

DESCRIPTION

TP4316 is a single-chip power management System-on-Chip (SoC) integrating lithium battery linear charging management, Type-C protocol, single-port charge & discharge, synchronous boost conversion, battery level indication and multiple protection functions. It delivers a complete single-chip power supply solution for lithium battery-powered electronic devices such as power banks.

The device embeds a 1 A linear charging scheme that supports charging of 0 V dead batteries, featuring three charging phases: trickle charge, constant current charge and constant voltage charge with a typical float voltage. It intelligently adjusts charging current based on internal IC temperature and input voltage. Built with an internal PMOSFET architecture and anti-reverse charging circuit, TP4316 eliminates the need for external sensing resistors and isolation diodes.

TP4316 integrates comprehensive safety protections including temperature compensation, thermal protection, over-charge protection, over-discharge protection, output over-voltage protection, output over-current protection and output short-circuit protection to safeguard both the IC and lithium-ion battery.

Its synchronous boost converter delivers up to 1 A output current with a peak conversion efficiency of 91%. Under no-load conditions, the IC automatically enters sleep mode, reducing quiescent current down to 20 μ A.

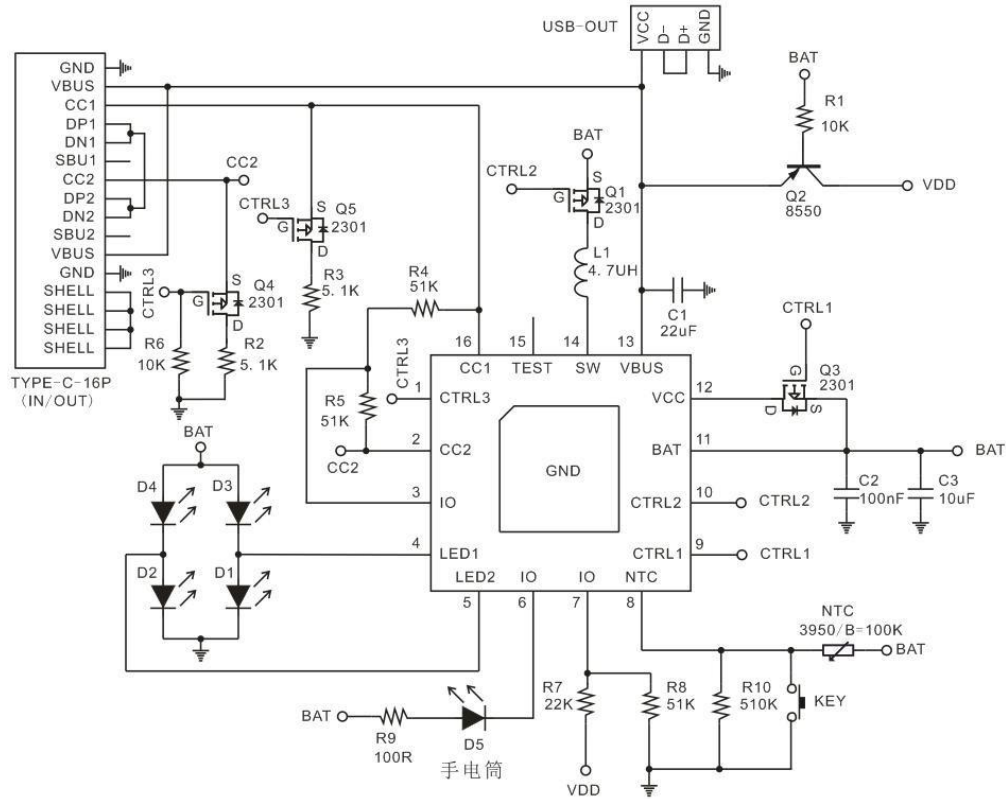
KEY FEATURES

- Single-port charge & discharge with synchronous boost conversion, supports charging while discharging
- 1 A synchronous boost converter and 1 A linear charging function
- Up to 91% discharge efficiency at 1 A output current
- No external MOSFET, sensing resistor or isolation diode required
- Automatic boost activation upon load insertion; auto sleep mode after load removal
- Single-port charge-discharge design with intelligent charge/discharge identification and automatic recharge
- Customizable battery level indicator with 4/2/1 LEDs:
4-LED version: TP4316_4D
2-LED version: TP4316_2D
1-LED version: TP4316_1D
- Up to 600 mA Charging Current
- Flashlight output function supported
- NTC temperature sensing function available
- Ultra-low power consumption, standby current as low as 20 μ A
- Comprehensive multi-protection circuits for high reliability
- Package: QFN3×3-16L

APPLICATION

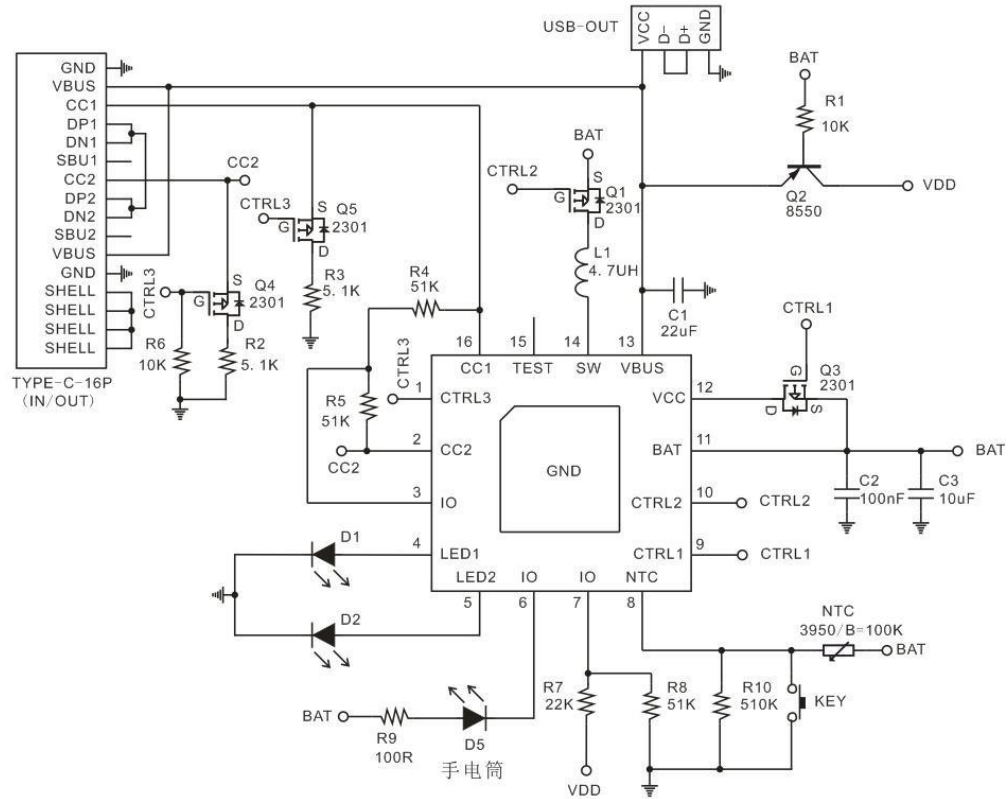
- Power banks
- Lithium battery-powered electronic devices
- Other low-power power management applications

TYPICAL APPLICATION CIRCUIT

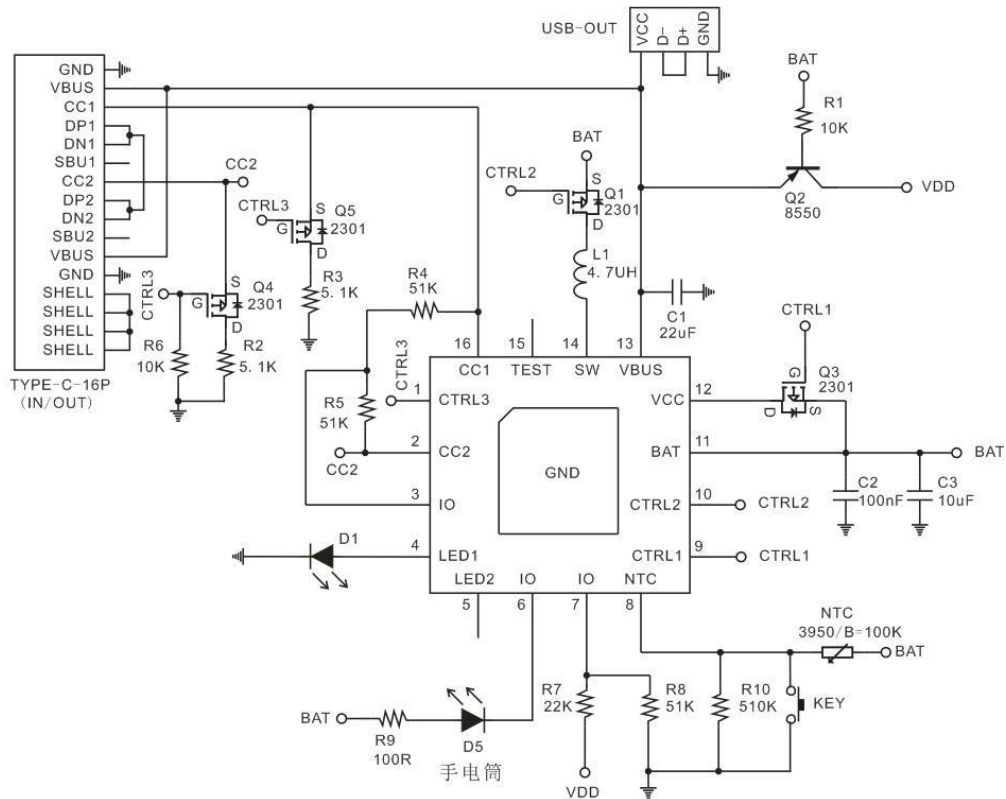


Typical Application Circuit for 4 LED Indicators

Note: When designing the PCB layout, C1, C2, and C3 must be placed close to the chip. In practical applications, if the flashlight functionality is not required, the IC pins may remain unconnected. If the NTC functionality is not required, connect a 10 kΩ resistor to BAT.

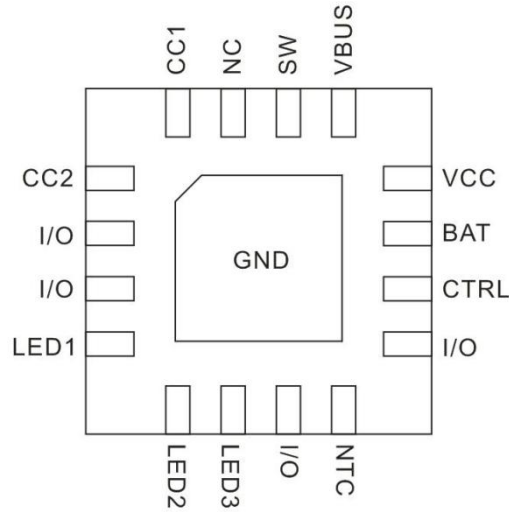


Typical Application Circuit for 2 LED Indicators



Typical Application Circuit for 1 LED Indicator

PIN CONFIGURATION



QFN3*3-16L

ORDER DESCRIPTION

Pin No	Pin Name	Description
1	CTRL3	Chip signal control pin CTRL3
2	CC2	USB-C Detection Port CC2
3	I/O	Chip I/O Port
4	LED1	Battery Level Indicator LED Driver Circuit
5	LED2	Battery Level Indicator LED Driver Circuit
6	I/O	Chip I/O Port
7	I/O	Chip I/O Port
8	NTC	For the battery temperature monitoring terminal: when the NTC function is not in use, connect the NTC pin to a 10 kΩ resistor between BAT and ground.
9	CTRL1	Chip signal control pin CTRL1
10	CTRL2	Chip signal control pin CTRL2
11	BAT	Lithium-ion battery cathode
12	VCC	Power input terminal
13	VBUS	Bidirectional DC 5 V, input and output terminals
14	SW	Power transistor switch terminal
15	TEST	Chip Testing Pin
16	CC1	USB-C Detection Port CC1
Exposed PAD	GND	The heat sink, which connects to the chip's ground pin, must be properly soldered to the PCB's ground trace.

ORDER INFORMATION

Order number	Product Description
TP4316	Package Size: QFN3*3-16L

ABSOLUTE MAXIMUM RATINGS (NOTE 1)

PARAMETER	Range	Unit
VDD to GND voltage	-0.3~+5.5	V
Other pin to GND voltage	-0.3~+5.5	V
Storage temperature	-40~+150	°C
Operating junction temperature	-40~+125	°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Range	Unit
VCC	Input Voltage	0.5~5	V
T _{OP}	Operating ambient temperature	-40~+70	°C

Note 1:

Exceeding the absolute maximum rating range may result in permanent damage to the IC. Within the recommended operating range, the IC works properly without full warranty for all individual parameters, though not all performance specifications are guaranteed under every condition.

Electrical Characteristics define DC and AC electrical specifications of the device under specified test conditions within the recommended operating range to guarantee designated performance parameters; accuracy is not warranted for parameters lacking min/max specs, while typical values represent typical device characteristics.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, VCC=5 V, BAT=3.7 V, Ta=25°C

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Linear Charge						
V _{CC}	Input Voltage		4.5	5	5.5	V
V _{BAT}	Battery Voltage		2.95		4.4	V
V _{FLOAT}	Stable output (float charge) voltage			4.2		V
ΔV _{RECHRG}	Recharge threshold voltage			4.1		V
I _{BAT}	BAT Constant Current Charging Current	V _{CC} =4.75 V-5.25 V		1		A
V _{TRK}	BAT Trickle Charge Threshold Voltage	V _{BAT} Raising		2.8		V
V _{TR_HYS}	Trickle charging hysteresis voltage			100		mV
Synchronous Boost						
V _O	Boost output voltage		4.95	5.1	5.25	V
	Output current	BAT=3.6V, V _{out} >4.8 V				
V _{OVP}	Overvoltage protection output			5.8		V
V _{OVP_DIS}				5.4		V
V _{UVLO}	Overvoltage and Undervoltage Protection	V _{BAT} Falling				
V _{UVLO_R}	Voltage Rise and Voltage Drop Recovery	V _{BAT} Raising				
I _{BAT1}		V _{out} =5.5 V No switching		1		mA
I _{BAT2}		V _{out} =4.5 V switching		60		mA
I _{auto_off}	Automatic shutdown load current	BAT=3.6 V, C _{out} =20 μF		60		mA
I _q	Quiescent current			30		μA
F _{OSC}	Working frequency			1		MHz
OTP	Overtemperature protection	Limited to chip internal temperature		150		°C
OTP_HYS	Delaying	Limited to chip internal temperature		20		°C

APPLICATION DESCRIPTION

Charging System

The internal charging current of TP4316 is fixed at 1 A. The pre-charge function is activated when the battery voltage drops below 2.8 V, with the pre-charging current equal to 10% of I_{ch} . It supports charging for 0V dead batteries and adopts a 3-stage charging scheme: trickle charge, constant current charge and constant voltage charge. The charging current will decrease as the internal IC temperature rises, and current derating starts at 130°C (only the IC internal junction temperature is monitored).

Boost System

In standby mode, the boost converter turns on automatically once the detected load current exceeds a typical value of 10 μ A. If the output load current is lower than the typical 60 mA, the IC will enter standby mode automatically after an 8-second delay. This synchronous rectified boost converter achieves a maximum conversion efficiency of 91% with a fixed 5.1 V output voltage. When the output current exceeds 1 A, the output voltage will be reduced. Over-voltage protection triggers when the output voltage rises above 5.8V, and the IC automatically resumes normal operation once the output voltage falls back to 5.4 V. It is equipped with output over-current protection, which can be reset automatically by plugging/unplugging the load. The switching frequency is 1 MHz. During discharge, thermal protection will shut down the output and switch to standby mode when the internal IC temperature reaches 150°C (only the IC internal junction temperature is monitored).

Charge While Discharging

TP4316 supports charge-while-discharge operation. That is, an external charger can charge both the power bank and connected mobile phones simultaneously during operation. The IC continuously detects whether an external charger is inserted while boosting. Once a charger is detected, it intelligently distributes current to charge the power bank and the connected mobile device according to the external input current magnitude. The boost function restarts automatically if the external charger is removed.

NTC Function

TP4316 integrates an NTC temperature sensing circuit to monitor battery temperature.

During charging: Charging is suspended if the battery temperature is lower than 0°C or higher than 45°C.

During discharging: Discharging is cut off if the battery temperature falls below -10°C or rises above 60°C.

Key Operation

TP4316 supports recognition of short press and long press operations.

Short press: A single short press triggers the LED indicators to display the remaining battery capacity; the LEDs will turn off after 2 seconds.

Long press: Hold the key for 2 seconds to turn on the flashlight; hold the key for another 2 seconds to turn off the flashlight.

Single-Port Discharge Detection

When charging a mobile device, the system generates a charger detection signal at the output terminal with a cycle of 2 s and a pulse width of 4 ms. If no external charger is connected, the output voltage drops to 4.7 V during the 4ms pulse, which is recognized as no charger detected.

If an external charger is connected: The output voltage remains above 4.7 V during the 4ms pulse, the IC identifies the charger insertion and automatically enters charge-while-discharge mode.

Component Selection

Select high-quality low-ESR multilayer ceramic chip capacitors for the OUT output terminal; otherwise, output ripple performance will be degraded.

Inductor L1 must be a power inductor with a saturation current rating matching application requirements. Inductor saturation may cause abnormal IC operation.

PCB Layout Guidelines

Lay a solid copper ground plane directly beneath the IC with the maximum possible ground area. Route non-critical signals around the ground region to preserve sufficient grounding area.

Place BAT capacitors close to both the IC BAT pin and the inductor. Connect the ground traces of BAT capacitors directly to the large ground plane; avoid routing through narrow ground paths between the IC and the main ground plane.

Place VCC capacitors adjacent to the IC VCC pin. Route their ground traces straight to the large ground plane instead of passing through narrow ground tracks.

Operating status and battery level indicator

4 LED mode

Discharge

Battery Level C (%)	D1	D2	D3	D4
$C \geq 75\%$	On	On	On	On
$50\% \leq C < 75\%$	On	On	On	Off
$25\% \leq C < 50\%$	On	On	Off	Off
$3\% \leq C < 25\%$	On	Off	Off	Off
$0\% < C < 3\%$	2HZ Flash	Off	Off	Off

Charge

Battery Level C (%)	D1	D2	D3	D4
Full	On	On	On	On
$75\% \leq C$	On	On	On	1HZ Flash
$50\% \leq C < 75\%$	On	On	1HZ Flash	Off
$25\% \leq C < 50\%$	On	1HZ Flash	Off	Off
$C < 25\%$	1HZ Flash	Off	Off	Off

2 LED Modes

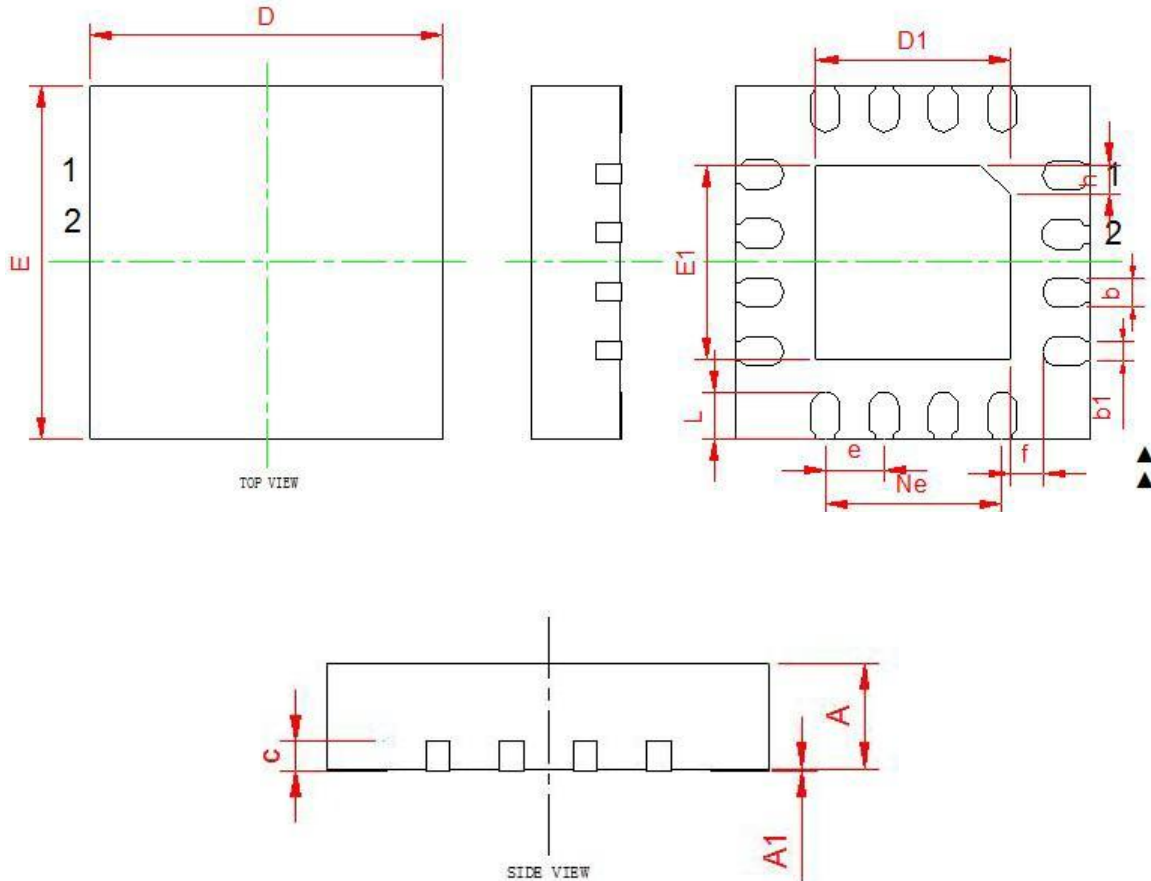
	Status	D1	D2
Charge	Charging process	Flash	Off
	Full	On	Off
Discharge		Off	On
	Low battery level	Off	Flash

1 Led mode

	Status	D1
Charge	Charging process	Flash
	Full	On
Discharge	Normal charge	On
	Low battery level	Flash

PACKAGE SIZE:

QFN3*3-16L



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.700	0.750	0.800
A1	0.000	0.020	0.050
b	0.200	0.250	0.300
b1	0.160REF		
c	0.180	0.210	0.240
D	2.900	3.000	3.100
E	2.900	3.000	3.100
D1	1.600	1.650	1.700
E1	1.600	1.650	1.700
e	0.500BSC		
Ne	1.500BSC		
f	0.225	0.275	0.325
h	0.200	0.250	0.300
L	0.350	0.400	0.450

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