

Total Solution Include PD for Bidirectional Fast Charge Power Bank

1. General Description

The SW6106 is a highly integrated power management IC for fast charge power bank application. It integrates 4A switching charger, 18W synchronous boost, PD/QC/FCP/PE/SFCP fast charge protocol, fuel gauge and power controller. With simple external components, The SW6106 provides a turn-key high efficiency solution for fast charge battery management.

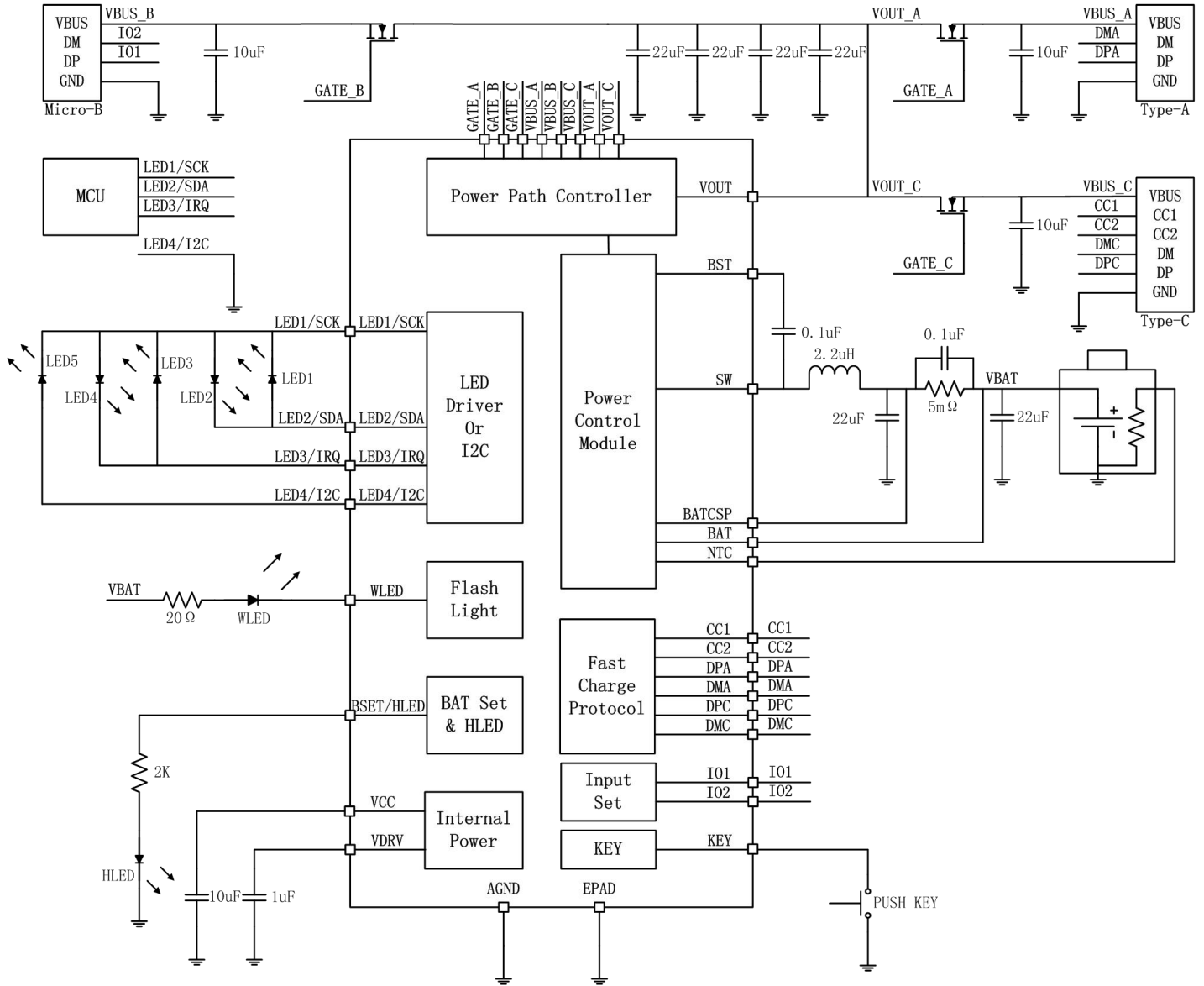
2. Applications

- Power Bank
- Battery Powered Device

3. Features

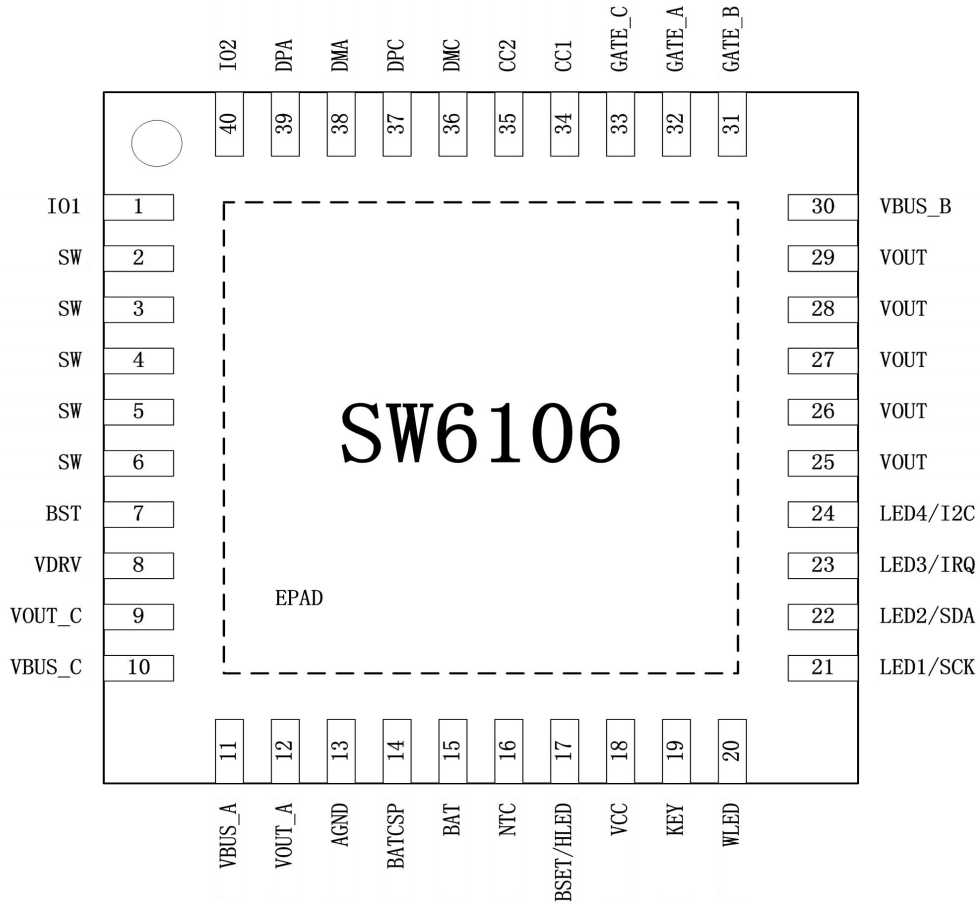
- **Switching Charger**
 - Current up to 4A , Efficiency up to 96%
 - Support 4.2/4.3/4.35/4.4 Battery Voltage
 - Support Battery NTC Protection
 - Thermal Regulation
- **Synchronous Boost**
 - Power up to 18W, Efficiency up to 95%
 - Support Wire Drop Compensation
 - Load Insert Detect and Auto Turn on
 - Light Load Detect and Auto Turn off
- **Output Fast Charge Protocol**
 - Support PD3.0/PD2.0
 - Support QC3.0/QC2.0
 - Support FCP
 - Support PE2.0/PE1.1
 - Support SFCP
- **Input Fast Charge Protocol**
 - Support PD3.0/PD2.0
- **Type-C Interface**
 - Support USB Type-C Specification
 - Support try.SRC Role
- **BC1.2 Module**
 - Support BC1.2 DCP
 - Support Apple & Samsung Device
- **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
- **Fast Charge LED**
 - Support Fast Charge LED 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-40(6x6mm) Package**

4. Functional Block Diagram



5. Pin Configuration and Function

5.1 Pin Configuration



5.2 Pin Descriptions

| Pin | Name | Function Description |
|---------------|--------|--|
| 1 | IO1 | Input set pin1. |
| 40 | IO2 | Input set pin2. |
| 2, 3, 4, 5, 6 | SW | Switching node. |
| 7 | BST | Bootstrap pin for high side NMOS. |
| 8 | VDRV | Driver power. |
| 9 | VOUT_C | Type-C port current sense pin. |
| 10 | VBUS_C | Type-C port current/voltage sense pin. |
| 11 | VBUS_A | Type-A port current/voltage sense pin. |
| 12 | VOUT_A | Type-A port current sense pin. |
| 13 | AGND | Analog ground. |
| 14 | BATCSP | Battery current sense pin. |
| 15 | BAT | Battery current/voltage sense pin. |
| 16 | NTC | Negative temperature coefficient (NTC) thermistor input. |

| | | |
|-----------------------|-----------|---|
| 17 | BSET/HLED | Battery voltage set and fast charge led driver. |
| 18 | VCC | Internal power. |
| 19 | KEY | Push key input. |
| 20 | WLED | Flash led driver. |
| 21 | LED1/SCK | Led1 for battery capacity indicator or i2c clock. |
| 22 | LED2/SDA | Led2 for battery capacity indicator or i2c data. |
| 23 | LED3/IRQ | Led3 for battery capacity indicator or irq. |
| 24 | LED4/I2C | Led4 for battery capacity indicator or i2c/led set. |
| 25, 26, 27, 28, 29 | VOUT | Boost output and charger input. |
| 30 | VBUS_B | Micro-B port input. |
| 31 | GATE_B | Micro-B port power path control pin. |
| 32 | GATE_A | Type-A port power path control pin. |
| 33 | GATE_C | Type-C port power path control pin. |
| 34 | CC1 | Type-C configure channel CC1. |
| 35 | CC2 | Type-C configure channel CC2. |
| 36 | DMC | Type-C port DM pin. |
| 37 | DPC | Type-C port DP pin. |
| 38 | DMA | Type-A port DM pin. |
| 39 | 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/VOUT_C /VBUS_A/VBUS_C | -0.3 | 16 | 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 may affect device reliability.

7. Recommended Operating Conditions

| Parameters | Symbol | MIN | Typical | MAX | UNIT |
|-----------------------|---------------|-----|---------|------|------|
| Input Voltage | VBUS B/VBUS C | 4.5 | | 13.5 | V |
| Battery Voltage | BAT | 2.8 | | 4.5 | V |
| Operating Temperature | | -40 | | +85 | °C |

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 | | | | | | |
| VBUS_B Input Voltage | V_{BUSB} | | 4 | | 13.5 | 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 | | 13.5 | 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 | | m Ω |
| High Side NMOS | R_{DSON_L} | | | 16 | | m Ω |
| 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} | V_{BUSB} or $V_{BUSC} = 5V$ | | 2.5 | | A |
| | | V_{BUSB} or $V_{BUSC} = 9V/12V$ | | 4 | | 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 | | $^\circ C$ |

| 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 | $V_{BAT_UVLO_HYS}$ | Voltage Rising | | 500 | | mV |
| VOUT Output Voltage | V_{OUT} | $V_{OUT}=5V$ | | 5.05 | | V |
| | | $V_{OUT}=9V$ | | 9.05 | | V |
| | | $V_{OUT}=12V$ | | 12.05 | | V |
| VOUT Output Current | I_{OUT} | $V_{OUT}=5V$ | | 3 | | A |
| | | $V_{OUT}=9V$ | | 2 | | A |
| | | $V_{OUT}=12V$ | | 1.5 | | A |
| Light Load Current | I_{LIGHT_LOAD} | $R_{DS_PATH}=10m\Omega$ | | 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 | | °C |
| 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 |
| PE | | | | | | |
| Current Threshold | I_{REF} | | | 300 | | mA |
| Quit Time | t_{PLUG_OUT} | | | 200 | | mS |
| LED | | | | | | |
| LED Source Current | I_{LED} | | | 4 | | mA |
| LED Flicker Frequency | f_{LED} | | | 1 | | Hz |
| WLED | | | | | | |

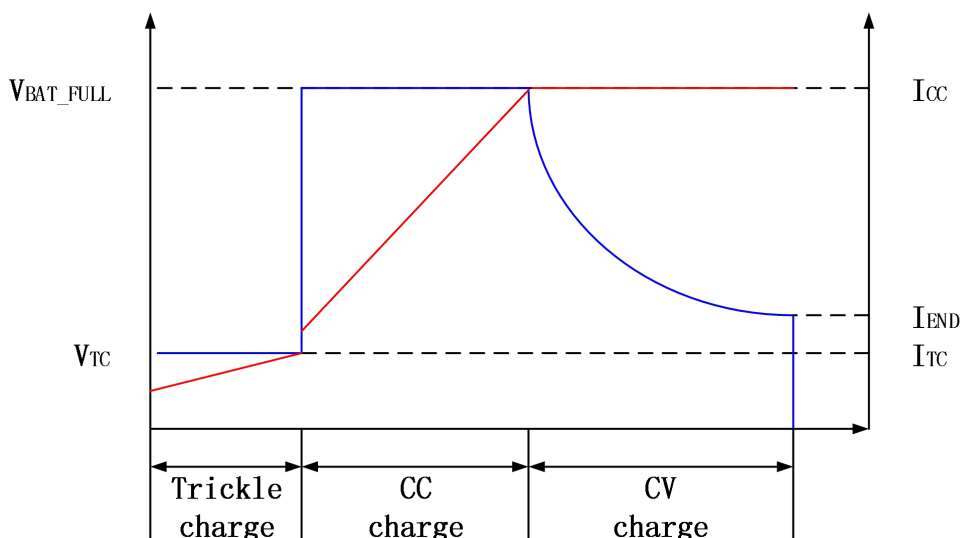
| | | | | | | |
|-----------------------------|-----------------|---------------------|--|-----|--|-------------|
| WLED Resistor | R_{WLED} | | | 20 | | Ω |
| KEY | | | | | | |
| Short Key Time | T_{SHORT} | | | 32 | | mS |
| Long Key Time | T_{LONG} | | | 2 | | S |
| I2C | | | | | | |
| Rate | f_{CLK} | | | 400 | | Kbit/S |
| Thermal Shutdown | | | | | | |
| Thermal Shutdown Threshold | T_{SHDT} | Temperature Rising | | 150 | | $^{\circ}C$ |
| Thermal Shutdown Hysteresis | T_{SHDT_HYS} | Temperature Falling | | 70 | | $^{\circ}C$ |

9. Functional Description

9.1 Charge Mode

The SW6106 integrates a switching charger with charge current up to 4A and 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/HLED pin. When BSET/HLED is floating, 4.2V is set; when connecting a 62K Ω resistor to ground, 4.35V is set; when connecting a 30K Ω resistor to ground, 4.4V is set; when connecting a 10K Ω resistor to ground, 4.3V is set.

The charge current varies with input voltage. When input voltage is 5V, charge current is set to 2.5A; When input voltage is high than 5V, charge current is set to 4A.

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°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 charge current by half; 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 charge current by half; When battery temperature continues to fall to lower than 40°C, charge current will return to normal. Resistors 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 SW6106 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 SW6106 integrates a synchronous boost with output power up to 18W 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 18W power output. When output voltage is lower than 6V, its current is up to 3A. When output voltage is higher than 6V, its power output is limited to 18W. When output voltage is 9V, its current is up to 2A; When output voltage is 12V, its current is up to 1.5A.

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°C or higher than 58°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. 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 SW6106 supports Type-A+Type-C+Micro-B. Type-A port supports QC3.0/QC2.0/FCP/PE2.0/PE1.1/SFCP fast charge output. Type-C port supports PD3.0/PD2.0/QC3.0/QC2.0/FCP/PE2.0/PE1.1/SFCP fast charge output, and PD3.0/PD2.0 fast input. Micro-B supports high voltage input.

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 R_{dson} 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 adapter inserts, Micro-B port will turn on and charger will automatically turn on.

The SW6106 supports charging the battery and supplying extern device simultaneously. When only one port turns on, it supports fast charge input and output; when two or three ports turn on, it only supports 5V input and output.

The SW6106 supports Type-A port and Type-C port supply extern devices simultaneously and only supports 5V output.

9.4 Type C Interface

The SW6106 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 SW6106 works in SOURCE role, and will broadcast power level of 3A. if adapter inserts in Micro-B port and boost not turns on, the 6106 will also broadcast power level of 3A.

9.5 PD Fast Charge

The SW6106 integrates PD3.0/PD2.0 fast charge protocol, supports input and output fast charge. It supports 5V/9V input voltage and 5V/9V/12V output voltage.

9.6 QC3.0/QC2.0 Fast Charge

The SW6106 integrates QC3.0/QC2.0 fast charge protocol. It supports Class A, while QC2.0 supporting 5V/9V/12V output voltage and QC3.0 supporting 5V~12V output voltage, 200mV/Step.

QC2.0/QC3.0 will output voltage base on DP/DM voltage:

| Device | | SW6106 | |
|--------|------|------------------|-------------|
| DP | DM | VOUT | Note |
| 3.3V | 3.3V | previous voltage | not respond |
| 0.6V | 0.6V | 12V | |
| 3.3V | 0.6V | 9V | |
| 0.6V | 3.3V | continuous mode | 0.2V/Step |
| 0.6V | GND | 5V | |

9.7 FCP Fast Charge

The SW6106 integrates FCP fast charge protocol, supports 5V/9V/12V output voltage.

9.8 PE Fast Charge

The SW6106 integrates PE2.0/PE1.1 fast charge protocol. PE1.1 supports 5V/7V/9V/12V output voltage. PE2.0 supports 5V~12V output voltage, 500mV/Step.

9.9 SFCP Fast Charge

The SW6106 integrates SFCP fast charge protocol, supports 5V/9V/12V output voltage.

9.10 BC1.2 Module

The SW6106 integrates BC1.2 controller, and automatically detects apple and samsung devices:

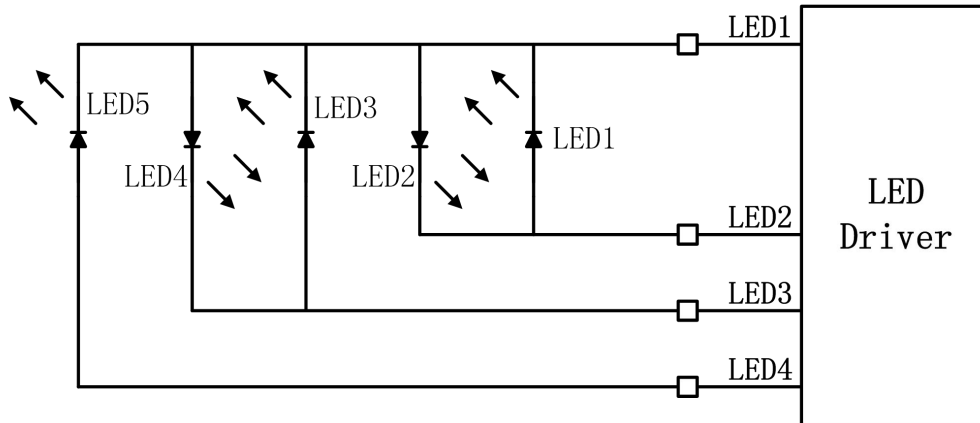
Apple 2.4A mode: DP=2.7V, DM=2.7V;

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

9.11 Led Driver

The led driver supports 3/4/5 LEDs.

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



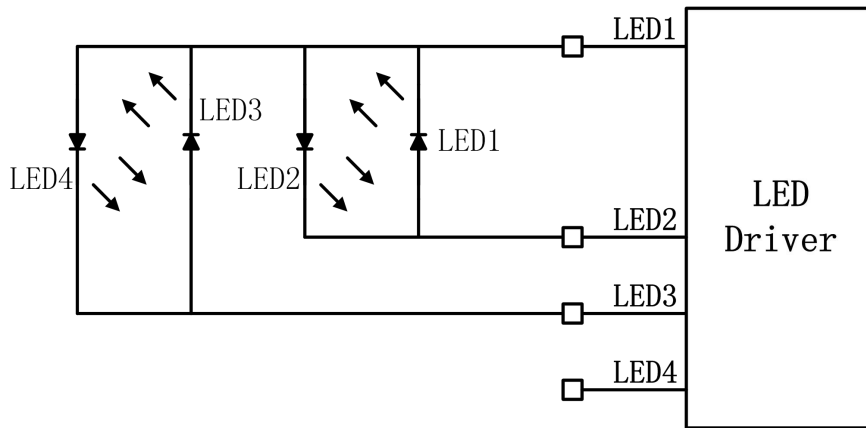
When discharging, battery capacity is shown as:

| 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:



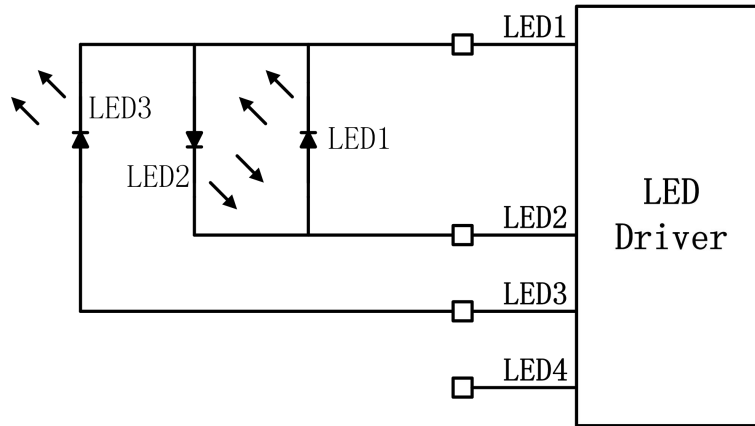
When discharging, battery capacity is shown as:

| 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.

9.12 WLED Driver

The SW6106 integrates flash light driver. WLED pin is connected to flash light to drives flash light.

9.13 Fast Charge Led

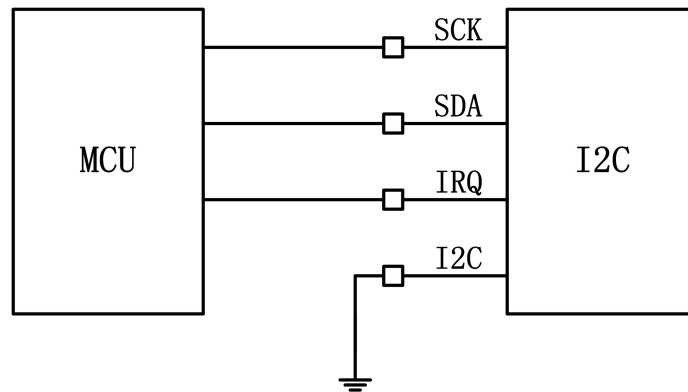
The SW6106 integrates fast charge LED driver through BSET/HLED pin. When being in input or output fast charge status, BSET/HLED pin will drive high to turn on fast charge led.

9.14 KEY

The SW6106 integrates key function. It supports push key, and supports short key and long key.

9.15 I2C Interface

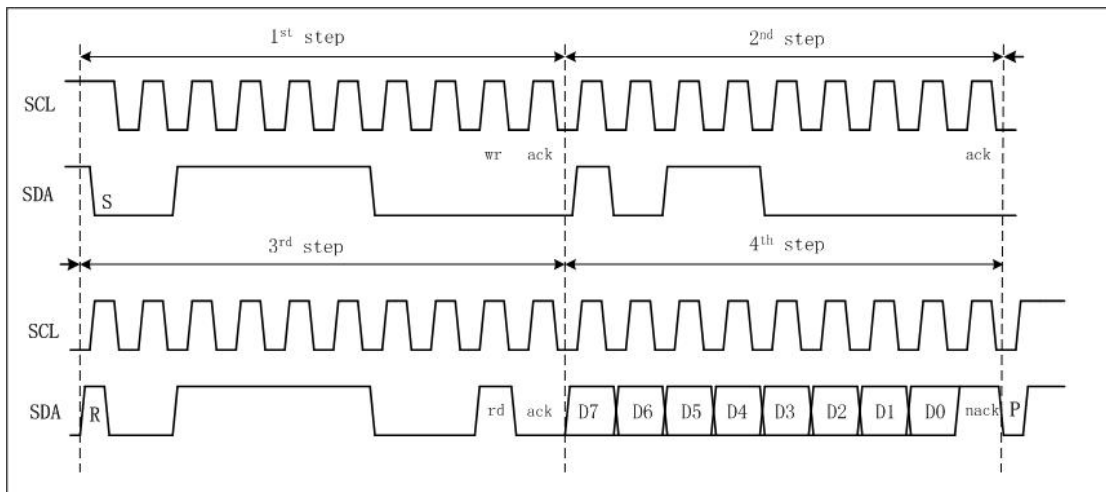
The SW6106 integrates I2C interface, supports 100K/400K rate. I2C interface and LED driver are shared the same four pins, identifying by setting led4/i2c pin. When using as I2C interface, LED4/I2C should connect to ground.



Read Timing:

Slave address : 0x3C

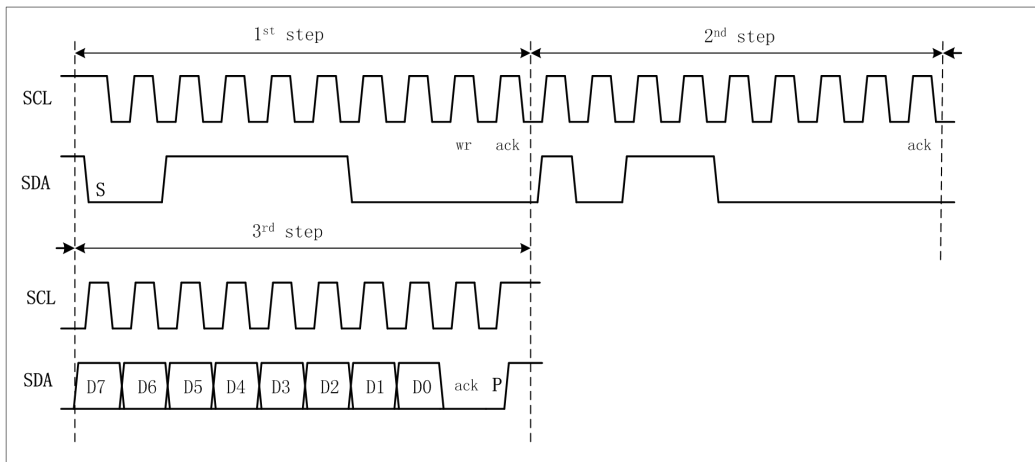
Register address: 0xB0



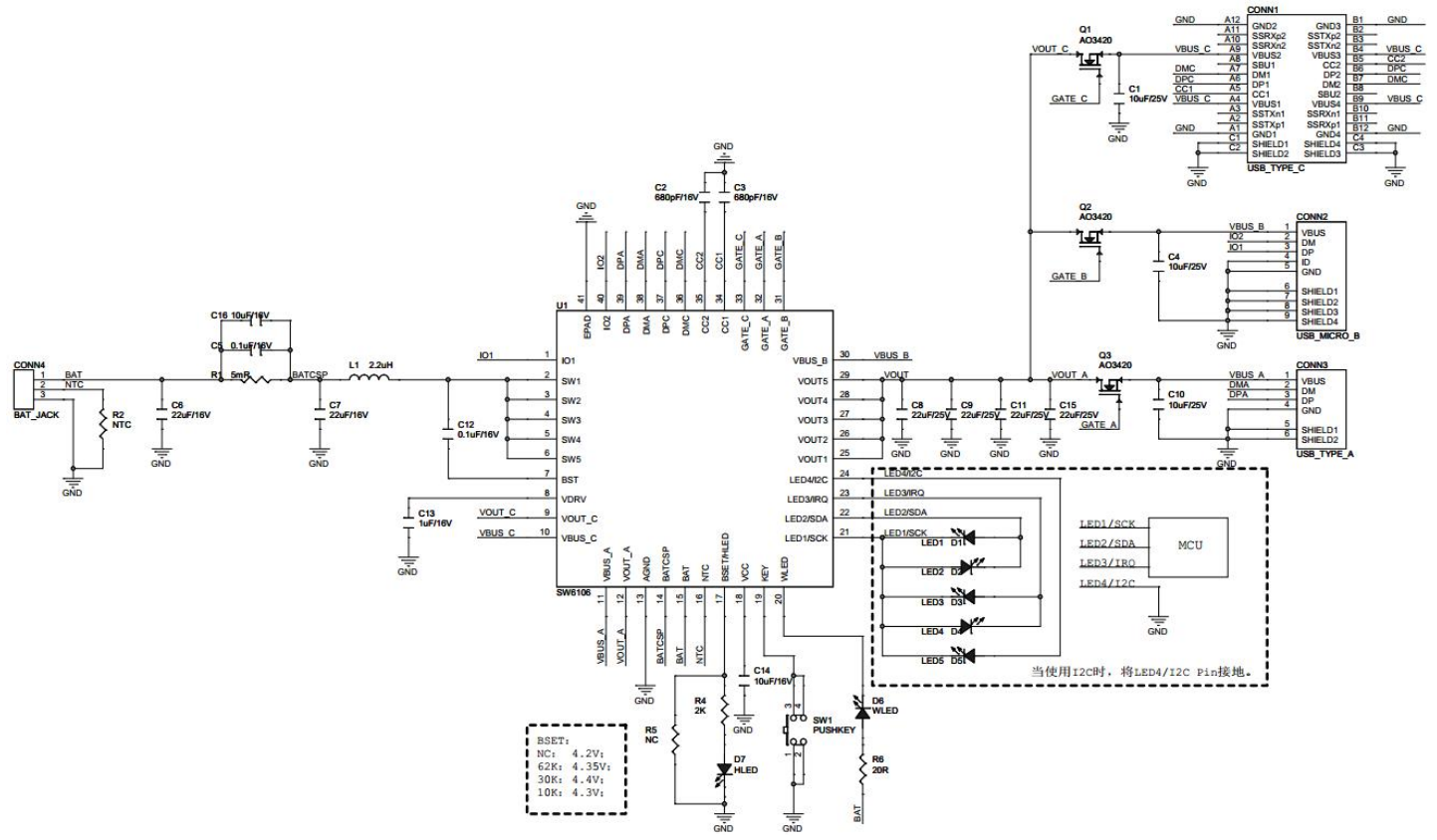
Write Timing:

Slave address : 0x3C

Register address: 0xB0

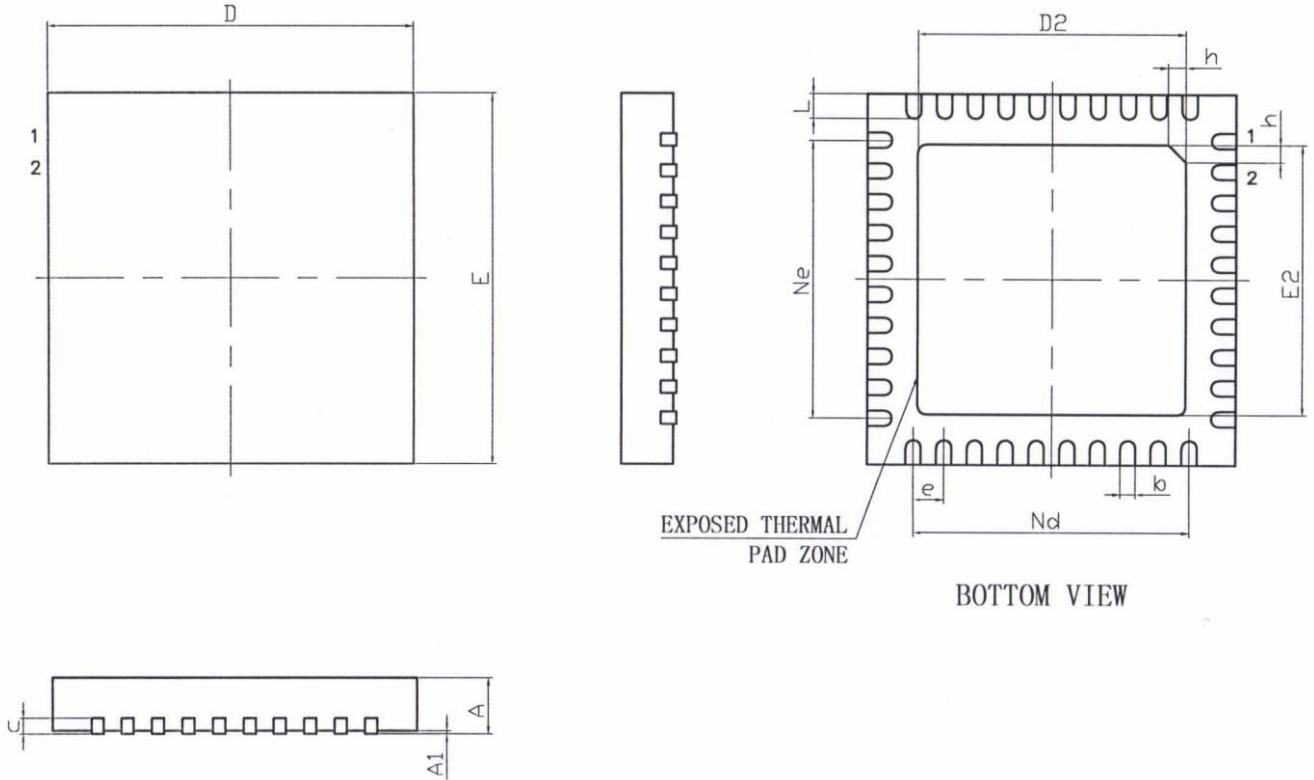


10. Typical Application Circuits



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 | 0.18 | 0.25 | 0.30 |
| c | 0.18 | 0.20 | 0.25 |
| D | 5.90 | 6.00 | 6.10 |
| D2 | 4.10 | 4.20 | 4.30 |
| e | 0.50BSC | | |
| Ne | 4.50BSC | | |
| Nd | 4.50BSC | | |
| E | 5.90 | 6.00 | 6.10 |
| E2 | 4.10 | 4.20 | 4.30 |
| L | 0.35 | 0.40 | 0.45 |
| h | 0.30 | 0.35 | 0.40 |

12. Revision History

V1.0 Initial version.