |     |     | ns   |
| $t_{SCK\_FALL}$      | SCK fall time       |                                                                   | 5   |     |     | ns   |
| $t_{CSN\_S}$         | CSN setup time      | Time between CSN high-low transition to first SCK high transition | 50  |     |     | ns   |
| $t_{CSN\_H}$         | CSN hold time       | Time between last SCK falling edge and CSN low-high transition    | 100 |     |     | ns   |
| $t_{CSN\_DIS}$       | CSN disable time    |                                                                   | 100 |     |     | ns   |
| $t_{DO\_S}$          | Data-out setup time |                                                                   | 5   |     |     | ns   |
| $t_{DO\_H}$          | Data-out hold time  |                                                                   | 5   |     |     | ns   |
| $t_{DI\_V}$          | Data-in valid       |                                                                   | 10  |     |     | ns   |

**Figure 10:**  
SPI Master Write Timing Diagram

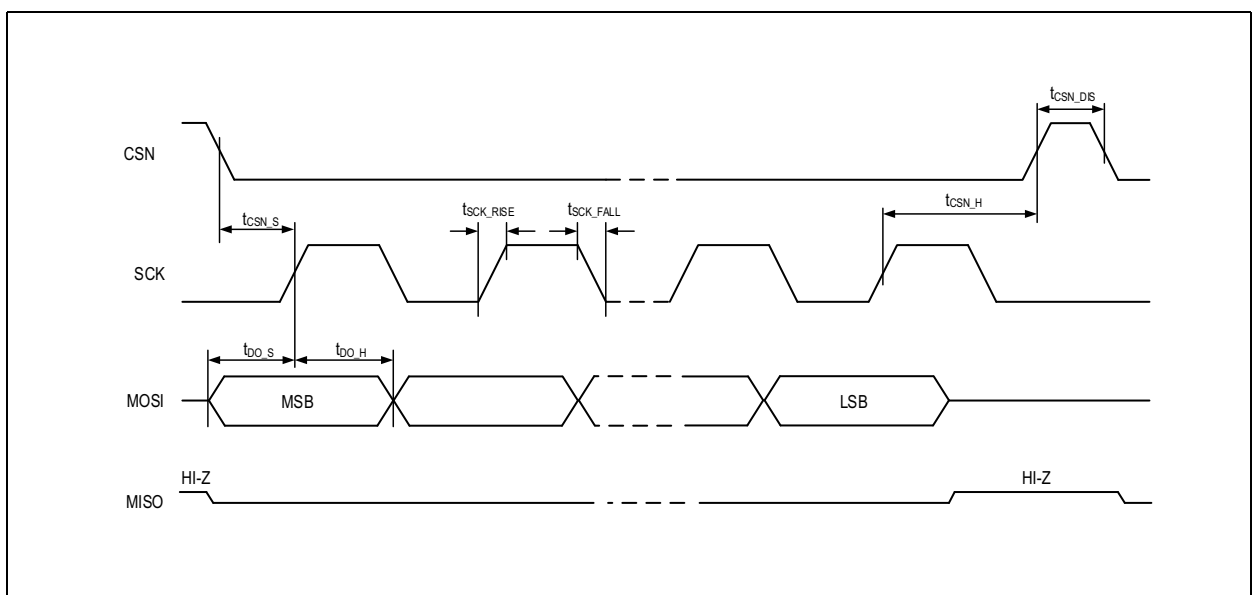
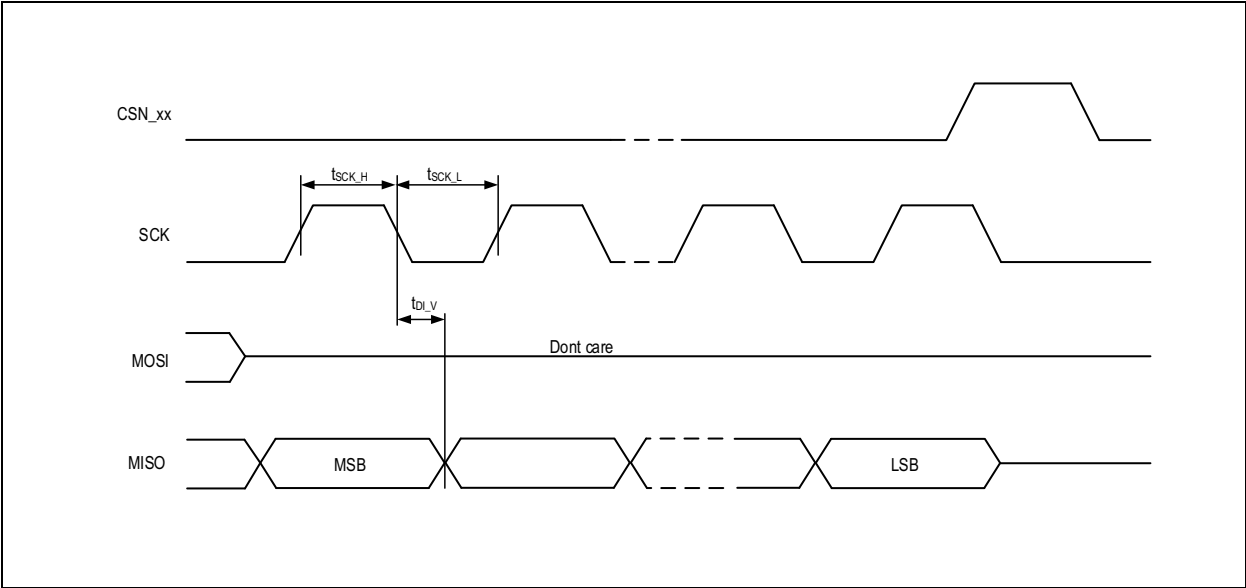
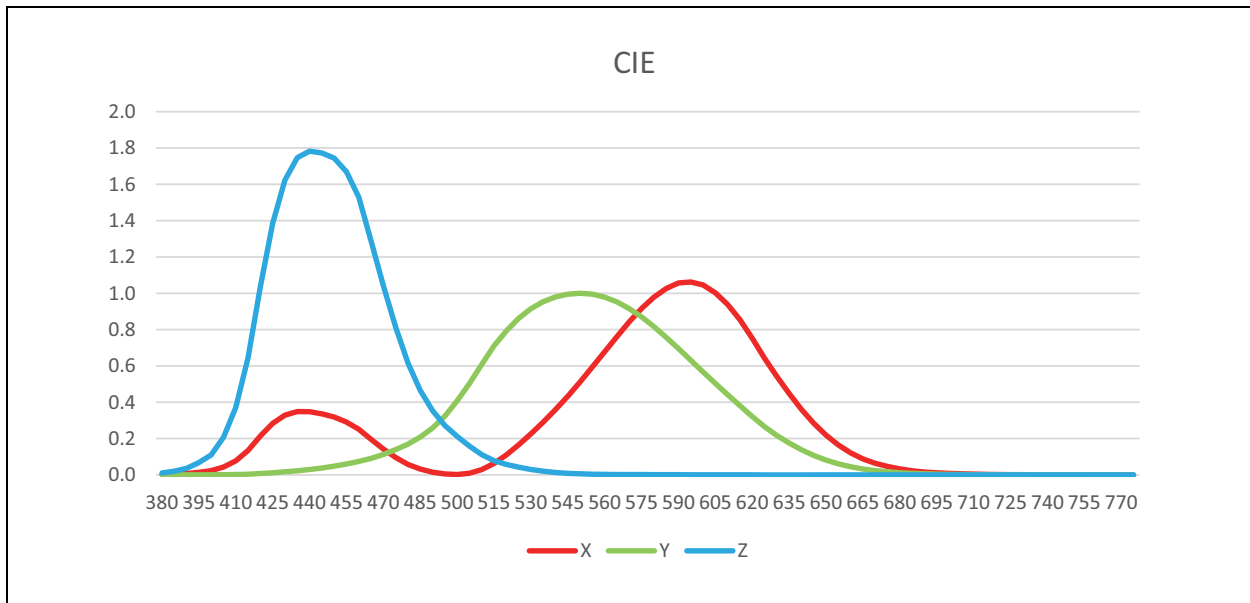


Figure 11:  
SPI Master Read Timing Diagram



## Typical Optical Characteristics

**Figure 12:**  
Spectral Responsivity



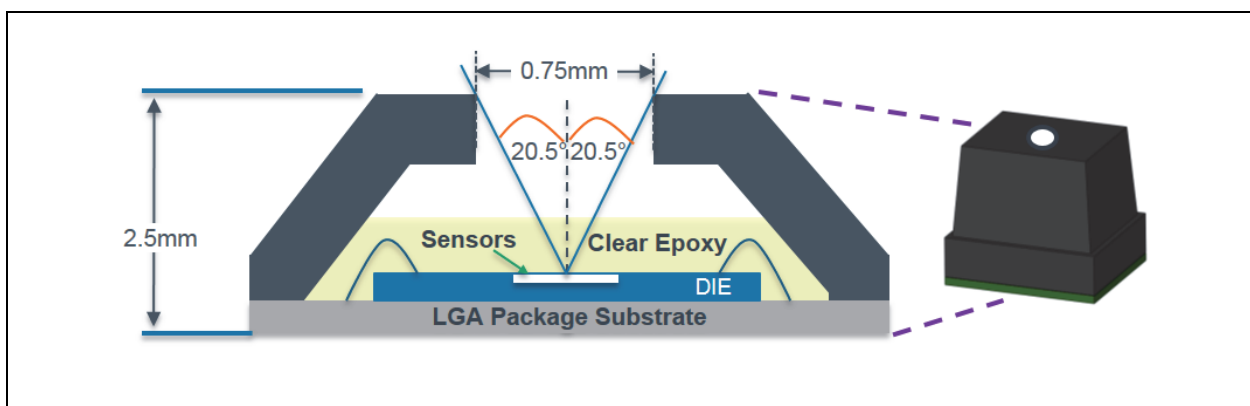
**Figure 13:**  
AS7261 Optical Characteristics

| Symbol                 | Parameter                  | Test Conditions                                    | Min   | Typ <sup>(1)</sup> | Max   | Unit                                     |
|------------------------|----------------------------|----------------------------------------------------|-------|--------------------|-------|------------------------------------------|
| Color_m <sup>(2)</sup> | Color measurement accuracy | White Light<br>CCT = 2700K, 3500K, 4500K and 5700K |       | 0.002              |       | du'v'                                    |
| Z_count                | Z channel count accuracy   | White Light<br>CCT = 5700K                         | 3.375 | 4.5                | 5.625 | counts/<br>( $\mu\text{W}/\text{cm}^2$ ) |

**Note(s):**

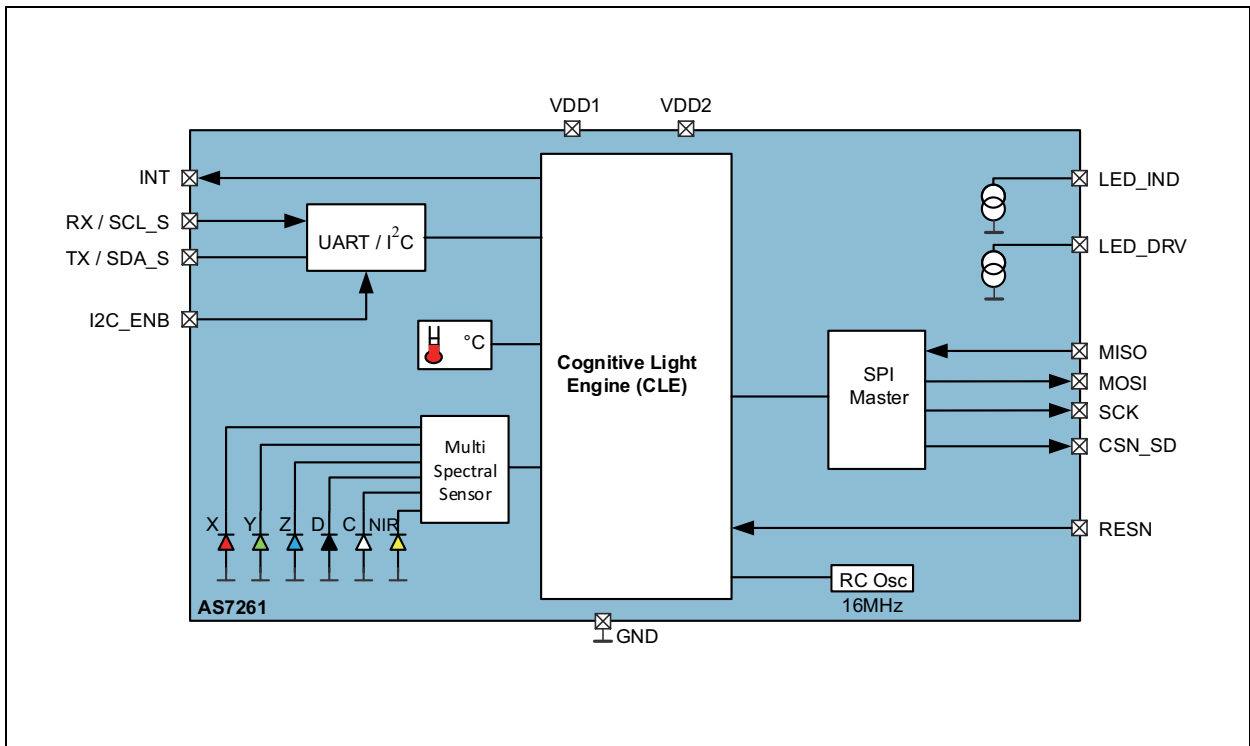
1. Typical values at Lux  $\geq 50$ , Integration time=400.4ms, Gain=1x,  $T_{\text{AMB}} = 25^\circ\text{C}$ .
2. Calibration and measurements are made using diffused light.

**Figure 14:**  
AS7261 LGA Package Field of View



Detailed Descriptions

Figure 15:  
Internal Block Diagram



**XYZ Chromatic White Color Sensor**

The XYZ Chromatic White Color sensor is a next-generation digital color sensor device. Each channel is a designed to meet the X, Y, Z standard observer filter characteristics compliant with the CIE 1931 standard or an NIR spectrum.

The sensor contains analog-to-digital converters (16-bit resolution ADC), which integrate the current from each channel’s photodiode. Upon completion of the conversion cycle, the integrated result is transferred to the corresponding data registers. The transfers are double-buffered to ensure that the integrity of the data is maintained.

Standard observer interference filters realize the XYZ response, which enables minimal life-time drift and very high temperature stability. Filter accuracy will be affected by the angle of incidence which itself is limited by an integrated aperture and an internal micro-lens structure. The aperture-limited field of view is ±20.5° to deliver specified accuracy.

## Data Conversion Description

AS7261 Spectral Conversion is implemented via two photodiode banks. The First Bank, Bank1 consists of data from the X, Y, Z and NIR (near-IR) photodiodes. Bank2 provides data from the same X and Y photodiodes as well as the D (dark) and C (Clear) photodiodes. Spectral conversion requires the integration time (IT in ms) set to complete. If both photodiode banks are required to complete the conversion, the 2nd bank requires an additional IT ms. Minimum IT for a single bank conversion is 2.8 ms. If data is required from all 6 photodiodes then the device must perform 2 full conversions (2 x Integration Time).

The spectral conversion process is controlled with four BANK Mode settings as follows:

### **BANK Mode 0:**

Conversions will occur continuously and data will be available in I<sup>2</sup>C registers X, Y, Z, and NIR or via the ATDATA command when using the UART device interface.

### **BANK Mode 1:**

Conversions will occur continuously and data will be available in I<sup>2</sup>C registers X, Y, D, and C or via the ATDATA command.

### **BANK Mode 2:**

Conversions occur continuously and data will be available in registers X, Y, Z, NIR, D and C or via the ATDATA command after two integration periods. In this Mode 2 the calibrated, corrected values may also be obtained from the appropriate I<sup>2</sup>C registers or using the ATXYZC command.

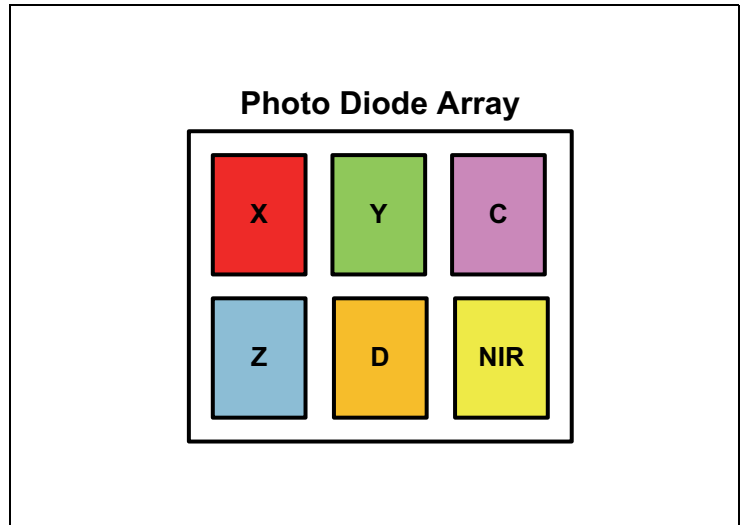
When the bank setting is Mode 0, Mode 1, or Mode 2, the spectral data conversion process operates continuously, with new data available after each IT ms period. In the continuous modes, care should be taken to assure prompt interrupt servicing so that integration values from both banks are all derived from the same spectral conversion cycle.

### **BANK Mode 3:**

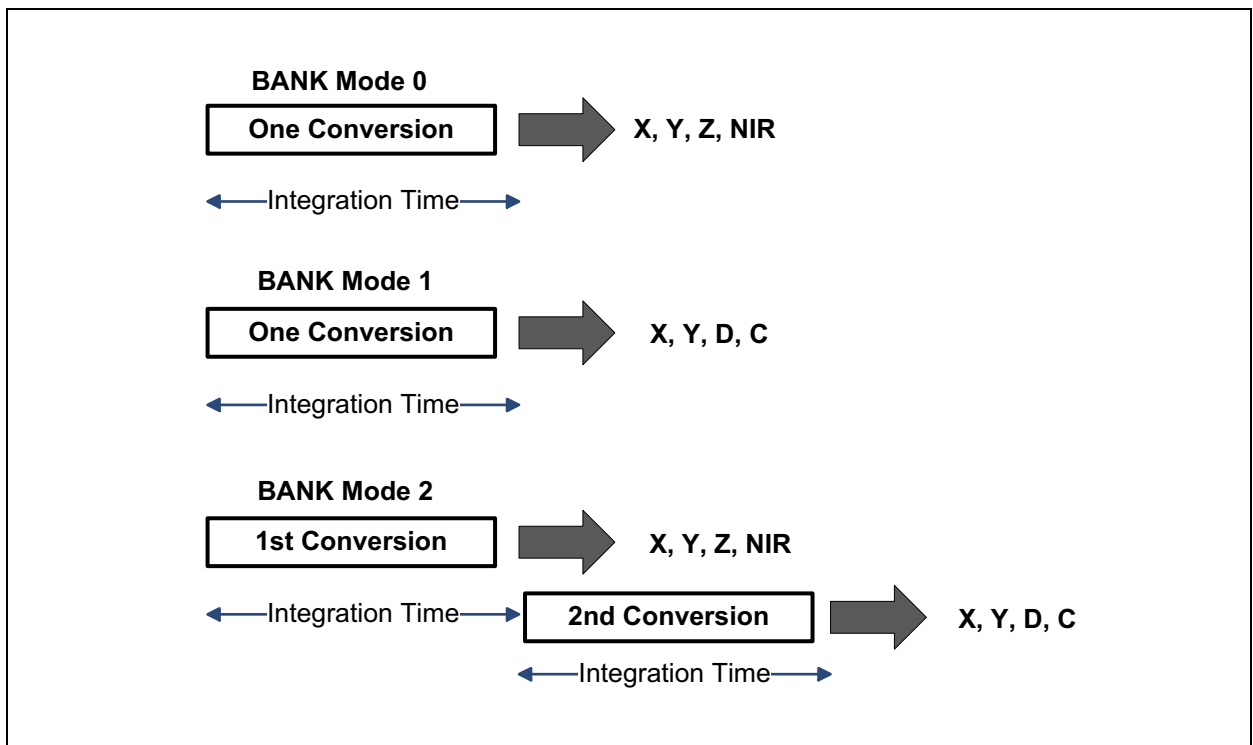
Data will be available in registers X, Y, Z, NIR, D and C in One-Shot mode. And in this Mode 3 the calibrated, corrected values may also be obtained from the appropriate I<sup>2</sup>C registers or using the ATXYZC command.

When the bank setting is set to Mode 3 the device initiates One-Shot operation. The DATA\_RDY bit is set to 1 once data is available, indicating spectral conversion is complete. One-Shot mode is intended for use when it is critical to ensure spectral conversion results are obtained contemporaneously.

**Figure 16:**  
Photo Diode Array



**Figure 17:**  
Bank Mode and Data Conversion



**RC Oscillator**

The timing generation circuit consists of an on-chip 16MHz, temperature compensated oscillator which provides the master clock for the AS7261.

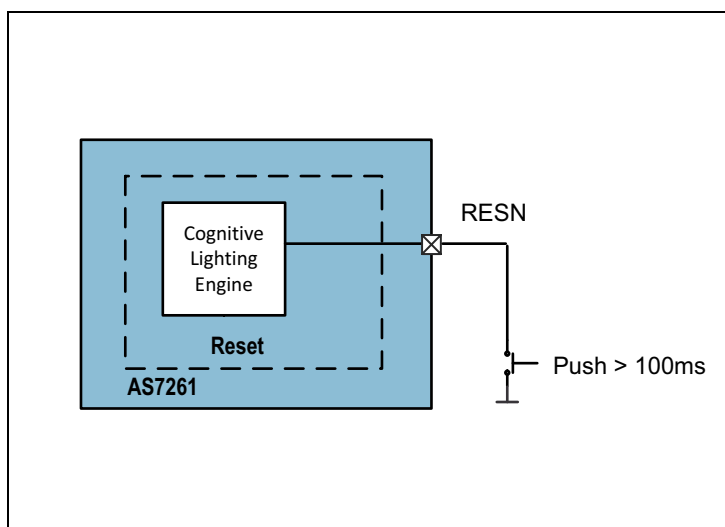
## Temperature Sensor

The internal temperature sensor is constantly measuring the on-chip temperature and enables temperature compensation procedures. It can be read via I<sup>2</sup>C or AT Command.

## Reset

Pulling down the RESN pin for longer than 100ms resets the AS7261.

**Figure 18:**  
Reset Circuit



## Indicator LED for Flash Memory Programming Progress

The LED, connected to pin LED\_IND, can be used to indicate Flash memory programming progress of the device. While programming the AS7261 via the external SD card the indicator LED automatically starts flashing. When programming is completed the indicator LED is automatically switched off. The Flash Memory Programming is initiated by the user as needed, but once started the LED flashing is not under user control.

## Electronic Shutter with LED\_IND or LED\_DRV Driver Control

Under user control there are two LED driver outputs that can be used to control LEDs on each driver pin. This allows different wavelength light sources to be used in the same system. The LED output sink currents are programmable and can drive external LED sources: LED\_IND for 1mA, 2mA, 4mA or 8mA and LED\_DRV for 12.5mA, 25mA, 50mA or 100mA. After programming for current the sources can be turned off and on via I<sup>2</sup>C registers or AT commands to provide the AS7261 with an electronic shutter capability.

## Interrupt Operation

If BANK is set to Mode 0 or Mode 1 then the data is ready after the 1st integration time. If BANK is set to Mode 2 or Mode 3 then the data is ready after two integration times. If the interrupt is enabled (INT = 1) then when the data is ready, the INT line is pulled low and DATA\_RDY is set to 1. The INT line is released (returns high) when the control register is read.

DATA\_RDY is cleared to 0 when any of the sensor registers X, Y, Z, NIR, D and C are read. For multi-byte sensor data (2 or 4 bytes), after the 1st byte is read the remaining bytes are shadow protected in case an integration cycle completes just after the 1st byte is read.

In continuous spectral conversion mode (BANK setting of Mode 0, 1, or 2), the sensors continue to gather information at the rate of the integration time, hence if the sensor registers are not read when the interrupt line goes low, it will stay low and the next cycle's sensor data will be available in the registers at the end of the next integration cycle.

When the control register BANK bits are written with a value of Mode 3, One-Shot Spectral Conversion mode is entered. When a single set of contemporaneous sensor readings is desired, writing BANK Mode 3 to the control register immediately triggers exactly two spectral data conversion cycles. At the end of these two conversion cycles, the DATA\_RDY bit is set as for the other BANK modes. To perform a new One-Shot sequence, the control register BANK bits should be written with a value of Mode 3 again. This process may continue until the user writes a different value into the BANK bits.

## I<sup>2</sup>C Slave Interface

If selected by the I2C\_ENB pin setting, interface and control can be accomplished through an I<sup>2</sup>C compatible slave interface to a set of registers that provide access to device control functions and output data. These registers on the AS7261 are, in reality, implemented as virtual registers in software. The actual I<sup>2</sup>C slave hardware registers number only three and are described in the table below. The steps necessary to access the virtual registers defined in the following are explained in pseudocode for external I<sup>2</sup>C master writes and reads below.



## I<sup>2</sup>C Feature List

- Fast mode (400kHz) and standard mode (100kHz) support
- 7+1-bit addressing mode
- Write format: Byte
- Read format: Byte

**Figure 19:**  
I<sup>2</sup>C Slave Device Address and Physical Registers

| Entity               | Description                                                   | Note                                                                                                                                                                                                                                                           |
|----------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Device Slave Address | 8-bit Slave Address                                           | Byte = 1001001x (device address = 49 hex)<br>x= 1 for Master Read (byte = 93 hex)<br>x= 0 for Master Write (byte = 92 hex)                                                                                                                                     |
| STATUS Register      | I <sup>2</sup> C slave interface STATUS register<br>Read-only | Register Address = 0x00<br>Bit 1: TX_VALID<br>0 → New data may be written to WRITE register<br>1 → WRITE register occupied. Do NOT write.<br>Bit 0: RX_VALID<br>0 → No data is ready to be read in READ register.<br>1 → Data byte available in READ register. |
| WRITE Register       | I <sup>2</sup> C slave interface WRITE register<br>Write-only | Register Address = 0x01<br>8-Bits of data written by the I <sup>2</sup> C Master intended for receipt by the I <sup>2</sup> C slave. Used for both virtual register addresses and write data.                                                                  |
| READ Register        | I <sup>2</sup> C slave interface READ register<br>Read-only   | Register Address = 0x02<br>8-Bits of data to be read by the I <sup>2</sup> C Master.                                                                                                                                                                           |

## I<sup>2</sup>C Virtual Register Write Access

I<sup>2</sup>C Virtual Register Byte Write, detailed below, shows the pseudocode necessary to write virtual registers on the AS7261. Note that, because the actual registers of interest are realized as virtual registers, a means of indicating whether there is a pending read or write operation of a given virtual register is needed. To convey this information, the most significant bit of the virtual register address is used as a marker. If it is 1, then a write is pending, otherwise the slave is expecting a virtual read operation. The pseudocode illustrates the proper technique for polling of the I<sup>2</sup>C slave status register to ensure the slave is ready for each transaction.

## I<sup>2</sup>C Virtual Register Byte Write

### Pseudocode

Poll I<sup>2</sup>C slave STATUS register;

If TX\_VALID bit is 0, a write can be performed on the interface;

Send a virtual register address and set the MSB of the register address to 1 to indicate the pending write;

Poll I<sup>2</sup>C slave STATUS register;

If TX\_VALID bit is 0, the virtual register address for the write has been received and the data may now be written;

Write the data.

### Sample Code:

```
#define I2C_AS72XX_SLAVE_STATUS_REG    0x00
#define I2C_AS72XX_SLAVE_WRITE_REG    0x01
#define I2C_AS72XX_SLAVE_READ_REG     0x02
#define I2C_AS72XX_SLAVE_TX_VALID     0x02
#define I2C_AS72XX_SLAVE_RX_VALID     0x01

void i2cm_AS72xx_write(uint8_t virtualReg, uint8_t d)
{
    volatile uint8_t status;

    while (1)
    {
        // Read slave I2C status to see if the write buffer is ready.
        status = i2cm_read(I2C_AS72XX_SLAVE_STATUS_REG);

        if ((status & I2C_AS72XX_SLAVE_TX_VALID) == 0)
            // No inbound TX pending at slave. Okay to write now.
            break;
    }
    // Send the virtual register address (setting bit 7 to indicate a pending write).
    i2cm_write(I2C_AS72XX_SLAVE_WRITE_REG, (virtualReg | 0x80));
    while (1)
    {
        // Read the slave I2C status to see if the write buffer is ready.
        status = i2cm_read(I2C_AS72XX_SLAVE_STATUS_REG);
        if ((status & I2C_AS72XX_SLAVE_TX_VALID) == 0)
            // No inbound TX pending at slave. Okay to write data now.
            break;
    }
    //Send the data to complete the operation.
    i2cm_write(I2C_AS72XX_SLAVE_WRITE_REG, d);
}
```

## I<sup>2</sup>C Virtual Register Read Access

I<sup>2</sup>C Virtual Register Byte Read, detailed below, shows the pseudocode necessary to read virtual registers on the AS7261. Note that in this case, reading a virtual register, the register address is not modified.

**I<sup>2</sup>C Virtual Register Byte Read**

## Pseudocode

Poll I<sup>2</sup>C slave STATUS register;  
 If TX\_VALID bit is 0, the virtual register address for the read may be written;  
 Send a virtual register address;  
 Poll I<sup>2</sup>C slave STATUS register;  
 If RX\_VALID bit is 1, the read data is ready;  
 Read the data.

## Sample Code:

```
uint8_t i2cm_AS72xx_read(uint8_t virtualReg)
{
    volatile uint8_t status, d;
    while (1)
    {
        // Read slave I2C status to see if the read buffer is ready.
        status = i2cm_read(I2C_AS72XX_SLAVE_STATUS_REG);

        if ((status & I2C_AS72XX_SLAVE_TX_VALID) == 0)
            // No inbound TX pending at slave. Okay to write now.
            break;
    }
    // Send the virtual register address (setting bit 7 to indicate a pending write).
    i2cm_write(I2C_AS72XX_SLAVE_WRITE_REG, virtualReg);
    while (1)
    {
        // Read the slave I2C status to see if our read data is available.
        status = i2cm_read(I2C_AS72XX_SLAVE_STATUS_REG);

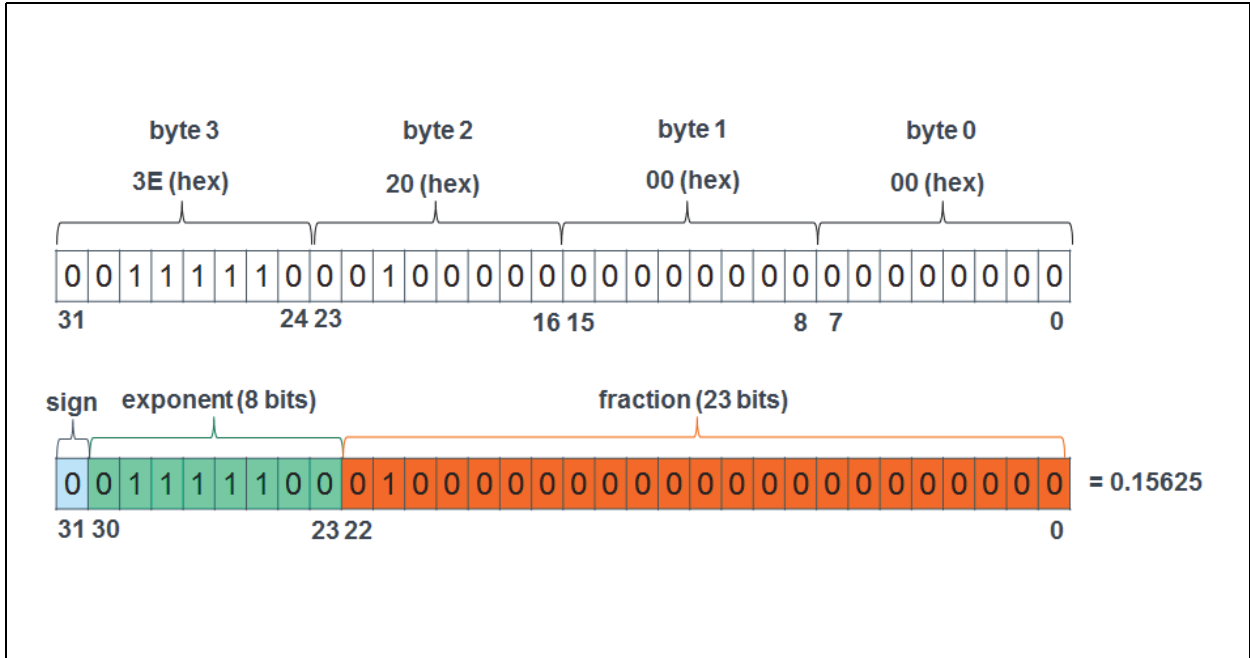
        if ((status & I2C_AS72XX_SLAVE_RX_VALID) != 0)
            // Read data is ready.
            break;
    }
    // Read the data to complete the operation.
    d = i2cm_read(I2C_AS72XX_SLAVE_READ_REG);
    return d;
}
```

The details of the *i2cm\_read()* and *i2cm\_write()* functions in previous Figures are dependent upon the nature and implementation of the external I<sup>2</sup>C master device.

### 4-Byte Floating-Point (FP) Registers

Several 4 byte registers (hex) are used by the AS7261. Here is an example of how these registers are used to represent floating point data (based on the IEEE 754 standard):

Figure 20:  
Example of the IEEE 754 Standard



The floating point (FP) value assumed by 32 bit **binary32 data** with a biased exponent **e** (the 8 bit unsigned integer) and a **23 bit fraction** is (for the above example):

$$(EQ1) \quad FPvalue = (-1)^{sign} \left( 1 + \sum_{i=1}^{23} b_{23-i} 2^{-i} \right) \times 2^{(e-127)}$$

$$(EQ2) \quad FPvalue = (-1)^0 \left( 1 + \sum_{i=1}^{23} b_{23-i} 2^{-i} \right) \times 2^{(124-127)}$$

$$(EQ3) \quad FPvalue = 1 \times (1 + 2^{-2}) \times 2^{(-3)} = 0.15625$$

## I<sup>2</sup>C Virtual Register Set

The figure below provides a summary of the AS7261 I<sup>2</sup>C register set. Figures after that provide additional register details. All register data is hex, and all multi-byte entities are Big Endian (most significant byte is situated at the lowest register address).

Multiple byte registers (2 byte integer, or, 4 byte floating point) must be read in the order of ascending register addresses (low to high). And if capable of being written to, must also be written in the order ascending register addresses.

**Figure 21:**  
I<sup>2</sup>C Virtual Register Set Overview

| Addr                             | Name          | <D7>                         | <D6> | <D5>    | <D4>    | <D3>    | <D2> | <D1>     | <D0> |
|----------------------------------|---------------|------------------------------|------|---------|---------|---------|------|----------|------|
| <b>Version Registers</b>         |               |                              |      |         |         |         |      |          |      |
| 0x00:0x01                        | HW_Version    | Hardware Version             |      |         |         |         |      |          |      |
| 0x02:0x03                        | FW_Version    | Firmware Version             |      |         |         |         |      |          |      |
| <b>Control Registers</b>         |               |                              |      |         |         |         |      |          |      |
| 0x04                             | Control_Setup | RST                          | INT  | GAIN    |         | Bank    |      | DATA_RDY | RSVD |
| 0x05                             | INT_T         | Integration Time             |      |         |         |         |      |          |      |
| 0x06                             | Device_Temp   | Device Temperature           |      |         |         |         |      |          |      |
| 0x07                             | LED_Control   | RSVD                         |      | ICL_DRV | LED_DRV | ICL_IND |      | LED_IND  |      |
| <b>Sensor Raw Data Registers</b> |               |                              |      |         |         |         |      |          |      |
| 0x08                             | X_High        | Channel X High Data Byte     |      |         |         |         |      |          |      |
| 0x09                             | X_Low         | Channel X Low Data Byte      |      |         |         |         |      |          |      |
| 0x0A                             | Y_High        | Channel Y High Data Byte     |      |         |         |         |      |          |      |
| 0x0B                             | Y_Low         | Channel Y Low Data Byte      |      |         |         |         |      |          |      |
| 0x0C                             | Z_High        | Channel Z High Data Byte     |      |         |         |         |      |          |      |
| 0x0D                             | Z_Low         | Channel Z Low Data Byte      |      |         |         |         |      |          |      |
| 0x0E                             | NIR_High      | Channel NIR High Data Byte   |      |         |         |         |      |          |      |
| 0x0F                             | NIR_Low       | Channel NIR Low Data Byte    |      |         |         |         |      |          |      |
| 0x10                             | Dark_High     | Channel Dark High Data Byte  |      |         |         |         |      |          |      |
| 0x11                             | Dark_Low      | Channel Dark Low Data Byte   |      |         |         |         |      |          |      |
| 0x12                             | Clear_High    | Channel Clear High Data Byte |      |         |         |         |      |          |      |
| 0x13                             | Clear_Low     | Channel Clear Low Data Byte  |      |         |         |         |      |          |      |

| Sensor Calibrated Data Registers |            |                                            |
|----------------------------------|------------|--------------------------------------------|
| 0x14:0x17                        | Cal_X      | Cal-X data (4-byte floating-point)         |
| 0x18:0x1B                        | Cal_Y      | Cal-Y data (4-byte floating-point)         |
| 0x1C:0x1F                        | Cal_Z      | Cal-Z data (4-byte floating-point)         |
| 0x20:0x23                        | Cal_x_1931 | Cal-x (CIE 1931) (4-byte floating-point)   |
| 0x24:0x27                        | Cal_y_1931 | Cal-y (CIE 1931) (4-byte floating-point)   |
| 0x28:0x2B                        | Cal_upri   | Cal_u' (CIE 1976) (4-byte floating-point)  |
| 0x2C:0x2F                        | Cal_vpri   | Cal_v' (CIE 1976) (4-byte floating-point)  |
| 0x30:0x33                        | Cal_u      | Cal_u (CIE 1976) (4-byte floating-point)   |
| 0x34:0x37                        | Cal_v      | Cal_v (CIE 1976) (4-byte floating-point)   |
| 0x38:0x3B                        | Cal_DUV    | Cal_DUV (CIE 1976) (4-byte floating-point) |
| 0x3C:0x3F                        | Cal_LUX    | Calibrated LUX (4-byte)                    |
| 0x40:0x4F                        | Cal_CCT    | Calibrated CCT (4-byte)                    |

### Detailed Register Description

**Figure 22:**  
HW Version Registers

| Addr: 0x00 |             | HW_Version |        |                    |
|------------|-------------|------------|--------|--------------------|
| Bit        | Bit Name    | Default    | Access | Bit Description    |
| 7:0        | Device Type | 01000000   | R      | Device type number |
| Addr: 0x01 |             | HW_Version |        |                    |
| Bit        | Bit Name    | Default    | Access | Bit Description    |
| 7:0        | HW Version  | 00111101   | R      | Hardware version   |

**Figure 23:**  
**FW Version Registers**

| Addr: 0x02 |               | FW_Version |        |                     |
|------------|---------------|------------|--------|---------------------|
| Bit        | Bit Name      | Default    | Access | Bit Description     |
| 7:6        | Minor version |            | R      | Minor version [1:0] |
| 5:0        | Sub version   |            | R      | Sub version         |
| Addr: 0x03 |               | FW_Version |        |                     |
| Bit        | Bit Name      | Default    | Access | Bit Description     |
| 7:4        | Major version |            | R      | Major version       |
| 3:0        | Minor version |            | R      | Minor version [5:2] |

**Figure 24:**  
**Control Setup Register**

| Addr: 0x04/0x84 |          | Control_Setup |        |                                                                                                                                                                          |
|-----------------|----------|---------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bit             | Bit Name | Default       | Access | Bit Description                                                                                                                                                          |
| 7               | RST      | 0             | R/W    | Soft Reset, Set to 1 for soft reset, goes to 0 automatically after the reset                                                                                             |
| 6               | INT      | 0             | R/W    | Enable interrupt pin output (INT),<br>1: Enable,<br>0: Disable                                                                                                           |
| 5:4             | GAIN     | 10            | R/W    | Sensor Channel Gain Setting (all channels)<br>'b00=1x; 'b01=3.7x; 'b10=16x; 'b11=64x;                                                                                    |
| 3:2             | BANK     | 10            | R/W    | Data Conversion Type (continuous)<br>'b00=Mode 0: X, Y, Z and NIR<br>'b01=Mode 1: X, Y, D and C<br>'b10=Mode 2: X, Y, Z, NIR, D and C<br>'b11=Mode 3: One-Shot operation |
| 1               | DATA_RDY | 0             | R/W    | 1: Data Ready to Read, sets INT active if interrupt is enabled.<br>Can be polled if not using INT.                                                                       |
| 0               | RSVD     | 0             | R      | Reserved; Unused                                                                                                                                                         |

**Figure 25:**  
Integration Time Register

| Addr: 0x05/0x85 |          | INT_T   |        |                                    |
|-----------------|----------|---------|--------|------------------------------------|
| Bit             | Bit Name | Default | Access | Bit Description                    |
| 7:0             | INT_T    | 0xFF    | R/W    | Integration time = <value> * 2.8ms |

**Figure 26:**  
Device Temperature Register

| Addr: 0x06 |             | Device_Temp |        |                                            |
|------------|-------------|-------------|--------|--------------------------------------------|
| Bit        | Bit Name    | Default     | Access | Bit Description                            |
| 7:0        | Device_Temp | 0xFF        | R/W    | Internal device temperature data byte (°C) |

**Figure 27:**  
LED Control Register

| Addr: 0x07/0x87 |          | LED Control |        |                                                                            |
|-----------------|----------|-------------|--------|----------------------------------------------------------------------------|
| Bit             | Bit Name | Default     | Access | Bit Description                                                            |
| 7:6             | RSVD     | 0           | R      | Reserved                                                                   |
| 5:4             | ICL_DRV  | 00          | R/W    | LED_DRV current limit<br>'b00=12.5mA; 'b01=25mA; 'b10=50mA;<br>'b11=100mA; |
| 3               | LED_DRV  | 0           | R/W    | Enable LED_DRV<br>1: Enabled;<br>0: Disabled                               |
| 2:1             | ICL_IND  | 00          | R/W    | LED_IND current limit<br>'b00=1mA; 'b01=2mA; 'b10=4mA;<br>'b11=8mA;        |
| 0               | LED_IND  | 0           | R/W    | Enable LED_IND<br>1: Enabled;<br>0: Disabled                               |



**Figure 28:**  
**Sensor Raw Data Registers**

| Addr: 0x08 |           | X_High    |        |                             |
|------------|-----------|-----------|--------|-----------------------------|
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | X_High    |           | R      | Channel X High Data Byte    |
| Addr: 0x09 |           | X_Low     |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | X_Low     |           | R      | Channel X Low Data Byte     |
| Addr: 0x0A |           | Y_High    |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | Y_High    |           | R      | Channel Y High Data Byte    |
| Addr: 0x0B |           | Y_Low     |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | Y_Low     |           | R      | Channel Y Low Data Byte     |
| Addr: 0x0C |           | Z_High    |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | Z_High    |           | R      | Channel Z High Data Byte    |
| Addr: 0x0D |           | Z_Low     |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | Z_Low     |           | R      | Channel Z Low Data Byte     |
| Addr: 0x0E |           | NIR_High  |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | NIR_High  |           | R      | Channel NIR High Data Byte  |
| Addr: 0x0F |           | NIR_Low   |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | NIR_Low   |           | R      | Channel NIR Low Data Byte   |
| Addr: 0x10 |           | Dark_High |        |                             |
| Bit        | Bit Name  | Default   | Access | Bit Description             |
| 7:0        | Dark_High |           | R      | Channel Dark High Data Byte |

| Addr: 0x11 |            | Dark_Low   |        |                              |
|------------|------------|------------|--------|------------------------------|
| Bit        | Bit Name   | Default    | Access | Bit Description              |
| 7:0        | Dark_Low   |            | R      | Channel Dark Low Data Byte   |
| Addr: 0x12 |            | Clear_High |        |                              |
| Bit        | Bit Name   | Default    | Access | Bit Description              |
| 7:0        | Clear_High |            | R      | Channel Clear High Data Byte |
| Addr: 0x13 |            | Clear_Low  |        |                              |
| Bit        | Bit Name   | Default    | Access | Bit Description              |
| 7:0        | Clear_Low  |            | R      | Channel Clear Low Data Byte  |

**Figure 29:**  
**Sensor Calibrated Data Registers**

| Addr: 0x14:0x17 |            | Cal_X      |        |                                                  |
|-----------------|------------|------------|--------|--------------------------------------------------|
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | X_Cal      |            | R      | Calibrated X data (4-byte floating-point)        |
| Addr: 0x18:0x1B |            | Cal_Y      |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Y_Cal      |            | R      | Calibrated Y data (4-byte floating-point)        |
| Addr: 0x1C:0x1F |            | Cal_Z      |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Z_Cal      |            | R      | Calibrated Z data (4-byte floating-point)        |
| Addr: 0x20:0x23 |            | Cal_x_1931 |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Cal_x_1931 |            | R      | Calibrated x (CIE 1931) (4-byte floating-point)  |
| Addr: 0x24:0x27 |            | Cal_y_1931 |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Cal_y_1931 |            | R      | Calibrated y (CIE 1931) (4-byte floating-point)  |
| Addr: 0x28:0x2B |            | Cal_upri   |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Cal_upri   |            | R      | Calibrated u' (CIE 1976) (4-byte floating-point) |
| Addr: 0x14:0x17 |            | Cal_vpri   |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Cal_vpri   |            | R      | Calibrated v' (CIE 1976) (4-byte floating-point) |
| Addr: 0x18:0x1B |            | Cal_u      |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Cal_u      |            | R      | Calibrated u (CIE 1976) (4-byte floating-point)  |
| Addr: 0x1C:0x1F |            | Cal_v      |        |                                                  |
| Bit             | Bit Name   | Default    | Access | Bit Description                                  |
| 31:0            | Cal_v      |            | R      | Calibrated v (CIE 1976) (4-byte floating-point)  |

| Addr: 0x20:0x23 |          | Cal_DUV |        |                                                   |
|-----------------|----------|---------|--------|---------------------------------------------------|
| Bit             | Bit Name | Default | Access | Bit Description                                   |
| 31:0            | Cal_DUV  |         | R      | Calibrated DUV (CIE 1976) (4-byte floating-point) |
| Addr: 0x24:0x27 |          | Cal_LUX |        |                                                   |
| Bit             | Bit Name | Default | Access | Bit Description                                   |
| 31:0            | Cal_LUX  |         | R      | Calibrated LUX (4-byte)                           |
| Addr: 0x28:0x2B |          | Cal_CCT |        |                                                   |
| Bit             | Bit Name | Default | Access | Bit Description                                   |
| 31:0            | Cal_CCT  |         | R      | Calibrated CCT (4-byte)                           |

### UART Interface

If selected by the I2C\_ENB pin setting, the UART module implements the TX and RX signals as defined in the RS-232 / V.24 standard communication protocol.

It has on both, receive and transmit path, a 16 entry deep FIFO. It can generate interrupts as required.

#### UART Feature List<sup>1</sup>

- Full Duplex Operation (Independent Serial Receive and Transmit Registers) with FIFO buffer of 8 byte for each.
- At a clock rate of 16MHz it supports communication at 115200 Baud.
- Supports Serial Frames with 8 Data Bits, no Parity and 1 Stop Bit

### Theory of Operation

#### TRANSMISSION

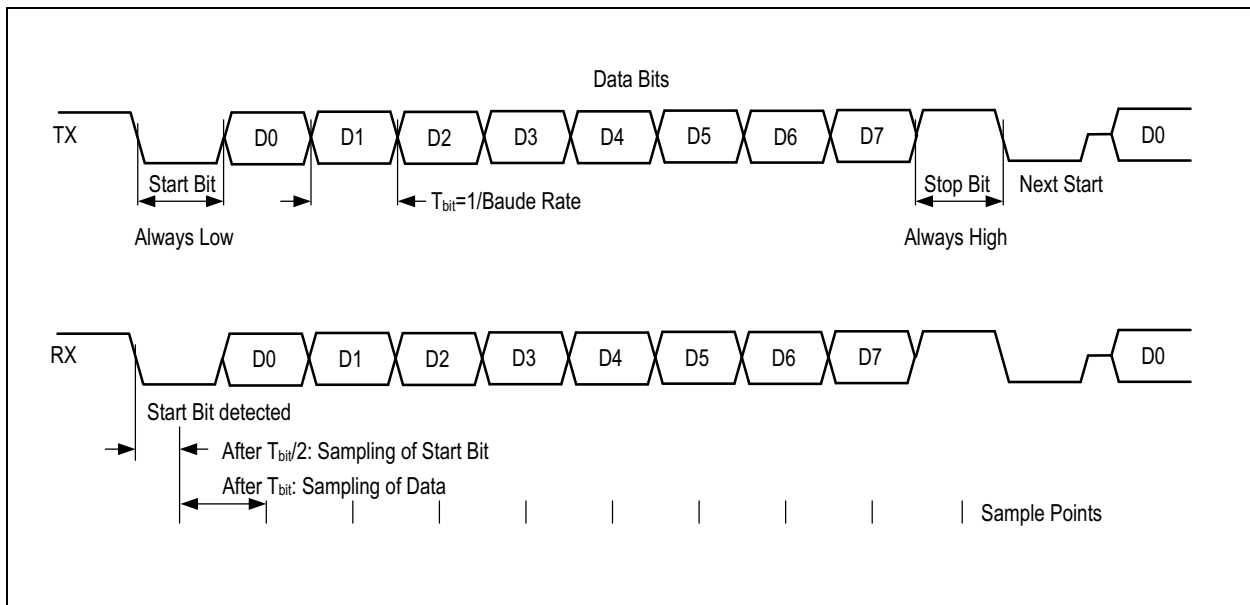
If data is available in the transmit FIFO, it will be moved into the output shift register and the data will be transmitted at the configured Baud Rate, starting with a Start Bit (logic zero) and followed by a Stop Bit (logic one).

#### RECEPTION

At any time, with the receiver being idle, if a falling edge of a start bit is detected on the input, a byte will be received and stored in the receive FIFO. The following Stop Bit will be checked to be logic one.

1. With UART operation, min VDD of 2.97V is required as shown in Electrical Characteristics figures.

**Figure 30:**  
**UART Protocol**



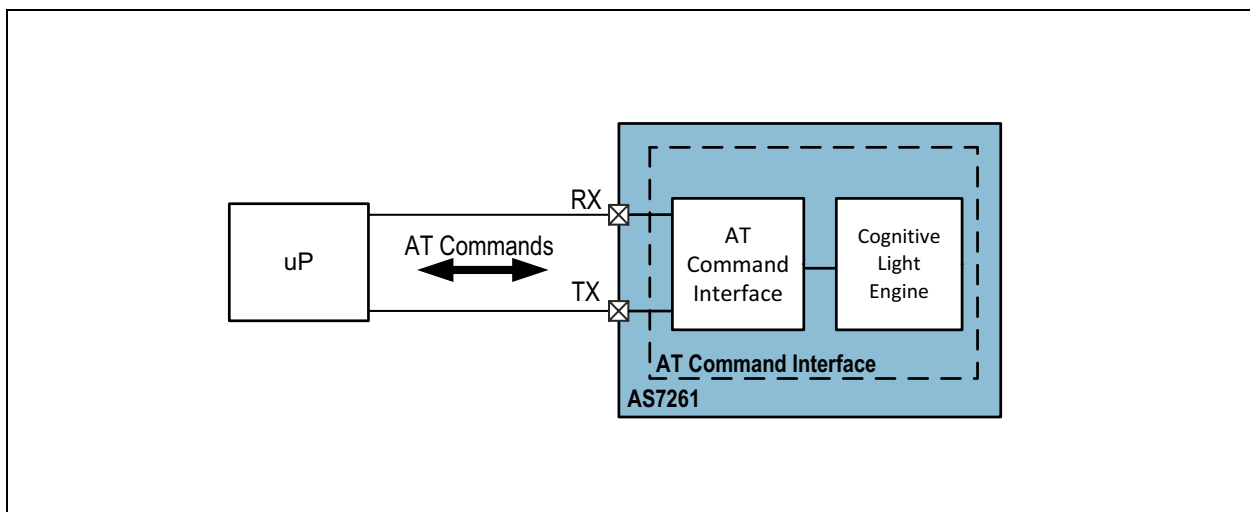
**AT Command Interface**

The microprocessor interface to control the AS7261 is via the UART, using AT Commands across the UART interface. This AT Command interface provides a text-based serial command interface borrowed from the “AT Command” model used in early Hayes modems. For example:

- Read DATA value: ATDATA → <data>OK
- Set the gain of the sensor to 1x: ATGAIN =0 → OK

The “AT Command Interface Block Diagram”, shown below between the network interface and the core of the system, provides access to the AS7261’s Cognitive Light Engine’s control and configuration functions.

**Figure 31:**  
**AT Command Interface Block Diagram**



In the figure below, numeric values may be specified with no leading prefix, in which case they will be interpreted as decimals, or with a leading “0x” to indicate that they are hexadecimal numbers, or with a leading “b” to indicate that they are binary numbers. The commands are loosely grouped into functional areas. Texts appearing between angle brackets (<’ and >’) are commands or response arguments. A carriage return character, a linefeed character, or both may terminate commands and responses. Note that any command that encounters an error will generate the “ERROR” response shown, for example, in the NOP command at the top of the first table, but has been omitted elsewhere in the interest of readability and clarity.

**Figure 32:**  
AT Commands

| Command                                         | Response                                                                                   | Description/Parameters                                                                                                      |
|-------------------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>XYZ Calibrated Data with Its Derivatives</b> |                                                                                            |                                                                                                                             |
| ATXYZC                                          | <X_cor_value>,<br><Y_cor_value>,<br><Z_cor_value> OK                                       | Read calibrated X, Y, and Z data. Returns comma-separated floating-point values                                             |
| ATLUXC                                          | <LUX_value> OK                                                                             | Read the calibrated LUX value from the sensor.                                                                              |
| ATCCTC                                          | <CCT_value> OK                                                                             | Read the calibrated CCT value from the sensor.                                                                              |
| ATSMALLXYC                                      | <smallX_value>,<br><smallY_value> OK                                                       | Read calibrated x and y for CIE 1931 color gamut. Returns comma separated floating-point values (5 decimal places).         |
| ATUVPRIMEC                                      | <Uprime_value>,<br><Vprime_value>,<br><U_value>,<br><V_value> OK                           | Read calibrated u', v' and u, v for CIE 1976 color gamut. Returns comma separated floating-point values (5 decimal places). |
| ATDUVC                                          | <DUV_value> OK                                                                             | Read calibrated Duv for CIE 1976-color gamut. Returns comma separated floating-point values (5 decimal places).             |
| <b>Spectral Data per Channel</b>                |                                                                                            |                                                                                                                             |
| ATXYZR                                          | <X_value>, <Y_value>,<br><Z_value> OK                                                      | Read raw X, Y, and Z data. Returns comma-separated 16-bit integers.                                                         |
| ATDATA                                          | <X_value>, <Y_value>,<br><Z_value>,<br><Spec_reg_NIR>,<br><Spec_reg_D>,<br><Spec_reg_C> OK | Read raw X, Y, Z and NIR data as well as two special internal registers D, & C. Returns comma-separated 16-bit integers.    |

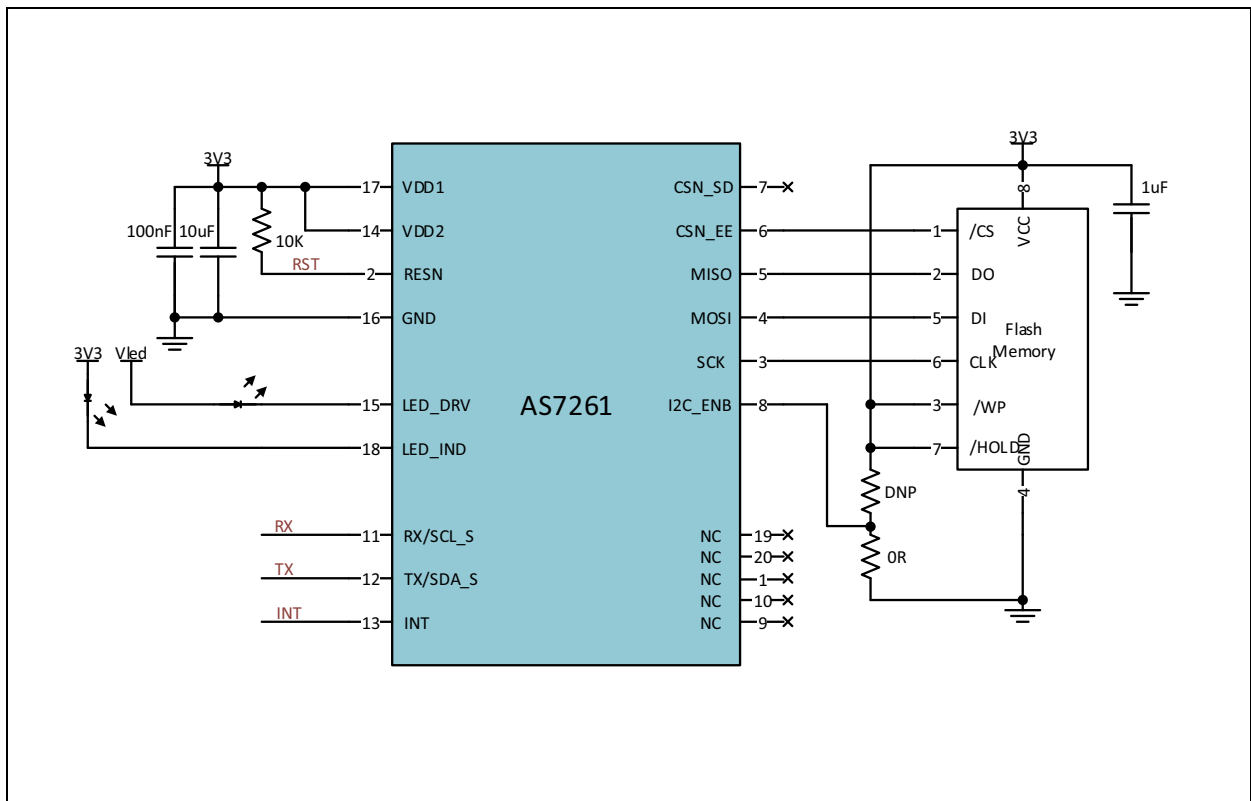
| <b>Sensor Configuration</b> |            |                                                                                                                                                                                                                                                                                                               |
|-----------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ATINTTIME=<value>           | OK         | Set sensor integration time. Values should be in the range [1... 255], with integration time = <value> * 2.8msecs.                                                                                                                                                                                            |
| ATINTTIME                   | <value> OK | Read sensor integration time, with integration time = <value> * 2.8msecs.                                                                                                                                                                                                                                     |
| ATGAIN=<value>              | OK         | Set sensor gain: 0=1X, 1=3.7X, 2=16X, 3=64X                                                                                                                                                                                                                                                                   |
| ATGAIN                      | <value>OK  | Read sensor gain setting, returning 0, 1, 2, or 3 as defined immediately above.                                                                                                                                                                                                                               |
| ATTEMP                      | <value>OK  | Read temperature of chip in Celsius                                                                                                                                                                                                                                                                           |
| ATTCSMD=<value>             | OK         | Set Chromatic White Color Sensor Mode<br>0 → Captures X, Y, Z, and IR (1 integration period)<br>1 → Captures X, Y, Dk, and CLR (1 integration period)<br>2 → Captures X, Y, Z, Dk, IR and CLR (2 integration period)<br>3 → Sensors are OFF                                                                   |
| ATTCSMD                     | <value> OK | Read Color Sensor Mode, see above                                                                                                                                                                                                                                                                             |
| ATINTRVL=<value>            | OK         | Set the sampling interval as an integer multiple of the Integration time. The <value> is an integer between [1..255].<br>A sampling interval=1 implies a sampling rate of 1x the current integration time.<br>A sampling interval=255 implies a slow sampling rate of 255 times the current integration time. |
| ATINTRVL                    | <value>OK  | Read the sampling interval as an integer multiple of the Integration time.<br>Returns an integer in the range [1..255] as defined above                                                                                                                                                                       |
| ATBURST=<value>.            | OK         | <value>= # of samples<br>(ATBURST=1 means run until ATBURST=0 is received (a special case for continuous output)                                                                                                                                                                                              |
| <b>LED Driver Controls</b>  |            |                                                                                                                                                                                                                                                                                                               |
| ATLED0=<value>              | OK         | Sets LED_IND: 100=ON, 0=OFF                                                                                                                                                                                                                                                                                   |
| ATLED0                      | <100 0>OK  | Reads LED_IND setting: 100=ON, 0=OFF                                                                                                                                                                                                                                                                          |
| ATLED1=<value>              | OK         | Sets LED_DRV: 100=ON, 0=OFF                                                                                                                                                                                                                                                                                   |
| ATLED1                      | <100 0>OK  | Reads LED_DRV setting: 100=ON, 0=OFF                                                                                                                                                                                                                                                                          |
| ATLEDC=<value>              | OK         | Sets LED_IND and LED_DRV current<br>LED_IND: bits 3:0; LED_DRV: 7:4 bits<br>LED_IND: 'b00=1mA; 'b01=2mA; 'b10=4mA; 'b11=8mA<br>LED_DRV: 'b00=12.5mA; 'b01=25mA; 'b10=50mA; 'b11=100mA                                                                                                                         |
| ATLEDC                      | <value>OK  | Reads LED_IND and LED_DRV current settings as shown above                                                                                                                                                                                                                                                     |

| <b>NOP, Version Access, System Reset</b> |                                   |                                                                                                                                                                |
|------------------------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AT                                       | OK → Success<br>ERROR → Failure   | NOP                                                                                                                                                            |
| ATSRST                                   | OK → Success<br>ERROR → Failure   | Software Reset                                                                                                                                                 |
| ATVERSW                                  | <SWversion#>OK<br>ERROR → Failure | Returns the system software version number                                                                                                                     |
| ATVERHW                                  | <HWversion#>OK<br>ERROR → Failure | Returns the system hardware revision and product ID, with bits 7:4 containing the part ID, and bits 3:0 yielding the chip revision value.                      |
| <b>Firmware Update</b>                   |                                   |                                                                                                                                                                |
| ATFWU=<value>                            | OK                                | <value>= 16-bit checksum. Initializes the firmware update process. Number of bytes that follow are always 56 KBytes                                            |
| ATFW=<value>                             | OK                                | Download new firmware<br>Up to 7 bytes represented as hex chars with no leading or trailing 0x.<br>Repeat command till all 56Kbytes of firmware are downloaded |
| ATFWA                                    | OK                                | Causes target address for FW updates to advance. Should be called after every successful “OK” returned after “ATFW=<value>” command usage.                     |
| ATFWS                                    | OK                                | Causes the active image to switch between the two possible current images and then resets the IC                                                               |



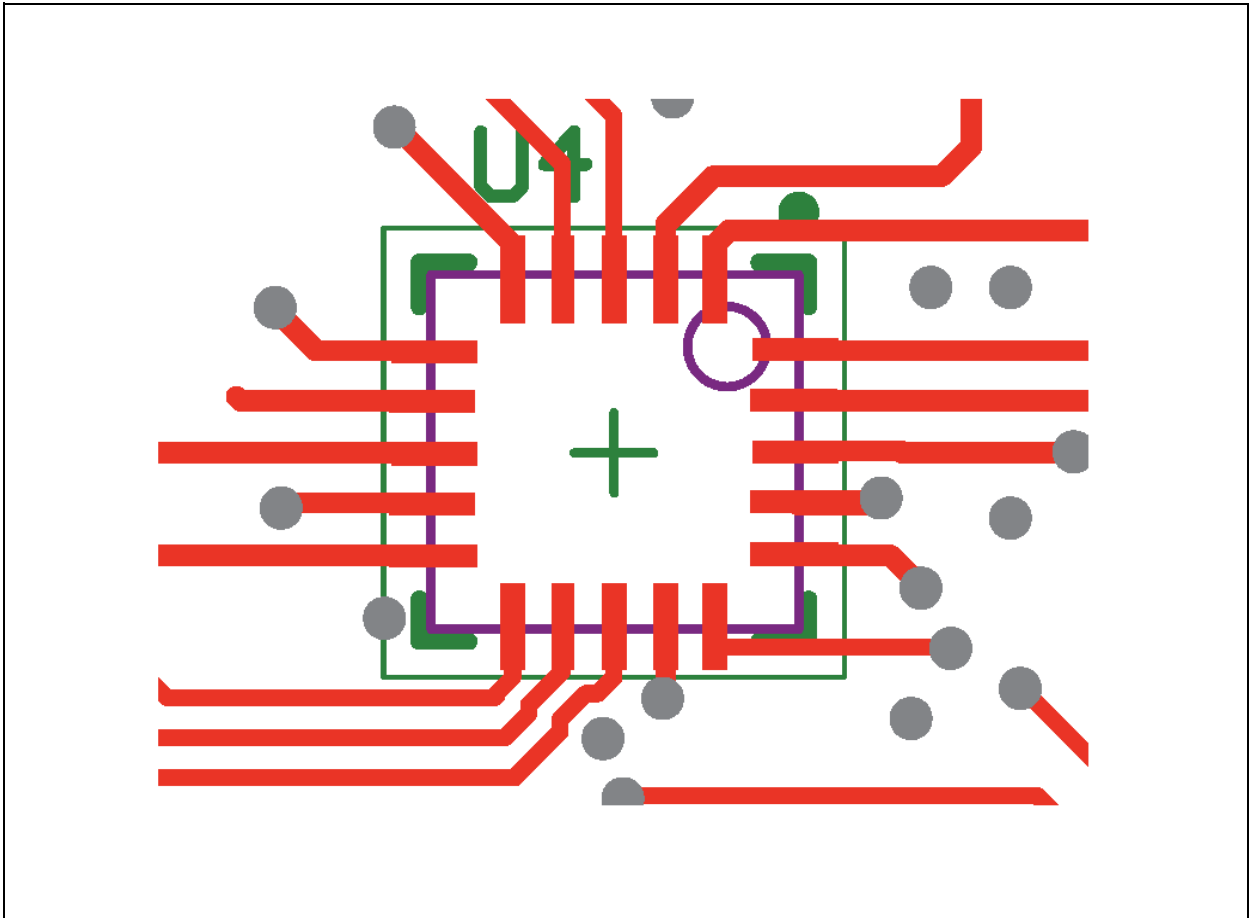
## Application Information

**Figure 33:**  
AS7261 Typical Application Circuit



## PCB Layout

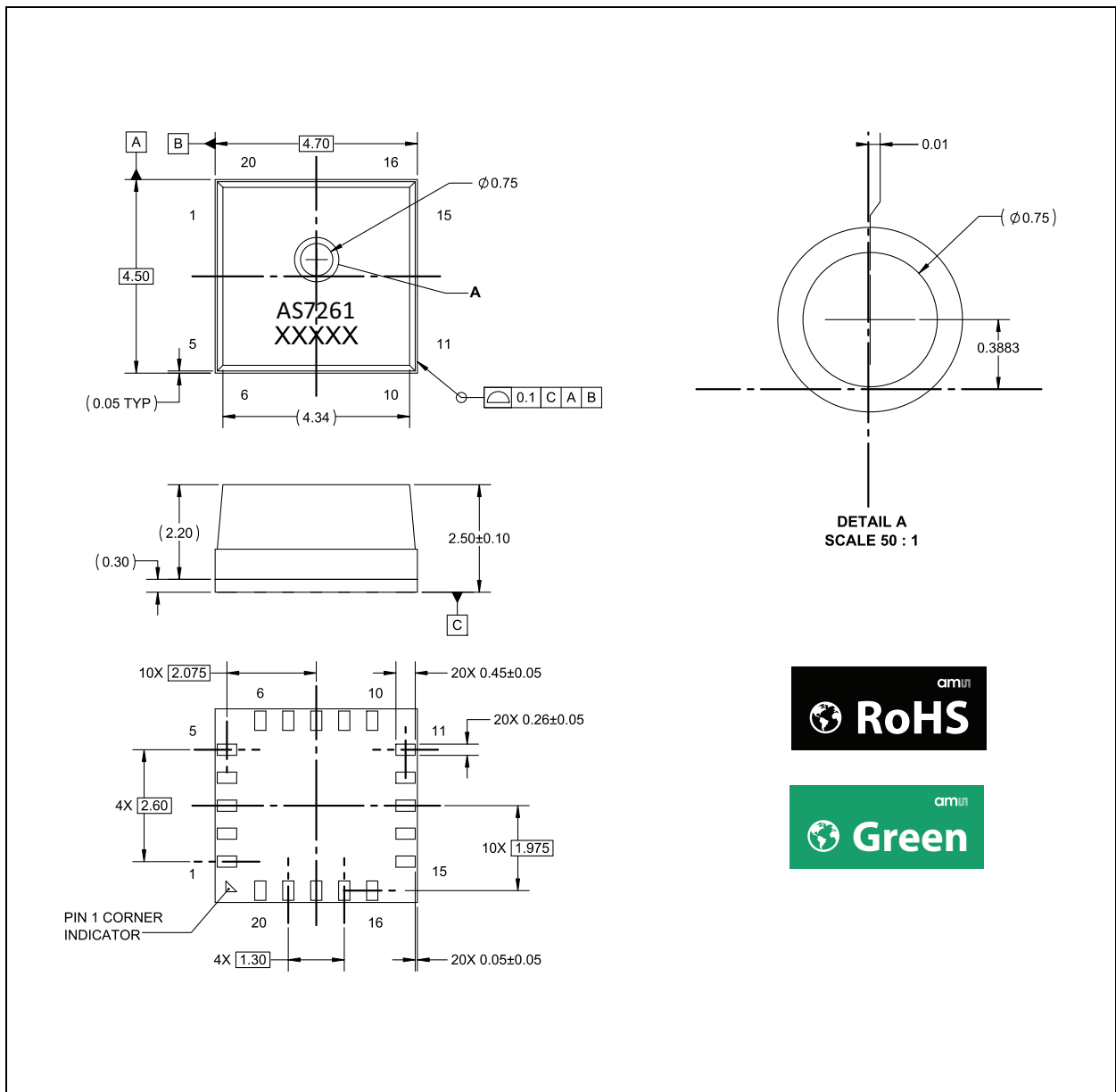
Figure 34:  
Typical Layout Reading



In order to prevent interference, avoid trace routing feedthroughs with exposure directly under the AS7261. An example routing is illustrated in the diagram.

## Package Drawings & Markings

**Figure 35:**  
AS7261 Package Drawing



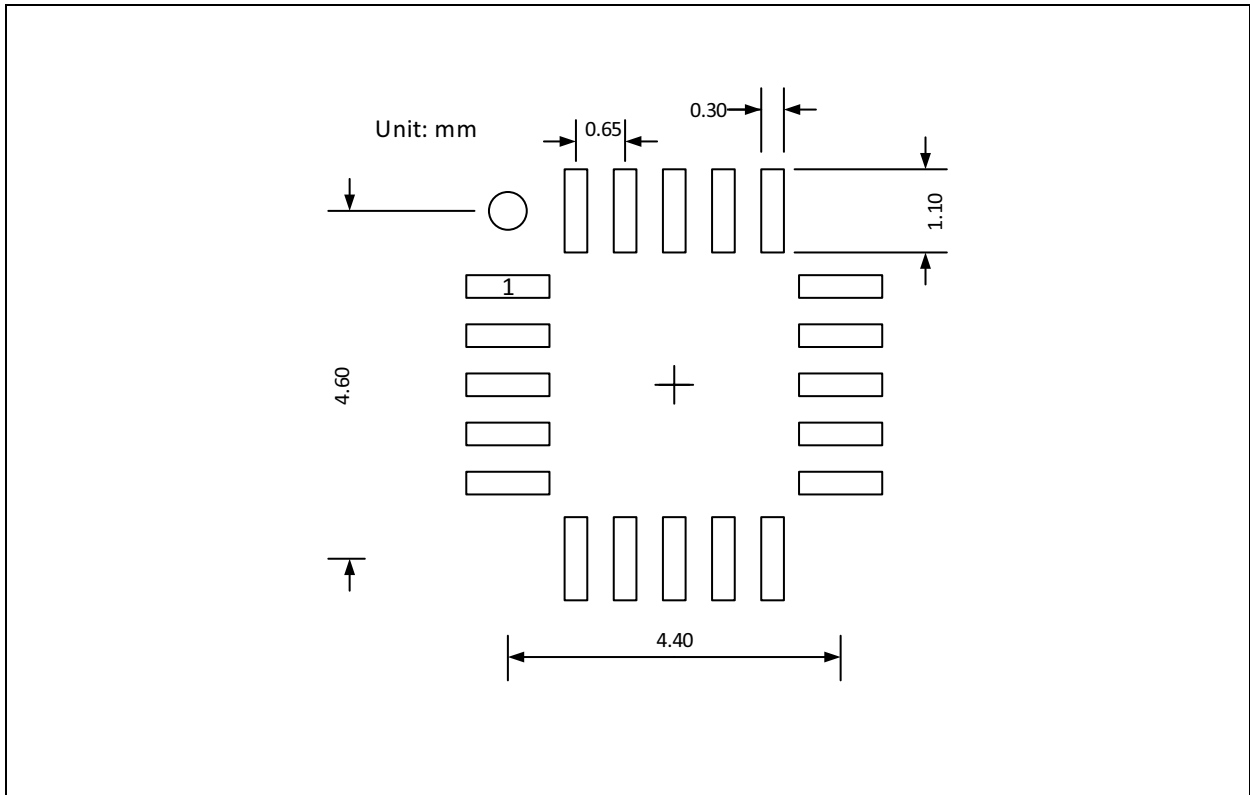
**Note(s):**

1. XXXXX = tracecode

**PCB Pad Layout**

Suggested PCB pad layout guidelines for the LGA device are shown.

**Figure 36:**  
Recommended PCB Pad Layout

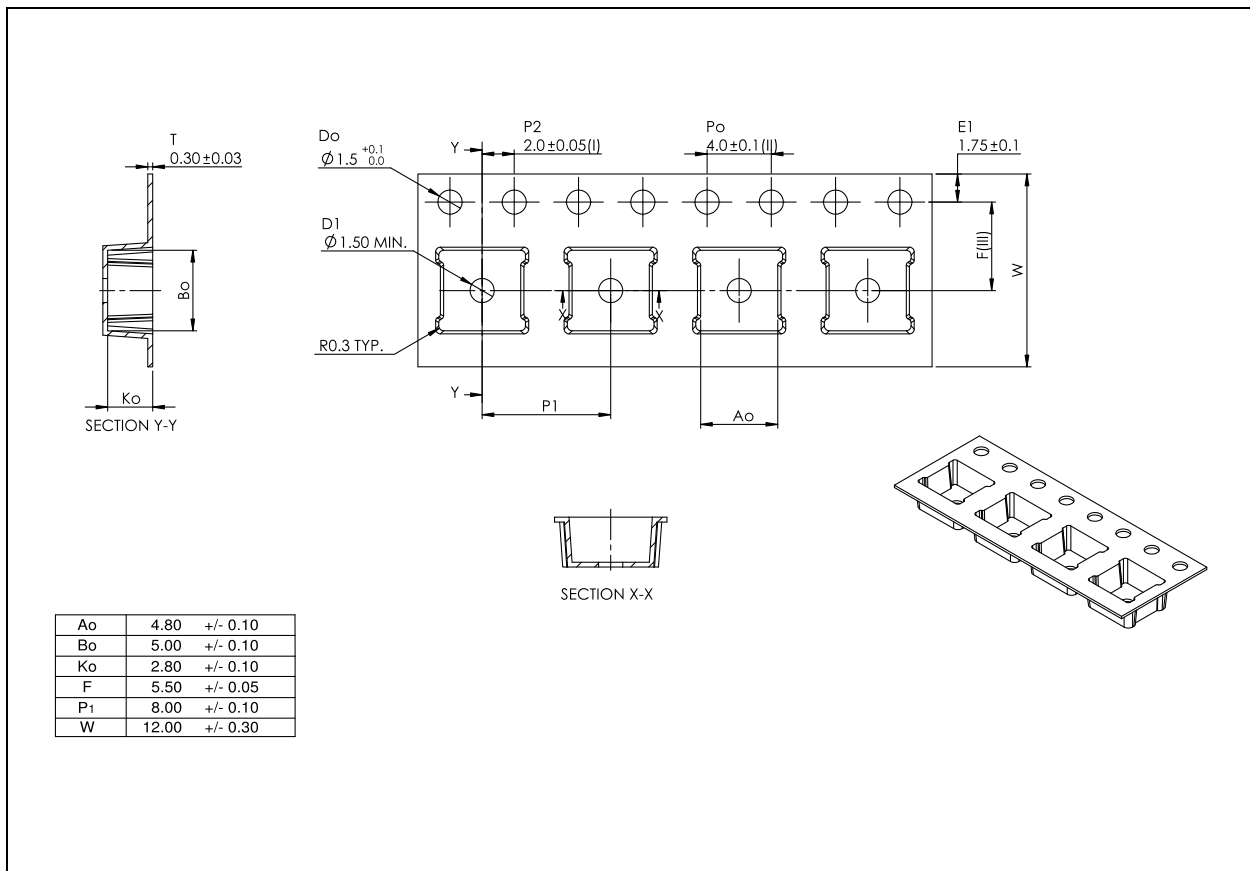


**Note(s):**

1. Unless otherwise specified, all dimensions are in millimeters.
2. Dimensional tolerances are  $\pm 0.05\text{mm}$  unless otherwise noted.
3. This drawing is subject to change without notice.

## Mechanical Data

**Figure 37:**  
Tape & Reel Information



**Note(s):**

1. All dimensions in millimeters unless of otherwise stated.
2. Measured from centreline of sprocket hole to centreline of pocket.
3. Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$ .
4. Measured from centreline of sprocket hole to centreline of pocket.
5. Other material available.

## Soldering & Storage Information

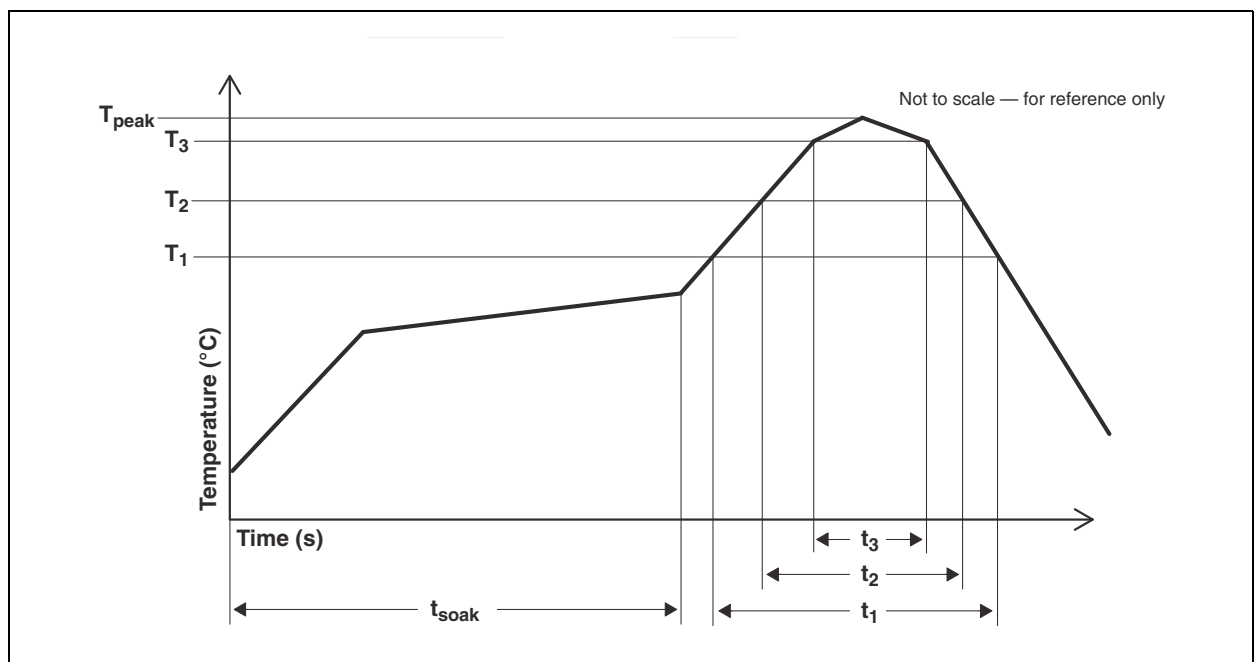
### Soldering Information

The module has been tested and has demonstrated an ability to be reflow soldered to a PCB substrate. The solder reflow profile describes the expected maximum heat exposure of components during the solder reflow process of product on a PCB. Temperature is measured on top of component. The components should be limited to a maximum of three passes through this solder reflow profile.

**Figure 38:**  
Solder Reflow Profile

| Parameter                                                 | Reference         | Device         |
|-----------------------------------------------------------|-------------------|----------------|
| Average temperature gradient in preheating                |                   | 2.5 °C/s       |
| Soak time                                                 | $t_{\text{soak}}$ | 2 to 3 minutes |
| Time above 217°C ( $T_1$ )                                | $t_1$             | Max 60 s       |
| Time above 230°C ( $T_2$ )                                | $t_2$             | Max 50 s       |
| Time above $T_{\text{peak}} - 10^\circ\text{C}$ ( $T_3$ ) | $t_3$             | Max 10 s       |
| Peak temperature in reflow                                | $T_{\text{peak}}$ | 260 °C         |
| Temperature gradient in cooling                           |                   | Max -5 °C/s    |

**Figure 39:**  
Solder Reflow Profile Graph



## **Manufacturing Process Considerations**

The AS7261 package is compatible with standard reflow no-clean and cleaning processes including aqueous, solvent or ultrasonic techniques. However, as an open-aperture device, precautions must be taken to avoid particulate or solvent contamination as a result of any manufacturing processes, including pick and place, reflow, cleaning, integration assembly and/or testing. Temporary covering of the aperture is allowed. To avoid degradation of accuracy or performance in the end product, care should be taken that any temporary covering and associated sealants/debris are thoroughly removed prior to any optical testing or final packaging.

## **Storage Information**

### ***Moisture Sensitivity***

Optical characteristics of the device can be adversely affected during the soldering process by the release and vaporization of moisture that has been previously absorbed into the package. To ensure the package contains the smallest amount of absorbed moisture possible, each device is baked prior to being dry packed for shipping.

Devices are dry packed in a sealed aluminized envelope called a moisture-barrier bag with silica gel to protect them from ambient moisture during shipping, handling, and storage before use.

### ***Shelf Life***

The calculated shelf life of the device in an unopened moisture barrier bag is 12 months from the date code on the bag when stored under the following conditions:

- Shelf Life: 12 months
- Ambient Temperature: < 40°C
- Relative Humidity: < 90%

Rebaking of the devices will be required if the devices exceed the 12 month shelf life or the Humidity Indicator Card shows that the devices were exposed to conditions beyond the allowable moisture region.

**Floor Life**

The CS package has been assigned a moisture sensitivity level of MSL 2. As a result, the floor life of devices removed from the moisture barrier bag is 1 year from the time the bag was opened, provided that the devices are stored under the following conditions:

- Floor Life: 1 year
- Ambient Temperature: <30°C
- Relative Humidity:<60%

If the floor life or the temperature/humidity conditions have been exceeded, the devices must be rebaked prior to solder reflow or dry packing.

**Rebaking Instructions**

When the shelf life or floor life limits have been exceeded, rebake at 50°C for 12 hours.



## Ordering & Contact Information

**Figure 40:**  
Ordering Information

| Ordering Code | Package    | Marking | Description                                                                        | Delivery Form | Delivery Quantity |
|---------------|------------|---------|------------------------------------------------------------------------------------|---------------|-------------------|
| AS7261-BLGT   | 20-pin LGA | AS7261  | XYZ Chromatic White Color Sensor + NIR with Electronic Shutter and Smart Interface | Tape & Reel   | 2000 pcs/reel     |

**Note(s):**

1. Required companion serial flash memory (must be **ams** verified) is ordered from the flash memory supplier (e.g. AT25SF041-SSHD-B from Adesto Technologies)
2. AS7261 flash memory software is available from **ams**

Buy our products or get free samples online at:  
[www.ams.com/ICdirect](http://www.ams.com/ICdirect)

Technical Support is available at:  
[www.ams.com/Technical-Support](http://www.ams.com/Technical-Support)

Provide feedback about this document at:  
[www.ams.com/Document-Feedback](http://www.ams.com/Document-Feedback)

For further information and requests, e-mail us at:  
[ams\\_sales@ams.com](mailto:ams_sales@ams.com)

For sales offices, distributors and representatives, please visit:  
[www.ams.com/contact](http://www.ams.com/contact)

**Headquarters**

ams AG  
Tobelbader Strasse 30  
8141 Premstaetten  
Austria, Europe

Tel: +43 (0) 3136 500 0

Website: [www.ams.com](http://www.ams.com)

## RoHS Compliant & ams Green Statement

**RoHS:** The term RoHS compliant means that ams AG products fully comply with current RoHS directives. Our semiconductor products do not contain any chemicals for all 6 substance categories, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, RoHS compliant products are suitable for use in specified lead-free processes.

**ams Green (RoHS compliant and no Sb/Br):** ams Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

**Important Information:** The information provided in this statement represents ams AG knowledge and belief as of the date that it is provided. ams AG bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. ams AG has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. ams AG and ams AG suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

## Copyrights & Disclaimer

Copyright ams AG, Tobelbader Strasse 30, 8141 Premstaetten, Austria-Europe. Trademarks Registered. All rights reserved. The material herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner.

Devices sold by ams AG are covered by the warranty and patent indemnification provisions appearing in its General Terms of Trade. ams AG makes no warranty, express, statutory, implied, or by description regarding the information set forth herein. ams AG reserves the right to change specifications and prices at any time and without notice. Therefore, prior to designing this product into a system, it is necessary to check with ams AG for current information. This product is intended for use in commercial applications. Applications requiring extended temperature range, unusual environmental requirements, or high reliability applications, such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional processing by ams AG for each application. This product is provided by ams AG "AS IS" and any express or implied warranties, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose are disclaimed.

ams AG shall not be liable to recipient or any third party for any damages, including but not limited to personal injury, property damage, loss of profits, loss of use, interruption of business or indirect, special, incidental or consequential damages, of any kind, in connection with or arising out of the furnishing, performance or use of the technical data herein. No obligation or liability to recipient or any third party shall arise or flow out of ams AG rendering of technical or other services.

## Document Status

| Document Status          | Product Status  | Definition                                                                                                                                                                                                                                                         |
|--------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Preview          | Pre-Development | Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice                                                                    |
| Preliminary Datasheet    | Pre-Production  | Information in this datasheet is based on products in the design, validation or qualification phase of development. The performance and parameters shown in this document are preliminary without any warranty and are subject to change without notice            |
| Datasheet                | Production      | Information in this datasheet is based on products in ramp-up to full production or full production which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade                                |
| Datasheet (discontinued) | Discontinued    | Information in this datasheet is based on products which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade, but these products have been superseded and should not be used for new designs |

## Revision Information

Initial production version 1-00 for release

## Content Guide

|           |                                                           |
|-----------|-----------------------------------------------------------|
| <b>1</b>  | <b>General Description</b>                                |
| 1         | Key Benefits & Features                                   |
| 2         | Applications                                              |
| 2         | Block Diagram                                             |
| <b>3</b>  | <b>Pin Assignments</b>                                    |
| 3         | Pin Description                                           |
| <b>5</b>  | <b>Absolute Maximum Ratings</b>                           |
| <b>6</b>  | <b>Electrical Characteristics</b>                         |
| 7         | Timing Characteristics                                    |
| <b>10</b> | <b>Typical Optical Characteristics</b>                    |
| <b>11</b> | <b>Detailed Descriptions</b>                              |
| 11        | XYZ Chromatic White Color Sensor                          |
| 12        | Data Conversion Description                               |
| 13        | RC Oscillator                                             |
| 14        | Temperature Sensor                                        |
| 14        | Reset                                                     |
| 14        | Indicator LED for Flash Memory Programming Progress       |
| 14        | Electronic Shutter with LED_IND or LED_DRV Driver Control |
| 15        | Interrupt Operation                                       |
| 15        | I <sup>2</sup> C Slave Interface                          |
| 16        | I <sup>2</sup> C Feature List                             |
| 16        | I <sup>2</sup> C Virtual Register Write Access            |
| 17        | I <sup>2</sup> C Virtual Register Byte Write              |
| 17        | I <sup>2</sup> C Virtual Register Read Access             |
| 18        | I <sup>2</sup> C Virtual Register Byte Read               |
| 19        | 4-Byte Floating-Point (FP) Registers                      |
| 20        | I <sup>2</sup> C Virtual Register Set                     |
| <b>22</b> | <b>Detailed Register Description</b>                      |
| 27        | UART Interface                                            |
| 27        | UART Feature List                                         |
| 27        | Theory of Operation                                       |
| 28        | AT Command Interface                                      |
| <b>32</b> | <b>Application Information</b>                            |
| <b>33</b> | <b>Package Drawings &amp; Markings</b>                    |
| <b>34</b> | <b>PCB Pad Layout</b>                                     |
| <b>35</b> | <b>Mechanical Data</b>                                    |
| <b>36</b> | <b>Soldering &amp; Storage Information</b>                |
| 36        | Soldering Information                                     |
| 37        | Manufacturing Process Considerations                      |
| 37        | Storage Information                                       |
| 37        | Moisture Sensitivity                                      |
| 37        | Shelf Life                                                |
| 37        | Floor Life                                                |
| 38        | Rebaking Instructions                                     |

- 39 Ordering & Contact Information**
- 40 RoHS Compliant & ams Green Statement**
- 41 Copyrights & Disclaimer**
- 42 Document Status**
- 43 Revision Information**

## X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for [Ambient Light Sensors](#) category:*

*Click to view products by [ams](#) manufacturer:*

Other Similar products are found below :

[IS31SE5000-UTLS2-TR](#) [SEN0390](#) [0805-PTSM D021](#) [ALS-PT19-315C/L177/TR8](#) [BH1680FVC-TR](#) [SI1132-A10-GM](#) [APS3227SP1C-P22](#)  
[ALS-PDIC144-6C/L378](#) [4681](#) [AS7211-BLGM](#) [AS7211-BLGT](#) [AS7220-BLGM](#) [AS7221-BLGM](#) [AS7341-DLGM](#) [AS7341-DLGT](#)  
[TMD27253M](#) [TMD27504](#) [TMD37024VCM](#) [TMD37253M](#) [TSL25403M](#) [TSL27403M](#) [DY-FPD204-6B/L3](#) [DY-FPD333-3B/L3](#) [DY-](#)  
[FPD333B-A5](#) [DY-FPD4134C-A3](#) [DY-PD204-6B](#) [DY-PD234-6B](#) [DY-PD333B-A5](#) [DY-PD673B-A2](#) [CLS15-22C/L213G/TR8](#) [CLS15-](#)  
[22C/L213R/TR8](#) [HLPT5I850HP25](#) [ISL76671AR0Z-T7A](#) [LTR-303ALS-01](#) [LTR-329ALS-01](#) [LTR-308ALS-01](#) [NJL7502L](#) [LV0111CF-](#)  
[TLM-H](#) [SFH 3711](#) [BH1600FVC-TR](#) [BH1603FVC-TR](#) [BH1620FVC-TR](#) [BH1621FVC-TR](#) [BH1710FVC-TR](#) [BH1715FVC-TR](#) [BH1721FVC-](#)  
[TR](#) [BH1730FVC-TR](#) [BH1749NUC-E2](#) [BH1750FVI-TR](#) [BH1751FVI-TR](#)