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S6AL211A21

ASSP 4 ch LED Driver IC for Intelligent Lighting Hardware Manual

Doc. No. 002-08547 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

S6AL211A21 corresponds to these specifications.

- Communication Interface: DALI
- VIN voltage: 24 V
- Dimming type: B

2. About Corresponded DALI Standard

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

- Standard: IEC 62386-101 Edition 1.0, -102 Edition 1.0 (Device type 0), -207 Edition 1.0 (Device type 6)
- Master / Slave mode
- Two-wire half-duplex communication
- Transmission rate: 1200 bps ± 10 %

It is necessary of the external IC, the isolation and level conversion circuits.

The VARIABLE in IEC 62386-102 and IEC 62386-207 is set the DEFAULT VALUE.

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	Mode setting Pin 1 Usually use: Input to VO pin output level. When you use the Direct memory bank access mode: Input to GND level.	
11	DIN2	I	Unused Pin Connect to GND level.	
12	SCL	I/O	Connect I^2C bus Clock.	Connect to VO pin if you do not use the Direct memory bank access mode.
13	SDA	I/O	Connect I^2C bus Data.	
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	Communication interface (DALI/UART) data input Pin Connect to DALI-RX.	
35	IF2	O	Communication interface (DALI/UART) data output Pin Connect to DALI-TX.	
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	Unused Pin Connect to GND level.
40	SENSE4/ADD4	I	Unused Pin Connect to GND level.
41	ADD5	I	DAL I interface diagnosis circuit connection Pin Normal mode: Input to VO pin output level. If fault is detected: Input to GND level.
42	ADD6	I	DALI Physical Selection setting Pin Normal mode: Input to GND level. Physical Selection mode: Input to VO pin output 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	BIAS3	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 Corresponded Commands

2.2.1 Corresponded Commands of Device Type 0

The commands of DALI IEC 62386-102Edition 1.0 (Device type 0) with which this product corresponds is shown below.

Table 2. Arc Power Control Commands

Number	Command
Direct arc power control command	
-	DIRECT ARC POWER CONTROL
Indirect arc power control command	
0	OFF
1	UP
2	DOWN
3	STEP UP
4	STEP DOWN
5	RECALL MAX LEVEL
6	RECALL MIN LEVEL
7	STEP DOWN AND OFF
8	ON AND STEP UP
9	ENABLE DAPC SEQUENCE
10 to 15	RESERVED
16 to 31	GO TO SCENE

Table 3. Configuration Commands

Number	Command
General Configuration commands	
32	RESET
33	STORE ACTUAL LEVEL IN THE DTR
34 to 41	RESERVED
Arc power parameters settings	
42	STORE THE DTR AS MAXLEVEL
43	STORE THE DTR AS MINLEVEL
44	STORE THE DTR AS SYSTEM FAILURE LEVEL
45	STORE THE DTR AS POWER ON LEVEL
46	STORE THE DTR AS FADE TIME
47	STORE THE DTR AS FADE RATE
48 to 63	RESERVED
64 to 79	STORE THE DTR AS SCENE
80 to 95	REMOVE FROM SCENE
96 to 111	ADD TO GROUP
112 to 127	REMOVE FROM GROUP
128	STORE DTR AS SHORT ADDRESS
129	ENABLE WRITE MEMORY
130 to 143	RESERVED

Table 4. Query Commands

Number	Command
Queries related to status information	
144	QUERY STATUS
145	QUERY CONTROL GEAR
146	QUERY LAMP FAILURE
147	QUERY LAMP POWER ON
148	QUERY LIMIT ERROR
149	QUERY RESET STATE
150	QUERY MISSING SHORTADDRESS
151	QUERY VERSION NUMBER
152	QUERY CONTENT DTR
153	QUERY DEVICE TYPE
154	QUERY PHYSICAL MINIMUM LEVEL
155	QUERY POWER FAILURE
156	QUERY CONTENT DTR1
157	QUERY CONTENT DTR2
158, 159	RESERVED
Queries related to arc power parameter settings	
160	QUERY ACTUAL LEVEL
161	QUERY MAX LEVEL
162	QUERY MIN LEVEL
163	QUERY POWER ON LEVEL
164	QUERY SYSTEM FAILURE LEVEL
165	QUERY FADE TIME/FADE RATE
166 to 175	RESERVED
Queries related to system parameter settings	
176 to 191	QUERY SCENE LEVEL (SCENES 0-15)
192	QUERY GROUPS 0-7
193	QUERY GROUPS 8-15
194	QUERY RANDOM ADDRESS (H)
195	QUERY RANDOM ADDRESS (M)
196	QUERY RANDOM ADDRESS (L)
197	READ MEMORY LOCATION
198 to 223	RESERVED

Table 5. Application Extended Commands

Number	Command
Application extended commands	
224 to 254	For device type 6 (207)
255	QUERY EXTENDED VERSION NUMBER

Table 6. Special Commands

Number	Command
Special commands	
256	TERMINATE
257	DATA TRANSFER REGISTER(DTR)
258	INITIALISE
259	RANDOMISE
260	COMPARE
261	WITHDRAW
262	RESERVED
263	RESERVED
264	SEARCHADDRH
265	SEARCHADDRM
266	SEARCHADDRL
267	PROGRAM SHORT ADDRESS
268	VERIFY SHORT ADDRESS
269	QUERY SHORT ADDRESS
270	PHYSICAL SELECTION
271	RESERVED

Table 7. Extended Special Commands

Number	Command
Extended special commands	
272	ENABLE DEVICE TYPE X
273	DATA TRANSFER REGISTER 1 (DTR1)
274	DATA TRANSFER REGISTER 2 (DTR2)
275	WRITE MEMORY LOCATION

2.2.2 Corresponded Commands of Device Type 6

The commands of DALI IEC 62386-207 Edition 1.0 (Device type 6) with which this product corresponds is shown below.

Table 8. Queries Related to Status Information

Number	Command
When received" Command 272 ENABLE DEVICE TYPE 6", replaced the commands	
146	QUERY LAMP FAILURE
153	QUERY DEVICE TYPE

Table 9. Application Extended Configuration Commands

Number	Command
Application extended configuration commands	
227	SELECT DIMMING CURVE
228	STORE DTR AS FAST FADE TIME
229	RESERVED
230, 231	RESERVED
232 to 235	RESERVED

Table 10. Application Extended Query Commands

Number	Command
Application extended query commands	
236	RESERVED
237	QUERY GEAR TYPE
238	QUERY DIMMING CURVE
239	QUERY POSSIBLE OPERATING MODES
240	QUERY FEATURES
241	QUERY FAILURE STATUS
242	QUERY SHORT CIRCUIT
243	QUERY OPEN CIRCUIT
244	QUERY LOAD DECREASE
245	QUERY LOAD INCREASE
246	Do not corresponded : QUERY CURRENT PROTECTOR ACTIVE [1]
247	Do not corresponded : QUERY THERMAL SHUT DOWN [1]
248	QUERY THERMAL OVERLOAD
249	Do not corresponded : QUERY REFERNCE RUNNING
250	Do not corresponded : QUERY REFERNCE MEASUREMENT FAILD
251	Do not corresponded : QUERY CURRENT PROTECTOR ENABLED
252	QUERY OPERATING MODE
253	QUERY FAST FADE TIME
254	QUERY MIN FAST FADE TIME
255	QUERY EXTENDED VERSION NUMBER

[1]: This product is integrated feature of output current protector and thermal shutdown. However, the composition of those features differs from the DALI specification.

Table 11. Extended Special Commands

Number	Command
Extended special commands	
272	ENABLE DEVICE TYPE 6

Table 12. Detail of Query Response

Number	Command	Details		
		Bit	Content	Response
239	QUERY POSSIBLE OPERATING MODES	0	PWM mode is possible	0 or 1 1: Dimming type A or C [1]
		1	AM mode is possible	0 : Do not care
		2	output is current controlled	0 or 1 1: Dimming type B or C [1]
		3	high current pulse mode	0: Do not care
		4	Not use	0
		5	Not use	0
		6	Not use	0
		7	Not use	0
240	QUERY FEATURES	0	short circuit detection can be queried	1
		1	open circuit detection can be queried	1
		2	detection of load decrease can be queried	1
		3	detection of load increase can be queried	1
		4	current protector is implemented and can be queried	0 [2]
		5	thermal shut down can be queried	0 [2]
		6	light level reduction due to over temperature can be queried	1
		7	physical selection supported	1
241	QUERY FAILURE STATUS	0	short circuit	0 or 1 1: Protection state
		1	open circuit	0 or 1 1: Protection state
		2	load decrease	0 or 1 1: Protection state
		3	load increase	0 or 1 1: Protection state
		4	current protector active	0: Do not care
		5	thermal shut down	0: Do not care
		6	thermal overload with light level reduction	0 or 1 1: Protection state
		7	reference measurement failed	0: Do not care
252	QUERY OPERATING MODE	0	PWM mode active	0 or 1 1: Dimming type A or C [2]
		1	AM mode active	0: Do not care
		2	output is current controlled	0 or 1 1: Dimming type B or C [2]
		3	high current pulse mode is active	0: Do not care
		4	non-logarithmic dimming curve is active	0 or 1 1: Linear curve
		5	Not use	0
		6	Not use	0
		7	Not use	0

[1]:The Product parts number is assigned to each Dimming type.

[2]:This product is integrated feature of output current protector and thermal shutdown. However, the composition of those features differs from the DALI specification.

Table 13. Comparison of Protection Function and DALI Query

Protection Function	State	DRV_1 to 4 SH_1 to 4	PCNT	DALI Query Response
Initializing operation	Initializing operation	DRV_x="H", SH_x="L" Stop Switching (All channels)	L	-
Normal Dimming operation	Normal Dimming operation	Switching	L	-
Output Over Current Protection	Dimming Protection	Switching (All channels) − Output current -10% − Disable output current increase	L	QUERY LAMP FAILURE, QUERY FAILURE STATUS: load increase QUERY LOAD INCREASE
Output Short Circuit Protection	Lights out Protection-2	DRV_x="H", SH_x="L" Stop Switching (All channels)	L	QUERY LAMP FAILURE QUERY FAILURE STATUS: short circuit QUERY SHORT CIRCUIT
Max Duty Protection	Lights out Protection-2	DRV_x="H", SH_x="L" Stop Switching (All channels)	L	QUERY LAMP FAILURE, QUERY FAILURE STATUS: load decrease, open circuit QUERY LOAD DECREASE QUERY OPEN CIRCUIT
Input Over Voltage Protection	Lights out Protection-1	DRV_x="H", SH_x="L" Stop Switching (All channels)	L	QUERY LAMP FAILURE [1]
Input Low Voltage Protection	Dimming Protection	Switching (All channels) − Output current -10% − Disable output current increase	L	QUERY LAMP FAILURE, QUERY FAILURE STATUS: load increase QUERY LOAD INCREASE
Input Under Voltage Shutdown	Lights out Protection-3	DRV_x="H", SH_x="L" Stop Switching (All channels)	X	(Because of IC shutdown)
External Over Temperature Protection	Dimming Protection	Switching (All channels) − Output current -10% − Disable output current increase	L	QUERY LAMP FAILURE, QUERY FAILURE STATUS: thermal overload with light level reduction QUERY THERMAL OVERLOAD
Internal Over Temperature Protection	Dimming Protection	Switching (All channels) − Output current -10% − Disable output current increase	L	QUERY LAMP FAILURE QUERY FAILURE STATUS: thermal overload with light level reduction QUERY THERMAL OVERLOAD
Internal Over Temperature Shutdown	Lights out Protection-3	DRV_x="H", SH_x="L" Stop Switching (All channels)	H	(Because of IC shutdown)
VO Under Voltage Protection	Dimming Protection	Switching (All channels) − Output current -10% − Disable output current increase	L	QUERY LAMP FAILURE, QUERY FAILURE STATUS: thermal overload with light level reduction QUERY THERMAL OVERLOAD [2]

[1]: After "Restart wait time", IC is initialized for return from the protection state.

[2]: The VO Under Voltage Protection is detected by TEMPx terminals. VO Under Voltage protection is indicated to be the THERMAL OVERLOAD on DALI query response.

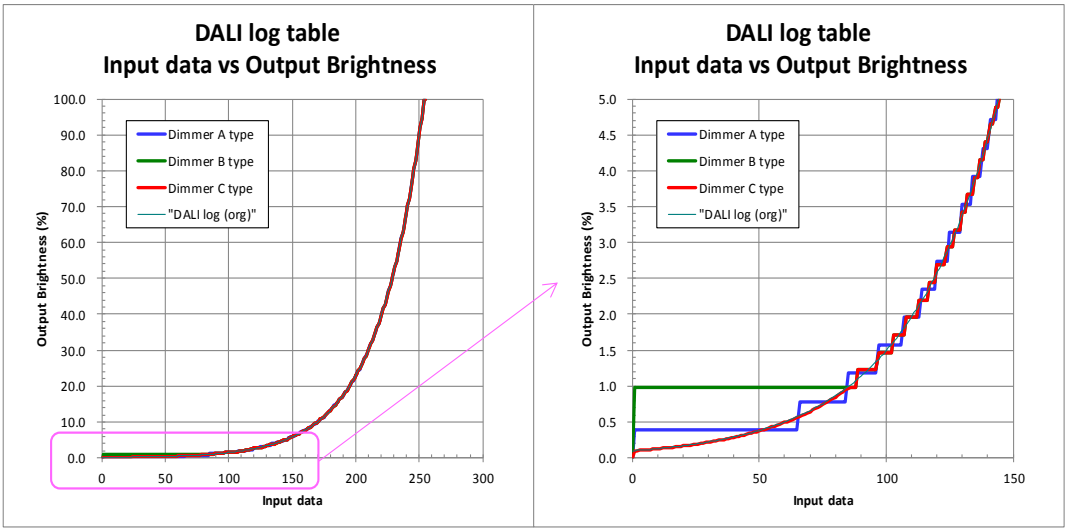
2.3 Dimming Curve

2.3.1 DALI Logarithm Curve

Figure 1. Formula of Logarithm Dimming Curve

$$X(n) = 10^{\frac{n-1}{253/3}-1} \quad (\%)$$

Figure 2. Logarithm Dimming Curve

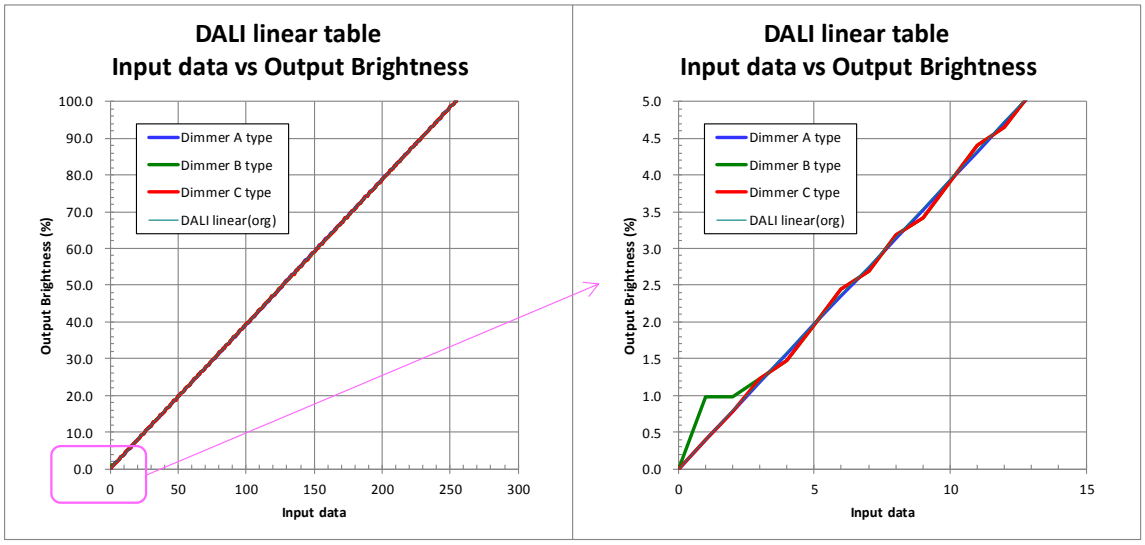


2.3.2 DALI Linear Curve

Figure 3. Formula of Linear Dimming Curve

$$X(n) = \frac{n}{254} \cdot 100 \quad (\%)$$

Figure 4. Linear Dimming Curve



2.4 Memory Bank

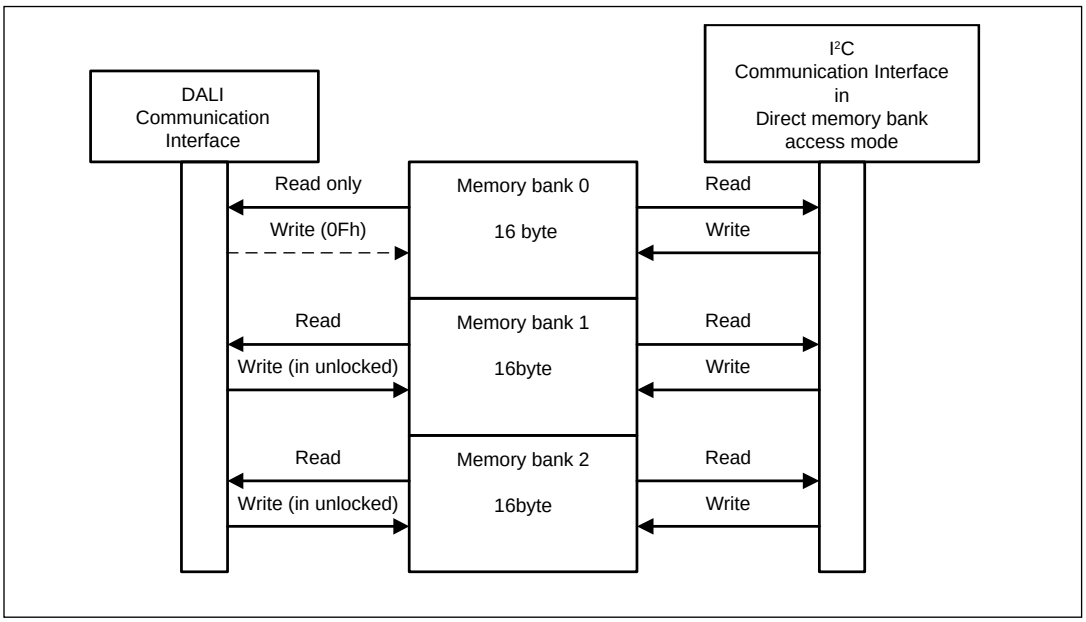
This product is integrated 3 Memory Banks which is 16 byte made by Non-volatile memory.

DALI communication can access to the memory bank of "Read" or "Read / Write".

I²C communication can access to the "Read / Write" to all memory bank.

When I²C access the "Read / Write" of all memory bank, it is necessary enter to the direct memory bank access mode by particular settings.

Figure 5. Structure of Memory Bank



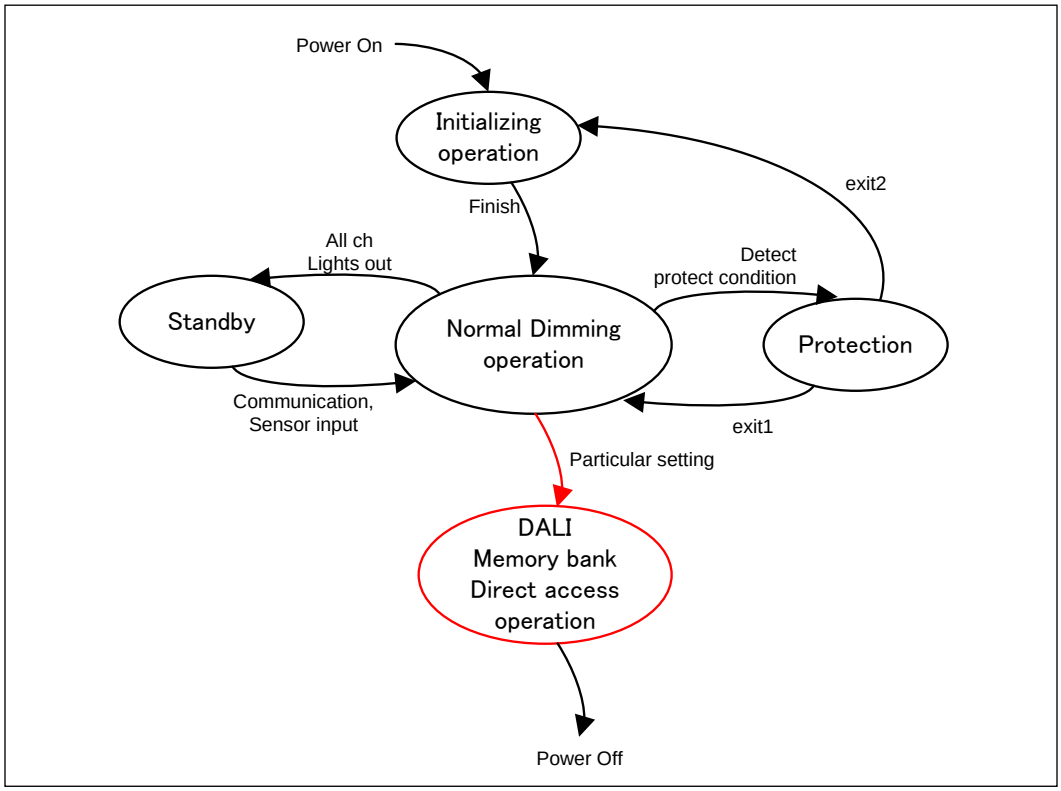
2.4.1 Direct Memory Bank Access Mode

- When entry to the direct memory bank access mode, the followings are set to IC.
- In the normal dimming operation,
  - ☐ Set to I^2C interface mode : DIN1 Pin = "L"
  - ☐ Send mode change command by I^2C
- After entry, IC Lights out and stops other functions.
- When exit to the direct memory bank access mode, Power off the IC.

Note:

Keep the Power supply 5s after executes write command.

Figure 6. State Flow

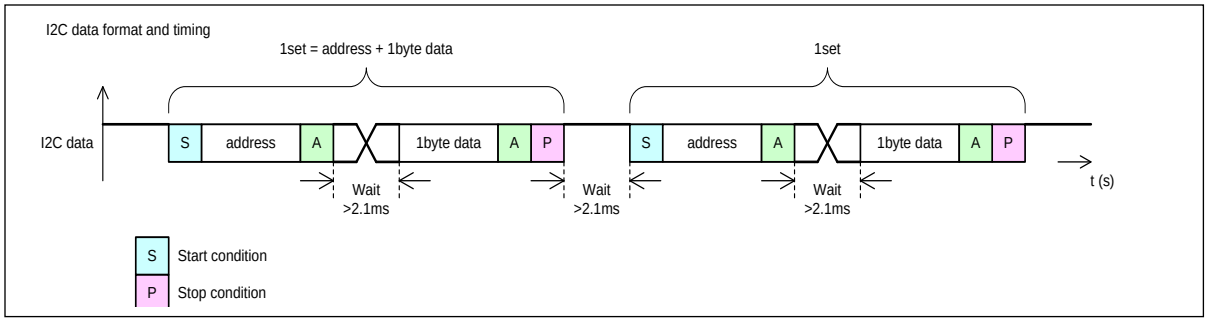


2.4.2 I²C Data Format and Timing

Entry and in the direct memory bank access mode, I²C data format and timing are shown below.

- I²C clock frequency: 75 kHz
- 1 set of data receive(Between Start - Stop condition): Address + 1 byte data
- Address to Data wait time: > 2.1 ms
- Stop to Start wait time: > 2.1 ms
- Slave address: AAh

Figure 7. I²C Data Format and Timing



2.4.3 Command of Direct Memory Bank Access Mode

Table 14. Command of Direct Memory Bank Access Mode

Address	Data	Address	Data	Address	Data	Address	Data	Remarks
Mode change command (Entry Direct memory bank access mode)								
AAh	FAh	AAh	AAh	AAh	50h	-	-	
Write data set command								
AAh	5Ah	AAh	<location1>	AAh	<location2>	AAh	<write data>	[2]
Write execute command								
AAh	4Bh	AAh	4Fh	-	-	-	-	[1], [2]
Read data command								
AAh	3Ch	AAh	<location1>	AAh	<location2>	ABh	<read data>	

[1]: Keep the Power supply 5 s after executes write command.

[2]: "write data" can be set to some addresses before "write execute". And, "write data" set address does not need to be continuing.

2.4.4 Memory Map of Memory Bank

Table 15. Memory Map of Memory Bank

DALI		I²C		Default Data	Remarks
Memory Bank	Location Address	<Location1>	<Location2>		
0	00h	01h	01h	0Fh[1]	Address of last accessible memory location
	01h	01h	02h	0Bh[2]	Checksum of memory bank 0
	02h	01h	03h	02h[1]	Number of last accessible memory bank
	03h	01h	04h	FFh	GTIN byte 0 (MSB)
	04h	01h	05h	FFh	GTIN byte 1
	05h	01h	06h	FFh	GTIN byte 2
	06h	01h	07h	FFh	GTIN byte 3
	07h	01h	08h	FFh	GTIN byte 4

DALI		I²C		Default Data	Remarks
Memory Bank	Location Address	<Location1>	<Location2>		
0	08h	02h	01h	FFh	GTIN byte 5
	09h	02h	02h	FFh	Control gear firmware version (major)
	0Ah	02h	03h	FFh	Control gear firmware version (minor)
	0Bh	02h	04h	FFh	Serial number byte 1 (MSB)
	0Ch	02h	05h	FFh	Serial number byte 2
	0Dh	02h	06h	FFh	Serial number byte 3
	0Eh	02h	07h	FFh	Serial number byte 4
	0Fh	02h	08h	FFh	Additional control gear information
1	00h	03h	01h	0Fh [1]	Address of last accessible memory location
	01h	03h	02h	0Eh [2]	Checksum of memory bank 1
	02h	03h	03h	FFh	Memory bank 1 lock byte (read-only if not 55h)
	03h	03h	04h	FFh	OEM GTIN byte 0 (MSB)
	04h	03h	05h	FFh	OEM GTIN byte 1
	05h	03h	06h	FFh	OEM GTIN byte 2
	06h	03h	07h	FFh	OEM GTIN byte 3
	07h	03h	08h	FFh	OEM GTIN byte 4
	08h	04h	01h	FFh	OEM GTIN byte 5
	09h	04h	02h	FFh	OEM serial number byte 1 (MSB)
	0Ah	04h	03h	FFh	OEM serial number byte 2
	0Bh	04h	04h	FFh	OEM serial number byte 3
	0Ch	04h	05h	FFh	OEM serial number byte 4
	0Dh	04h	06h	FFh	Subsystem (bit 4 to 7), Device number (bit 0 to 3)
	0Eh	04h	07h	FFh	Lamp type number (lockable)
	0Fh	04h	08h	FFh	Lamp type number

DALI		I²C		Default Data	Remarks
Memory Bank	Location Address	<Location1>	<Location2>		
2	00h	05h	01h	0Fh [1]	Address of last accessible memory location
	01h	05h	02h	0Eh [2]	Checksum of memory bank 2
	00h	05h	01h	0Fh [1]	Address of last accessible memory location
	01h	05h	02h	0Eh [2]	Checksum of memory bank 2
	02h	05h	03h	FFh	Memory bank 1 lock byte (read-only if not 55h)
	03h	05h	04h	FFh	For free use
	04h	05h	05h	FFh	
	05h	05h	06h	FFh	
	06h	05h	07h	FFh	
	07h	05h	08h	FFh	
	08h	06h	01h	FFh	
	09h	06h	02h	FFh	
	0Ah	06h	03h	FFh	
	0Bh	06h	04h	FFh	
	0Ch	06h	05h	FFh	
	0Dh	06h	06h	FFh	
	0Eh	06h	07h	FFh	
	0Fh	06h	08h	FFh	

[1]: Do not change data

[2]: When writing a memory bank by I²C, it is necessary to write check sum value by I²C. The check sum calculator does not work in I²C.

Revision History

Document Revision History

Document Title: S6AL211A21, ASSP 4 ch LED Driver IC for Intelligent Lighting Hardware Manual Document Number: 002-08547			
Revision	Issue Date	Origin of Change	Description of Change
**	02/10/2015	HSAT	Initial Release
*A	06/01/2016	HSAT	Migrated Spansion guide “MN405-00003-1v0-E“ to Cypress format
*B	01/17/2018	SSAS	Updated the Cypress logo and legal. Completing Sunset Review.