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S6AL211A94

ASSP 4 ch LED Driver IC for Intelligent Lighting Hardware Manual

Doc. No. 002-08545 Rev. *B

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Preface

Thank you for your continued use of Cypress semiconductor products.
Read this manual and "Data Sheet" thoroughly before using products in this series.

Purpose of this manual and intended readers

This manual explains the functions and operations of this product and describes how it is used. The manual is intended for engineers engaged in the actual development of products using this product.

Note:

This manual explains the configuration and operation, but does not cover the specifics of each device in the series. Users should refer to the respective data sheets of devices for device-specific details.

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1. Product Overview

S6AL211A94 corresponds to these specifications.

- Communication Interface: UART
- VIN voltage: 24 V
- Dimming type: C
- Sensor input: motion sensor, ambient light sensor

2. About Corresponded UART Interface

This product corresponds to UART communication interface for dimming and color control function.

- Baud rate: 115.2 kbps ± 5 %
- Asynchronous transfer mode, LSB first, NRZ format
- Data length: 8-bit
- Stop bit: 1-bit
- Parity error: no parity

2.1 Terminal connection

Table 1. Terminal connection

Pin No.	Pin Name	I/O	Terminal Connection Place
1	DGND	-	Ground
2	BIAS2	O	Connect By-pass capacitor. (Do not connect external load)
3	BIAS	O	Connect By-pass capacitor. (Do not connect external load)
4	VIN	-	DC 24 V Power supply
5	DRV_1	O	Connect external switching FET1 gate of current control.
6	DRV_2	O	Connect external switching FET2 gate of current control.
7	VIN	-	DC 24 V Power supply
8	DRV_3	O	Connect external switching FET3 gate of current control.
9	DRV_4	O	Connect external switching FET4 gate of current control.
10	DIN1	I	Unused Pin Input to VO pin output level.
11	DIN2	I	Unused Pin Connect to GND level.
12	SCL	I/O	Unused Pin Input to VO pin output level.
13	SDA	I/O	Unused Pin Input to VO pin output level.
14	SH_1	O	Connect external switching FET1 gate of PWM dimming control.
15	SH_2	O	Connect external switching FET2 gate of PWM dimming control.
16	AGND	-	Ground
17	SH_3	O	Connect external switching FET3 gate of PWM dimming control.
18	SH_4	O	Connect external switching FET4 gate of PWM dimming control.
19	TEMP1	I	Connect Temperature sensor 1.
20	TEMP2	I	Connect Temperature sensor 2.
21	TEMP3	I	Connect Temperature sensor 3.
22	TEMP4	I	Connect Temperature sensor 4.
23	AGND	-	Ground
24	CS_1P	I	Connect LED current sense 1 of High side.
25	CS_1N	I	Connect LED current sense 1 of Low side.
26	CS_2P	I	Connect LED current sense 2 of High side.
27	CS_2N	I	Connect LED current sense 2 of Low side.
28	CS_3P	I	Connect LED current sense 3 of High side.
29	CS_3N	I	Connect LED current sense 3 of Low side.
30	CS_4P	I	Connect LED current sense 4 of High side.
31	CS_4N	I	Connect LED current sense 4 of Low side.
32	PCNT	O	IC status output Pin
33	TEST	I	Exclusive use of the Test Connect to BIAS3Pin.
34	IF1	I	UART Communication interface data input Pin
35	IF2	O	UART Communication interface data output Pin
36	AGND	-	Ground
37	SENSE1	I	Unused Pin Connect to GND level.
38	SENSE2/ADD2	I	Unused Pin Connect to GND level.

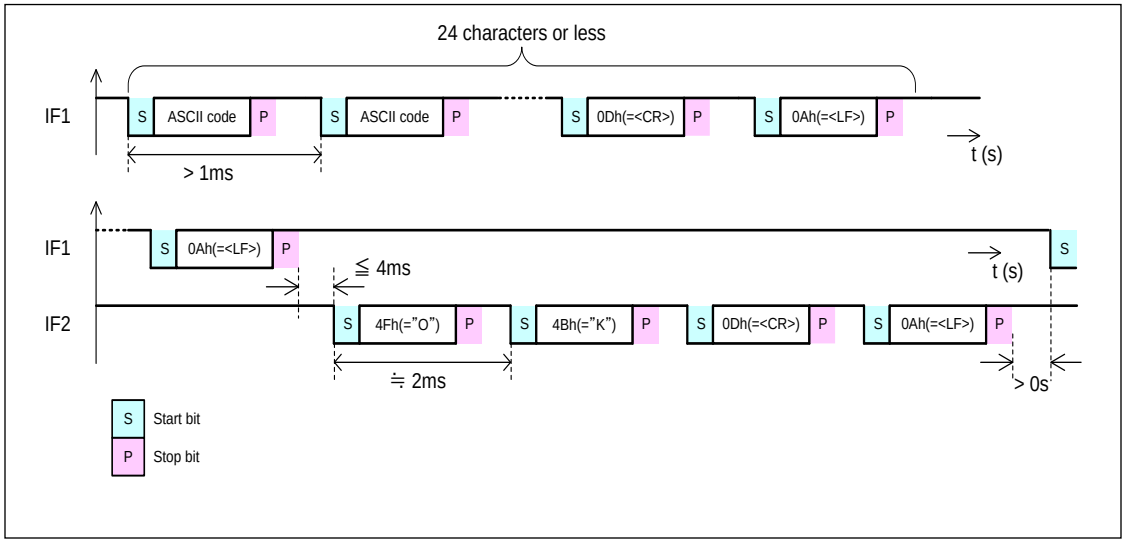
Pin No.	Pin Name	I/O	Terminal Connection Place
39	SENSE3/ADD3	I	Ambient light sensor connection Pin Please connect to GND level if you do not use the function.
40	SENSE4/ADD4	I	Motion sensor connection Pin Please connect to GND level if you do not use the function.
41	ADD5	I	Unused Pin Connect to GND level.
42	ADD6	I	Unused Pin Connect to GND level.
43	ADD7	I	Unused Pin Connect to GND level.
44	ADD8	I	Unused Pin Connect to GND level.
45	SP	I	Exclusive use of the Test Connect to BIAS 3Pin.
46	BIAS 3	O	Connect By-pass capacitor. (Do not connect external load)
47	AGND	-	Ground
48	VO	O	3 V LDO output Pin Connect Temperature sensor of power supply side. Connect Other 3 V loads.

2.2 Description of Functions

2.2.1 Data Format and Timing

The data format and timing of the UART communication is shown below.

Figure 1. UART Data Format and Timing



Data to be transmitted and received, all are treated as ASCII character code.

Valid send and receive data is numbers and uppercase and control characters.

Received data length is within 24 byte.When continuous reception<CR>(ASCII code:0Dh) and <LF>(ASCII code:0Ah) within 24 byte, it is interpreted as the delimiter of receive data. Next received data of continuous reception of<CR>, <LF>are treated as 1st byte data.

If there is no delimiter is within 24 byte, received data of 24 byte will be discarded. And 25th received byte data are treated as 1st byte data.

If the received string is a valid control commands, this device output response.

2.2.2 Control Command

First six characters of the received string are treated as a control command.

The argument is only valid ASCII character code A, B, C, D, E, F and 0-9.When it received an invalid value will be treated as receiving a "0".

Please send a space character in front of the argument.

Table 2. Control Commands

Command	Argument	Function	Response
DIMSET	1st : ch1 dimming level 2nd : ch2 dimming level 3rd : ch3 dimming level 4th : ch4 dimming level	Set the dimming level on each channel. ex.) DIMSET FF AA FF 93<CR><LF>	OK<CR><LF>
MEMSET	1st : write address 2nd : write data	Write data to the memory. [1] ex.) MEMSET 3055<CR><LF>	OK<CR><LF>
QUERYS	1st : read address	Read from memory. ex.) QUERYS 24<CR><LF>	Read Data or "TRUE" or "FALSE"＋<CR><LF>
WAKEUP	No argument	Return to the normal dimming operation state from the standby state.[2] This command is ignored when the state is not the standby.	OK<CR><LF>[3]
PRESET	No argument	Initialize the device when the light is off bye protection. This command is ignored when the light is not off bye protection.	OK<CR><LF>
SELECT	1st : slave address	Select the slave device. When the argument matches the parameter "SLAVE ADDRESS", all commands is accepted. When the argument don't match the parameter "SLAVE ADDRESS",it is accepted only command of WAKEUP and SELECT. If the received argumentis "FF", regardless of the setting value of "SLAVE ADDRESS", all commands is accepted.	If the received argument is "FF" or the value of "SLAVE ADDRESS", output the response "OK<CR><LF>".
(Others)	―	It is determined that the invalid command, input is ignored.	No response

[1]: Write data to excluding the address "0x10" is stored in non-volatile memory. Therefore, please do not power-off from the transmission of the MEMSET command within 5 seconds. If power is lost within 5 seconds, the write data is not guaranteed.

[2]: Unless setting to illuminate within 3 seconds after receiving the WAKEUP command, it moves again to the standby state.

[3]: When receive at standby state, this device outputs the response within 4 ms from the first character.

2.2.3 Memory Map

Table 3. Memory Map

Address	Bit	Parameter Name	R/W	Initial Value	Feature Description
0x00	[7:0]	POWER ON LEVEL1	R/W	00h	Power-on Dimming level of ch.1
0x01	[7:0]	POWER ON LEVEL2	R/W	00h	Power-on Dimming level of ch.2
0x02	[7:0]	POWER ON LEVEL3	R/W	00h	Power-on Dimming level of ch.3
0x03	[7:0]	POWER ON LEVEL4	R/W	00h	Power-on Dimming level of ch.4
0x04	[7:0]	FADE TIME	R/W	00h	Fade time 00h : no fade 01h :0.5 s 02h :1 s 03h : 2 s Others: invalid
0x05	[7:4]	reserved	R/W	0000	-
	[3]	DIMMING CURVE4		1	Dimming curve of each channel 0 : Log curve 1 : Linear curve
	[2]	DIMMING CURVE3		1	
	[1]	DIMMING CURVE2		1	
	[0]	DIMMING CURVE1		1	
0x06	[7:4]	reserved	R/W	0000	-
	[3]	DIMMING ENABLE4		1	Dimming of each channel 0 : Disable 1 : Enable **Note**: Please set to "0" to not use channel.
	[2]	DIMMING ENABLE3		1	
	[1]	DIMMING ENABLE2		1	
	[0]	DIMMING ENABLE1		1	
0x10	[7:1]	reserved	R/W	0000000	-
	[0]	MOTION SENSOR SWITCH		1	Dimming by the trigger input 0 : Disable 1 : Enable **Note**: This setting is not written to non-volatile memory.
0x11	[7:4]	reserved	R/W	0000	-
	[3]	MOTION SENSOR CHECK TIME		0	Time to move to the standby state 0 : 10 s 1 : 5 min
	[2]	ILLUMINANCE SENSOR ENABLE		0	Illumination sensor input 0 : no input 1 : input
	[1:0]	MOTION SENSOR MODE		00	Select the trigger input 2'b00 : trigger input disable 2'b01 : trigger input by motion sensor (SENSE4-pin input) 2'b1* : trigger input by UART communication[1] (motion sensor input disable)
0x12	[7:0]	ILLUMINANCE SENSOR LOWER DATA	R	-	Illumination sensor Lower 8 bit data [0-5V input, 10 bit A/D convert]
0x13	[7:2]	reserved	R	000000	-
	[1:0]	ILLUMINANCE SENSOR UPPER DATA		-	Illumination sensor upper 2 bit data [0-5 V input, 10 bit A/D convert]
0x20	[7:0]	ACTUAL LEVEL1	R	-	Current dimming level of ch.1
0x21	[7:0]	ACTUAL LEVEL2	R	-	Current dimming level of ch.2
0x22	[7:0]	ACTUAL LEVEL3	R	-	Current dimming level of ch.3
0x23	[7:0]	ACTUAL LEVEL4	R	-	Current dimming level of ch.4

Address	Bit	Parameter Name	R/W	nitial Value	Feature Description
0x24	[7:0]	LAMP FAILURE LEVEL1	R	-	Protection status 1 [Output over current, Input low voltage, External over temperature, Internal over temperature] Protection state: Output the response "TRUE", when read this address. Not protection state: Output the response " FALSE ", when read this address.
0x25	[7:0]	LAMP FAILURE LEVEL2	R	-	Protection status 2 [Light out protection excluding Protection status 1] Protection state: Output the response "TRUE", when read this address. Not protection state: Output the response " FALSE ", when read this address.
0x30	[7:0]	COMMENT0	R/W	00h	For free use
0x31	[7:0]	COMMENT1	R/W	00h	For free use
0x32	[7:0]	COMMENT2	R/W	00h	For free use
0x33	[7:0]	COMMENT3	R/W	00h	For free use
0x34	[7:0]	COMMENT4	R/W	00h	For free use
0x35	[7:0]	COMMENT5	R/W	00h	For free use
0x36	[7:0]	COMMENT6	R/W	00h	For free use
0x37	[7:0]	COMMENT7	R/W	00h	For free use
0x40	[7:0]	SLAVE ADDRESS	R/W	FFh	Slave address
0xFE	[7:0]	reserved	R	-	-

[1]: Please refer to the chapter "2.4 Trigger Input Dimming".

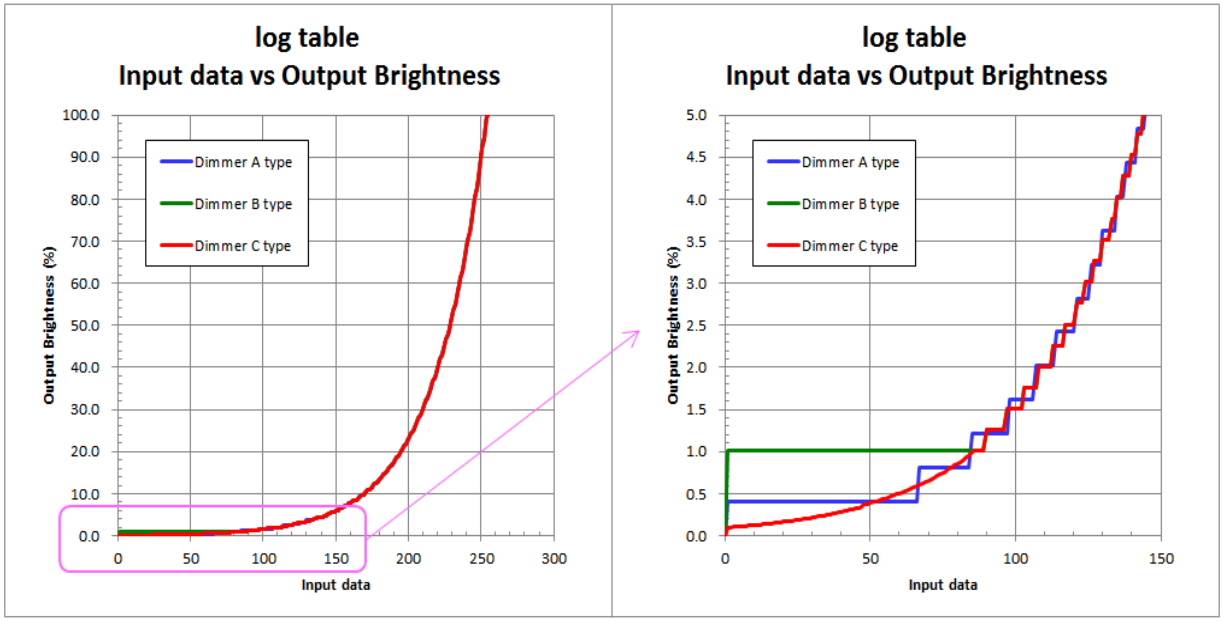
2.3 Dimming Curve

2.3.1 Logarithm Curve

Figure 2. Formula of Logarithm Dimming Curve

$$X(n) = 10^{\frac{n-1}{254/3}-1} \quad (\%)$$

Figure 3. Logarithm Dimming Curve

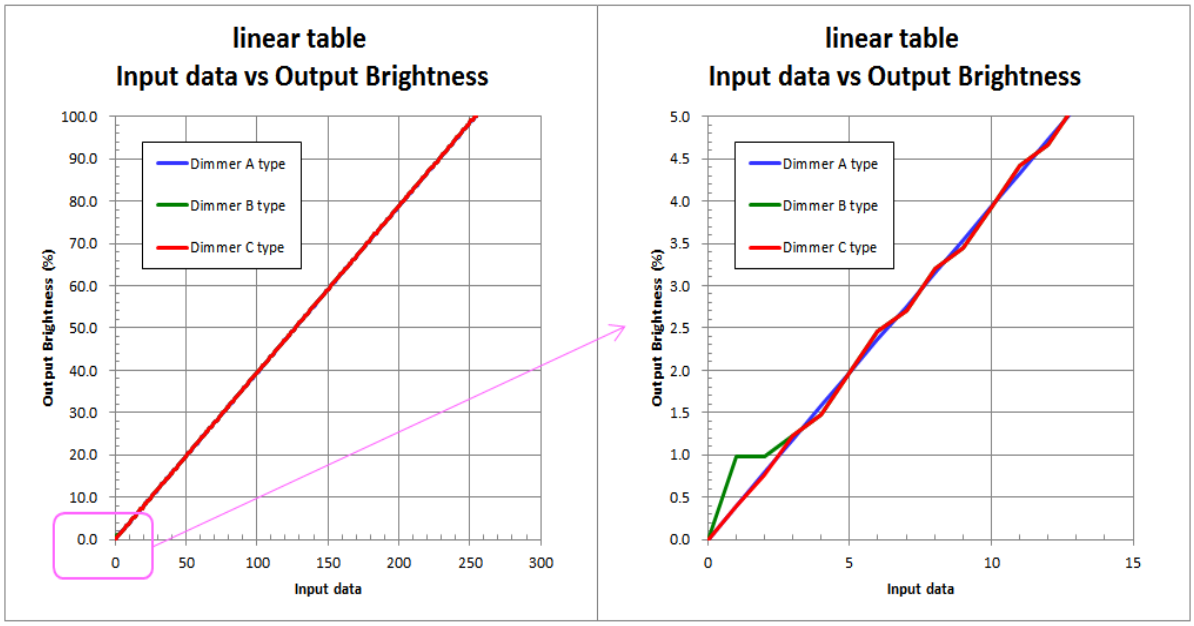


2.3.2 Linear Curve

Figure 4. Formula of Linear Dimming Curve

$$X(n) = \frac{n}{255} \cdot 100 \quad (\%)$$

Figure 5. Linear Dimming Curve



2.4 Trigger Input Dimming

It controls the lights on and off by a trigger signal input.

2.4.1 Trigger Signal

By the parameter setting values of "MOTION SENSOR MODE" and "MOTION SENSOR SWITCH", can be selected a trigger signal.

"MOTION SENSOR SWITCH" setting is not stored in non-volatile memory. It can switch to enable or disable temporarily control.

Table 4. Trigger Signal

Parameter Name	MOTION SENSOR MODE		MOTION SENSOR SWITCH	Select the trigger signal
	bit1	bit0	bit0	
Setting	0	0	-	Control by the trigger input is invalid
	0	1	0	Control by the trigger input is invalid
			1	SENSE4 pin trigger input
	1	-	0	Control by the trigger input is invalid
			1	UART communication (valid received string)

2.4.2 Dimming Control

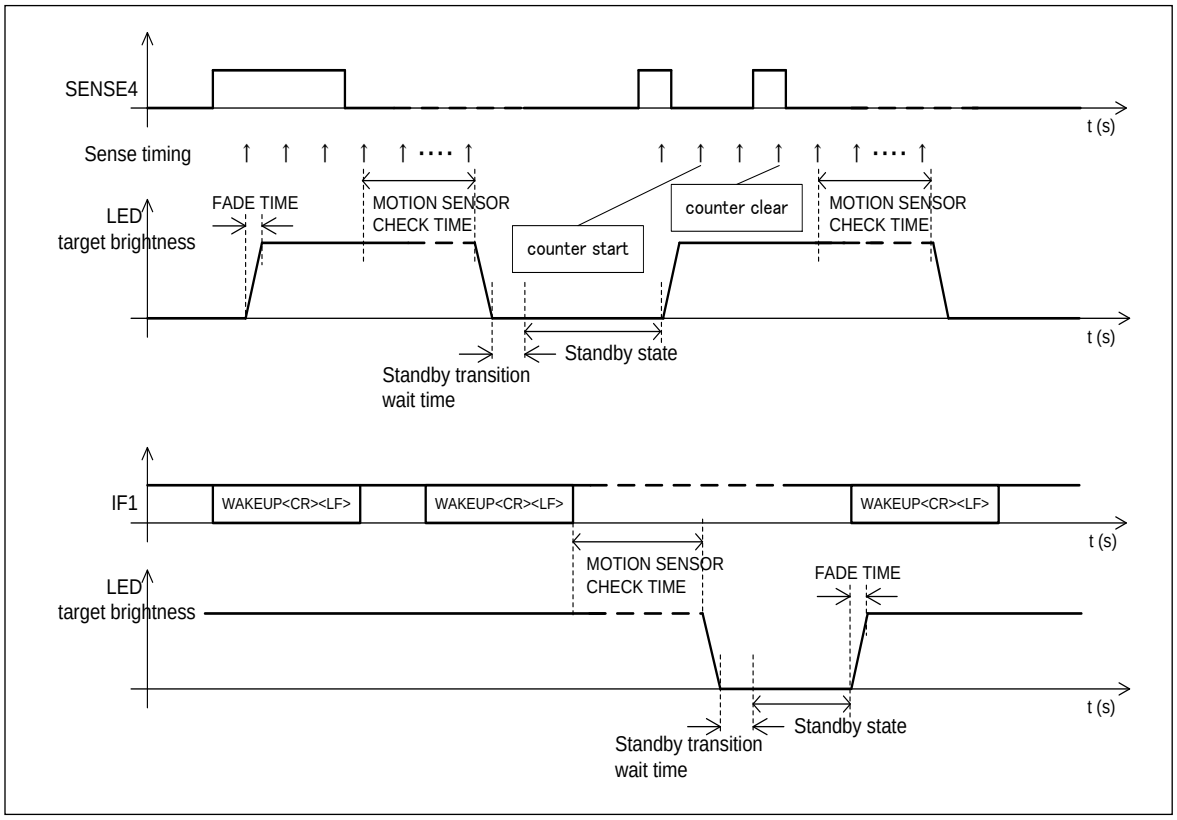
<Control by SENSE4 pin trigger input>

- This device return to the normal dimming operation state from standby state when it detects the input "H", and it lights in the brightness of before the lights off.
  - After the change input to "L", lighting is continued until over time that has been set "MOTION SENSOR CHECK TIME".
  - After the set time the light turn off, and this device moves to the standby state to reduce the power consumption.
- When it detects the input "H" again during the set time, the timer that counts the set time is cleared.
- Because immediately after the power is turned on unstable output of the motion sensor, ignores the trigger input for 30 seconds.
  - When the power is turned on, it lights in the brightness of the "POWER ON LEVEL" setting.
  - In addition to the 30 seconds, lighting is continued until over time that has been set "MOTION SENSOR CHECK TIME".

<Control by UART communication>

- This device return to the normal dimming operation state from standby state when it receives the command "WAKEUP<CR><LF>", and it lights in the brightness of before the lights off.
  - If there is a valid received string within the set time (="MOTION SENSOR CHECK TIME"), the lighting is continued. (Recommend the "WAKEUP<CR><LF>" as a valid received string)
  - If there is no valid received string until over the set time, the light turn off and this device moves to the standby state to reduce the power consumption.
- 30 seconds from power-on, it lights if there is no valid received string.
  - When the power is turned on, it lights in the brightness of the "POWER ON LEVEL" setting.
  - In addition to the 30 seconds, lighting is continued until over time that has been set "MOTION SENSOR CHECK TIME".

Figure 6. Trigger Input Dimming



Revision History

Document Revision History

Document Title: S6AL211A94, ASSP 4 ch LED Driver IC for Intelligent Lighting Hardware Manual Document Number: 002-08545			
Revision	Issue Date	Origin of Change	Description of Change
**	02/10/2015	HSAT	Initial Release
*A	05/30/2016	HSAT	Migrated Spansion guide “MN405-00002-1v0-E“ to Cypress format
*B	01/17/2018	SSAS	Updated the Cypress logo and legal. Completing Sunset Review.