5V/3.4A Type-C Solution for Power Bank

1. General Description

The SW6115 is a highly integrated power management IC for Type-C power bank application. It integrates 2.5A switching charger, 3.4A synchronous boost, Type-C logic controller, fuel gauge and power controller. With simple external components, The SW6115 provides a turn-key high efficiency solution for Type-C battery management.

2. Applications

- Power Bank
- Battery Powered Device

3. Features

- **Switching Charger**
  - Current up to 2.5A, Efficiency up to 96%
  - Support 4.2/4.3/4.35/4.4 Battery Voltage
  - Support Battery NTC Protection
  - Thermal Regulation
- **Synchronous Boost**
  - Current up to 3.4A, Efficiency up to 95%
  - Support Wire Drop Compensation
  - Load Insert Detect and Auto Turn on
  - Light Load Detect and Auto Turn off
- **Type-C Interface**
  - Support USB Type-C Specification
  - Support try.SRC Role
- **BC1.2 Module**
  - Support BC1.2 DCP
  - Support Apple & Samsung Device
- **Lightning Decryption**
  - Support Lightning Decryption

- **Fuel Gauge**
  - Include 12bit ADC
  - Support Percent Display
  - Support Various Battery Voltage
  - Support 3~5 LEDs
  - Automatic Recognition of LED Number
- **WLED Driver**
  - Support WLED Driver
- **Key Support**
  - Support Push Key
- **Protection**
  - Input Over Voltage Protection
  - Output Over Current Protection
  - Output Short Protection
  - Charger Over Time Protection
  - Charger Over Voltage Protection
  - Over Temperature Protection
- **I2C Interface**
- **QFN-32(5x5mm) Package**

4. Functional Block Diagram
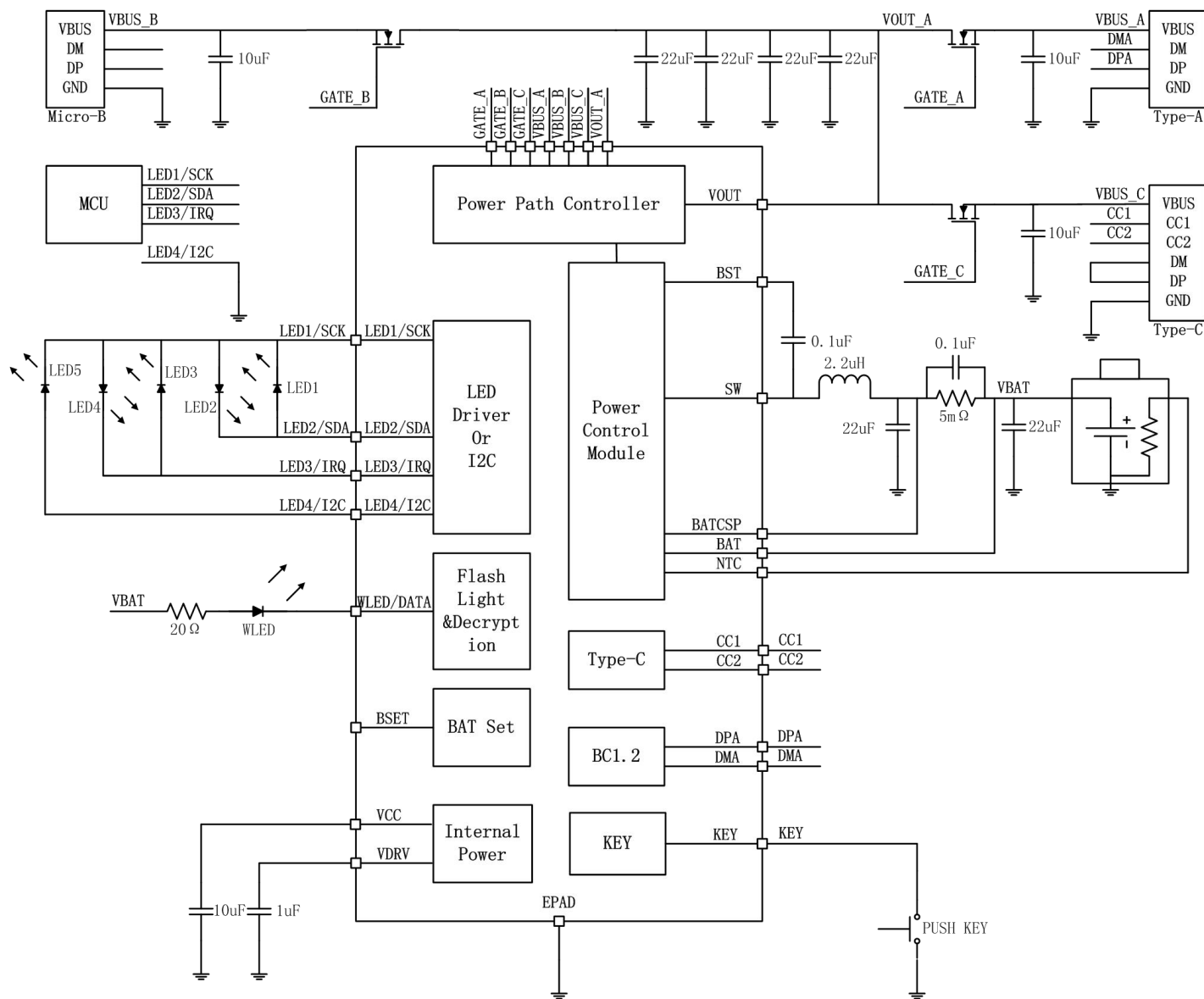
5. Pin Configuration and Function

5.1 Pin Configuration
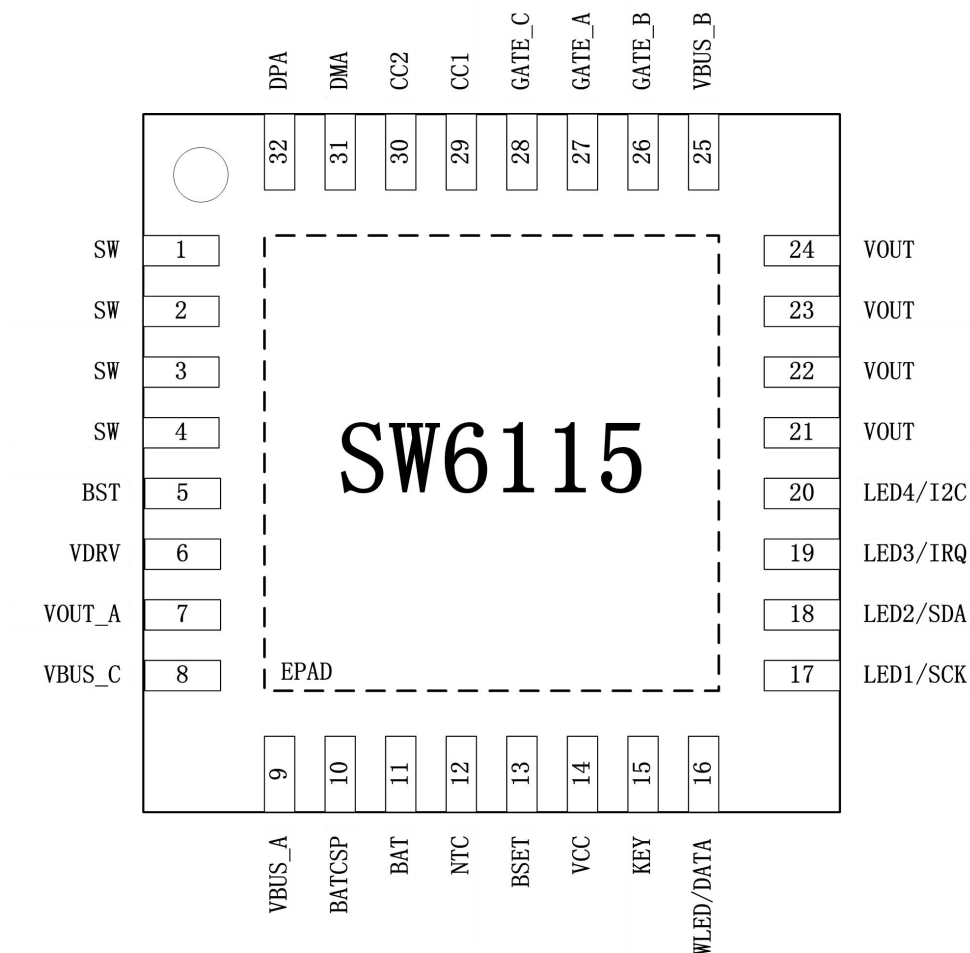
5.2 Pin Descriptions

Pin	Name	Function Description
1, 2, 3, 4	SW	Switching node.
5	BST	Bootstrap pin for high side NMOS.
6	VDRV	Driver power.
7	VOUT_A	Type-A port current sense pin.
8	VBUS_C	Type-C port current/voltage sense pin.
9	VBUS_A	Type-A port current/voltage sense pin.
10	BATCSP	Battery current sense pin.
11	BAT	Battery current/voltage sense pin.
12	NTC	Negative temperature coefficient (NTC) thermistor input.
13	BSET	Battery voltage set.
14	VCC	Internal power.

15	KEY	Push key input.
16	WLED/DATA	Flash led driver or lightning decryption pin.
17	LED1/SCK	Led1 for battery capacity indicator or i2c clock.
18	LED2/SDA	Led2 for battery capacity indicator or i2c data.
19	LED3/IRQ	Led3 for battery capacity indicator or irq.
20	LED4/I2C	Led4 for battery capacity indicator or i2c/led set.
21, 22, 23, 24	VOUT	Boost output and charger input.
25	VBUS_B	Micro-B port input.
26	GATE_B	Micro-B port power path control pin.
27	GATE_A	Type-A port power path control pin.
28	GATE_C	Type-C port power path control pin.
29	CC1	Type-C configure channel CC1.
30	CC2	Type-C configure channel CC2.
31	DMA	Type-A port DM pin.
32	DPA	Type-A port DP pin.
	EPAD	Exposed pad.

6. Absolute Maximum Ratings

Parameters	Symbol	MIN	MAX	UNIT
Input Voltage	VBUS_B/VBUS_C	-0.3	16	V
Output Voltage	VOUT/VOUT_A /VBUS_A/VBUS_C	-0.3	6	V
SW Voltage	SW	-0.3	16	V
BST Voltage	BST-SW	-0.3	6	V
Power Path Control Voltage	GATE_A/GATE_B /GATE_C	-0.3	24	V
Other Pin Voltage		-0.3	6	V
Junction Temperature		-40	+150	°C
Storage Temperature Range		-60	+150	°C
ESD(HBM)		-4	+4	KV

【Notice】Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods my affect device reliability.

7. Recommended Operating Conditions

Parameters	Symbol	MIN	Typical	MAX	UNIT
Input Voltage	VBUS_B/VBUS_C	4.5		5.5	V
Battery Voltage	BAT	2.8		4.5	V

8. Electrical Characteristics

(V_{IN} = 5V, V_{BAT} = 3.7V, T_A = 25°C, unless otherwise specified.)

Parameters	Symbol	Test Conditions	MIN	TYP	MAX	UNIT
Power Supply						
VBUS_B Input Voltage	V_{BUSB}		4		5.5	V
VBUS_B Input UVLO Threshold	V_{BUSB_UVLO}	Voltage Falling		4		V
VBUS_B Input UVLO Hysteresis	$V_{BUSB\_UVLO\_HYS}$	Voltage Rising		400		mV
VBUS_C Input Voltage	V_{BUSC}		4		5.5	V
VBUS_C Input UVLO Threshold	V_{BUSC_UVLO}	Voltage Falling		4		V
VBUS_C Input UVLO Hysteresis	$V_{BUSC\_UVLO\_HYS}$	Voltage Rising		400		mV
VCC Output Voltage	V_{CC}	Boost or V_{BUSB}/V_{BUSC} Insert		5		V
		Power Off		V_{BAT}		V
VCC Output current	I_{CC}	Boost or V_{BUSB}/V_{BUSC} Insert		60		mA
		Power Off		60		mA
Power MOS Rdson						
High Side NMOS	R_{DSON_H}			22		mΩ
Low Side NMOS	R_{DSON_L}			16		mΩ
Charge Mode						
Trickle Charge End Voltage	V_{TC}			3		V
Trickle Charge Current	I_{TC}	$1.5V < V_{BAT} < 3V$		300		mA
		$V_{BAT} < 1.5V$		200		mA
Constant Current Charge Current	I_{CC}			2.5		A
Termination Charge Current	I_{END}			10		%
Target Charge Voltage	V_{BAT_FULL}			4.2		V
Recharge Threshold	V_{BAT_RECH}			4.1		V
Switching Frequency	F_{CHG}			400		KHz
Trickle Charge Over Time	t_{TC_OT}			40		Min
Constant Charge Over Time	t_{CC_OT}			33		Hour
Thermal Regulation Threshold	T_{REGU_CHG}			115		℃
Boost Mode						
VBAT Input Voltage	V_{BAT}		2.9		4.5	V
VBAT Input UVLO Threshold	V_{BAT_UVLO}	Voltage Falling		2.9		V
VBAT Input UVLO Hysteresis	$V_{BAT\_UVLO\_HY}$	Voltage Rising		500		mV

	s				
VOUT Output Voltage	V_{OUT}		5.05		V
VOUT Output Current	I_{OUT}		3		A
Light Load Current	I_{LIGHT_LOAD}	R_{DS_PATH}=10mΩ	60		mA
Light Load Time	t_{LIGHT_LOAD}		32		S
Quiescent Current	I_Q	V_{BAT}=3.7V	40		uA
Wire Drop Compensation	V_{OUT_WDC}	0A<I_{OUT}<1A	0		mV
		1A<I_{OUT}<2A	50		mV
		I_{OUT}>2A	100		mV
Switching Frequency	F_{BST}		400		KHz
Thermal Regulation Threshold	T_{REGU_BST}		115		℃
Type-C					
CC Current Source	I_{CC_SOURCE}	Power Level=3.0A	330		uA
CC Termination Resistor	R_D		5.1		kΩ
BC1.2					
DP/DM Voltage	DP	Apple 2.4A Mode	2.7		V
	DM	Apple 2.4A Mode	2.7		V
LED					
LED Source Current	I_{LED}		4		mA
LED Flicker Frequency	f_{LED}		1		Hz
WLED					
WLED Resistor	R_{WLED}		20		Ω
KEY					
Short Key Time	T_{SHORT}		32		mS
Long Key Time	T_{LONG}		2		S
I2C					
Rate	f_{CLK}		400		Kbit/S
Thermal Shutdown					
Thermal Shutdown Threshold	T_{SHDT}	Temperature Rising	150		℃
Thermal Shutdown Hysteresis	T_{SHDT_HYS}	Temperature Falling	70		℃

9. Functional Description

9.1 Charge Mode

The SW6115 integrates a switching charger with efficiency is up to 96%. The switching charger supports 4.2V/4.3V/4.35V/4.4V battery voltage. Its switching frequency is up to 400KHz, so a small size inductor with inductance of 2.2uH can be used.

The switching charger charges battery in three charge phases: trickle charge(TC), constant current charge(CC) and constant voltage charge(CV). When battery voltage is lower than 3V, charger enters into trickle charge while the charge current is 200mA when battery voltage is lower than 1.5V and 300mA when battery voltage is between 1.5V and 3.0V. When battery voltage rises to 3V, charge enters into constant current charge while charge current is fast charge current. When battery voltage rises to target charge voltage, charger enters into constant voltage charge while charge current falls so as battery voltage stays to target voltage. When charge current falls to termination charge current, charge cycle completes and charger stops. When battery voltage is lower than recharge threshold, charger automatically restarts.
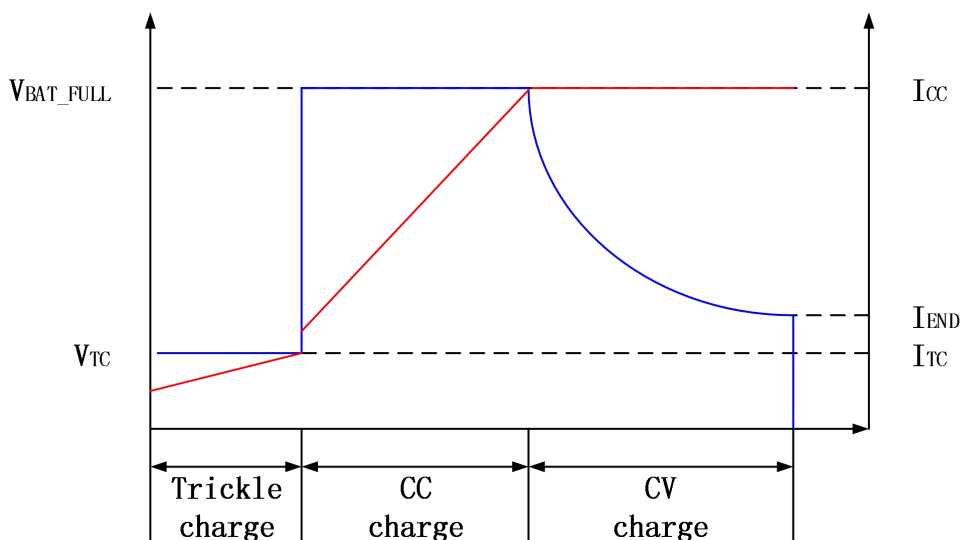
The battery target voltage can be set by BSET pin. When BSET is floating, 4.2V is set; when connecting a 62K Ω resister to ground，4.35V is set; when connecting a 30K Ω resister to ground，4.4V is set; when connecting a 10K Ω resister to ground，4.3V is set.

The switching charger has battery temperature protection. It monitors battery temperature by measuring the voltage of NTC pin which connects to a negative temperature coefficient (NTC) thermistor. When battery temperature is abnormal,charger will reduce charge current or stop to protect battery.While using a typical NTC thermistor of 103AT, When battery temperature is lower than 5℃, charger will reduce charge current by half; When battery temperature continues to fall to lower than 0℃, charger will stop; When battery temperature rises to 5℃, charger will restart and reduce charge current by half; When battery temperature continues to rise to higher than 10℃, charge current will return to normal; When battery temperature is higher than 45℃, charger will reduce charge current by half; When battery temperature continues to rise to higher than 50℃, charger will stop; When battery temperature falls to 45℃, charger will restart and reduce charge current by half; When battery temperature continues to fall to lower than 40℃, charge current will return to normal. Resisters

can be in series or parallel with the NTC thermistor to change the protection temperature range. If not needing NTC protection, connect NTC pin to GND.

The switching charger integrates thermal regulation. When die temperature rises to the charge thermal regulation threshold, charge current will automatically fall down so the die temperature stops increasing. If temperature continues rising to thermal shutdown temperature, charger will stop and the SW6115 powers off.

The switching charger integrates over time protection. When charging remains in trickle charge beyond the trickle charge over time, t_{TC_OT}, or charging remains in constant current charge beyond the constant current charge over time, t_{CC_OT}, charger will terminate. Charger will restart only when re-inserting the adapter.

9.2 Boost Mode

The SW6115 integrates a synchronous boost with output current up to 3.4A and efficiency is up to 95%.

The synchronous boost works in PSM/PWM mode. It works in PSM mode when in light load and in PWM mode in heavy load to make a better efficiency. It will automatically change in these two modes base on output current.

The synchronous boost has battery temperature protection. When battery temperature is abnormal,boost will stop to protect battery.While using a typical NTC thermistor of 103AT, When battery temperature is lower than -15℃ or higher than 58℃, boost will stop and turn off. When battery temperature enters into normal range, boost will not automatically restart except a start condition such as short key or load detect occur. Resisters can be in series or parallel with the NTC thermistor to change the protection temperature range. If not needing NTC protection, connect NTC pin to GND.

The synchronous boost integrates thermal regulation. When die temperature rises to boost thermal regulation threshold, output voltage will automatically fall down so as die temperature stop increasing. If die temperature still rises to thermal shutdown threshold, boost will stop and turn off. When die temperature falls to thermal shutdown hysteresis, boost will not automatically restart except a start condition such as short key or load detect occur.

The synchronous boost integrates input under voltage, output over voltage, output overload and short protection.

9.3 Power Path

The SW6115 supports Type-A+Type-C+Micro-B.

When short key occurs or load inserts, Type-A port will turn on to power supply extern device, and light load detection will turn off Type-A port. Light load current is related to power path MOS of Type-A port. if power path MOS Rdson is 10mΩ, the light load current will be about 60mA. When SOURCE is attached, Type-C port will turn on and charger will automatically turn on to charge battery. When SINK is attached, Type-C port will turn on and boost will automatically turn on to supply device. When SINK is unattached, Type-C port will turn off and boost will automatically turn off. Type-C port also support light load detection. When SINK is light load, Type-C port and boost will turn off to reduce power consumption.When adapter inserts, Micro-B

port will turn on and charger will automatically turn on.

The SW6115 supports charging the battery and supplying extern device simultaneously.

The SW6115 supports Type-A port and Type-C port supply extern devices simultaneously.

9.4 Type C Interface

The SW6115 integrates Type-C logic controller include try.SRC role. When SOURCE is attached, charger will automatically turn on to charge battery. When SOURCE is detached, charger will automatically turn off. When SINK is attached, boost will automatically turn on to supply device. When SINK is detached, boost will turn off .

When SINK is attached and boost turns on , the SW6115 works in SOURCE role, and will broadcast power level of 3A. if adapter inserts in Micro-B port and boost not turns on, the SW6115 will also broadcast power level of 3A.

9.5 BC1.2 Module

The SW6115 integrates BC1.2 controller, and automatically detects apple and samsung devices:

Apple 2.4A mode: DP=2.7V, DM=2.7V;
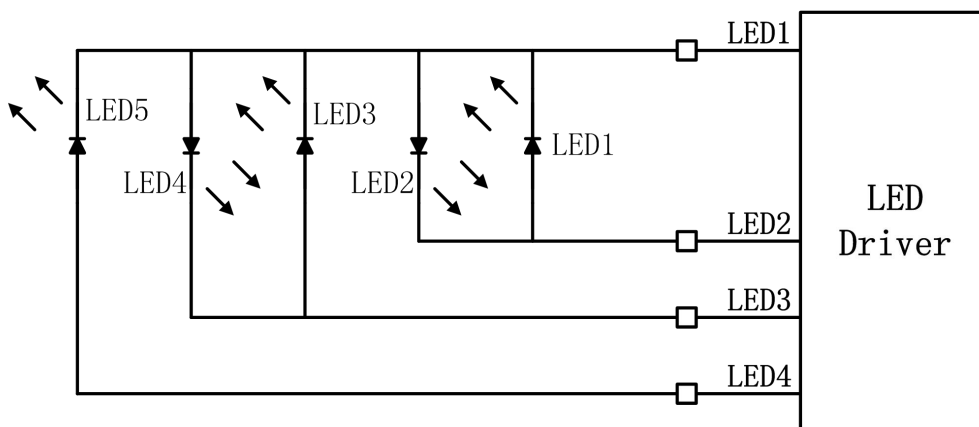
Samsung 2A mode: DP=1.2V, DM=1.2V;

9.6 Lightning Decryption

The SW6115 integrates lightning decryption. Lightning decryption function and WLED driver is shared with WLED/DATA pin, so only one of these two functions can be used in one application.

9.7 Led Driver

The led driver supports 3/4/5 LEDs.

When connecting 5 LEDs, the LEDs connect way is as below:

When discharging, battery capacity is shown as:

Capacity	LED1	LED2	LED3	LED4	LED5
80~100%	On	On	On	On	On
60~80%	On	On	On	On	Off
40~60%	On	On	On	Off	Off
20~40%	On	On	Off	Off	Off
5~20%	On	Off	Off	Off	Off
1~5%	Flicker	Off	Off	Off	Off
0%	Off	Off	Off	Off	Off

When charging, battery capacity is shown as:

Capacity	LED1	LED2	LED3	LED4	LED5
100%	On	On	On	On	On
80~99%	On	On	On	On	Flicker
60~80%	On	On	On	Flicker	Off
40~60%	On	On	Flicker	Off	Off
20~40%	On	Flicker	Off	Off	Off
0~20%	Flicker	Off	Off	Off	Off

When connecting 4 LEDs, the LEDs connect way is as below:
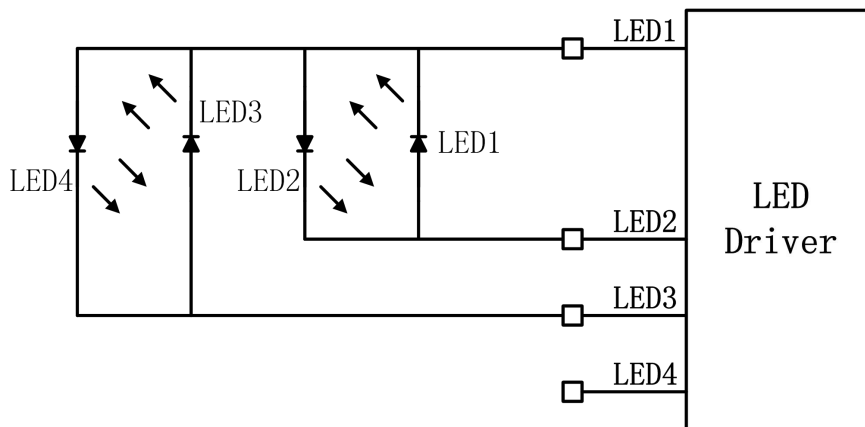
When discharging, battery capacity is shown as:

Capacity	LED1	LED2	LED3	LED4
75~100%	On	On	On	On
50~75%	On	On	On	Off
25~50%	On	On	Off	Off
5~25%	On	Off	Off	Off
1~5%	Flicker	Off	Off	Off
0%	Off	Off	Off	Off

When charging, battery capacity is shown as:

Capacity	LED1	LED2	LED3	LED4
100%	On	On	On	On
75~99%	On	On	On	Flicker
50~75%	On	On	Flicker	Off
25~50%	On	Flicker	Off	Off
0~25%	Flicker	Off	Off	Off

When connecting 3 LEDs, the LEDs connect way is as below:
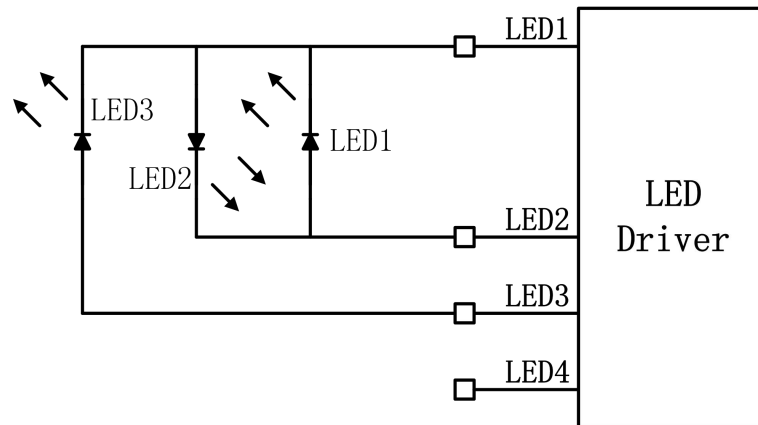
When discharging, battery capacity is shown as:

Capacity	LED1	LED2	LED3
66~100%	On	On	On
33~66%	On	On	Off
5~33%	On	Off	Off
1~5%	Flicker	Off	Off
0%	Off	Off	Off

When charging, battery capacity is shown as:

Capacity	LED1	LED2	LED3
100%	On	On	On
66~99%	On	On	Flicker
33~66%	On	Flicker	Off
0~33%	Flicker	Off	Off

The led driver supports low power indication. When battery is low power, LED1 will flicker 5 times to indicate battery needs to charge, and boost will also not turn on.

9.8 WLED Driver

The SW6115 integrates flash light driver. WLED pin is connected to flash light to drives flash light.

9.9 KEY

The SW6115 integrates key function. It supports push key, and supports short key, long key and double short key.

Short key: Type-A port, Type-C port of light load and led driver will turn on;

Long key: WLED driver will turn on or turn off;

Double short key: Type-A port, Type-C output port and led driver will turn off；
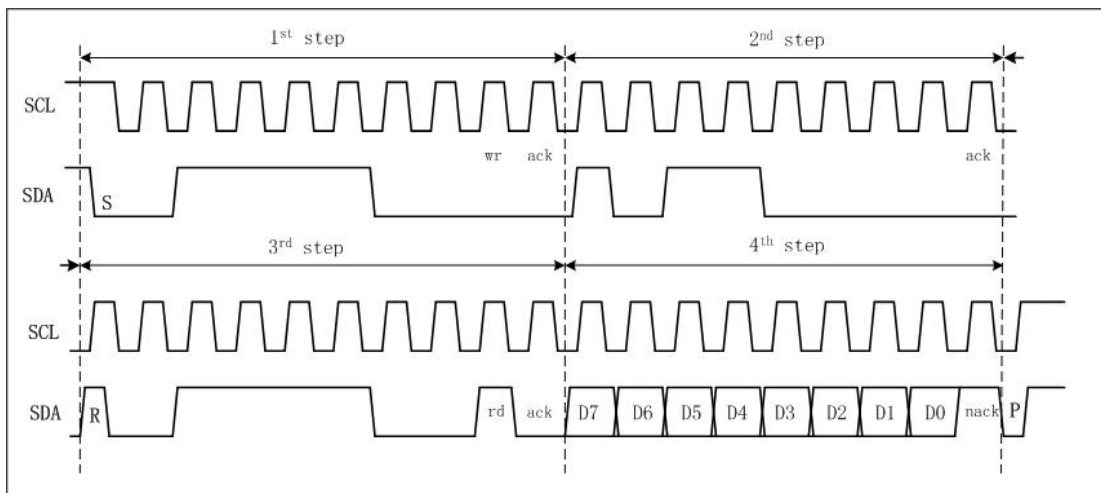
9.10 I2C Interface

The SW6115 integrates I2C interface, supports 100K/400K rate. I2C interface and LED driver are shared the same four pins, identifying by seting led4/i2c pin. When using as I2C interface, LED4/I2C should connect to ground.
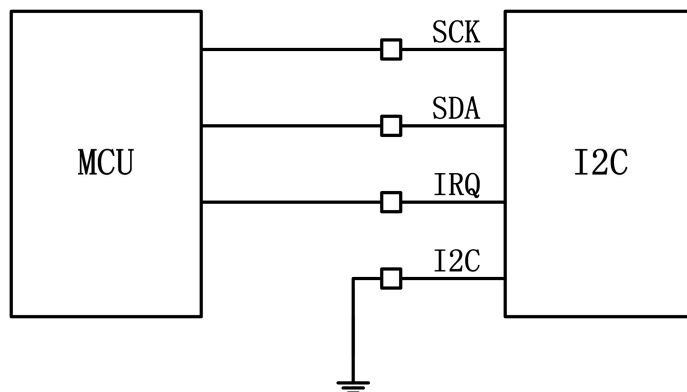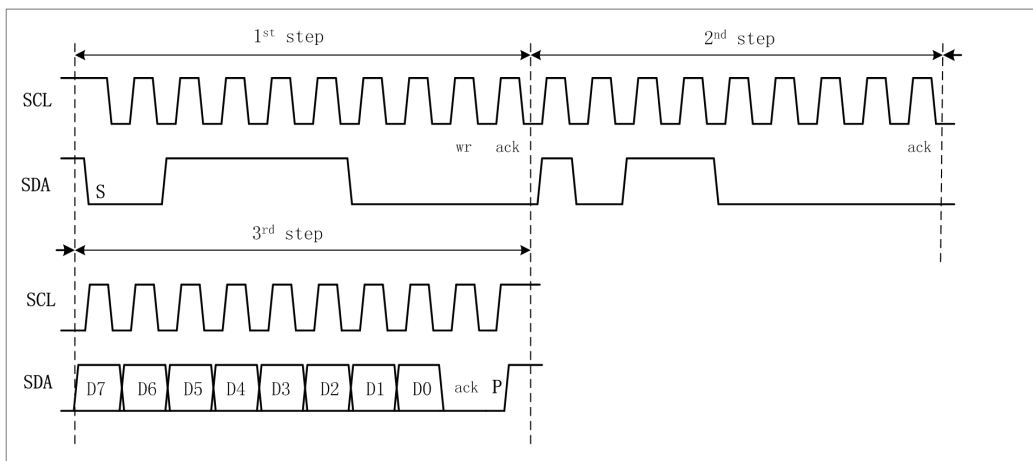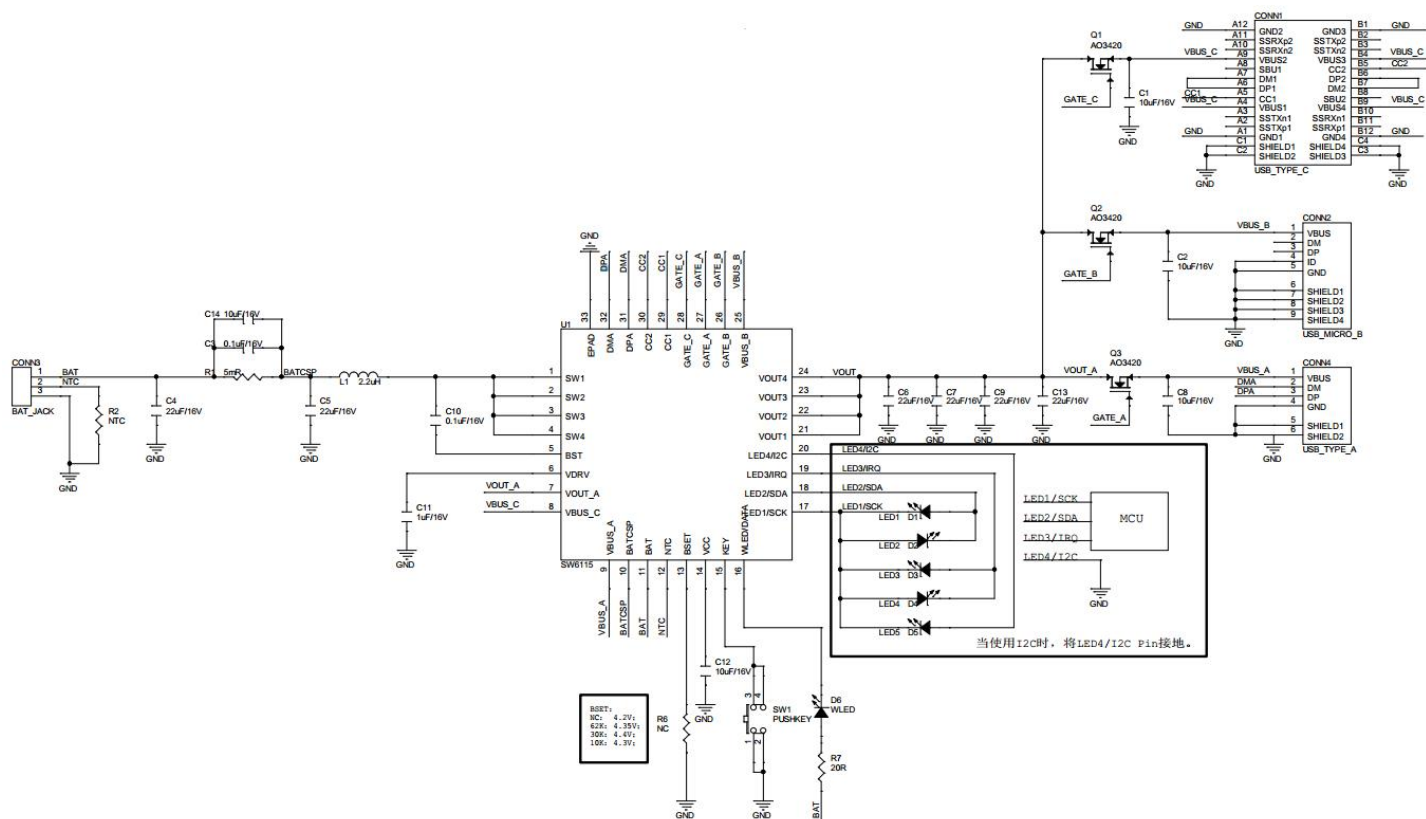

Read Timing:

Slave address ：0x3C
Register address：0xB0

Write Timing:

Slave address ：0x3C
Register address：0xB0
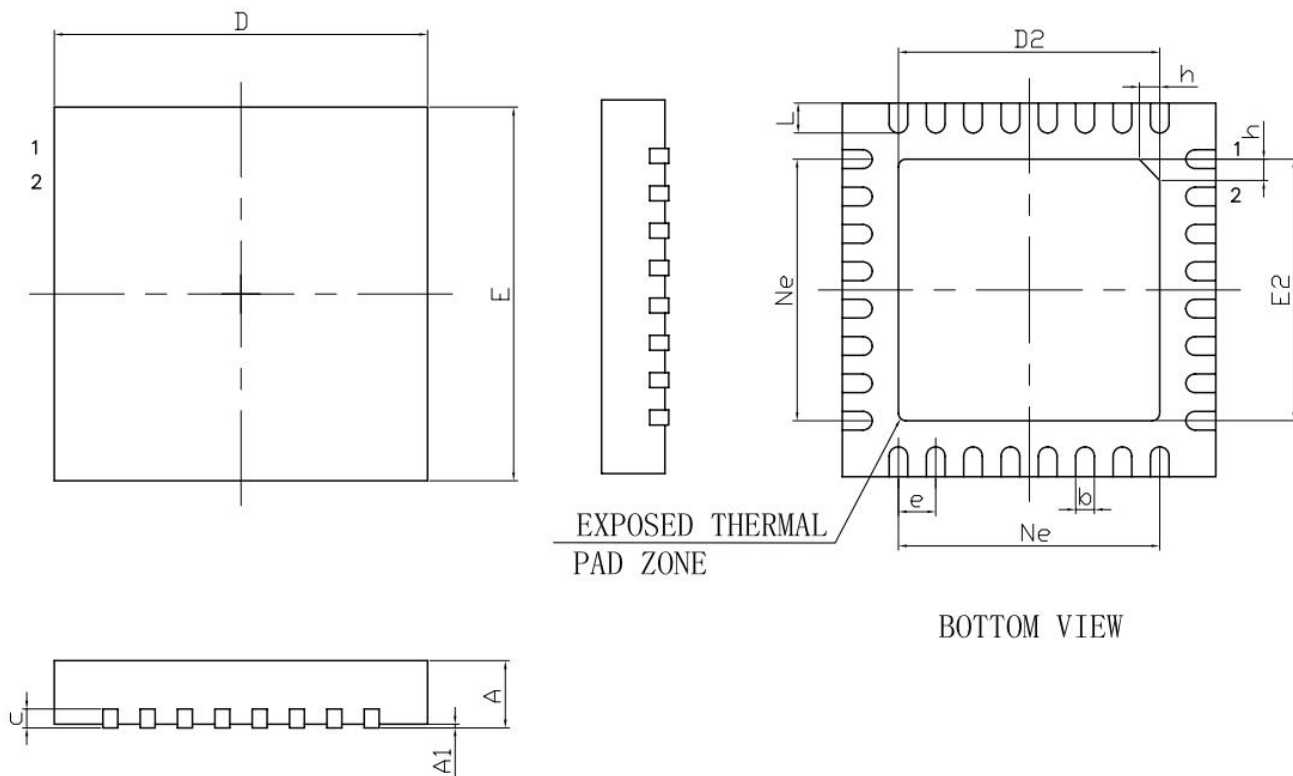
10. Typical Application Circuits

11. Mechanical and Packaging

11.1 Package Summary

EXPOSED THERMAL PAD ZONE

BOTTOM VIEW

11.2 Package Outline and Dimensions

Symbol	Dimension in Millimeters		
	MIN	**NOM**	**MAX**
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.18	0.25	0.30
c	0.18	0.20	0.25
D	4.90	5.00	5.10
D2	3.40	3.50	3.60
e	0.50BSC		
Ne	3.50BSC		
E	4.90	5.00	5.10
E2	3.40	3.50	3.60
L	0.35	0.40	0.45
h	0.30	0.35	0.40

12. Revision History

V1.0   Initial version.

V1.1   Add description of key action.

V2.0   Add description of lightning decryption and other functions.