ADJD-S313
Digital Color sensor

Application Note 5261

Introduction

This application note describes the programming of the ADJD-S313 in color sensing application.

An application example, color LED grouping and a typical circuit is also provided in this note.

Serial interface protocol.

The programming is done through the serial interface. The serial interface protocol details are described in the datasheet. The device address consists of the most significant 7-bit slave device address and a R/W bit. The 7-bit slave device address is 58H or decimal 88. Thus, the device address for writing is B0H and for reading is B1H. The dataflow diagram for the serial communication is as follow.

For Write, S [D_w] a [R] a [V_w] a P

For Read, S [D_w] a [R] a S_r [D_r] a [V_r] n P

KEY	Description
S	Start transition from host controller
a	Acknowledge bit from device
n	Not acknowledge bit sent by host controller to device
S_r	Repeat start transition
P	Stop transition from host controller
[D_w]	ADJD-S313 device write address byte = B0H
[D_r]	ADJD-S313 device read address byte = B1H
[R]	Device register address byte in the write or read operation
[V_w]	Value to write to device register address 'R'
[V_r]	Value to read from device register address 'R'

Example:

a) To write a setup data, 01H to SETUP1 register (address 04H), the datagram is

S [B0] a [04] a [01] a P

b) To read ACQ register (address 02H), the datagram is

S [B0] a [02] a S_r [B1] a [V_r] n P

Key:

- S - Start transition
- a - Acknowledge bit receive from device
- n - Not acknowledge bit send to device
- S_r - Repeat start transition
- P - Stop transition
- [B0] - ADJD-S313 device write address byte = B0H
- [B1] - ADJD-S313 device read address byte = B1H
- [02] - ACQ register address = 02H
- [04] - SETUP1 register address = 04H
- [01] - Setup data 01H to write to SETUP1 register
- [V_r] - Byte value read from device

Programming

Before the ADJD-S313 can be used, a one time sensor gain optimization routine is done so that the analog to digital converter (ADC) values ranges from 0 to 230.

Figure 1 show the flowchart to obtain the optimum ADC values.

Figure 2 show the typical sensor operation flowchart after the sensor gain settings has been obtained.

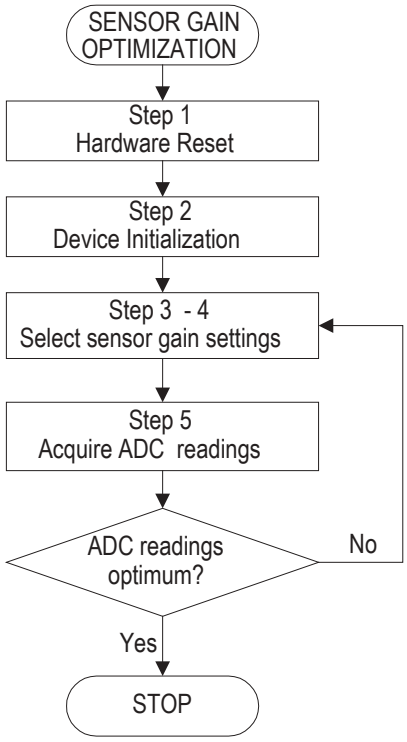

Figure 1. Sensor gain optimization flowchart

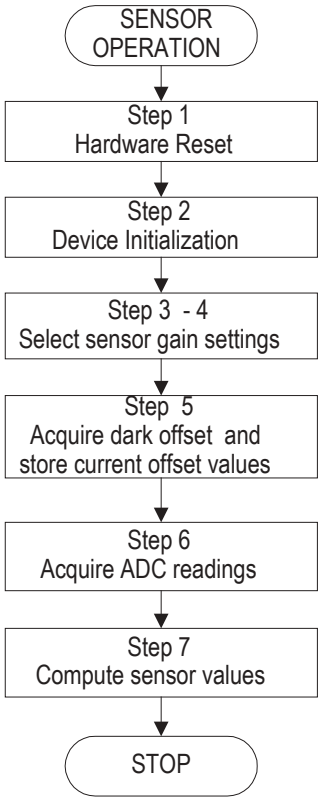

Figure 2. Sensor operation flowchart

Sensor Gain Optimization Procedure

This procedure selects gain settings to optimize the ADC value. The optimized ADC value should never exceed 230 in normal sensor operation.

1. First perform an external power on reset. Wait 10us for the reset sequence to be completed.
2. Write setup data 01H to SETUP0, SETUP1, SETUP2, SETUP3 and SETUP4 registers. These registers are at address 03H, 04H, 0CH, 0DH and 0EH.
3. Write sensor gain registers, PDASR, PDASG and PDASB to select the photodiode size.

   The photodiode size can be written with any of the four values.

   01H - Select ¼ size photodiode

   03H - Select ½ size photodiode

   07H - Select ¾ size photodiode

   0FH - Select full size photodiode

   All values other than the above values are not valid and should not be used.
4. Write sensor gain registers, TINTR, TINTG and TINTB to select the integration time. The values must range from 00H to 0FH. A higher value in integration time will generally result in higher sensor ADC value if the PDASR, PDASG, and PDASB have the same value.
5. Acquire sensor ADC values by writing 02H to ACQ register (address 02H). Read ACQ register. When the value is 00H, the sensor ADC values are read from ADCR, ADCG and ADCB register. If these sensor ADC values are not optimum, do another iteration loop consisting of step 3, 4 and 5.
6. If the sensor ADC values obtained in step 5 are optimum, a check is done to ensure that the sensor ADC values will never exceed 230. This is done by selecting running condition or any operating case which the sensor will give maximum value in

   a) red, green and blue channel, or

   b) any of the red, green or blue channels.

   Step 5 is done again to obtain sensor ADC values for these operating cases. If the checks show that the sensor ADC values do not exceed 230, then the sensor gain optimization procedure is completed. The sensor operation procedure can be done or the device is put to sleep mode.

Sensor Operation Procedure.

1. First perform an external power on reset. Wait 10us for the reset sequence to be completed.
2. Write setup data 01H to SETUP0, SETUP1, SETUP2, SETUP3 and SETUP4 registers. (Address 03H, 04H, 0CH, 0DH, and 0EH)
3. Write sensor gain registers, PDASR, PDASG and PDASB with values obtained from the previous sensor gain optimization procedure.
4. Write sensor gain registers, TINTR, TINTG and TINTB with values obtained from the previous sensor gain optimization procedure.
5. Acquire offsets in normal operating environment. The light source for color sensing must be turned off. The current offsets are acquired by writing 02H to ACQ register. Read ACQ register. When the value is 00H, the offsets are acquired in sensor ADC registers. Refer to table 1. The offsets are then written to external memory locations, for example, OFFSR, OFFSG and OFFSB.

Address	Register name	External memory location
44	ADCR	OFFSR
43	ADCG	OFFSG
42	ADCB	OFFSB

Table 1. External offset registers.

6. Acquire sensor ADC values by writing 02H to ACQ register (address 02H). Read ACQ register. When the value is 00H, sensor ADC values are acquired in ADCR, ADCG and ADCB registers.
7. Compute the sensor readings SENSR, SENSG and SENSB by using the following equation.
   SENSR = ADCR – OFFSR
   SENSG = ADCG – OFFSG
   SENSB = ADCB – OFFSB
   SENSR is the red channel sensor reading, SENSG is the green channel sensor reading, and SENSB is the blue channel sensor reading.

Repeat step 6 and 7 for more sensor readings. If there are no more sensor readings, the device can be put to sleep mode.

Color LED grouping example

An example in transmission color sensing is provided for illustration. LED lamps of three colors, red, green and blue are to be grouped into three colors depending on its light source color. The LED lamps are lighted one by one and grouped according to its color.

Refer to figure 3 for an illustration of the setup.

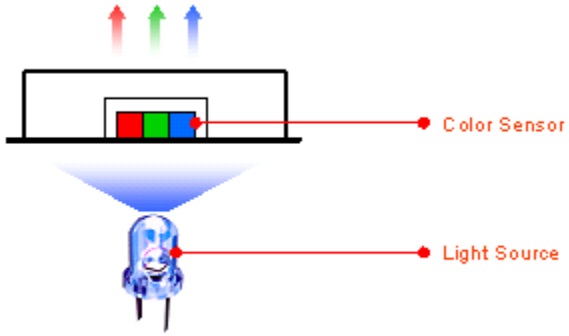

Figure 3. Illustration of the LED lamp under test.

The circuit for the application is shown in figure 4.

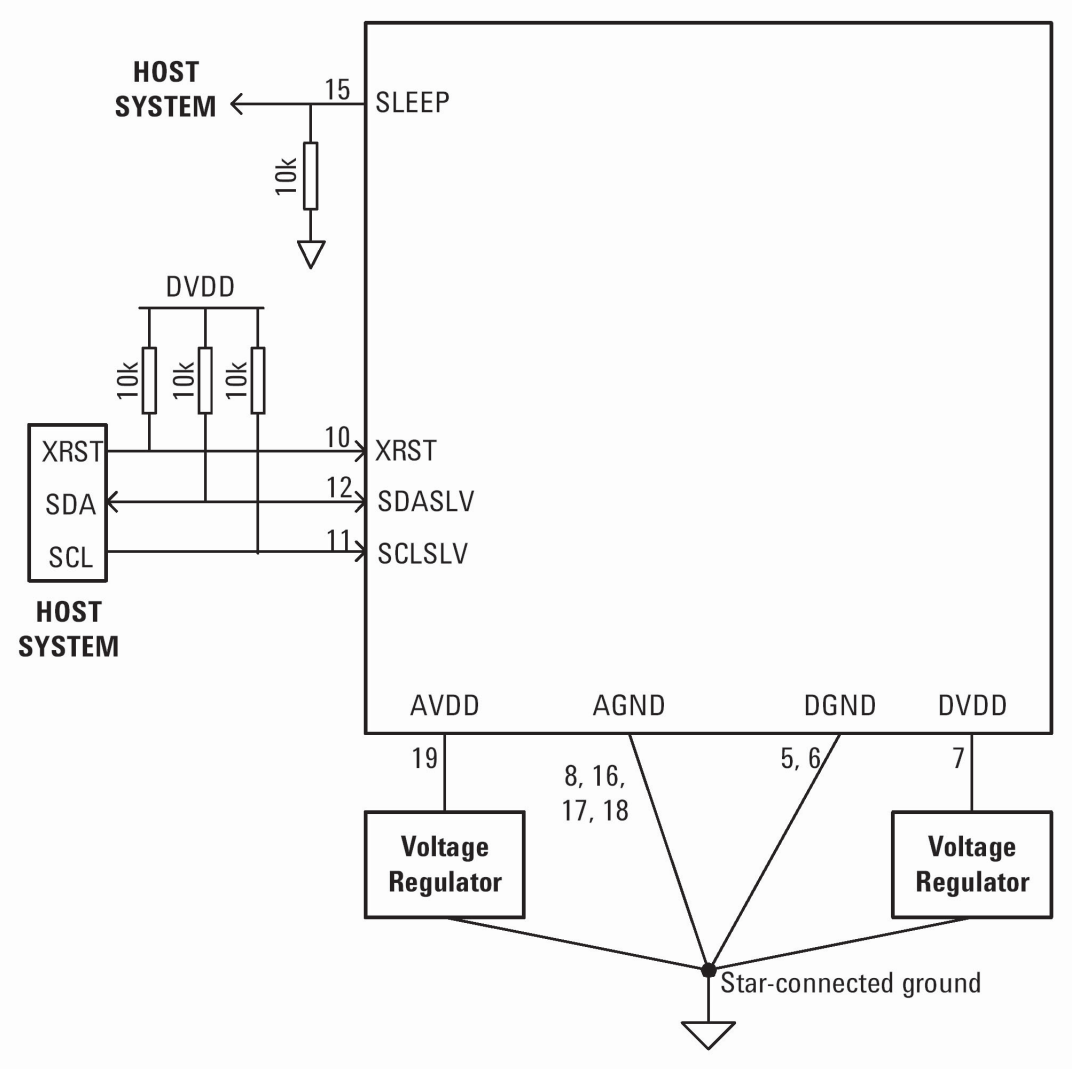

Figure 4. Typical circuit diagram.

Sensor Value Interpretation.

The sensor readings SENSR, SENSG and SENSB obtained in step 7 of sensor operation procedure is processed to yield color information which control the binning.

The LED is grouped as follows:

a) Red bin if SENSR is the highest value.

b) Green bin if SENSG is the highest value

c) Blue bin if SENSB is the highest value

Appendix1. Sensor Registers

Table 2. Programming registers.

Address Hex	Register	Description	Reset Value Hex
02	ACQ	Acquire sensor analog to digital converter (ADC) values when 02H is written. Reset to 00H when sensor acquisition is completed	00
03	SETUP0	Setup register 0 - 4: Write 01H to these registers to perform device initialization	00
04	SETUP1		00
0C	SETUP2		1F
0D	SETUP3		1F
0E	SETUP4		1F
09	PDASB	Blue channel photodiode size	07
0A	PDASG	Green channel photodiode size	07
0B	PDASR	Red channel photodiode size	07
0F	TINTB	Blue channel Integration Time	07
10	TINTG	Green channel Integration Time	07
11	TINTR	Red channel Integration Time	07
42	ADCB	Sensor blue channel ADC value	N/A
43	ADCG	Sensor green channel ADC value	N/A
44	ADCR	Sensor red channel ADC value	N/A

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