SY20751B

Highly Integrated Bi-Directional Power Regulator For Single-Cell Battery Power Banks

General Description

The SY20751B is a bi-directional regulator designed for a 4.5-5.7V input range for single-cell Li-Ion battery power bank applications. It utilizes advanced bi-directional energy flow control with automatic input power source detection, enabling seamless switching between battery charge and power supply modes.

When connected to an external power supply, the SY20751B operates in battery charge mode, offering comprehensive protection functions. Without an external power supply, it switches to battery power supply mode, capable of delivering an output current of up to 3A.

The SY20751B has an integrated reverse blocking switch to prevent current leaking from the system or battery side to the input side. The high-side switch protects the battery from a high discharge current and short-circuits at the SYS point.

The SY20751B includes a KEY control for user interaction and four LED driver outputs for status indication.

SY20751B is available in a compact QFN4x4 package to minimize the PCB layout size.

Features

- Maximum 18V Input Voltage Rating
- Built-in Low R_{dson} Power Path NFETs and Power Switches
- Programmable Boost Switching Frequency
- Maximum 3A Charge Current
- Maximum 3A Boost Output Current
- 4.2V/4.35V/4.4V Selectable Cell Termination Voltage
- +/-0.5% Battery Cell Voltage Tolerance
- 4 LED Battery Level Indicators
- Trickle Current / Constant Current / Constant Voltage Charge Mode
- Adaptive Input Current Limit
- Input Voltage UVLO and OVP
- Output Divider Mode, DCP Mode Handshaking
- Boost Auto Start When Portable Device Inserts
- Boost Auto Shutdown with Light Load
- Boost Cycle-by-Cycle Peak Current Limit
- Boost Programmable Output Current Limit
- Boost Output Short Circuit Protection
- Thermal Shutdown Protection
- Compact Package: QFN4×4-26

Applications

- Power Banks
- Portable Devices with Single-Cell Batteries

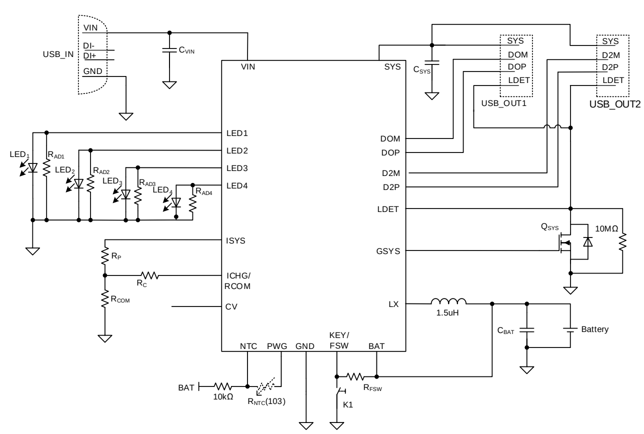


Figure 1. Typical Application Circuit

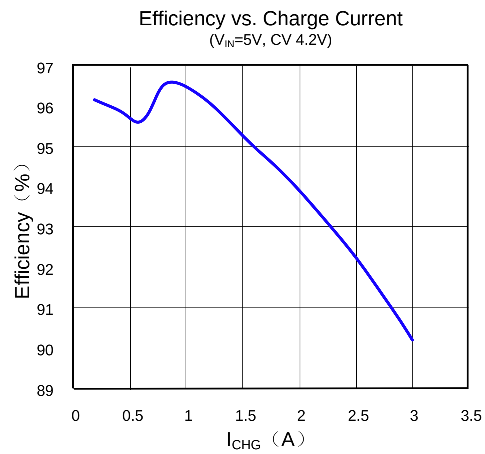


Figure 2. Efficiency vs. Charge Current

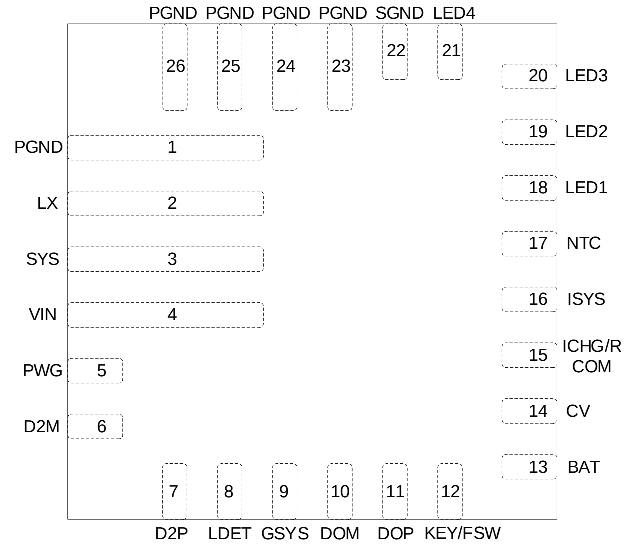
Ordering Information

Ordering Part Number	Package type	Top Mark
SY20751BTYC	QFN 4×4-26 RoHS Compliant and Halogen Free	**DGG*xyz***

Device code: DGG

x=year code, y=week code, z= lot number code

Pinout (Top View)



(QFN4x4)

Figure 3. Package Pinout

Pin No	Pin Name	Pin Description
1,23,24,25,26	PGND	Power ground.
2	LX	Switch node pin. Connect to external inductor.
3	SYS	System connection point. Decouple to GND with at least two 22µF ceramic capacitors.
4	VIN	Power input pin. Connect a MLCC from this pin to ground to decouple high frequency noise. This pin has OVP and UVLO functions to ensure the charger operates within a safe input voltage range.
5	PWG	Negative connection point to the NTC resistor network.
6, 7	D2M, D2P	Data pins for system output port2.
8	LDET	Load inserted detection pin.
9	GSYS	Gate driver for external system power MOSFET.
10,11	DOM, DOP	Data pins for system output port1.
12	KEY/FSW	Connect to a momentary push-button KEY from this pin to the ground. Pressing the button restarts the boost and GSYS. This pin is also used to program the boost switching frequency by connecting a resistor to the BAT pin.
13	BAT	Battery voltage sense pin.
14	CV	Battery cell voltage setting. Leave floating to set to 4.2V, pull low to set to 4.35V and pull high to set to 4.4V.
15	ICHG/RCOM	Connect a resistor to set the maximum charge current in charge mode. This pin is also used as battery internal-resistance compensation for battery level indication in boost mode.
16	ISYS	Connect a resistor to set the maximum system current in boost mode.
17	NTC	Battery thermal sense pin for thermal protection. Connect the pull-up resistor between NTC and BAT pins. Connect the pull-down resistor between NTC and PWG pins.
18,19,20,21	LED1-4	LED driver for battery level indicator. They are also used as battery level indication threshold adjustment pins, both in buck and boost mode.
22	SGND	Analog ground.

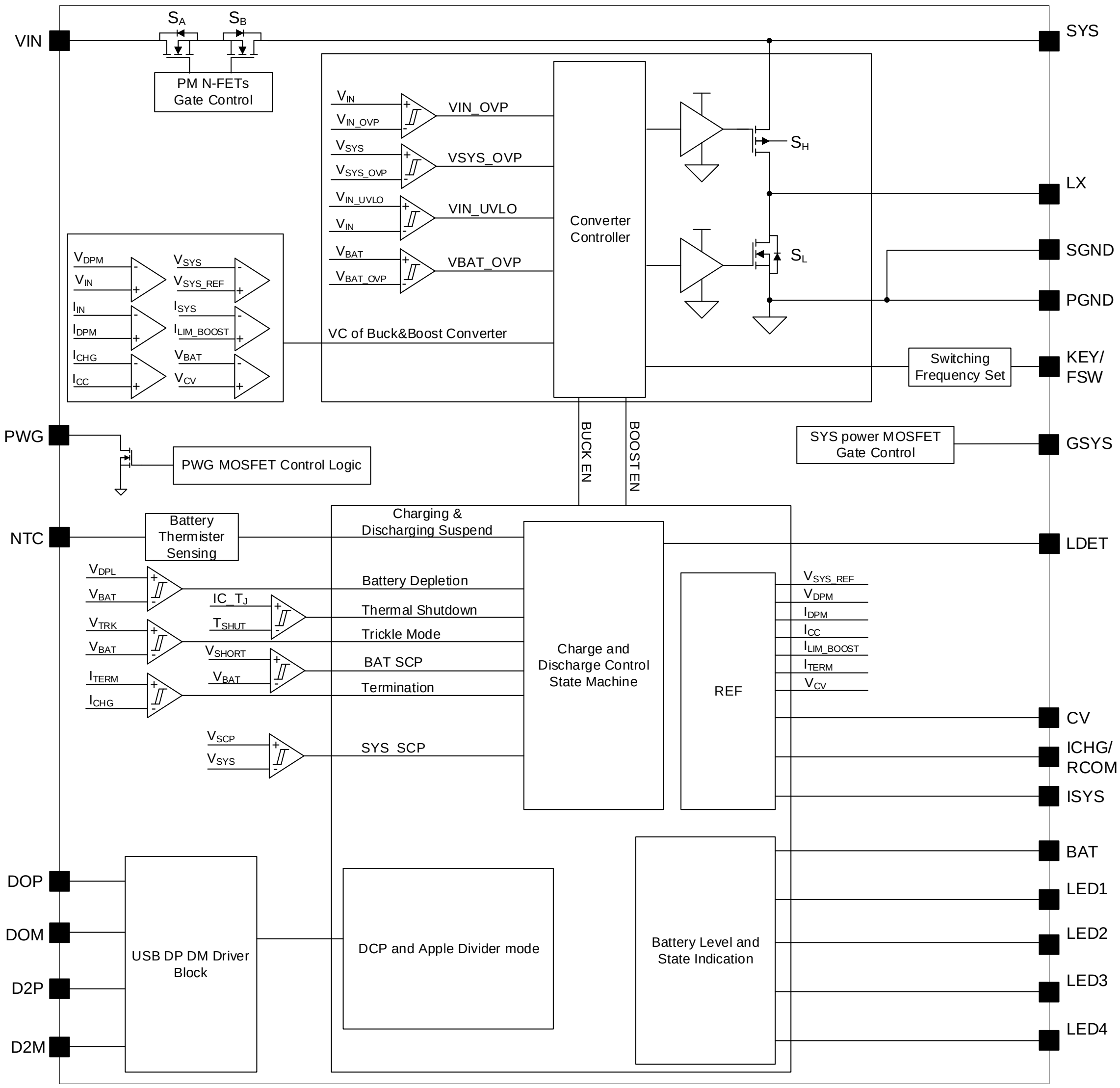


Figure 3. Block Diagram

Absolute Maximum Ratings (1)	Min	Max	Unit
VIN	-0.3	18	V
Others	-0.3	6	
Junction Temperature Range	-40	150	°C
Lead Temperature (Soldering,10sec.)		260	
Storage Temperature	-65	150	

Thermal Information (2)	Min	Max	Unit
θ_{JA} Junction-to-ambient Thermal Resistance		41.6	°C/W
θ_{JC} Junction-to-case Thermal Resistance		28.3	
P_D Power Dissipation T_A=25°C		2.5	W

Recommended Operating Conditions (3)	Min	Max	Unit
VIN, others	0	5.5	V
Junction Temperature Range	-40	125	°C
Ambient Temperature Range	-40	85	

Electrical Characteristics

T_A=25°C, V_{IN}=5V, C_{IN}=10µF, C_{BAT}=10µF, C_{SYS}=44µF, L=1.5µH, unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Bias Supply (V_{IN})						
V_{IN}	Supply Voltage		4.5		5.7	V
V_{UVLO}	V_{IN} under Voltage Lockout Threshold	V_{IN} rising and measured from VIN to SGND			4.5	V
ΔV_{UVLO}	V_{IN} under Voltage Lockout Hysteresis	Measured from VIN to SGND		150		mV
V_{OVP}	Input Overvoltage Protection	V_{IN} rising and measured from VIN to SGND	5.72	5.9	6.03	V
ΔV_{OVP}	Input Overvoltage Protection Hysteresis	Measured from VIN to SGND		100		mV
V_{DPM}	The Regulated SYS Voltage When VDPM Loop Works	Measured from SYS to SGND, GSYS turns on	4.69	4.77	4.85	V
Quiescent Current						
I_{BAT}	Battery Discharge Current	Disable Boost			20	uA
I_{IN}	Input Quiescent Current	Disable Buck			1.5	mA
Oscillator and PWM						
f_{OSC_BOOST}	Oscillator Frequency of Boost	R_F=50kΩ		350		kHz
f_{OSC_BUCK}	Oscillator Frequency of Buck			350		kHz
Power MOSFET						
R_{HIGH}	$R_{DS(ON)}$ of High Side P-FET	R_{SH}		30		mΩ
R_{LOW}	$R_{DS(ON)}$ of Low Side N-FET	R_{SL}		20		mΩ
R_{PM}	$R_{DS(ON)}$ of Power Path Management N-FETs	R_{SA}+R_{SB}		90		mΩ
I_{CHG_PEAK}	Peak Current of Switching FETs on Charge Mode			6		A
I_{BST_PEAK}	Peak Current of Switching FETs on Discharge Mode			11		A
Voltage Threshold and Regulation						
V_{CV}	Cell Charge Voltage Tolerance	V_{CV}=4.2V	-0.5		0.5	%
ΔV_{RCH}	CV Hysteresis for Recharge	V_{CV}=4.2V	50	100	150	mV
V_{SYS}	Discharge Output Voltage at SYS	V_{BAT}=3.7V, I_{SYS}=1A, R_{ISYS}=1.5kΩ	5.05	5.15	5.25	V
		V_{BAT}=3.7V, I_{SYS}=1.8A, R_{ISYS}=1.5kΩ	5.15	5.25	5.35	V
Current Regulation						
I_{CC}	Internal Charge Current Accuracy for Constant Current Mode	I_{CC}=3A, R_{CHG}=1.8kΩ	-8		8	%
		I_{CC}=1A, R_{CHG}=5.4kΩ	-10		10	%
I_{TC}	Internal Charge Current Accuracy for Trickle Current Mode	I_{TC}=1/8 I_{CC}, I_{CC}=3A	-30		30	%
		I_{TC}=1/8 I_{CC}, I_{CC}=1A	-50		50	%
I_{TERM}	Termination Current Accuracy	I_{TERM}=1/20 I_{CC}, I_{CC}=3A	-30		30	%
		I_{TERM}=1/20 I_{CC}, I_{CC}=1A	-60		50	%
I_{INMAX}	Internal Maximum Input Current Limit When Charger is Switching	I_{CHG}=1A	2.7		3.3	A
I_{INMIN}	Internal Minimum Input Current Limit When Charger is Switching	I_{CHG}=500mA			500	mA
I_{SYS_LL}	SYS Current with Light Load for Boost Auto Shutdown	V_{BAT}=3.7V, R_{ISYS}=1.5kΩ	30	50	70	mA

Electrical Characteristics

T_A=25°C, V_{IN}=5V, C_{IN}=10µF, C_{BAT}=10µF, C_{SYS}=44µF, L=1.5µH, unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
System and BAT OVP						
V_{SYS_OVP}	SYS Voltage OVP Threshold	Rising edge	102%	104%	106%	V_{SYS}
ΔV_{SYS_OVP}	SYS Voltage OVP Hysteresis	Falling edge		2%		V_{SYS}
V_{BAT_OVP}	BAT Voltage OVP Threshold	Rising edge	103%	105%	107%	V_{CV}
ΔV_{BAT_OVP}	BAT Voltage OVP Hysteresis	Falling edge		2%		V_{CV}
Battery Voltage Threshold						
V_{DPL}	Battery Depletion Threshold Accuracy in Boost Mode	Falling edge, R_{AD1}=50kΩ	2.65	2.75	2.85	V
		Falling edge, R_{AD1}=100kΩ	2.9	3.0	3.1	V
ΔV_{DPL}	Battery Depletion Hysteresis	Rising edge		450		mV
V_{TRK}	Battery Trickle Charge Threshold	Falling edge	2.45	2.6	2.7	V
ΔV_{TRK}	Battery Trickle Charge Hysteresis	Rising edge		250		mV
BAT Short Protection						
V_{SHORT}	Output Short Protection Threshold	V_{BAT} falling edge	1.9	2.0	2.1	V
SYS Current Limit						
I_{SYSMAX}	Maximum SYS Current Limit on Boost Mode	V_{BAT} =3.7V, R_{ISYS}=1.5kΩ	2.7	3	3.3	A
Timing						
T_{TC}	Trickle Current Charge Timeout			2		hour
T_{SYS_LL}	Boost Shutdown Deglitch Time with Light-load		22	27	32	s
Battery NTC Thermal Protection in Charge Mode						
V_{T1}	V_{COLD}, Cold (-2°C) Threshold	Rising edge	74.2	74.8	75.6	$\%V_{BAT}$
	Cold Hysteresis	Falling edge		2		$\%V_{BAT}$
V_{T2}	V_{COOL}, Cool (14°C) Threshold	Rising edge	59.6	60.4	61.2	$\%V_{BAT}$
	Cool Hysteresis	Falling edge		2		$\%V_{BAT}$
V_{T3}	V_{WARM}, Warm (50°C) Threshold	Falling edge	28.7	29.4	30.1	$\%V_{BAT}$
	Warm Hysteresis	Rising edge		2		$\%V_{BAT}$
V_{T4}	V_{HOT}, Hot (58°C) Threshold	Falling edge	23.7	24.3	24.9	$\%V_{BAT}$
	Hot Hysteresis	Rising edge		2		$\%V_{BAT}$
Battery NTC Thermal Protection in Boost Mode						
V_{COLD}	Cold (-18°C) Threshold	Rising edge	85	85.7	86.4	$\%V_{BAT}$
	Cold Hysteresis	Falling edge		2		$\%V_{BAT}$
V_{HOT}	Hot (58°C) Threshold	Falling edge	23.8	24.4	25	$\%V_{BAT}$
	Hot Hysteresis	Rising edge		2		$\%V_{BAT}$
KEY Active Voltage						
V_{KEY}	KEY Active Low Voltage	Falling edge			0.4	V

Note 1: Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

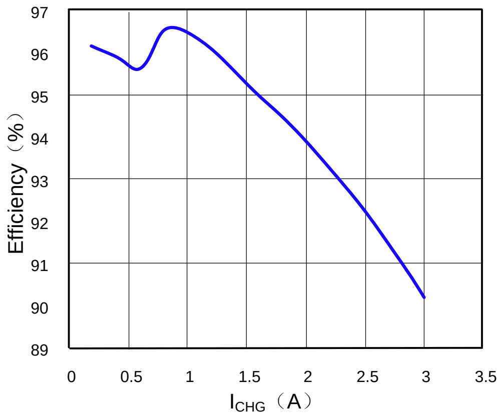
Note 2: Θ_{JA} is measured in the natural convection at T_A= 25°C on a low effective four-layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

Note 3: The device is not guaranteed to function outside its operating conditions.

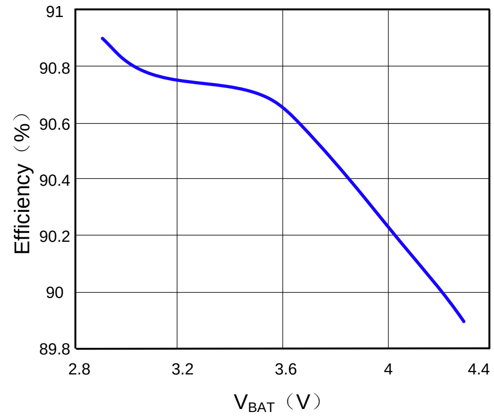
Typical Performance Characteristics

(T_A=25°C, V_{IN}=5V, R_{CHG}=1.8kΩ, R_{ISYS}=1.5kΩ, 1cell battery, unless otherwise specified)

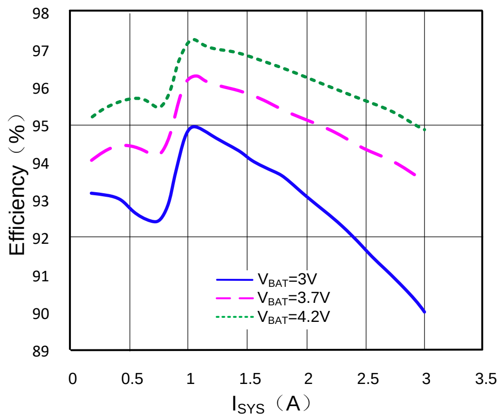
Efficiency vs. Charge Current
(V_{IN}=5V, CV 4.2V)



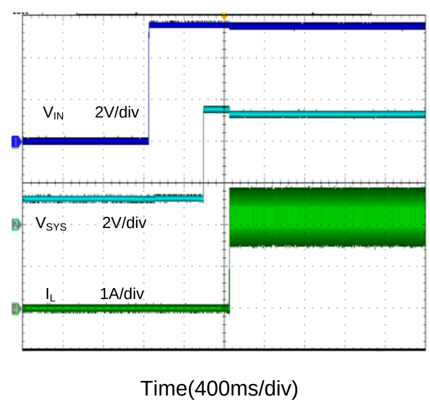
Efficiency vs. BAT Voltage
(V_{IN}=5V, CC 3A)



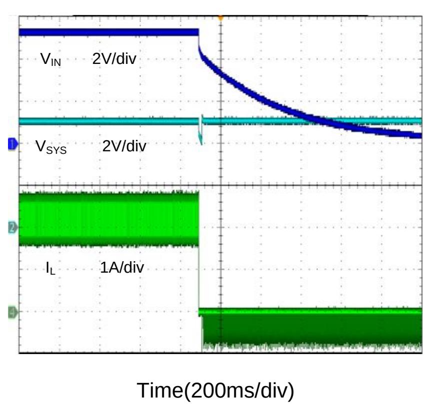
Efficiency vs. Discharge Current
(SYS=5V)



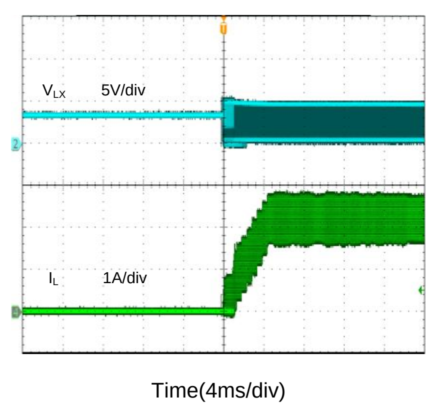
Adapter Insert
(V_{BAT}=3.5V)



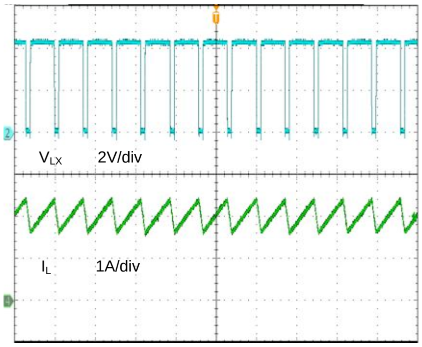
Adapter remove
(V_{BAT}=3.5V)



Charge Current Soft Start
(V_{BAT}=3.5V)

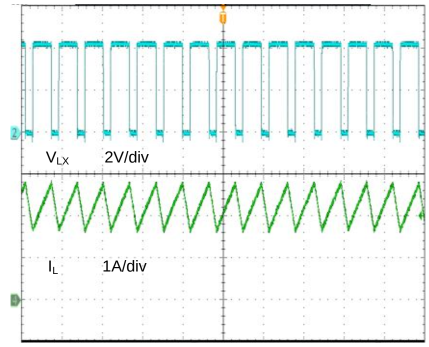


CV Mode Steady State
(V_{BAT}=4.2V)



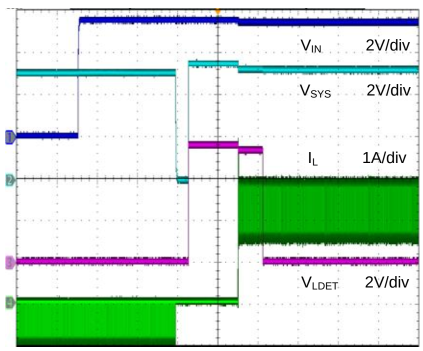
Time(4µs/div)

CC Mode Steady State
(V_{BAT}=3.5V)



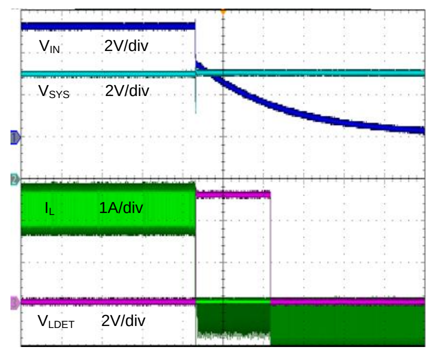
Time(4µs/div)

Boost To Buck Transition
(I_{SYS}=0.1A)



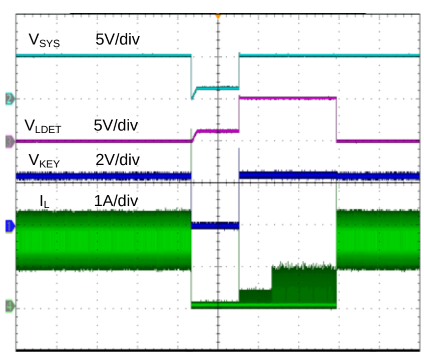
Time(200ms/div)

Buck To Boost Transition
(I_{SYS}=0.1A)



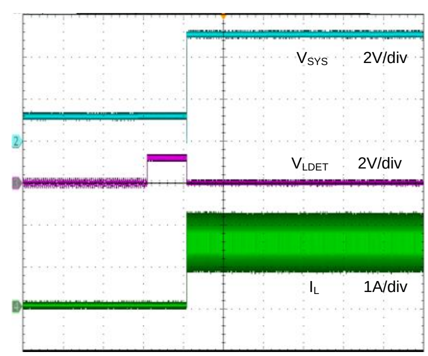
Time(200ms/div)

Press Key to Reset Boost



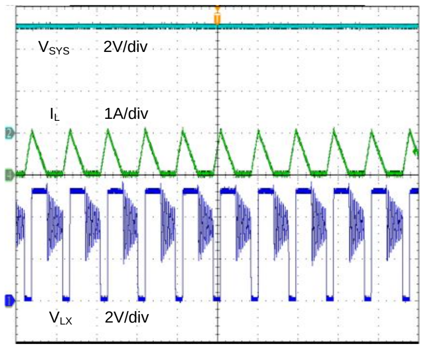
Time(400ms/div)

Load Insert To Enable Boost



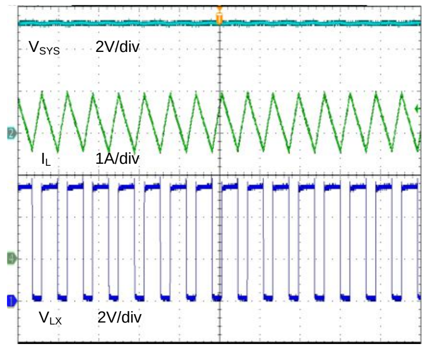
Time(400ms/div)

Boost Mode Steady State
(I_{SYS}=0.1A)



Time(4µs/div)

Boost Mode Steady State
(I_{SYS}=2A)



Time(4µs/div)

Application Information

The SY20751B is a bi-directional regulator designed for an 4.5-5.7V input range for single-cell Li-Ion battery power bank applications. It utilizes advanced bi-directional energy flow control with automatic input power source detection, enabling seamless switching between battery charge and power supply modes.

When connected to an external power supply, the SY20751B operates in battery charge mode, offering comprehensive protection functions. Without an external power supply, it switches to battery power supply mode, capable of delivering an output current of up to 3A.

Press Key Function:

The SY20751B features two operation modes controlled by the KEY actions. The functionality of the KEY pin is as follows:

1. **Single Click**: A single press on the push-button connected to the KEY pin will reset the device in either buck or boost mode.
2. **Double Click**: Two rapid push-button presses (within 300ms) while in boost mode will deactivate GSYS and shutdown boost mode.

The KEY pin also sets the switching frequency of boost mode. This is achieved by connecting a resistor from the KEY pin to the BAT pin.

LED Status Indicators:

Connecting an LED to the STAT pins can indicate the charging status, the discharging status, and the fault mode as shown below:

- **Charging Mode:** When the adapter is present, the SY20751B operates in charging mode, even after the charging is complete. In charging mode, the LED ON indicates ongoing charging. LED OFF indicates charging is complete.

- **Discharging Mode:** When the adapter is removed, and the boost mode is enabled, the device will operate in discharging mode. In discharging mode, the LEDs indicate the battery level, as shown in the table below.

- **Fault Mode:** In the event of any fault during charging mode (input OVP, battery OVP, SYS OVP, NTC faults, timeout, SYS short), the LEDs flicker.

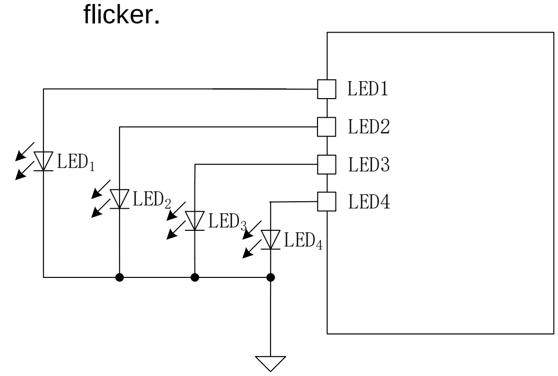


Figure 5. LED Configuration for Status Indicators

Table 1. LED Status Indication

Operation	Level	V_{BAT}	LED1	LED2	LED3	LED4
Charging	0-25%	< V_{TH1}	Flicker	OFF	OFF	OFF
	25-50%	V_{TH1}~ V_{TH2}	ON	Flicker	OFF	OFF
	50-75%	V_{TH2}~ V_{TH3}	ON	ON	Flicker	OFF
	75-100%	V_{TH3}~V_{CV}	ON	ON	ON	Flicker
	100%	=V_{CV}	ON	ON	ON	ON
Discharging	0-5%	V_{DEP}~ V_{TH0}	Flicker	OFF	OFF	OFF
	5-25%	V_{TH0}~ V_{TH1}	ON	OFF	OFF	OFF
	25-50%	V_{TH1}~ V_{TH2}	ON	ON	OFF	OFF
	50-75%	V_{TH2}~ V_{TH3}	ON	ON	ON	OFF
	75-100%	≥V_{TH3}	ON	ON	ON	ON

Flicker—ON 640ms, OFF 640ms.

The thresholds (V_{TH1}, V_{TH2}, V_{TH3}) can be controlled using the adjustment resistors (R_{AD1}, R_{AD2}, R_{AD3}, R_{AD4}) connected to LED1~LED4 pins.

	Charge mode	Discharge mode
V_{TH1}	83%*V_{CV}+0.5R_{AD2}/R_{AD1}	80%*V_{CV}+ 0.5R_{AD2}/R_{AD1}
V_{TH2}	88%*V_{CV}+0.5R_{AD3}/R_{AD1}	85%*V_{CV}+ 0.5R_{AD3}/R_{AD1}
V_{TH3}	93%*V_{CV}+0.5R_{AD4}/R_{AD1}	90%*V_{CV}+ 0.5R_{AD4}/R_{AD1}

Changing the adjustment resistors using external switches can provide different battery level thresholds for charge and discharge modes.

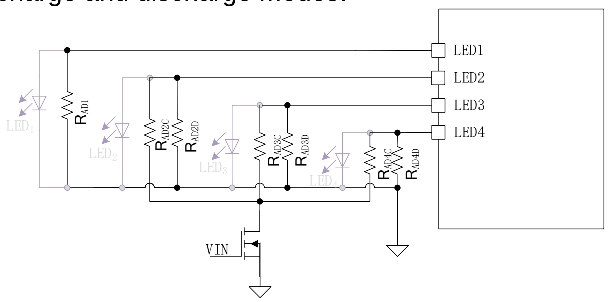


Figure 6.

Input Dynamic Power Management:

The SY20751B can effectively manage the input power limit. It has input VDPM and IDPM functions to protect the input source. The device can detect the input source power capability and automatically protect it from overloading.

Charge Current Setting:

In charging mode, the SY20751B mirrors the current information to the ICHG pin, and the charge current is determined by the equivalent resistance from the ICHG pin to SGND. The equivalent resistance R_{CHG} can be calculated using the following equation:

$$R_{CHG} = R_C + R_{COM}$$

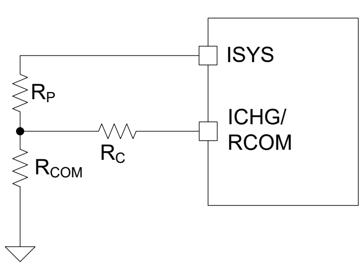
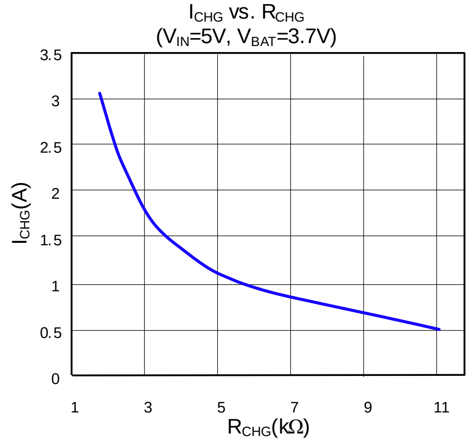
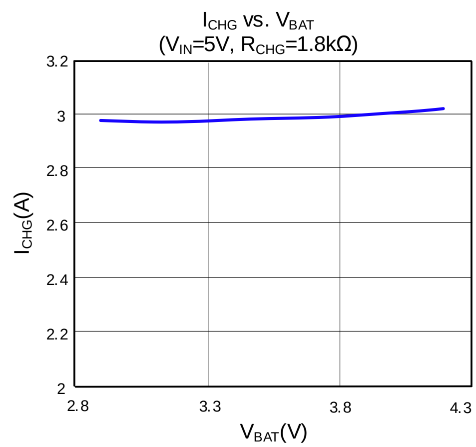


Figure 7.

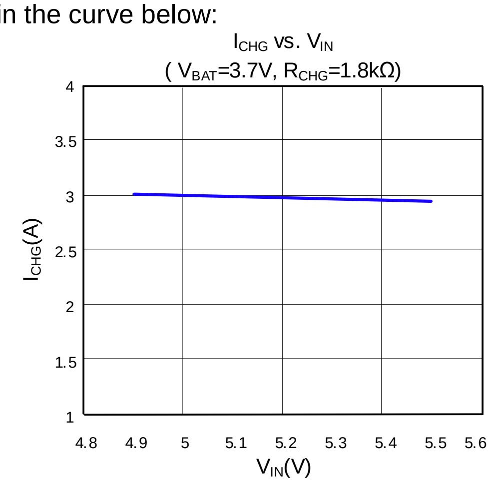
The relationship between the charging current and R_{CHG} is shown in the curve below:



The SY20751B has good I_{CHG} regulation performance even across wide V_{IN} and V_{BAT} ranges. The relationship between the charging current and V_{BAT} is shown in the graph below:



The relationship between the charging current and V_{IN} is shown in the curve below:



SYS Current Limit Setting:

In discharge mode, the SY20751B mirrors the system output current information to the ISYS pin, and the system output current limit is determined by the resistance from the ISYS pin to the SGND.

$$R_{ISYS} = R_P + R_{COM}$$

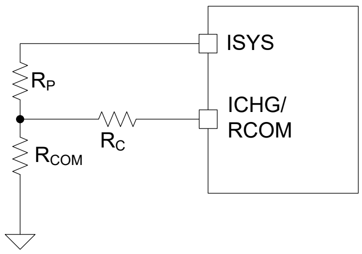
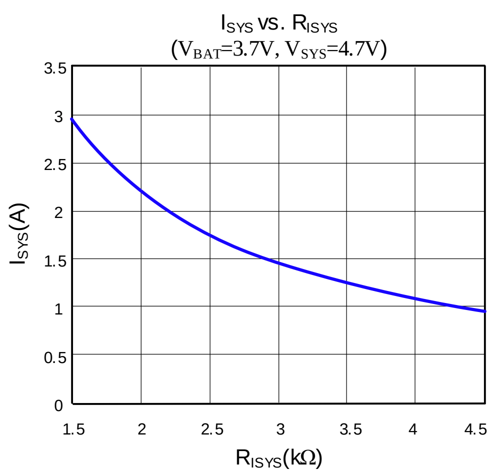
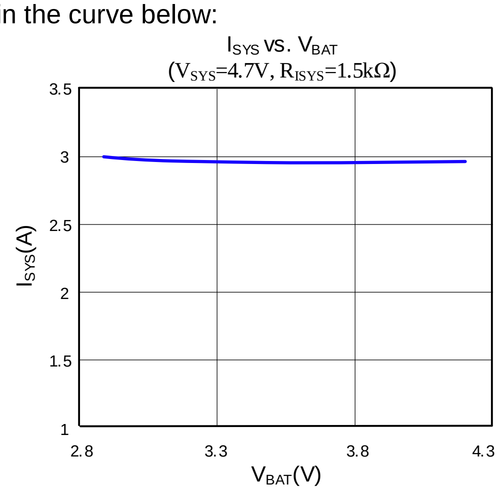


Figure 8.

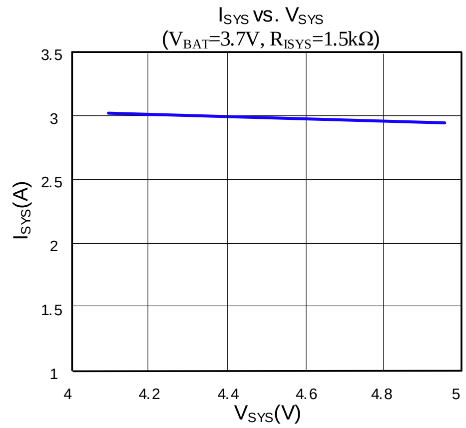
The relationship between the system output current limit and R_{ISYS} is shown in the graph below:



The SY20751B offers good I_{SYS} regulation performance even across the V_{SYS} and V_{BAT} ranges. The relationship between the system output current limit and V_{BAT} is shown in the curve below:



The relationship between the system output current limit and V_{SYS} is shown in the graph below:



Battery Internal Resistance Compensation:

In boost mode, the SY20751B will use the RCOM pin to compensate for the battery's internal resistance R_{BAT}. The sensed voltage will be added to the battery voltage on the BAT pin as the actual battery voltage used for LED indication. The compensation resistor R_{COM} is determined with the following equation:

$$R_{COM} = \frac{R_{BAT}}{90\mu}$$

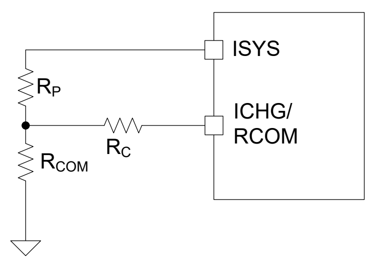


Figure 9.

Portable Device Insert Detection:

The SY20751B can detect the inserted load (phone or other devices) when the LDET pin is pulled high. Its load-inserted detection feature can be utilized in applications involving two ports.

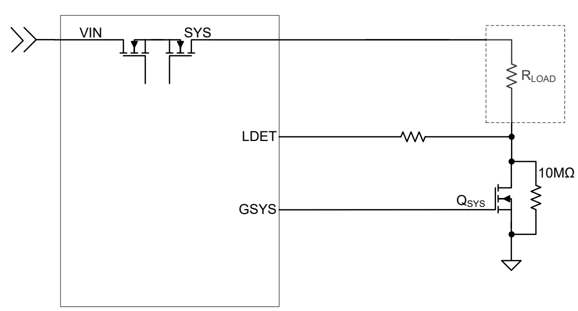


Figure 10.

GSYS Control:
When the adapter is present in charge mode, GSYS will turn on after load insertion is detected on the SYS port.

In boost mode, GSYS turns on after load insertion is detected on SYS and turns off after boost shuts down.

Buck Charger Operation:
When the adapter is present, the SY20751B operates as a synchronous buck mode battery charger. It utilizes a 350kHz switching frequency to minimize the solution size.

The charger will operate in battery short mode, trickle charge mode, constant current charge mode, and constant voltage charge mode according to the battery voltage. The charge current in every mode is shown in the graph below:

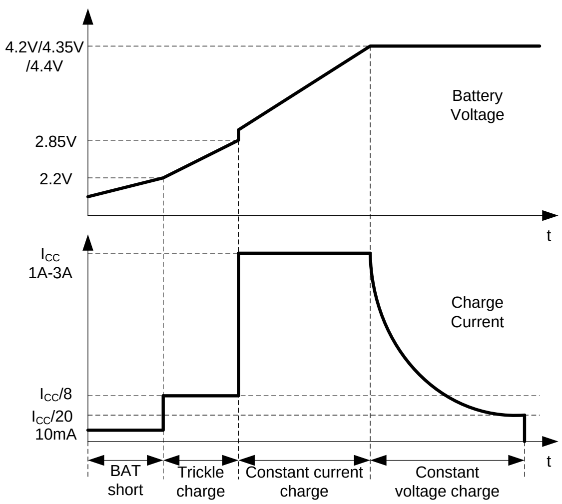


Figure 11.

In charging mode, the SY20751B offers protection features to protect the device and the battery:

- **Input Overvoltage Protection:** The SY20751B incorporates overvoltage protection for both VIN and SYS. In the event of input OVP, it deactivates the blocking MOSFETs and the switching charger. Normal operation resumes automatically upon removal of the fault.
- **Battery Overvoltage Protection:** Charging stops when BAT OVP is detected in the SY20751B. Normal operation resumes automatically upon removal of the fault.
- **BAT Short Protection:** The SY20751B will limit the charge current until the fault is removed.

Protection Features:
The SY20751B offers the following protections:

- **Input Overcurrent Protection:** The SY20751B will turn off the blocking MOSFETs to avoid SYS overload.
- **Timeout Protection:** The charger is designed to identify a bad battery. If the charger operates in trickle mode for over 2 hours, it will stop charging and latch off. Recycling the input is necessary to return to normal operation.

Boost Mode Operation:
The battery can power the portable device connected to the SYS pin when the adapter is disconnected. The converter works as a programmable synchronous boost, delivering up to 3A current to the load.

The boost-regulated voltage of the device will adjust based on the system current, as shown in the diagram below. To compensate for the voltage drop across the cable, the device will increase the SYS-regulated voltage by 100mV when the load current increases.

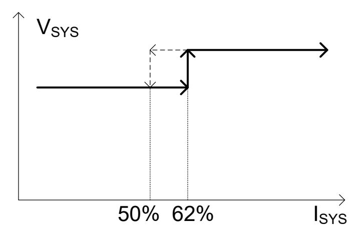


Figure 12.

While in boost mode, the SY20751B extends the following protections to the portable device, the battery, and itself:

- **SYS Overvoltage Protection:** If a SYS OVP event is detected, the SY20751B stops switching to prevent overvoltage.
- **BAT Depletion Protection:** In the event of BAT depletion, the SY20751B halts operation.

Boost Switching Frequency Control:
The boost switching frequency of SY20751B can be programmed by the pull-up resistor R_F between the KEY/FSW and BAT pins.

The frequency is determined by the resistor with the following equation:

$$F_{SW} = \frac{1.75 \times 10^7}{R_F} (kHz)$$

- **SYS Short Protection:** The SY20751B will turn off the system output when an SYS short occurs.

- **Battery Thermal Protection:** The converter will stop switching when the NTC voltage is lower than the VHOT threshold or higher than the VCOLD threshold. The device will resume normal operation when the fault is removed in charge mode.

- **Thermal Shutdown Protection:** The device will stop operation when the junction temperature is higher than 150°C. The device will resume normal operation when the fault is removed.

Charging NTC Guideline:

The SY20751B offers flexible charge current settings for different temperature ranges. At cooler temperatures (T1–T2), the charge current can be set to 50% of the fast charge current. At warmer temperatures (T3 - T4), the charge current can also be reduced to 50% of the fast charge current.

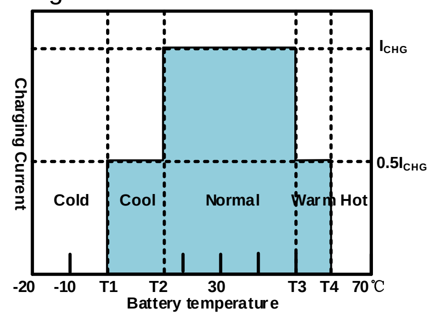


Figure 1

Design Procedure

The following paragraphs provide information on the selection process for the filter capacitors (C_{IN}, C_{BAT} and C_{SYS}), inductor (L), NTC resistors (R_1, R_2), and current setting resistors (R_{CHG}, R_{SYS}) based on the target application specifications.

NTC Resistor:

The SY20751B monitors the battery temperature by measuring the BAT and NTC voltages. The temperature sensing network is shown below, when using a 103-AT type thermistor:

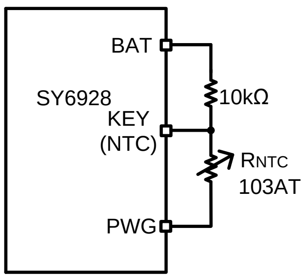


Figure 14.

Input Capacitor C_{IN}:

To handle the ripple current, X5R or X7R ceramic capacitors with greater than 10µF capacitance are recommended. The voltage rating of the capacitor should be higher than 16V.

Output Capacitor C_{BAT}:

The charger output capacitor is selected to handle the output ripple noise requirements. This ripple voltage is related to the capacitance and its equivalent series resistance (ESR). For the best performance, it is recommended to use an X5R or better grade low ESR ceramic capacitor. The voltage rating of the output capacitor should be higher than 10V.

A capacitance of greater than 10µF is recommended for most applications where a low output ripple is desired.

Output Capacitor C_{SYS}:

The boost output capacitor is selected to handle the output ripple noise and outload transient requirements. For the best performance, it is recommended to use an X5R or a better-grade, low-ESR ceramic capacitor. The voltage rating of the output capacitor should be higher than 10V.

For low output ripple and improved transient performance, using at least two capacitors with capacitance greater than 22µF is recommended for an SYS current lower than 2A. Using three capacitors with capacitance greater than 22µF is recommended for a SYS current higher than 2A.

Inductor L:

When selecting the inductor, consider the following factors:

1. Choose the inductance to achieve the desired ripple current. The ripple current is suggested to be approximately 40% of the average input current. Given that the boost inductor current is more critical than the charger mode, base the inductor selection on the boost mode.

   The minimum inductance is calculated as follows:

$$L = \left(\frac{VBAT}{VSYS}\right)^2 \frac{VSYS - VBAT}{ISYS \cdot FSW \cdot 40\%}$$

   (Where F_{SW} is the switching frequency, and I_{SYS} is the maximum discharge current.)
   The SY20751B is tolerant to different ripple current amplitudes. Therefore, the final inductance selection can deviate slightly from the calculated value without significantly affecting performance. For most SY20751B applications, an inductance of 1.5µH is recommended.

2. The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT} > \frac{V_{SYS} \cdot I_{SYS}}{V_{BAT}} + \left(\frac{V_{BAT}}{V_{SYS}}\right)^2 \frac{V_{SYS} - V_{BAT}}{2 \cdot F_{SW} \cdot L}$$

3. The DC resistance (DCR) of the inductor and the core loss at the switching frequency should be sufficiently low to meet the desired efficiency requirements. It is recommended to select an inductor with DCR < 10mΩ.

Application Schematic

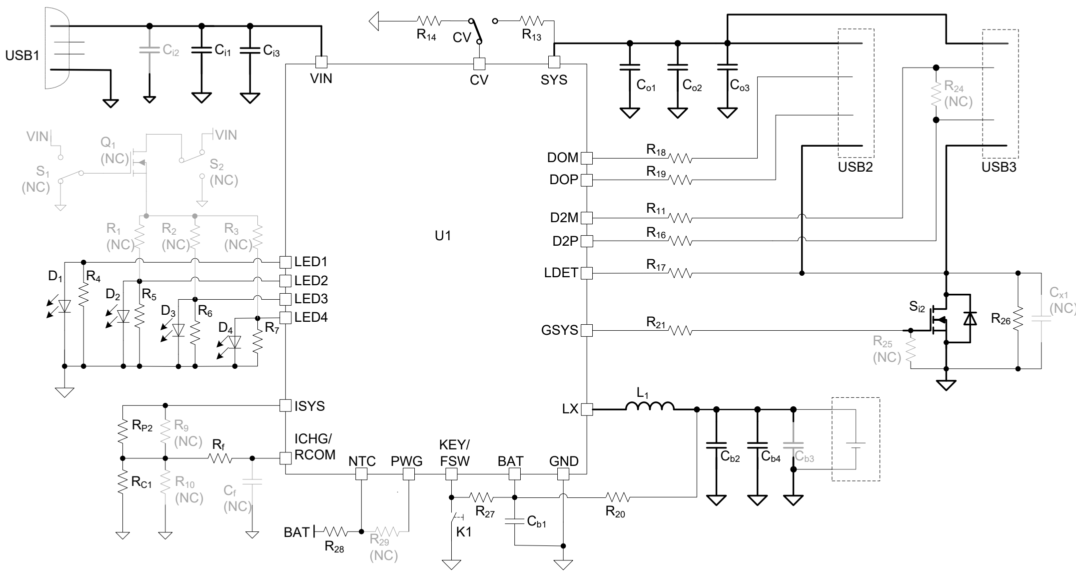


Figure 15. Typical Application Circuit

BOM List

Designator	Description	Part Number	Manufacturer
U1	3IN1, Highly Integrated Bi-Directional Power Regulator for Single-Cell Battery Power Bank Applications	SY20751B	Silergy
L1	Inductor 1.5µH	SPM6530T-1R5M	TDK
Ci1, Cb4	16V/10µF	C3216X7R1C106K160AC	TDK
Co1, Co2	16V/22µF	C3216X5R1C226M160AB	TDK
Cb1	1µF/25V	CGA4J3X7R1E105K125AB	TDK
Ci3, Co3, Cb2	100nF/50V	C1608X7R1H104K080AE	TDK
Cb3, Ci2, Cf, Cx1	NC		
R1, R2, R3, R9, R10, R24, R25, R29	NC		
R4	100kΩ, 0603, 5%		
R5, R6, R7, R13, R14, R17, R21, R28	10kΩ, 0603, 5%		
R11, R16, R18, R19, Rc1	0Ω, 0603, 5%		
R20	10Ω, 0603, 5%		
R26	2MΩ, 0603, 5%		
R27	51kΩ,0603, 1%		
Rf	2.7kΩ,0603, 1%		
RP2	1.5kΩ,0603, 1%		
CV, S1, S2	Jumper		
D1, D2, D3, D4	Chip LED 0603		
K1	Touch Switch		
Q1	NC		
USB1	MicroUSB Plug		
USB2, USB3	MicroUSB Receptacle		

PCB Layout Guide:

For best performance of the SY20751B, the following guidelines must be followed:

1. Enhance thermal and noise performance by maximizing the PCB copper area connected to the GND pin.
2. For the best efficiency and to minimize switching noise, the following components should be placed close to the device: C_{IN}, L, C_{SYS}, and C_{SYS}.
3. The main MOSFET, rectifier MOSFET, and CSYS loops must be as small as possible.
4. Place the inductor input terminal as close to the LX pin as possible.
5. Route the analog ground separately from the power ground. The ground of the small signal components (R_{CHG}, R_{ISYS}, LED1~LED4) must be connected to the analog ground node.

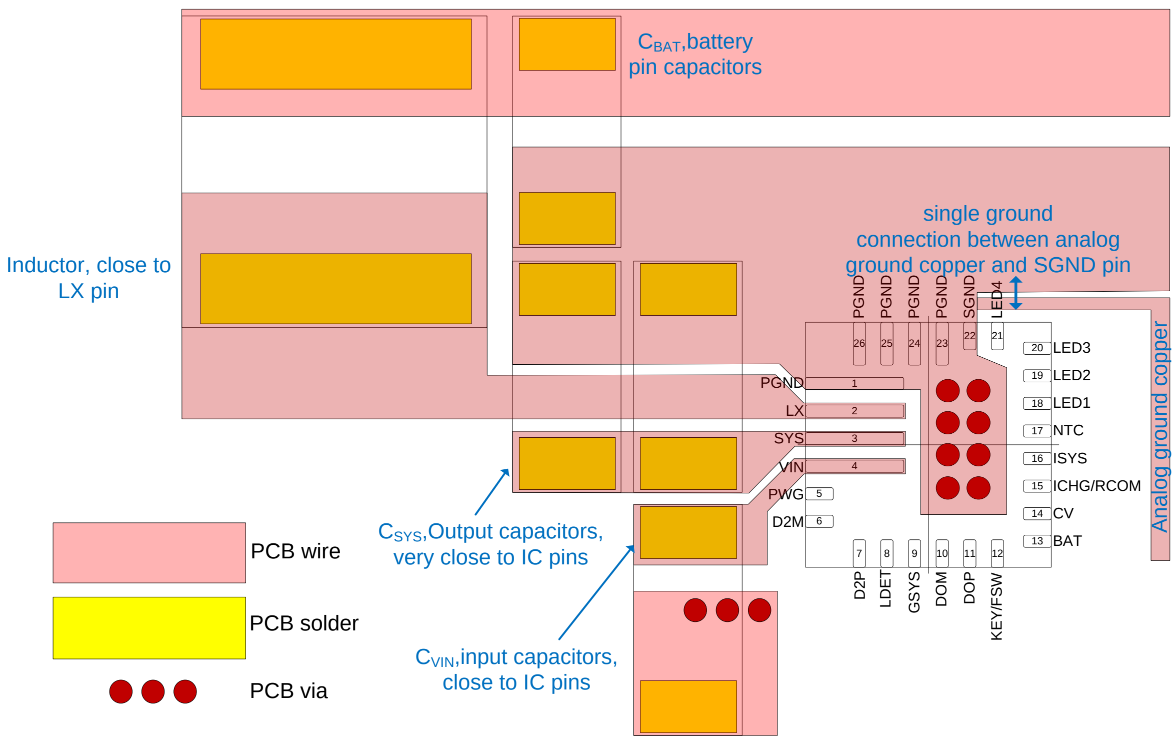
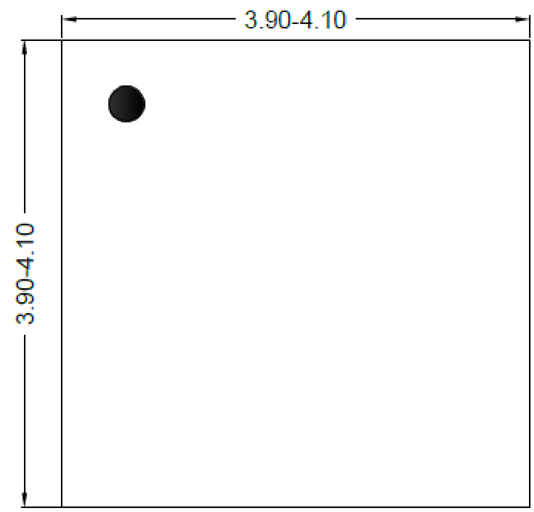
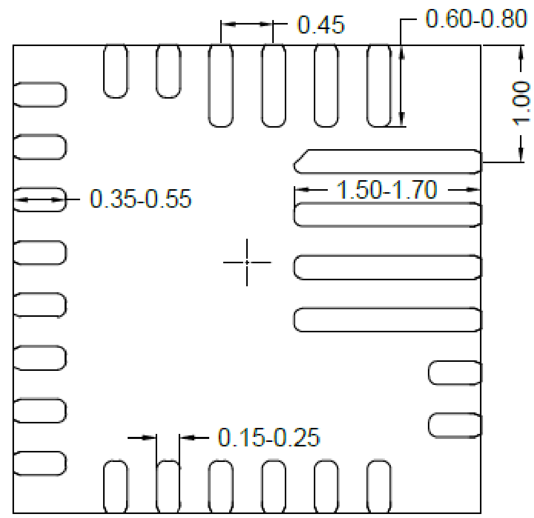


Figure 15. PCB Layout Suggestion

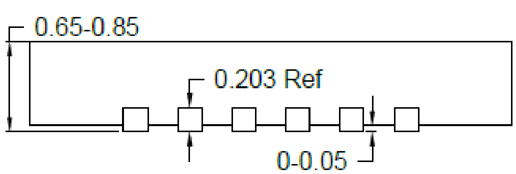
QFN4×4-26 Package Outline Drawing



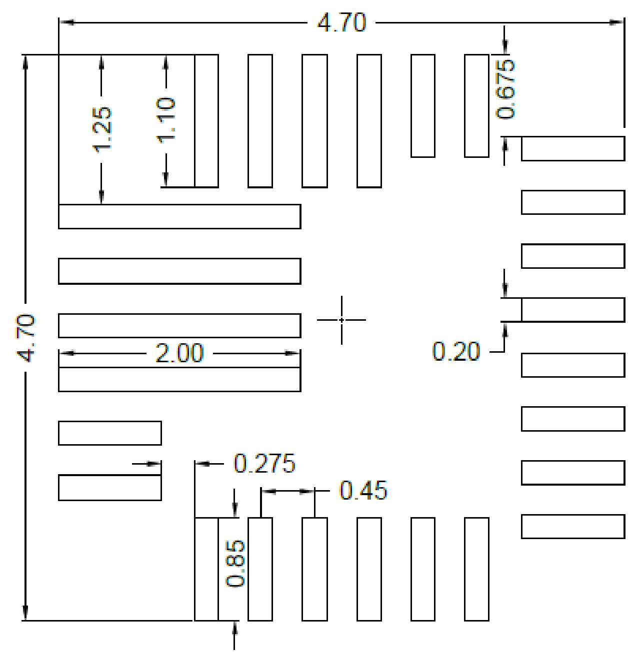
Top View



Bottom View



Side View

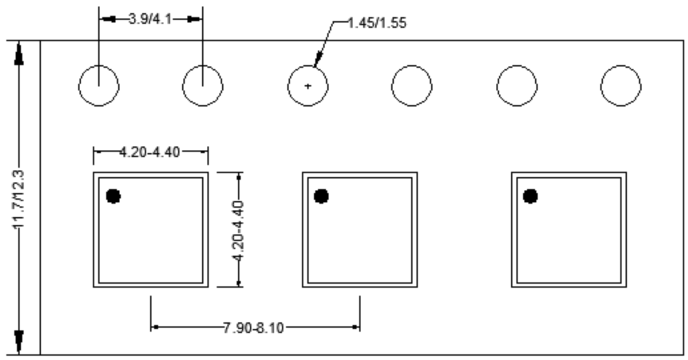


Recommended PCB Layout (Reference Only)

Notes: All dimensions are in millimeters and exclude mold flash and metal burr.
The center line refers to the chip body center.

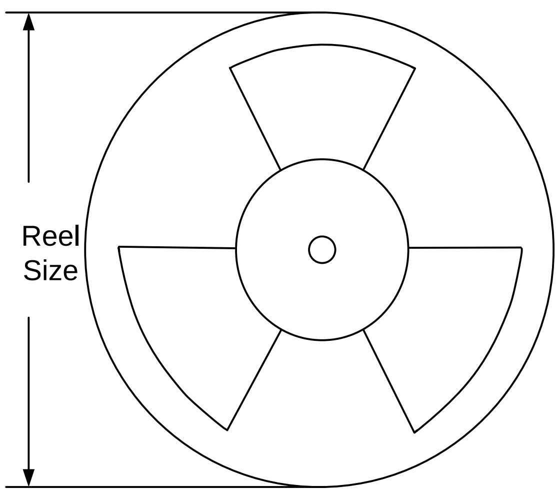
Taping & Reel Specification

QFN4x4 Taping Orientation



Feeding direction →

Carrier Tape & Reel Specification for Packages



Package type	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel
QFN4x4	12	8	13"	400	400	5000

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