

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

1. General Description

The SW6009 is a highly integrated power management IC for Type-C power bank application. It integrates 3A switching charger, 3.4A synchronous boost, fuel gauge, segment/led driver and power controller. With simple external components, The SW6009 provides a turn-key high efficiency solution for Type-C battery management.

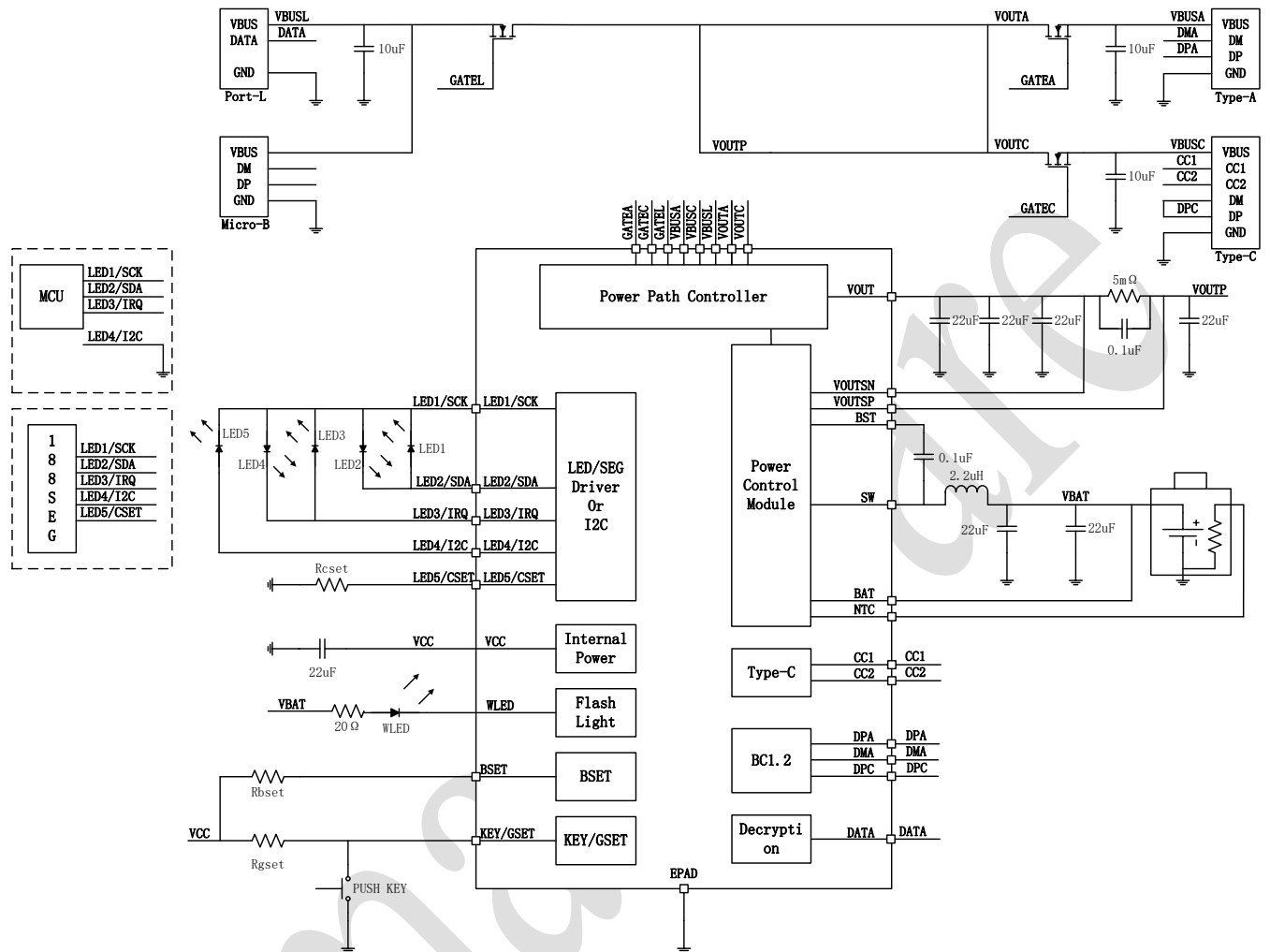
2. Applications

- Power Bank
- Battery Powered Device

3. Features

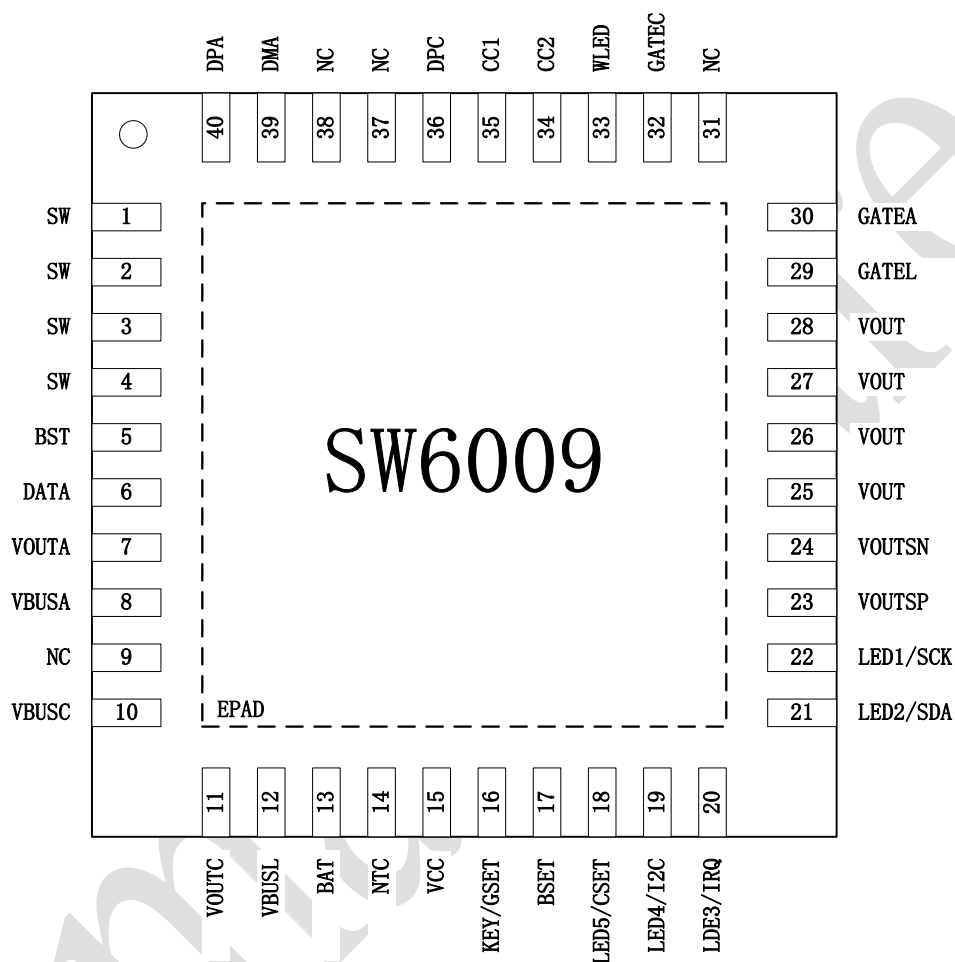
- **Switching Charger**
 - Current up to 3A, Efficiency up to 96%
 - Support 4.2/4.35/4.4/4.5V Battery Voltage
 - Support JEITA
 - Thermal Regulation
- **Synchronous Boost**
 - Current up to 3.4A, Efficiency up to 95%
 - Load Insert Detect and Light Load Detect
 - Support Small Current Charge Mode
- **Type-C Interface**
 - Support 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 Coulometer
 - Support Segment Driver
 - Support 3~5 LEDs Driver
- **WLED Driver**
 - Support WLED Driver
- **Key Support**
 - Support Push Key
- **Protection**
 - Output Over Current Protection
 - Output Short Protection
 - Charger Over Voltage Protection
 - Over Temperature Protection
- **I2C Interface**
- **QFN-40(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	DATA	Lightning decryption pin.
7	VOUTA	Type-A port current sense pin.
8	VBUSA	Type-A port current/voltage sense pin.
9, 31, 37, 38	NC	Floating.
10	VBUSC	Type-C port current/voltage sense pin.

11	VOUTC	Type-C port current sense pin.
12	VBUSL	Lightning port input.
13	BAT	Battery voltage sense pin.
14	NTC	Negative temperature coefficient (NTC) thermistor input.
15	VCC	Internal power.
16	KEY/GSET	Push key input, constant charge time set for fuel gauge.
17	BSET	Battery voltage set.
18	LED5/CSET	Led5 for segment driver and battery capacity set.
19	LED4/I2C	Led4 for segment driver, led driver or i2c set.
20	LED3/IRQ	Led3 for segment driver, led driver or irq.
21	LED2/SDA	Led2 for segment driver, led driver or i2c data.
22	LED1/SCK	Led1 for segment driver, led driver or i2c clock.
23	VOUTSP	Current sense positive pin.
24	VOUTSN	Current sense negative pin.
25, 26, 27, 28	VOUT	Boost output and charger input.
29	GATEL	Lightning port power path control pin.
30	GATEA	Type-A port power path control pin.
32	GATEC	Type-C port power path control pin.
33	WLED	Flash led driver .
34	CC2	Type-C port configure channel CC2.
35	CC1	Type-C port configure channel CC1.
36	DPC	Type-C port DP pin.
39	DMA	Type-A port DM pin.
40	DPA	Type-A port DP pin.
	EPAD	Exposed pad.

6. Absolute Maximum Ratings

Parameters	Symbol	MIN	MAX	UNIT
Input Voltage	VBUSC/VBUSL	-0.3	16	V
Output Voltage	VOUT/VOUTSP/VOUTSN/ VOUTA/VOUTC/ VBUSA/VBUSC	-0.3	16	V
SW Voltage	SW	-0.3	16	V
BST Voltage	BST-SW	-0.3	6	V
Power Path Control Voltage	GATEA/GATEC/GATEL	-0.3	21	V
CC1/CC2Voltage	CC1/CC2	-0.3	16	
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 may affect device reliability.

7. Recommended Operating Conditions

Parameters	Symbol	MIN	Typical	MAX	UNIT
Input Voltage	VBUSC/VBUSL	4.5		5.5	V
Battery Voltage	BAT	2.8		4.5	V

8. Electrical Characteristics

($V_{IN} = 5V$, $V_{BAT} = 3.7V$, $T_A = 25^\circ C$, unless otherwise specified.)

Parameters	Symbol	Test Conditions	MIN	TYP	MAX	UNIT
Power Supply						
VBUSC/VBUSL Input Voltage	V _{BUSC/L}	V _{BUSC} /V _{BUSL}	4		5.5	V
VBUSC/VBUSL Input UVLO Threshold	V _{BUSC/L_UVLO}	VBUSC/VBUSL Voltage Falling	3.9	4	4.1	V
VBUSC/VBUSL Input UVLO Hysteresis	V _{BUSC/L_UVLO_HYS}	VBUSC/VBUSL Voltage Rising	300	400	500	mV
VBUSC/VBUSL Input OVP Threshold	V _{BUSC/L_OVP}	VBUSC/VBUSL Voltage Rising	5.4	5.55	5.7	V
VBUSC/VBUSL Input OVP Hysteresis	V _{BUSC/L_OVP_HYS}	VBUSC/VBUSL Voltage Falling	100	200	300	mV
VCC Output Voltage	V _{CC}	Boost or V _{BUSC} /V _{BUSL} Insert	4.9	5	5.1	V
		Power Off		V _{BAT}		V
VCC Output current	I _{CC}	Boost or V _{BUSC} /V _{BUSL} Insert	40	60	80	mA
		Power Off	40	60	80	mA
Power MOS Rdson						

High Side NMOS	$R_{\text{DS(on)}_H}$		17	20	24	m Ω
Low Side NMOS	$R_{\text{DS(on)}_L}$		9	11	14	m Ω
Peak Current Limit for High Side NMOS	$I_{\text{PEAK_H}}$	Charge Mode	6	8	10	A
Peak Current Limit for Low Side NMOS	$I_{\text{PEAK_L}}$	Boost Mode	8	10	12	A
Charge Mode						
Trickle Charge End Voltage	V_{TC}		2.9	3	3.1	V
Trickle Charge Current(I_{BAT})	I_{TC}	$V_{\text{BAT}} < 0.5\text{V}$	30	60	100	mA
		$0.5\text{V} < V_{\text{BAT}} < 3\text{V}$	200	300	400	mA
Constant Current Charge Current	I_{CC}	$V_{\text{BUSB}} / V_{\text{BUSL}} = 5\text{V}$, $I_{\text{CCSET}} = 2\text{A}$	1.8	2	2.1	A
		$V_{\text{BUSC}} = 5\text{V}$, $I_{\text{CCSET}} = 3\text{A}$	2.7	3	3.2	A
Termination Charge Current	I_{END}	$V_{\text{BUSC}} / V_{\text{BUSL}} = 5\text{V}$	200	230	260	mA
Target Charge Voltage	$V_{\text{BAT_FULL}}$		4.16	4.2	4.24	V
Recharge Threshold	$V_{\text{BAT_RECH}}$		4.06	4.1	4.14	V
Switching Frequency	F_{CHG}		350	400	450	KHz
Trickle Charge Over Time	$t_{\text{TC_OT}}$		36	40	44	Min
Constant Charge Over Time	$t_{\text{CC_OT}}$		30	33	36	Hour
Thermal Regulation Threshold	$T_{\text{REGU_CHG}}$		100	115	130	$^{\circ}\text{C}$
Hold Voltage Threshold	V_{HOLD}	$V_{\text{BUSC}} / V_{\text{BUSL}} = 5\text{V}$	4.4	4.5	4.6	V
Boost Mode						
VBAT Input Voltage	V_{BAT}		2.9		4.5	V
VBAT Input UVLO Threshold	$V_{\text{BAT_UVLO}}$	V_{BAT} Voltage Falling	2.8	2.9	3.0	V
VBAT Input UVLO Hysteresis	$V_{\text{BAT_UVLO_HYS}}$	V_{BAT} Voltage Rising	400	500	600	mV
VOUT Output Voltage	V_{OUT}	$V_{\text{OUT}} = 5\text{V}$, $I_{\text{OUT}} = 0\text{A}$	5	5.1	5.2	V
VOUT Output Current	I_{OUT}	$V_{\text{OUT}} = 5\text{V}$, $I_{\text{OUTSET}} = 3\text{A}$	3.0		3.4	A
Light Load Current	$I_{\text{LIGHT_LOAD}}$	$R_{\text{DS_PATH}} = 10\text{m}\Omega$, $V_{\text{OUT}} = 5\text{V}$	40	60	80	mA
Light Load Time	$t_{\text{LIGHT_LOAD}}$		28	32	40	S
Quiescent Current	I_{Q}	$V_{\text{BAT}} = 3.7\text{V}$	40	50	65	μA
Wire Drop Compensation	$V_{\text{OUT_WDC}}$	$0\text{A} < I_{\text{OUT}} < 1\text{A}$		0		mV
		$1\text{A} < I_{\text{OUT}} < 2\text{A}$	30	50	70	mV

		$I_{OUT}>2A$	80	100	120	mV
Switching Frequency	F_{BST}		350	400	450	KHz
Thermal Regulation Threshold	T_{REGU_BST}		100	115	130	°C
Type-C						
CC Current Source	I_{CC_SOURCE}	Power Level=3.0A	310	330	350	uA
CC Termination Resistor	R_D		4.9	5.1	5.3	kΩ
BC1.2						
DP/DM Voltage	DP	Apple 2.4A Mode	2.55	2.7	2.85	V
	DM	Apple 2.4A Mode	2.55	2.7	2.85	V
LED						
Segment Source Current	I_{SEG}		6	10	14	mA
LED Source Current	I_{LED}		2	4	6	mA
LED Flicker Frequency	f_{LED}		0.8	1	1.2	Hz
WLED						
WLED Resistor	R_{WLED}		10	20	30	Ω
KEY						
Short Key Time	T_{SHORT}		24	32	500	mS
Long Key Time	T_{LONG}		1.5	2	3	S
Double Short Key	T_{DOUBLE}	Longest Time For Two Short Key Happen	1.2	1.5	1.8	S
I2C						
Rate	f_{CLK}			100	400	Kbit/S
Thermal Shutdown						
Thermal Shutdown Threshold	T_{SHDT}	Temperature Rising	135	150	165	°C
Thermal Shutdown Hysteresis	T_{SHDT_HYS}	Temperature Falling	55	70	85	°C

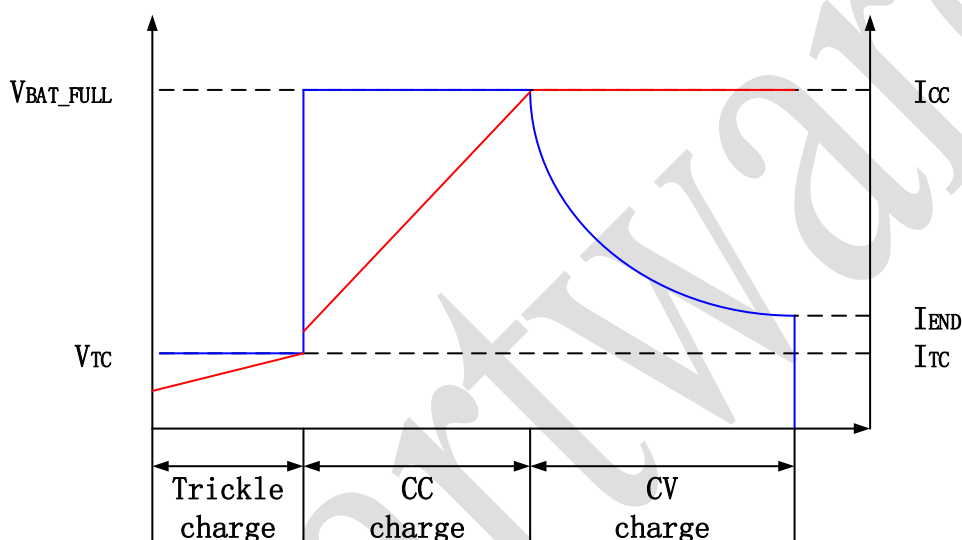
9. Functional Description

9.1. Charge Mode

The SW6009 integrates a switching charger with efficiency is up to 96%. The switching charger supports 4.2V/4.35V/4.4V/4.5V 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 small current. 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 pulled up to VCC with a 10K Ω resistor, 4.2V is set; when selecting a 15K Ω resistor, 4.35V is set; when selecting a 5.6K Ω resistor, 4.4V is set; when selecting a 3K Ω resistor, 4.5V is set.

The charge current in input current is set to 2A for Lightning port, and 3A for Type-C port.

The switching charger has battery temperature protection and support JEITA. 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, reduce target charge voltage or stop to protect battery. While using a typical NTC thermistor of 103AT, When battery temperature is lower than 5°C, charger will reduce charge current by half; When battery temperature continues to fall to lower than 0°C, charger will stop; When battery temperature rises to 5°C, charger will restart and reduce charge current by half; When battery temperature continues to rise to higher than 10°C, charge current will return to normal; When battery temperature is higher than 45°C, charger will reduce target charge voltage by 0.1V; When battery temperature continues to rise to higher than 50°C, charger will stop; When battery temperature falls to 45°C, charger will restart and reduce target charge voltage by 0.1V; When battery temperature continues to fall to lower than 40°C, target charge voltage will return to normal. Resistors can be in series or parallel with the NTC thermistor to change the protection temperature range. JEITA function can be disabled if not needing.

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 SW6009 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 SW6009 integrates a synchronous boost with output current is 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 supports CC/CV mode. When output current is lower than CC limited current, output voltage will keep constant. When output current reaches CC limited current, output voltage will drop to keep output current constant.

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 higher than 60°C or lower than -20°C, 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. Resistors can be in series or parallel with the NTC thermistor to change the protection temperature range.

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 SW6009 supports Type-A+Micro-B+Type-C+Lightning. Type-A port supports BC1.2, and Lightning port

Support cable decryption.

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/Type-C port. Light load current is related to power path MOS. if power path MOS $R_{ds(on)}$ is $10m\Omega$, 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 or Lightning port will turn on and charger will automatically turn on.

The SW6009 supports charging the battery and supplying extern device simultaneously, and this function can be disabled if not needing. In this situation, charger hold voltage is set to 4.8V. if input voltage drops due to the weak power supply of adapter, charge current will automatically fall down so the input voltage holds to 4.8V and supplies extern device in priority.

The SW6009 supports Type-A/Type-C ports supplying extern devices simultaneously.

9.4. Mode Set

The SW6009 supports small current charge mode. This mode are set by register in I2C mode, and set by pin in segment/led mode.

In small current charge mode, SW6009 can charge small current device such as bluetooth headset. When enter into small current charge mode, light load detect will be disabled for two hours, and double short key will also quit this mode. Besides, fuel gauge display will also change to indicate it is in small current charge mode. Small current charge mode is set when LED2/SDA pin connects a $100K\Omega$ resister to ground.

9.5. Type C Interface

The SW6009 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 SW6009 works in SOURCE role, and will broadcast power level of 3A. if adapter inserts in Micro-B or Lightning port and boost not turns on, the SW6009 will also broadcast power level of 3A.

9.6. BC1.2 Module

The SW6009 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;

9.7. Lightning Decryption

The SW6009 integrates lightning decryption and supports inner decryption or external decryption. When selecting inner decryption, DATA pin is directly connected to Lightning port. When selecting external decryption, DATA pin is connected to VCC, and use external decryption chip to decrypt Lightning cable.

9.8. Fuel Gauge

The SW6009 integrates coulometer to obtain accurate battery capacity.

The coulometer supports battery maximal capacity self-learning, and can learn the battery current maximal capacity in one complete charge cycle .

The battery initial capacity can be set by a resister which connecting LED5/CSET pin to ground. The relation between initial capacity Cset and resister Rset is:

$$Rset = (Cset + 2000) * 5/3$$

While Cset unit is mAh, and Rset unit is Ω .

The constant charge time can be set by a resister which connecting KEY/GSET pin to VCC.

9.9. ADC

The SW6009 integrates 12 bit ADC, and samples VOUT voltage/IOUT current/battery voltage/NTC voltage/chip temperature.

ADC channel	Range	Step
VOUT voltage	0~16.384V	4mV
IOUT current	0~9.309A	25/11mA

Battery voltage	0~4.915V	1.2mV
NTC voltage	0~4.505V	1.1mV
Chip temperature	-100~200°C	1/6.82°C

9.10. NTC Function

The SW6009 integrates NTC function. It monitors battery temperature and protects when battery temperature is abnormal. NTC Pin will source a current to a NTC thermistor of 103AT, and measure the voltage to calculate battery temperature. NTC Pin will source 80uA for higher accuracy when NTC thermistor is in low resistance, and 40uA for wider range in high resistance. It sources 80uA in default mode. When NTC voltage is higher than 2.712V, it changes to 40uA; When NTC voltage is lower than 0.718V, it changes to 80uA.

While using a typical NTC thermistor of 103AT, protection threshold and NTC voltage in discharge mode is as below:

Threshold Description	NTC Temperature/°C	NTC Voltage/V	NTC Current/uA
NTC Low Temperature Protection	-20	2.711	40
NTC High Temperature Regulation	55	0.283	80
NTC High Temperature Protection	60	0.242	80

Protection threshold and NTC voltage in Charge mode is as below:

Threshold Description	NTC Temperature/°C	NTC Voltage/V	NTC Current/uA
NTC Low Temperature Protection	0	2.182	80
NTC JEITA Low Temperature for Reducing Current	5	1.764	80
NTC JEITA Low Temperature for Returning to Normal	10	1.437	80

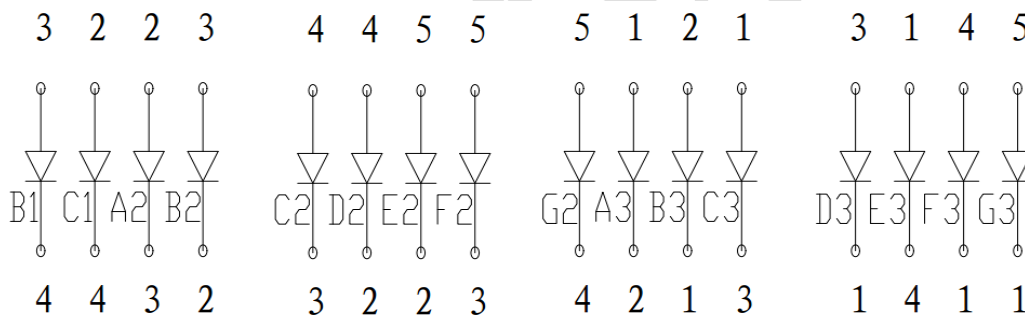
NTC JEITA High Temperature for Returning to Normal	40	0.466	80
NTC JEITA High Temperature for Reducing Target Voltage	45	0.393	80
NTC High Temperature Protection	50	0.333	80

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.

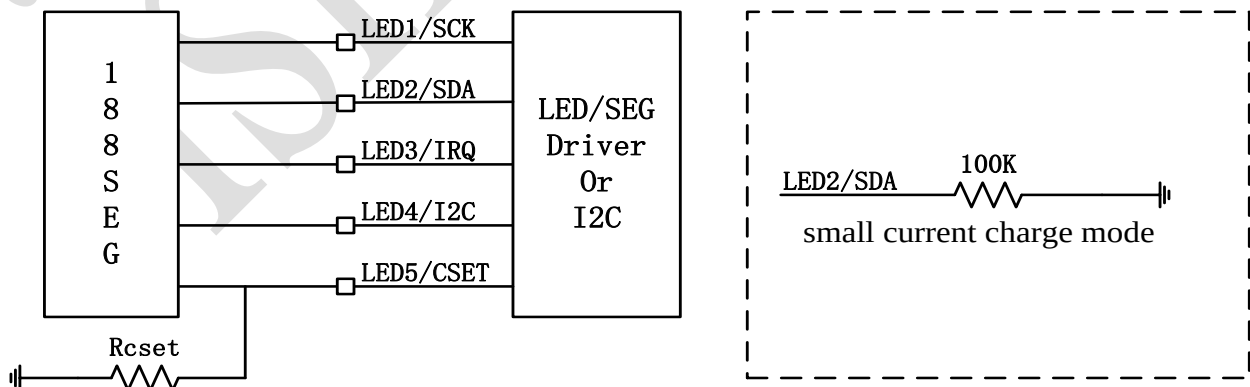
9.11. Segment Driver

The SW6009 integrates segment driver, and supports normal 188 segment.

The normal 188 segment type is YF2252S-5. Its mechanical outline and circuit diagram is as below:



The normal 188 segment driver connection is as below:



In discharge mode, segment will keep on to indicate battery capacity. When battery capacity is lower than 5%, segment will flicker with frequency of 1Hz. When battery is low power, segment 0% will

flicker 5 times to indicate battery needs to charge and then power off.

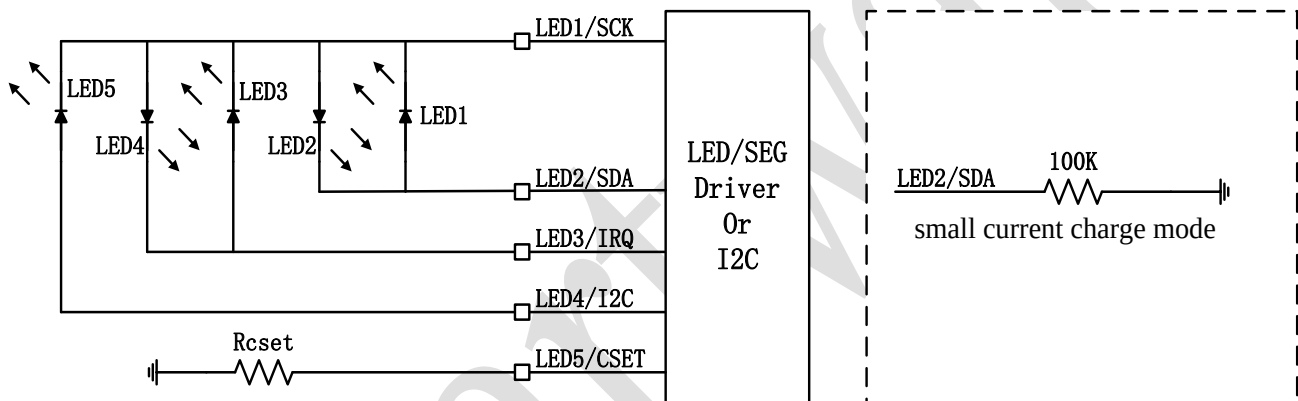
In charge mode, segment units will flicker to indicate battery capacity.

In abnormal situation such as output over current, output short, input over voltage, chip over temperature and NTC protection, segment will flicker 5 times to indicate abnormal situation and then power off.

9.12. 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:

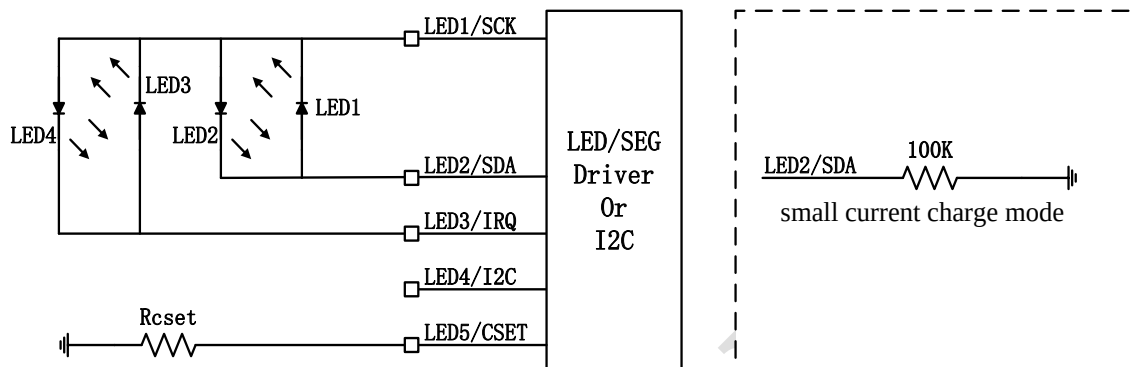
Capacity	LED1	LED2	LED3	LED4	LED5
80~100%	On	On	On	On	On
60~80%	On	On	On	On	Off
40~60%	On	On	On	Off	Off
20~40%	On	On	Off	Off	Off
5~20%	On	Off	Off	Off	Off
1~5%	Flicker	Off	Off	Off	Off
0%	Off	Off	Off	Off	Off

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:



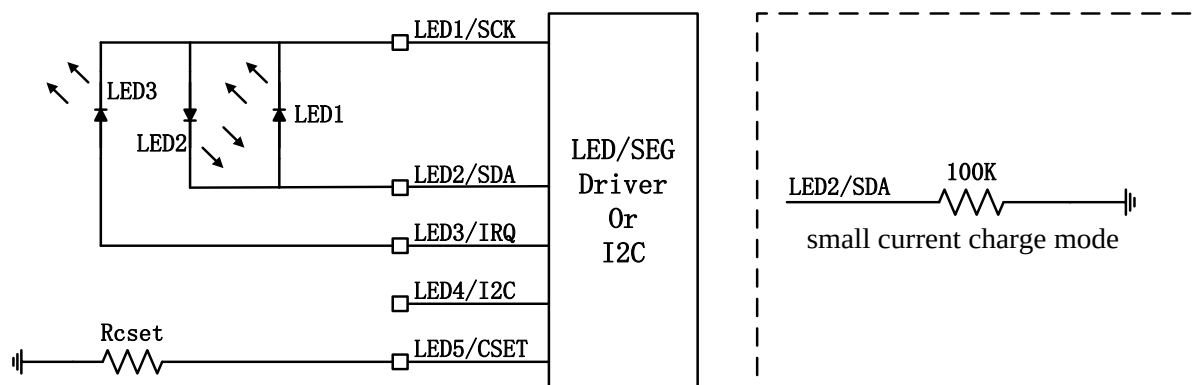
When discharging, battery capacity is shown as:

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 then power off.

In abnormal situation such as output over current, output short, input over voltage, chip over temperature and NTC protection, all LED will flicker 5 times to indicate abnormal situation and then power off.

9.13. WLED Driver

The SW6009 integrates flash light driver, and controlled by long key.

9.14. KEY

The SW6009 integrates key function. It supports push key, and supports short key, long key and double short key.

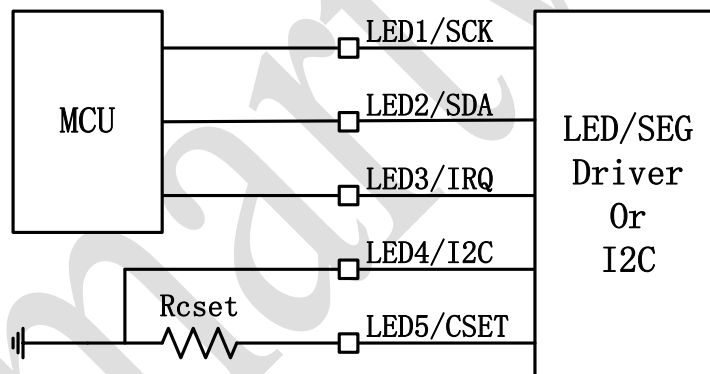
Short key: Type-A port, Type-C port of light load and segment/led driver will turn on;

Long key: WLED driver will turn on or turn off; When in small current charge mode, enter or quit small current charge mode.

Double short key: Type-A port, Type-C output port and segment/led driver will turn off ;

9.15. I2C Interface

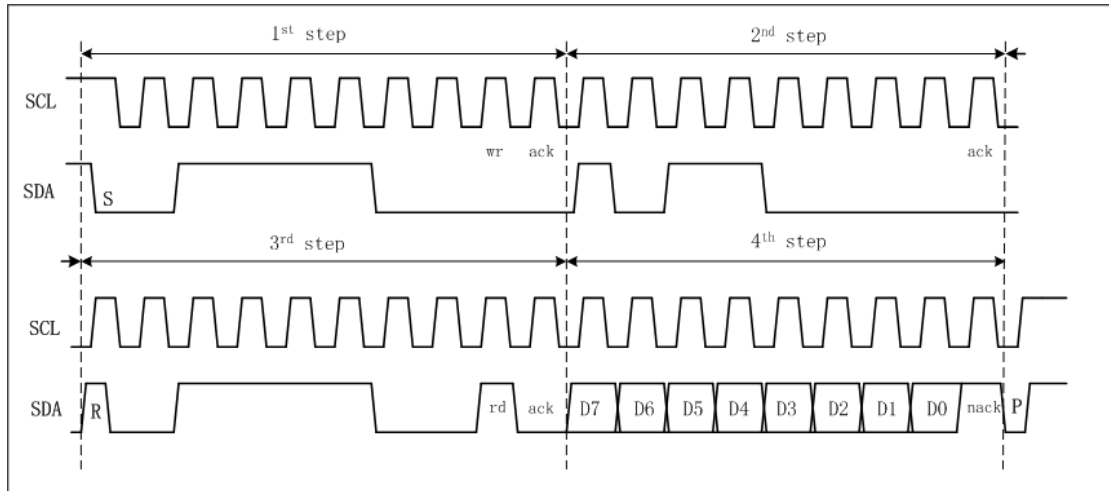
The SW6009 integrates I2C interface, supports 100K/400K rate. I2C interface and Segment/led driver are shared the same four pins, identifying by setting led4/i2c pin. When using as I2C interface, LED4/I2C should connect to ground. Wireless charge, small current charge and flash light driver modes are set by register in I2C mode.



Read Timing:

Slave address : 0x3C

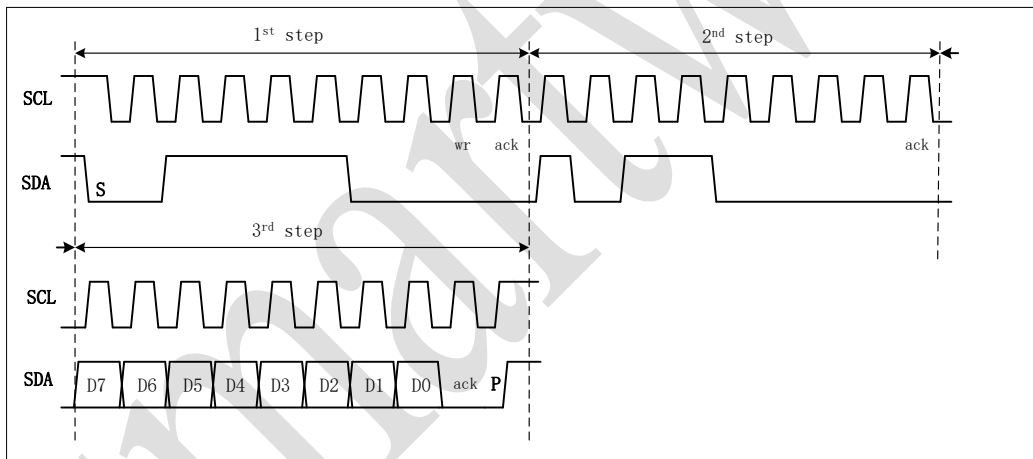
Register address: 0xB0



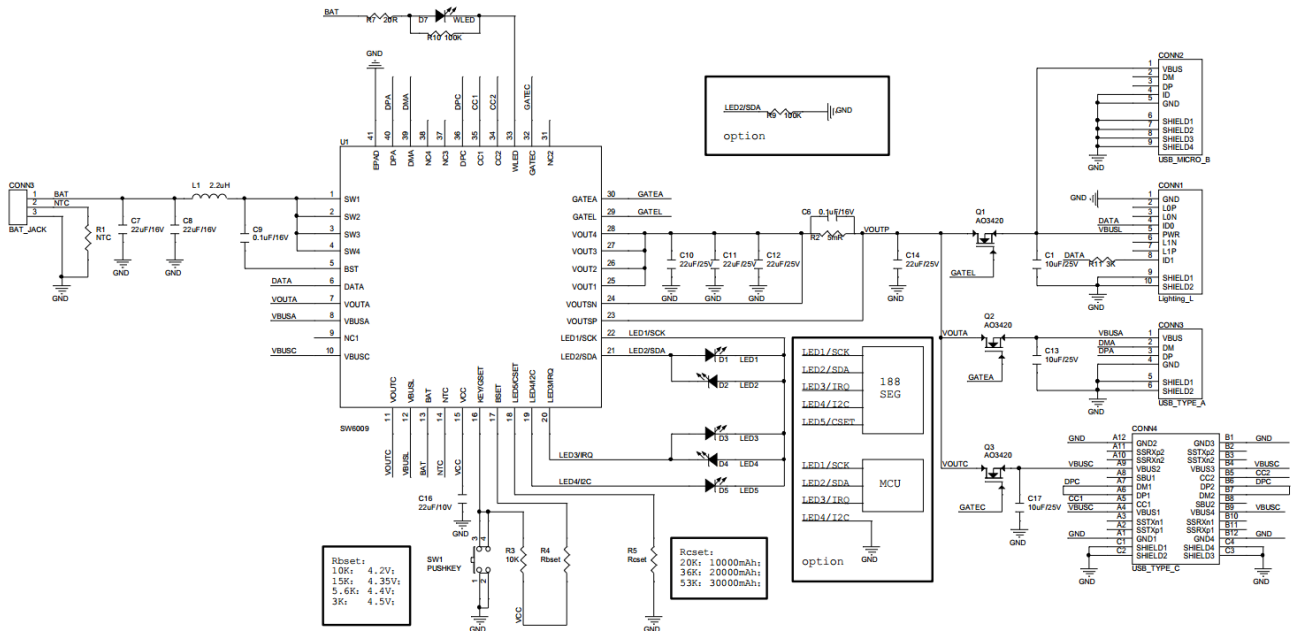
Write Timing:

Slave address : 0x3C

Register address: 0xB0

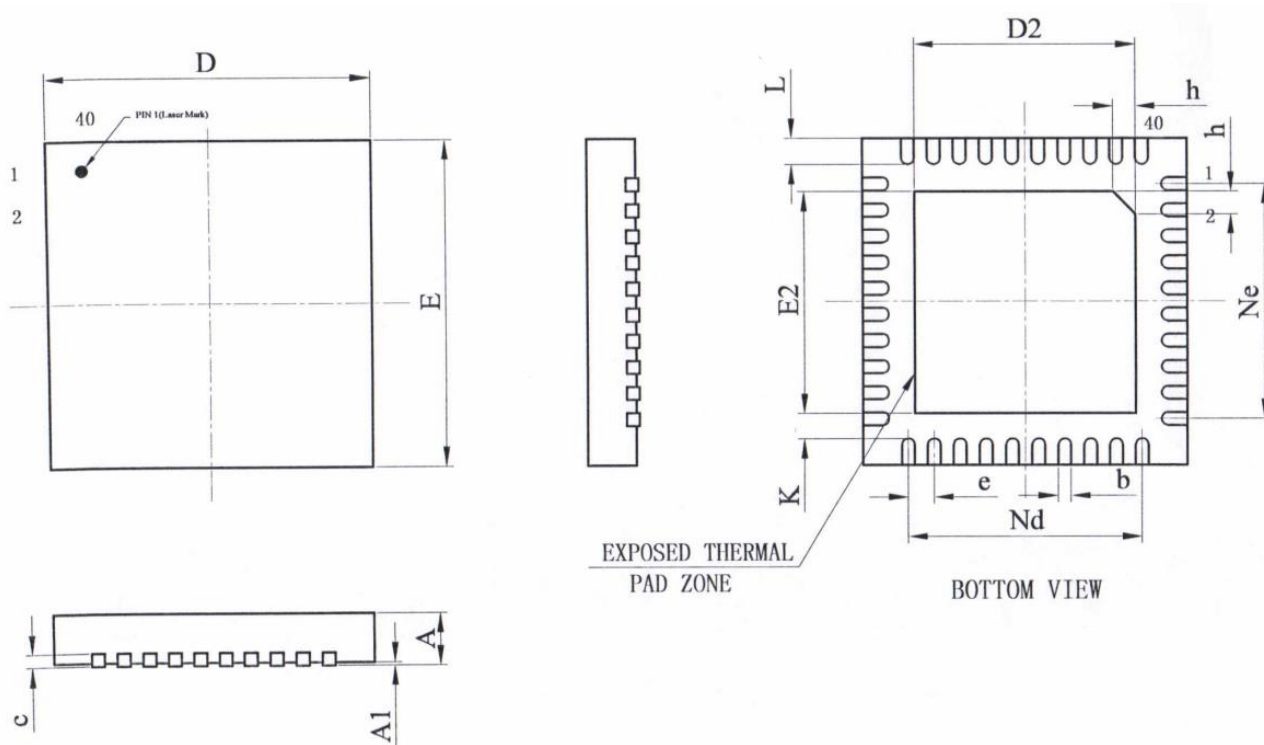


10. Typical Application Circuits



11. Mechanical and Packaging

11.1. Package Summary



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	0.15	0.20	0.25
c	0.18	0.20	0.25
D	4.90	5.00	5.10
D2	3.30	3.40	3.50
e	0.40BSC		
Nd	3.60BSC		
E	4.90	5.00	5.10
E2	3.30	3.40	3.50
Ne	3.60BSC		
L	0.35	0.40	0.45

K	0.20	-	-
h	0.30	0.35	0.40

12. Revision History

- V1.0 Initial version.
- V1.1 Modify some electrical characteristics.
- V1.2 Modify description of NTC protection in boost mode.
- V1.3 Modify company logo.
- V1.4 Modify company name.
- V1.5 Update document template.

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