SC668 EVB

Evaluation Board User's Guide

POWER MANAGEMENT

Description

SC668 EVB is the EVB (Evaluation Board) for the SC668 LMU (Light Management Unit). This EVB provides a working demonstration the IC that allows the user to thoroughly evaluate the part's features.

This guide contains information relating to the usage of the EVB and should be used in conjunction with the datasheet for the device. The datasheet contains detailed information including the electrical characteristics and the detailed features of the device.

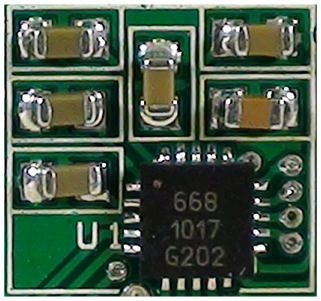
The EVB is supplied with a SC668 device and all necessary support components. The schematics, board layouts, and detailed instructions for operating the EVB are included in this user's guide.

Feature Content

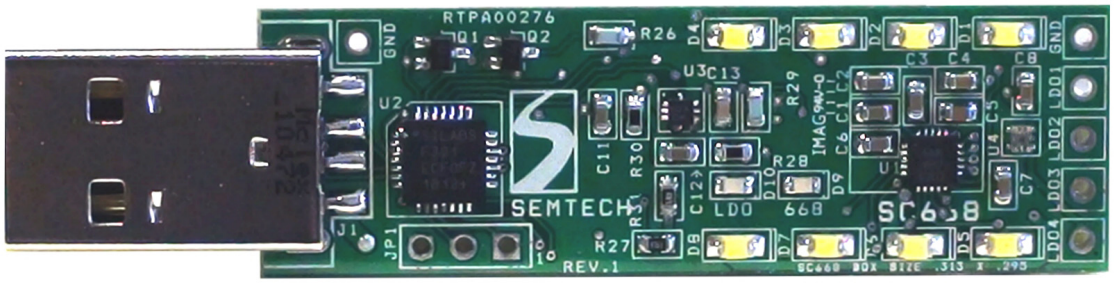
- EVB schematic
- EVB bill of material and hardware notes
- EVB layout
- Software operation

Critical and Non-Critical Components

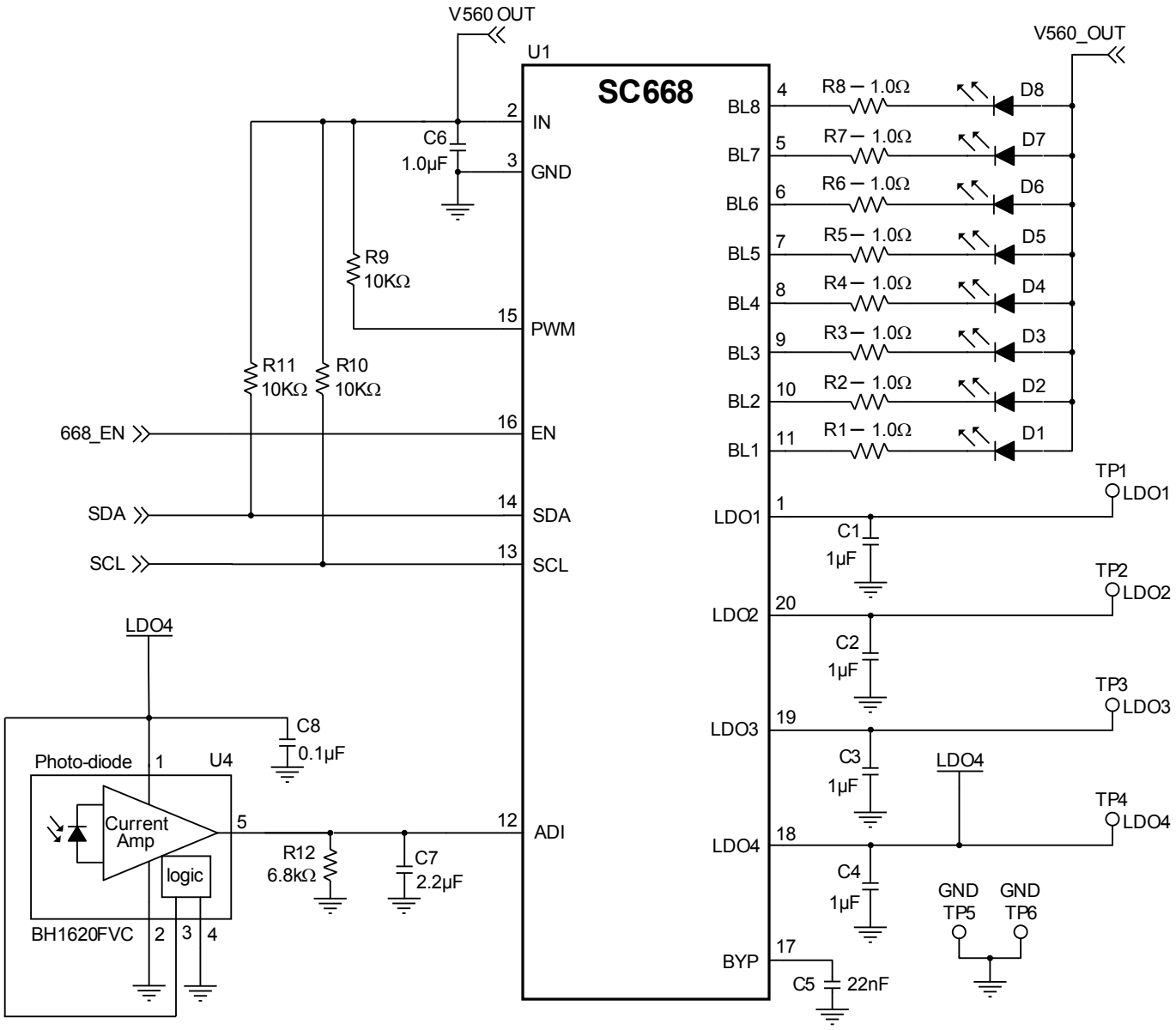
The critical components necessary for design-in are shown in the image below next to the 3x3 (mm) SC668 device (not to scale). The bill of materials includes many non-critical components that are useful for evaluation purposes.



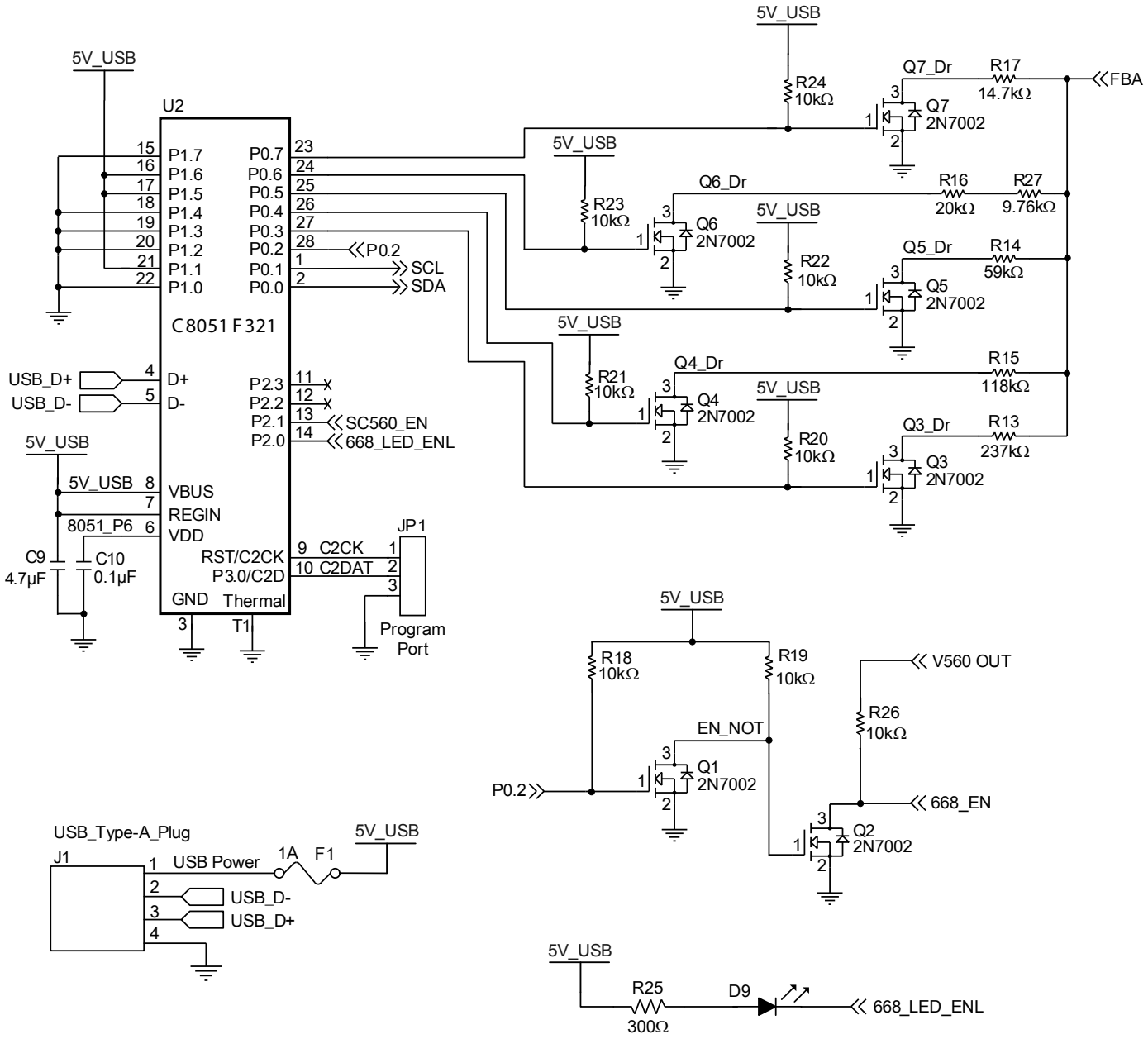
SC668 EVB — R3



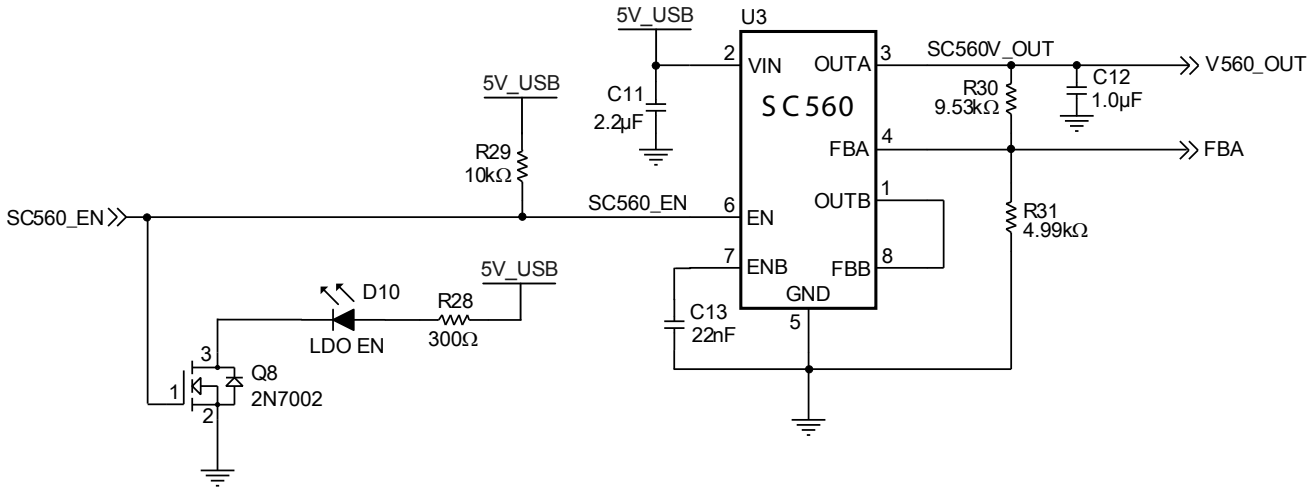
EVB Schematic 1 of 3



EVB Schematic 2 of 3



EVB Schematic 3 of 3



EVB Bill of Material List

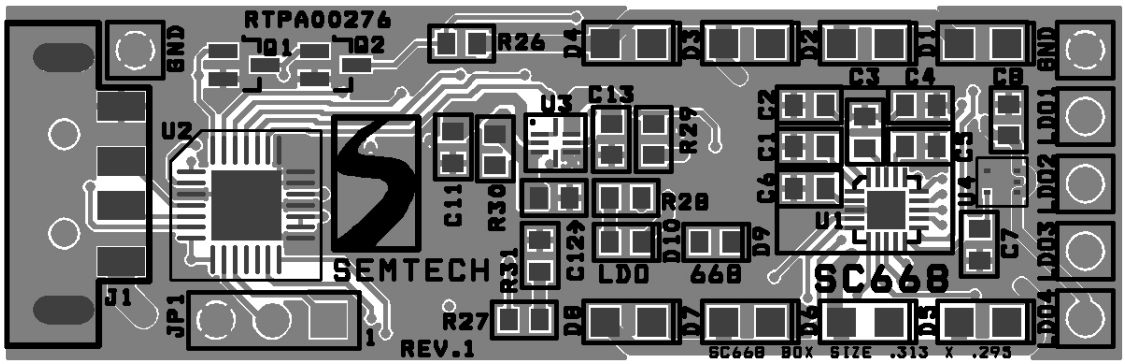
Reference[1]	Value	Footprint	Hardware Notes[2]
C1, C2, C3, C4	1µF	0603	LDO output capacitors
C5	22nF	0603	LDO bypass capacitor
C6	1µF	0603	IN pin bypass capacitor
C7	2.2µF	0603	Prevents 60Hz lighting fluctuations from introducing ripple on the light sensor output.
C8	0.1µF	0603	Noise decoupling of the supply pin on light sensor IC
C9	4.7µF	0603	VBUS decoupling for U2
C10	0.1µF	0603	VDD decoupling for U2
C11	2.2µF	0603	Input decoupling for U3
C12	1.0µF	0603	Output decoupling for U3
C13	22nF	0603	LDO bypass output for U3
D1, D2, D3, D4, D5, D6, D7, D8	AND4WB	0805	White LEDs for backlight functions
D9		0603	Green LED SC668 enable light
D10		0603	Green LED LDO power light
F1	1A	1210	USB power fuse
JP1	No-pop	3 pin conn.	Programming connections
J1	USB type A	USB type A	USB connector
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	2N7002	SC70_123	Q1 and Q2 provide a non-inverting level shift for enable signal. Q3 through Q7 are switched to set the LDO voltage. Q8 is used to switch the LDO enable indicator LED on/off.
R1, R2, R3, R4, R5, R6, R7, R8	1Ω, 1%	0603	Current sense resistor for backlight testing
R9, R10, R11, R18, R19, R20, R21, R22, R23, R24, R26, R29	10kΩ	0603	Pull-up resistors
R12	6.8kΩ	0603	Load resistor for light sensor IC
R13	237kΩ	0603	LDO program resistors
R14	59kΩ	0603	
R15	118kΩ	0603	
R16	20kΩ	0603	
R17	14.7kΩ	0603	

EVB Bill of Material List (continued)

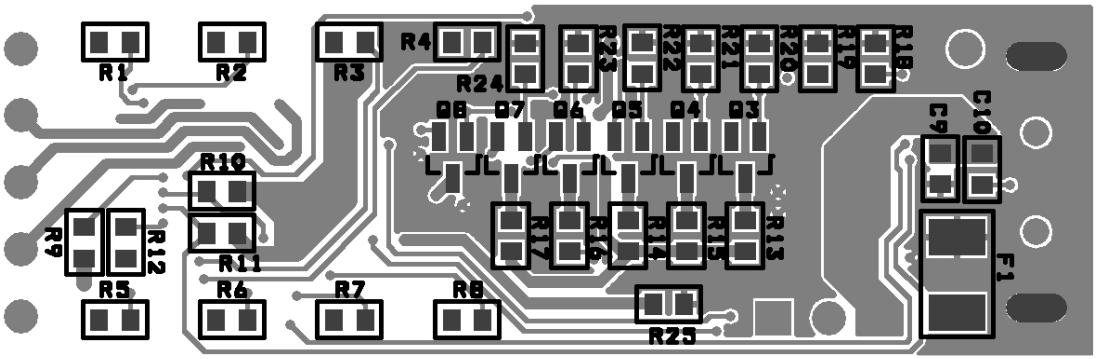
Reference[1]	Value	Footprint	Hardware Notes[2]
R25, R28	300Ω	0603	Ballast for LED indicators
R27	9.76kΩ	0603	LDO program resistors
R30	9.53kΩ	0603	
R31	4.99kΩ	0603	
TP1, TP2, TP3, TP4, TP5, TP6	No_pop	40 mil	Test points for LDO1,2,3,4, and GND
U1	**SC668**	**MLPQ-UT-20 3 x 3 (mm)**	**Semtech integrated circuit — LMU**
U2	C8051F321	MLPQ-5 x 5 (MM)	USB to SemPulse interface plus GPIO
U3	SC560	MPOQ-UT8	Semtech Integrated circuit — Adjustable LDO
U4	BH1620	1.6 x 1.6 (mm)	Light Sensor Amplifier

Note:
(1) Component references in BOLD indicate critical components
(2) All capacitors are X5R type.

EVB Layout Drawings — Top Layer (top view)



EVB Layout Drawings — Bottom Layer (bottom view)



EVB Operation

SC668 EVB Software Installation

The SC668 EVB uses a USB compatible microprocessor on a separate board to communicate I²C commands to the SC668. The software driver and executable program included in the SC668 GUI kit should be installed before connecting the USB interface board to a USB port.

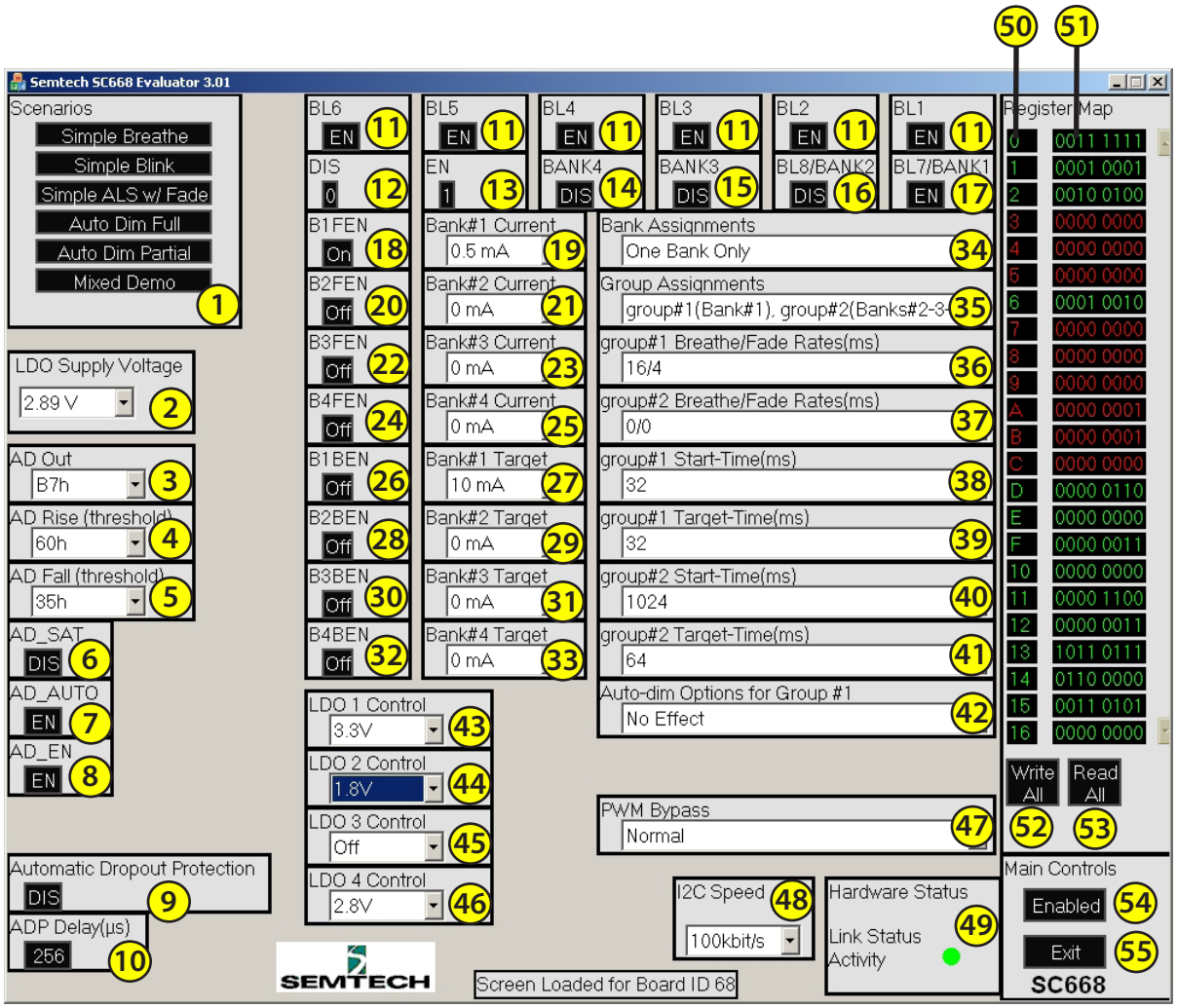
The following sequence is recommended.

- Run **USBXpressinstaller.exe**.
- Place **SiUSBXp.dll** in the windows/system32 directory.
- Place **SC668_R1p01.xml** in the same folder as **Semtech.exe**.
- Connect the USB A/B cable and confirm that the USB device driver is found.
- Run **Semtech.exe** to start the user interface.

SC668 Software Interface Functions

The Semtech SC668 Evaluator GUI is illustrated for reference to the following list of functions. Differences for the SC667 and SC668 are noted in the applicable sections.

1. **Scenarios** — contains the following buttons; Simple Breathe, Simple Blink, Simple ALS w/Fade, Auto Dim Full, Auto Dim Partial, and Mixed Demo. Each button performs multiple write operations to configure and demonstrate a function of the SC668. These buttons provide a convenient way to quickly view some of the basic lighting effect capabilities of the SC668.
   - Simple Breathe — Initiates cycling of the breathe function on all LEDs.



EVB Operation (continued)

- Simple Blink — Initiates the blink function on all LEDs with a 4 second delay time between blinks.
- Simple ALS with Fade — Enables the ALS function on all LEDs and provides fading at the same time. All LEDs should fade to a lower brightness when the light sensor U2 on the EVB is covered up to prevent light from reaching it. Cover U2 for at least 1 second to give the ADC time to process the change in ambient lighting.
- Mixed Demo — This button enables several features simultaneously. BL1 pin provides DC current for LED D1. BL2 pin provides the blink function for LED D2. BL3 and BL4 pins provide the breathe function for LEDs D3 and D4. BL5, BL6, BL7, and BL8 pins provide a DC current with fade, ALS and ADP functions for LEDs D5, D6, D7, and D8 on bank #1.
- Auto Dim Full — This button sets bank #1 to 12mA for 4 seconds and then automatically dims bank #1 to 1mA. Another 4 seconds elapses and bank #1 turns off. The fade option is enabled during this scenario.
- Auto Dim Partial — This button sets bank #1 to 12mA for 4 seconds and then automatically dims bank #1 to 1mA. Bank #1 will remain at 1mA. Auto Dim Partial does not automatically turn off bank #1. The fade option is enabled during this scenario.

2. **LDO Supply Voltage** — An adjustable voltage supply for the SC668 is provided by an on-board SC560A LDO. The LDO is programmable between 4.13V and 2.89V in increments of 40mV — the approximate range provided by a typical Li-ion battery. Typical LDO output accuracy is 1%. The LDO output is provided as a tool to demonstrate performance of the SC668 and the ADP (Automatic Dropout Protection). This output provides voltage (V_{IN}) to the anodes of D1 through D8.
3. **AD Out** — A value may be selected from this list to be written directly to the ADC output (value of register 13h).
4. **AD Rise (threshold)** — A value may be selected from this list to set the the ADC rising threshold (value in register 14h). When AD Out is greater than AD Rise, backlight bank #1 changes to the "Bank#1 Target" value (the value of register 06h).
5. **AD Fall (threshold)** — A value may be selected from this list to set the ADC falling threshold (value in register 15h). When AD Out is less than AD Fall, backlight bank #1 changes to the "Bank#1 Current" value (the value of register 02h).
6. **AD_SAT** — When enabled, this button allows an interrupt to be generated if AD Out (register 13h) reaches overflow or underflow.
7. **AD_AUTO** — When this button is enabled, the comparison of AD_OUT with AD_RISE and AD_FALL is used to control the brightness of the bank #1 backlights.
8. **AD_EN** — When enabled, the ADC is activated, and the result of each conversion is stored in register 13h.
9. **Automatic Dropout Protection** — When enabled, ADP (Automatic Dropout Protection) reduces the current in bank #1 to ensure accurate current matching in the LEDs. When this button is enabled, ADP will become active when the supply voltage is too low to provide the required LED anode voltage.
10. **ADP Delay(µs)** — This button is used to select the delay time for ADP. The options are 256µs and 4000µs. When a reduction in bank #1 backlight current becomes necessary, the first step change is delayed for the time selected by this button. If further reductions in current are needed, the second and all subsequent reductions occur at a faster rate equal to 1/4 of the initial delay time.

When 4000µs is selected:
1st delay = 4000µs
2nd and all subsequent delays = 1000µs

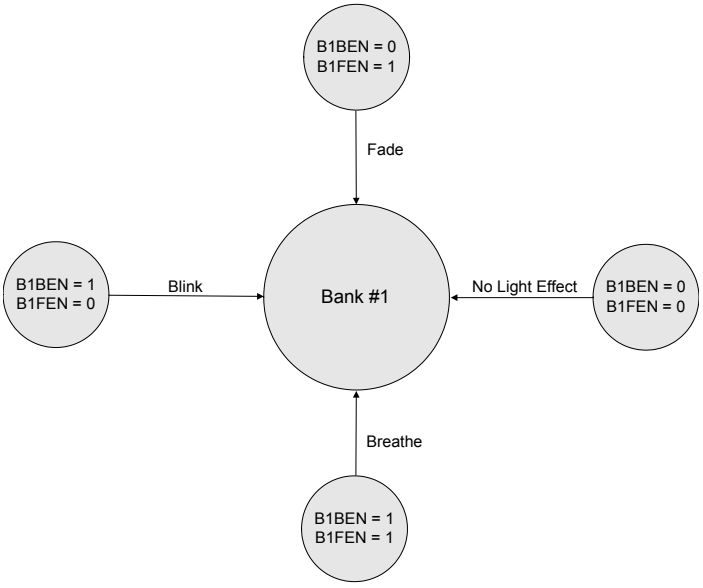
when 256µs is selected:
1st delay = 256µs
2nd and all subsequent delays = 64µs

Further reductions in current will stop when the backlight accuracy and matching have normalized.

11. **BL1 through BL6 Enable** — These buttons are used to individually enable and disable backlights BL1 through BL6.

EVB Operation (continued)

12. **DIS** — This button is used in combination with the **EN** button to control the multi-function bits DIS and EN. When DIS is enabled and EN is disabled, DIS disables the banks selected with buttons 13 though 16.
13. **EN** — This button is used in combination with the **DIS** button to control the multi-function bits DIS and EN. When EN is enabled and DIS is disabled, EN enables the banks selected with buttons 13 though 16.
14. **BANK4** — BANK4 is used with EN or DIS to enable or disable bank #4.
15. **BANK3** — BANK3 is used with EN or DIS to enable or disable bank #3.
16. **BANK2** — BANK2 is used with EN or DIS to enable or disable bank #2. This button also serves an alternate function; **BL8** — When EN and DIS are both disabled, this button is used to enable or disable the indivual backlight BL8.
17. **BANK1** — BANK1 is used with EN or DIS to enable or disable bank #1. This button also serves an alternate function; **BL7** — When EN and DIS are both disabled, this button is used to enable or disable the individual backlight BL7.
18. **B1FEN** — This button works in conjunction with button **B1BEN** to set a lighting effect for bank #1 as illustrated in the following figure.



19. **Bank #1 Current** — This menu is used to select a value of current for LEDs in bank #1. This menu sets the current to be used when fade or no lighting effect is needed, and also provides the "starting" current for blink and breathe effects.
20. **B2FEN** — This button works in conjunction with button **B2BEN** to set a lighting effect for bank #2. Lighting effect choices for bank #2 are the same as illustrated previously for bank #1.
21. **Bank #2 Current** — This menu is used to select a value of current for LEDs in bank #2. This menu sets the current to be used when fade or no lighting effect is needed, and also provides the "starting" current for blink and breathe effects.
22. **B3FEN** — This button works in conjunction with button **B3BEN** to set a lighting effect for bank #3. Lighting effect choices for bank #3 are the same as illustrated previously for bank #1.
23. **Bank #3 Current** — This menu is used to select a value of current for LEDs in bank #3. This menu sets the current to be used when fade or no lighting effect is needed, and also provides the "starting" current for blink and breathe effects.
24. **B4FEN** — This button works in conjunction with button **B4BEN** to set a lighting effect for bank #4. Lighting effect choices for bank #4 are the same as illustrated previously for bank #1.
25. **Bank #4 Current** — This menu is used to select a value of current for LEDs in bank #4. This menu sets the current to be used when fade or no lighting effect is needed, and also provides the "starting" current for blink and breathe effects.
26. **B1BEN** — This button works in conjunction with button **B1FEN** to select a lighting effect for bank #1.
27. **Bank #1 Target** — This menu is used to select a target value of current for LEDs in bank #1 at the end of a breathe or blink lighting effect cycle.
28. **B2BEN** — This button works in conjunction with button **B2FEN** to select a lighting effect for bank #2.
29. **Bank #2 Target** — This menu is used to select a target value of current for LEDs in bank #2 at the end of a breathe or blink lighting effect cycle.
30. **B3BEN** — This button works in conjunction with button **B3FEN** to select a lighting effect for bank #3.

EVB Operation (continued)

31. **Bank #3 Target** — This menu is used to select a target value of current for LEDs in bank #3 at the end of a breathe or blink lighting effect cycle.
32. **B4BEN** — This button works in conjunction with button **B4FEN** to select a lighting effect for bank #4.
33. **Bank #4 Target** — This menu is used to select a target value of current for LEDs in bank #4 at the end of a breathe or blink lighting effect cycle.
34. **Bank Assignments** — This menu provides choices for assigning LEDs to banks.
35. **Group Assignments** — This menu provides choices for assigning banks into groups.
36. **Group #1 Breathe/Fade Rates(ms)** — This menu provides choices for assigning the incremental step rates for progressing through the breathe and fade lighting effects. The rate will be assigned only to banks associated with group #1.
37. **Group #2 Breathe/Fade Rates(ms)** — This menu provides choices for assigning the incremental step rates for progressing through the breathe and fade lighting effects. The rate will be assigned only to banks associated with group #2.
38. **Group #1 Start-Time(ms)** — The duration of time that a bank will dwell at the start current during a breathe or blink lighting effect. These menu selections apply only to banks associated with group #1.
39. **Group #1 Target-Time(ms)** — The duration of time that a bank will dwell at the target current during a breathe or blink lighting effect. These menu selections apply only to banks associated with group #1.
40. **Group #2 Start-Time(ms)** — The duration of time that a bank will dwell at the start current during a breathe or blink lighting effect. These menu selections apply only to banks associated with group #2.
41. **Group #2 Target-Time** — The duration of time that a bank will dwell at the target current during a breathe or blink lighting effect. These menu selections apply only to banks associated with group #2.
42. **Auto-dim Options for Group #1** — This menu is used to select lighting effects auto-dim full, auto-dim partial, or no effect. Auto-dim full provides a time-out and dim function followed by a time-out and turn-off function. Auto-dim partial provides the time-out and dim function, but does not turn off backlights. Auto-dim is only available for group #1. After selecting an auto-dim option, the bank's blink effect must be enabled to enable auto-dim. The bank must be enabled or re-enabled to begin the auto-dim.

    Auto-dim Full — The cycle begins when the bank is enabled (or re-enabled). The bank will first go to the target current and wait for a count of 8 times the group #1 target time. The bank will then dim to the "start" current and wait for a count of 8 times the group #1 start time. The bank will then turn off. Auto-dim Partial — The cycle begins when the bank is enabled (or re-enabled). The bank will first go to the target current and wait for a count of 8 times the group #1 target time. The bank will then dim to the "start" current. The bank will not turn off automatically.

43. **LDO1 Control** — This menu is used to select a voltage for LDO1 or turn it off.
44. **LDO2 Control** — This menu is used to select a voltage for LDO2 or turn it off.
45. **LDO3 Control** — This menu is used to select a voltage for LDO3 or turn it off.
46. **LDO4 Control** — This menu is used to select a voltage for LDO4 or turn it off. Note that LDO4 must be turned on for the ADC to function.
47. **PWM Bypass** — This menu is used to select between normal and bypass mode. Normal — provides normal PWM function at the PWM pin. Bypass — provides no function at the PWM pin, so that a high or low at the pin serves no function.
48. **I²C Speed** — This menu is used for setting the data rate of I²C to either 100kbit/s or 400kbit/s.
49. **Hardware Status** — A link status activity indicator flashes green continuously while USB is connected. The green light gives no indication of I²C activity.
50. **Register Address (in hexadecimal notation)** — One mouse click in this box will send the 8 bits of data located in the field to the right of register address field. Data color is red if in the cue and green after sending.
51. **Register Data (8 bit binary data)** — Data color is red if in the cue and green after sending.

EVB Operation (continued)

52. **Write All** — One mouse click initiates writing of all registers.
53. **Read All** — One mouse click initiates reading of all registers.
54. **Device Enable/Disable** — This button is used to enable and disable the SC668.
55. **Exit** — This button is used to exit the program and close the window.

SC668 Evaluation and Measurement Tips

This section provides setup information about the EVB.

- Install the software and plug the EVB into a USB port. Suggestion: A USB A to A cable may be used to relocate the EVB away from the USB port for easier access to the board while taking measurements.
- Resistors R1, R2, R3, R4, R5, R6, R7, and R8 are in series between the sink pins (BL1 through BL8) and the LED cathodes of D1 through D8. The resistors are 1Ω 1% sense resistors for measuring current with a voltmeter at 1mV/1mA.
- Test points are provided for voltage measurement at the right edge of the card (as shown on page 1) for LDO1, LDO2, LDO3, LDO4, and GND.

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