IP2368

Supports multiple fast charging input and output protocols such as PD3.0, supports 2~6 series cells, integrated buck-boost driver, and a power management chip with a maximum charging and discharging power of 100W.

Characteristics

- Charge and discharge gauge
- Integrated •BUCK-BOOST buck-boost power • NMOS driver
- The maximum charging and discharging power is 100W
- Adaptive charging current regulation
- The external resistor can set the full voltage, the full voltage of a single-cell lithium battery can be set to 4.1V~4.4V, and the full voltage of a single-cell lithium iron phosphate battery can be set to: 3.5V~3.7V
- The external resistor can set the maximum charging and discharging power, the maximum support is 100W
- External resistor selection. 2/3/4/5/6 series battery charging

Quick charge

- Integrated FCP, AFC, SCP, DRP, SRC, PD3.0, QC2.0/QC3.0/QC3.0+ input and output fast charging protocol

Power display

- Built in 14bit ADC and fuel gauge
- self-learning fuel gauge, for more uniform battery percentage
- Initial battery capacity configuration pin

Other features

- 4/2/1 LED battery indicator
- NTC battery temperature monitor
- supports I2C communication

Multiple protections

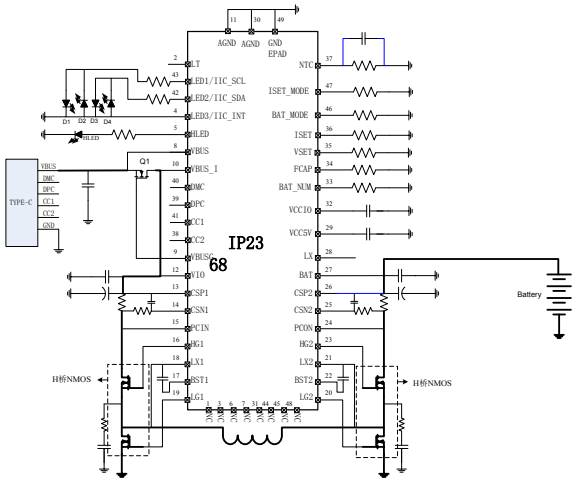
- Input Over voltage
- Input Under voltage
- Over current
- Short Circuit
- IC Over temperature
- Battery over temperature
- ESD 4kv, withstand voltage of 30v

•Package Specifications： **7mm × 7mm 0.5pitch QFN48**

Overview

P2368 is an integrated AFC/FCP/PD2.0/PD3.0 and other input and output fast Lithium battery charge and discharge management chip for charging protocol and synchronous buck-boost converter; The high integration and rich functions of IP2368 only need one inductor to realize the synchronous buck- boost function, and only a few peripheral devices are needed in the application, which effectively reduces the overall The size of the solution reduces the BOM cost. IP2368 supports 2/3/4/5/6 cells in series, and the number of battery cells in series can be selected through external resistors; IP2368 supports external resistors to select ordinary lithium batteries or lithium iron phosphate batteries, external resistors can be set to full voltage, and lithium batteries are fully charged The voltage can be set to: 4.15V/4.2V/4.3V/4.35V/4.4V, the lithium iron phosphate battery is fully charged The voltage can be set to: 3.5V/3.55V/3.6V/3.65V/3.7V. The synchronous switching charging and discharging system of IP2368 can provide up to 100W charging and discharging power, and the maximum charging and discharging power can be set through an external resistor. IP2368 built-in IC temperature, battery NTC temperature and input voltage control the detection loop, which can intelligently adjust the charging current according to different power chargers. IP2368 has a built-in 14bit ADC, which can accurately measure the charging input voltage and power current, battery voltage and current. IP2368 has built-in power calculation method, which can obtain information such as battery power, charging voltage, charging current, etc. through I2C. IP2368 supports 4 battery indicator lights, and can be customized to support 188 digital tubes.

Typical application



Model vairations

Model	Description
IP2368_BZ	Standard IP2368, support 2-6 battery charging
IP2368_COUT	Standard ip2368 with discharge output function
IP2368_I2C_COUT	With output, LED replaced with I2C interface

1. Pinout

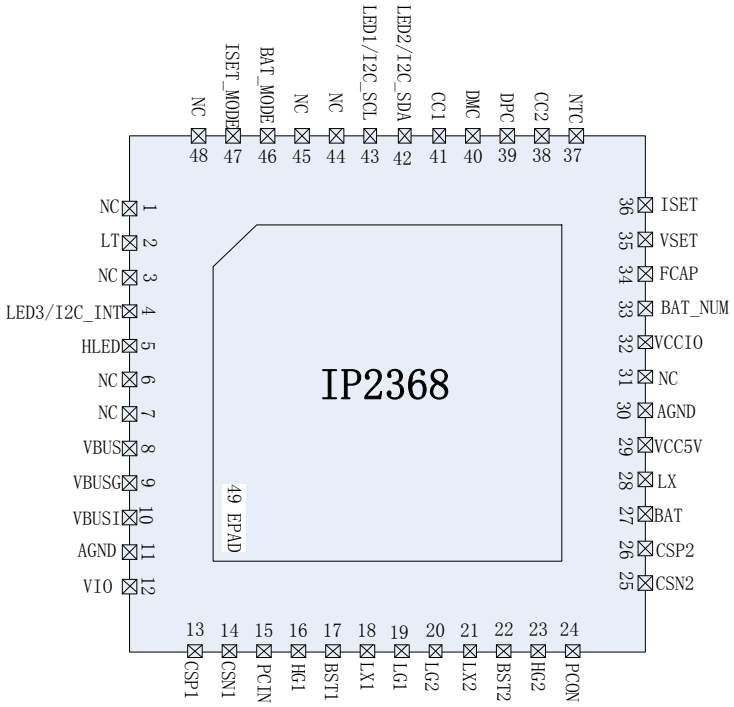


Figure 2 pin Diagram

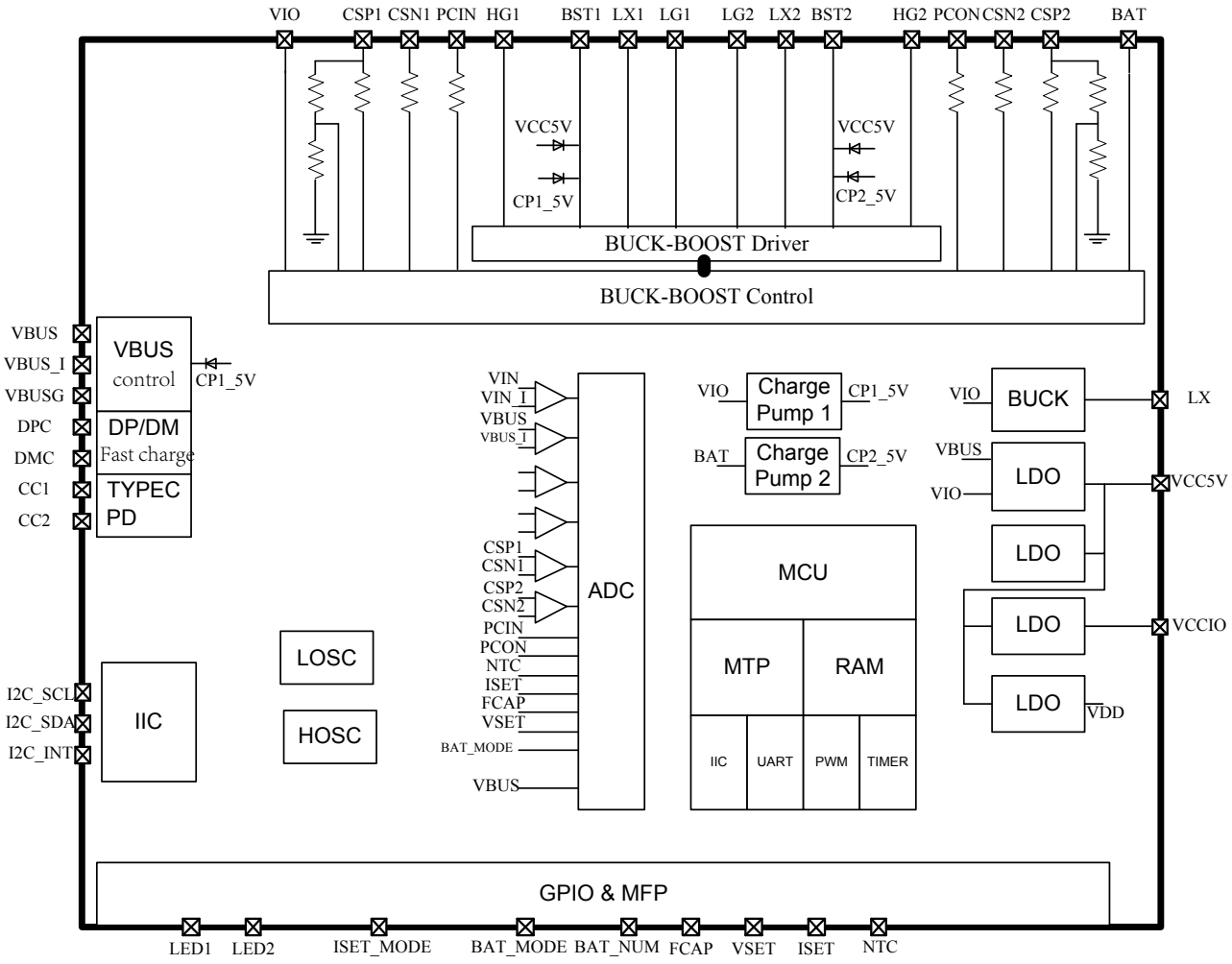
IP2368 Pin Function

Pin Num	Pin Name	Pin Description
1	NC	Unused pin, leave floating
2	LT	Lighting Decode pin
3	NC	Unused pin, leave floating
4	LED3/I2C_INT	Charging light 3 or I2c initialize pin

5	HLED	Fast charging indicator
6	NC	Unused pin, leave floating
7	NC	Unused pin, leave floating
8	VBUS	VBUS input detection
9	VBUSG	VBUS input NMOS control pin
10	VBUS_I	VBUS input current sense pin
11	AGND	Ground
12	VIO	Power input pin
13	CSP1	Input current measure positive
14	CSN1	Input current measure negative
15	PCIN	输入峰值电流采样引脚
16	HG1	H 桥功率管输入端上管控制引脚
17	BST1	H 桥功率管输入端自举电压引脚
18	LX1	Inductor input side
19	LG1	H 桥功率管输入端下管控制引脚
20	LG2	H 桥功率管输出电池端下管控制引脚
21	LX2	Inductor battery side
22	BST2	H 桥功率管电池端自举电　　脚
23	HG2	H 桥功率管电池端上管控制引脚
24	PCON	电池端峰值电流采样引脚
25	CSN2	Battery current measure negative
26	CSP2	Battery current measure positive
27	BAT	Battery positive
28	LX	5v power supply buck inductor (default is floating)
29	VCC5V	系统 5V 供电电源，给 IC 内部模拟电路供电
30	AGND	Ground
31	NC	Unused pin, leave floating
32	VCCIO	系统 3.3V 供电电源，给 IC 内部数字电路供电
33	BAT_NUM	电池串联节数选择，连接不同的电阻，可选择不同的串联节数
34	FCAP	电池容量选择，连接不同的电阻，可选择不同的电池容量
35	VSET	电池充满电压选择，连接不同的电阻，可以选择不同的充电电池电压
36	ISET	恒流充电功率或充电电流设置
37	NTC	NTC 10k therimister
38	CC2	USB C fast charge PD communication pin
39	DPC	USB C 口快充智能识别 DP
40	DMC	USB C 口快充智能识别 DM

41	CC1	USB C fast charge PD communication pin
42	LED2/I2C_SDA	Charging light 2 or I2c SDA pin
43	LED1/I2C_SCL	Charging light 1 or I2c SCL pin
44	NC	Unused pin, leave floating
45	NC	Unused pin, leave floating
46	BAT_MODE	Choose battery type: Ground for LiFePO4, Float for regular Lithium
47	ISET_MODE	Charging mode: Ground for constant current, Floating for Max Power (watts)
48	NC	Unused pin, leave floating
49(EPAD)	GND	Important used for heat dissipation

2 Chip Internal Block Diagram



3. Limitations

Parameter	Symbol	Value	Units
Port voltage range	VBAT/VBUS	-0.3 ~ 35	**V**
Protocol interface voltage range	DPC/DMC/CC1/CC2	-0.3 ~ 30	**V**
GPIO Voltage range	LED/GPIO	-0.3 ~ 8	**V**
Junction Temperature range	T_J	-40 ~ 125	℃
Storage Temperature range	Tstg	-60 ~ 150	℃
Thermal resistance	θ_{JA}	30	℃/**W**
人体模型（HBM）	ESD	4	**KV**

* Going outside the values above may cause permanent damage to the chip. Additionally being near limits for long durations may cause damage and shorten lifespan of the chip. Device operation beyond these values are not guaranteed.

4 Working Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Input voltage	VBUS	4.5		25	**V**
Battery Voltage	VBAT			28	**V**
Working Tempature	T_A	-40		85	℃

* Going outside the values above may cause permanent damage to the chip. Additionally being near limits for long durations may cause damage and shorten lifespan of the chip. Device operation beyond these values are not guaranteed.

5. Electrical Characteristics

Unless otherwise specified TA=25℃，L=10uH

Parameter	Symbol	Test conditions		Minimum	Typical	Maximum	Unit
Charging system							
Input Voltage	V_{BUS}			4.5	5/9/12/15/20	25	V
Input OV	V_{BUS}	Rising voltage				25	V
Charging voltage	V_{TRGT}	BAT_MODE 悬空，选择普通锂电池 V_{TRGT}=4000+0.02*R_{VSET}（单位 mV）step=10mV	R_{VSET} = 7.5K	N*4.11	N*4.15	N*4.19	V
			R_{VSET} = 10K	N*4.16	N*4.20	N*4.24	V
			R_{VSET} = 15K	N*4.26	N*4.30	N*4.34	V
			R_{VSET} = 17.5K	N*4.31	N*4.35	N*4.39	V
			R_{VSET} ≥20K	N*4.36	N*4.40	N*4.44	V
		BAT_MODE 接地，选择磷酸铁锂电池 V_{TRGT}=3500+0.01*R_{VSET}（单位 mV）step=10mV	R_{VSET} = 5K	N*3.51	N*3.55	N*3.59	V
			R_{VSET} = 10K	N*3.56	N*3.60	N*3.64	V
			R_{VSET} = 15K	N*3.61	N*3.65	N*3.69	V
			R_{VSET} ≥20K	N*3.66	N*3.70	N*3.74	V
Charging current or power	P_{CCIN} OR I_{CHRG}	ISET_MODE 悬空选择 ISET 电时的最大输入功率 P_{CCI} =4*R 设置恒（单 mW step=1W	R_{ISET}= 5K		20		W
			R_{ISET}= 7.5K		30		W
			R_{ISET}= 11.2K		45		W
			R_{ISET}= 15K		60		W
			R_{ISET}≥ 25K		100		W
		ISET_MODE 选择 ISET 设置恒流充电时的最大电流 I_{CHRG}=0.2*R_{ISET}（单位 mA）step=100mA	R_{ISET}= 5K		1		A
			R_{ISET}= 10K		2		A
			R_{ISET}= 12.5K		2.5		A
			R_{ISET}= 15K		3		A
			R_{ISET}≥ 25K		5		A
Peak current	I_{PK}	Inductor peak current limit				8	A
Trickle Charge current	I_{TRKL}	VIN=5V, VBAT<2.5V		30	50	70	mA
		VIN=5V, 2.5V<=VBAT<VTRKL		100	200	300	mA
Trickle cut-off voltage	V_{TRKL}	BAT_MODE 脚 NC 悬空，选择普通锂电池，电池节数为 N		N*2.9	N*3	N*3.1	V
		BAT_MODE 脚接地，选择磷酸铁锂电池锂电池，电池节数为 N		N*2.4	N*2.5	N*2.6	V
Charging stop current	I_{STOP}				100		mA
Recharge threshold	V_{RCH}	The number of battery cells is N			V_{TRGT} – N*0.1		V

Charing time cut off	T_{END}		45	48	51	Hour
Discharge system						
电池工作电压	V_{BAT}	电池节数为 N	N*2.75		N*4.5	V
Battery working voltage	I_{BAT}	VBAT=4*3.7V, VOUT=5.0V, fs=250kHz, Iout=0mA	3	7		mA
DC output voltage	QC2.0 V_{OUT}	V_{OUT}=5V@1A	4.75	5.00	5.25	V
		V_{OUT}=9V@1A	8.70	9	9.30	V
		V_{OUT}=12V@1A	11.60	12	12.40	V
	QC3.0/ QC3+ V_{OUT}	@1A	3.6		12	V
	QC3.0 Step			200		mV
	QC3+ Step			20		mV
Output voltage ripple	ΔV_{OUT}	VBAT=4*3.7V, VOUT=5.0V, fs=250KHz, Iout=1A		120		mV
		VBAT=4*3.7V, VOUT=9.0V，fs=250KHz, Iout=1A		135		mV
		VBAT=4*3.7V， VOUT=12V， fs=250KHz, Iout=1A		370		mV
放电系统最大输出功率	Pmax	PD 协议下，不同 PMAX 电阻值对应不同 Pmax	20		100	W
Efficiency	η_{out}	V_{BAT}=8V, V_{OUT}=5V, I_{OUT}=2A		94.69		%
		V_{BAT}=8V, V_{OUT}=9V, I_{OUT}=2A		95.36		%
		V_{BAT}=8V, V_{OUT}=12V, I_{OUT}=2A		95.86		%
		V_{BAT}=15V, V_{OUT}=5V, I_{OUT}=2A		91.55		%
		V_{BAT}=15V, V_{OUT}=9V, I_{OUT}=2A		95.05		%
		V_{BAT}=15V, V_{OUT}=12V, I_{OUT}=2A		95.37		%
over current shutdown	I_{shut}	VBAT=N*3.7V,多口输出 5V	4.1	4.4	4.7	A
		VBAT= N *3.7V,单口输出 5V	3.1	3.4	3.8	A
		VBAT= N *3.7V，单口输出 9V，非 PD 状态	2.7	3	3.3	A

		VBAT= N *3.7V, 单口输出 12V，非 PD 状态	2	2.2	2.5	A
		VBAT= N *3.7V, 单口输出 PD 状态		PDO * 1.1		A
Over current detection time	T_{UVD}	输出电压持续低于 2.4V		30		ms
Over current detection time	T_{OCD}	输出电压持续低于 2.2V		40		us
Control system						
frequency	fs	switching frequency		250		kHz
		switching frequency		250		kHz
VCCIO 输出电压	V_{CCIO}		3.15	3.3	3.45	V
Standby current	I_{STB}	VBAT=14.8V，按键关机后的平均电流		180		uA
LDO 输出电流	I_{LDO}		25	30	35	mA
LED 照明驱动电流	I_{WLED}		10	15	20	mA
LED 显示驱动电流	I_{L1} I_{L2} I_{L3}	Voltage drop 10%	5	7	9	mA
热关断温度	T_{OTP}	Rising tempature	110	125	140	℃
热关断温度迟滞	ΔT_{OTP}			40		℃

6. Function Description

Charging Process

IP2368 has a constant current, constant voltage lithium battery charging management system that supports a synchronous switch structure. IP2368 Uses the switching frequency of 250kHz。

IP2368可以通过外接电阻设置不同的电池类型、充满电压和充电电流，可以支持2/3/4/5/6串磷酸铁锂或锂电池充电，最大充电电流可达5A或100W充电输入，充电效率最高到96%；

IP2368支持涓流-恒流-恒压充电的过程：

当电池电压V_{BAT}≤ 2.5V时，为小电流涓流充电，电池充电电流100mA左右；

当电池电压2.5V <V_{BAT}≤ V_{TRKL}时，为涓流充电，电池充电电流200mA左右；BAT_MODE悬空时，涓流充电截止电压V_{TRKL}为N*3V；BAT_MODE接地时，涓流充电截止电压V_{TRKL}为N*2.5V；

当电池电压V_{TRKL}<V_{BAT}< V_{TRGT}时，为恒流充电，充电电流按设置的恒流充电电流对电池充电；充满电压V_{TRGT}和恒流充电电流可通过外接R_{VSET}和R_{ISET}来设置；

当电池电压 V_{BAT} = V_{TRGT}时，电池电压上升到接近充满电压时，充电电流会缓慢下降，进入恒压充电；

进入恒压充电后，当电池充电电流小于I_{STOP}（100mA）且电池电压接近恒压电压时，停止充电，充满转充饱状态。

充饱停充后，会继续检测电池电压，当电池电压低于V_{BAT} <V_{TRGT} – N*0.1V后，会重新开始充电；

IP2368可以定制不同的涓流充电截止电压V_{TRKL}，也可以定制0V电池禁止充电功能；

IP2368_COUT默认第一次接电池后，需要充电激活后才能对外放电；可以定制去掉充电激活功能；

Type_C PD

IP2368 集成 USB Type_C 输入、输出识别接口，自动切换内置上下拉电阻，自动识别插入设备的充放电属性。带有 Try.SRC 功能，当连接到对方为 DRP 设备时，可优先给对方充电。

IP2368 支持 PD2.0/PD3.0 双向输入/输出协议。最大支持 100W 功率输出，输入支持 5V，9V，12V，15V，20V 电压档位，输出支持 5V，9V，12V，15V，20V 电压档位。IP2368 定制可以实现 PPS 输出功能；

快充功能

IP2368 支持多种规格的快充形式： QC2.0/QC3.0/QC3+、FCP、AFC、SCP、Apple。

给电池输入充电可支持 FCP、AFC 等快充输入，由于 FCP、AFC 是通过 DP/DM 进行快充握手请求的，所以当增加了其他快充协议 IC 时，无法再支持 FCP、AFC 快充。

IP2368 集成有 AFC/FCP/ PD2.0/PD3.0 输入快充协议，可以通过 TypeC 口上的 DPC/DMC/CC1/CC2 来向快充适配器申请快充电压，会自动调节充电电流大小，来适应不同负载能力的适配器。

当用没有快充的普通 5V 充电器或电源供电充电时，输入端最大最大充电电流会设到 3A；

当用只有华为 FCP 或三星 AFC 快充协议，但没有 PD 快充的充电器充电时，输入端最大充电功率会限制到 18W（9V/2A，12V/1.5A）；

当用 PD 快充适配器充电时，会按收到的 PD 包来限制最大输入充电功率，当收到的 PD 包功率小于 ISET 设置的充电需求的功率时，会主动降低充电电流，使输入端的最大功率小于等于适配器给出的 PD 广播功率；

例如 1：ISET_MODE 悬空，R_{ISET}=15K，设置恒流充电时的最大输入功率为 60W，如果用 30W 的 PD 适配器给 IP2368 充电，则输入充电电流会限制到 30W；只有用 60W 或 60W 以上的 PD 适配器给 IP2368 充电，输入端功率才会达到设定的 60W；

例如 2：ISET_MODE 接地，R_{BAT_NUM}=9.1K，3 串电池充电， R_{ISET}=15K，设置的电池端最大充电电流为 3A，用 30W 的 PD 适配器给 IP2368 充电，且成功进入 PD 快充，不考虑充电转换效率，在电池电压 V_{BAT}<10V 时，充电功率小于 30W，没有达到适配器的最大输出功率，电池充电电流是可以保证 3A 恒流充电的；当电池电压 V_{BAT}>10V 后，由于充电所需功率已经大于 30W，超过了 PD 适配器的最大输出功率，所以会自动降低电池充电电流，使输入功率维持在 30W；

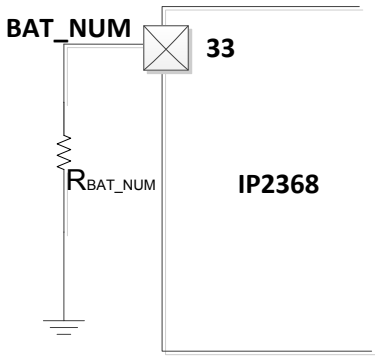
如果充电输入是固定电压输入，不是用的适配器，可以用 IP2368_NA 的定制型号；IP2368_NA 的定制型号不管适配器功率，会按照 ISET 脚设定的输入功率或电池充电电流来充电，不会自动降低充电功率或充电电流，但需要保证充电输入的电源负载能力要大于设置的充电最大功率；

电池对外放电时，自动检测 DP、DM 引脚上的快充时序，智能识别手机类型，可支持 QC2.0/QC3.0/QC3+、FCP、AFC、SCP 协议的手机，以及苹果手机 2.4A 模式、BC1.2 普通 Android 手机 1A 模式。

电池串联节数设定

IP2368 可支持 2/3/4/5/6 串电池的充电；
IP2368 可通过 BAT_NUM 脚外接不同的电阻来选择设置电池串联节数；
BAT_NUM 脚外接电阻 R_{BAT_NUM} 和电池串联节数的关系如下：

R_{BAT_NUM} (欧姆)	设定电池串联节数 (串)
6.2k	2串
9.1k	3串
13k	4串
18k	5串
27k	6串

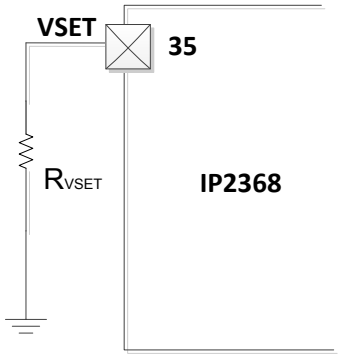


当 R_{BAT_NUM} 电阻大于 33K，会检测认为 R_{BAT_NUM} 电阻开路，为保证充电安全，充电状态指示灯会异常报警；

电池类型和充满电压设定

IP2368 的 BAT_MODE 脚悬空，选择普通锂电池，单节电池充满电压范围 4.1V~4.4V；BAT_MODE 脚接 1K 电阻到地，选择磷酸铁锂电池，单节电池充满电压范围 3.5V~3.7V；

VSET 脚对地电阻 R_{VSET} 和设置的充满电压的关系如下：



RBAT MODE悬空,普通锂电池		RBAT MODE接地,磷酸铁锂电池	
单节电池充满电压 V_{TRGT}=4000+0.02*R_{VSET} 单位mV step=10mV	R_{VSET}	单节电池充满电压 V_{TRGT}=3500+0.01*R_{VSET} 单位mV step=10mV	R_{VSET}
4.15V	7.5K	3.55V	7.5K
4.20V	10K	3.60V	10K
4.30V	15K	3.65V	15K
4.35V	17.5K	3.70V	≥20K
4.40V	≥20K		

注意：

1、R_{VSET} 设置的单节电池充满电压，实际 BAT 输出电压还要乘上电池节数；

2、单节电池充满电压电压设置步进是 10mV，为保证精度，R_{VSET} 要用 1%精度的电阻；

3、当 R_{VSET} 电阻大于 33K，会检测认为 R_{VSET} 电阻开路，为保证充电安全，充电状态指示灯会异常报警；

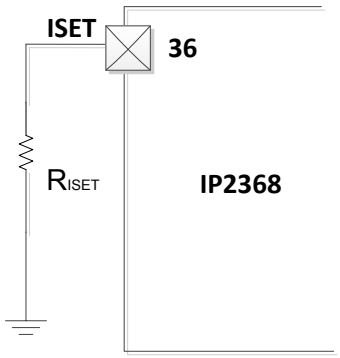
充电电流设定

IP2368 可以通过 ISET 脚来设置充电电流；

ISET_MODE 脚悬空时，ISET 脚设定的是充电时的最大输入功率，恒流充电时，输入电压和电流保持不变，随着电池电压的上升，电池端的充电电流会减小；

ISET_MODE 脚接 1K 电阻到地时，ISET 脚设定的是电池端的充电电流，在输入负载能力足够的情况下，电池端的充电电流保持恒定，随着电池电压的上升，输入端的电流和功率会变大；

ISET 脚电阻 R_{ISET} 和设定的输入输出功率或充电电流的关系如下：



ISET_MODE悬空 RISET设置恒流最大输入功率		ISET_MODE接地 RISET设置恒流最大电池电流	
充电时的最大输入功率 $P_{CCIN}=4*R_{ISET}$ 单位mW step=1W	R_{ISET}	单节电池充满电压 $I_{CHRG}=0.2*R_{ISET}$ 单位mA step=100mA	R_{ISET}
20W	5K	1A	5K
30W	7.5K	2A	10K
45W	11.2K	2.5A	12.5K
60W	15K	3A	15K
100W	≥25K	5A	≥25K

注意：

1、设置输入功率时，最小步进是 1W，最大输入功率是 100W；设置电池电流时，最小步进是 100mA，最大输入电流是 5A；R_{ISET} 大于 25K 后，会设置成最大 100W 或 5A 充电；

2、当 R_{ISET} 电阻大于 33K，会检测认为 R_{ISET} 电阻开路，为保证充电安全，充电状态指示灯会异常报警；

3、标准品会根据所用充电器的供电能力，来自动调整充电电流；如果所用充电器供电能力小于 R_{ISET} 设定的充电功率，会自动减小充电电流；

4、如果输入电源不是第 3 方充电器，而是固定的输入电源，可以使用 P2368_NA 的定制型号，该定制型号不会根据充电器供电能力来自动减小充电电流；

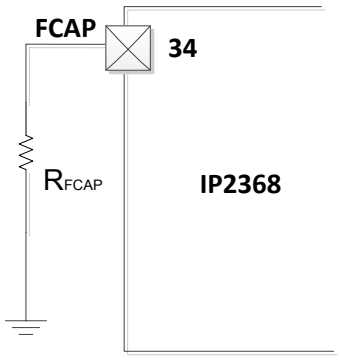
IP2368_COUT 支持 C 口放电输出功能，放电输出的 PDO，也可以通过 ISET 脚来设置，输出功率设置和输入功率设置计算公式一样；当设置的功率大于 60W 后，未识别到 E-MARK 线缆时输出广播能力会最大限制到 60W，输出 PDO：5V/3A，9V/3A，12V/3A ，15V/3A，20V/3A。在识别到 E-MARK 线缆（需外加 EMARK 电路）时输出广播能力最大可到 100W，输出 PDO：5V/3A，9V/3A，12V/3A ，15V/3A，20V/5A；

电量计

IP2368 内置电量计功能，可实现准确的电池电量计算。

IP2368 支持外部设置电芯的容量，利用电芯端电流和时间的积分来计算电池已充电电量。

IP2368 外部 PIN 设定电芯初始容量公式：电池容量=R_{FCAP}*0.8 (mAH)。最小支持 2000mAH，最大支持 25000Mah，所设置的容量为单串电芯的容量。



典型电池容量配置表：

R17 电阻值(欧姆)	对应设定的电芯容量(mAH)
6.2k	5000mAH
12.4k	10000mAH
18.7k	15000mAH
24.9k	20000mAH
30.9K	25000mAH

注意：表中电芯容量指单节电池的电芯容量；

NTC 功能

IP2368 集成 NTC 功能，可检测电池温度。IP2368 上电后 NTC PIN 在高温时输出 80uA 的电流，在低温时输出 20uA 电流，通过外部 NTC 电阻来产生电压，IC 内部检测 NTC PIN 脚的电压来判断当前电池的温度。

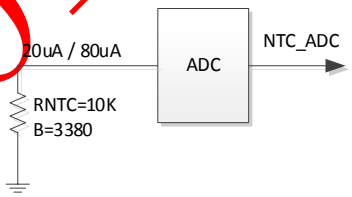


图 12 电池 NTC 比较

充电状态下：NTC 温度低于 0 度（0.55V）停止充电，0~45 度之间正常充电，温度超过 45 度（0.39V）停止充电。

放电状态下：温度低于-20 度（1.39V）时，停止放电，-20 度到 60 度之间正常放电，高于 60 度（0.24V）停止放电；

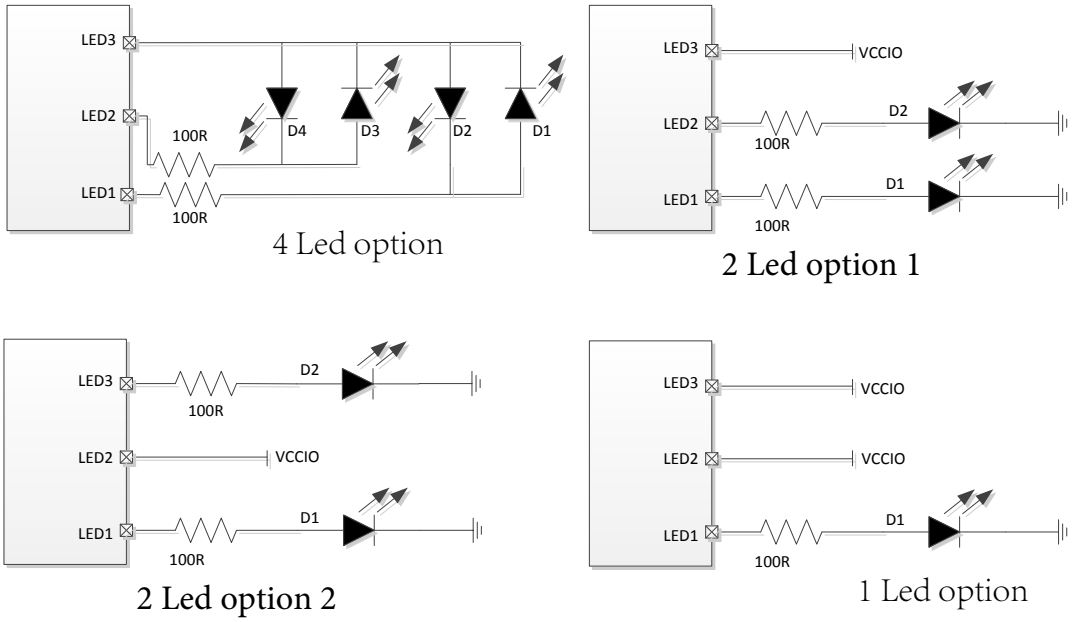
在 NTC 检测到温度异常后，恢复温度为保护温度±5 度。上述括号内为该温度对应的 NTC 引脚电压，计算方法为：NTC 脚放出的电流*该温度下的 NTC 电阻阻值。

以上温度范围参考的 NTC 电阻参数为 10K@25℃ B=3380，其他型号存在差异，需要调整。

如果方案不需要 NTC, 需要在 NTC 引脚对地接 10k 电阻，不能浮空或者直接接地。

Led Indicators

IP2368 supports 4, 2, or 1 Led for battery indication, As shown below



4、2、1 LED Connection Method

4 Led option display during charing

Battery charge（%）	D1	D2	D3	D4
Full 100%	on	on	on	on
75%≤C	on	on	on	0.5Hz flash
50%≤C＜75%	on	on	0.5Hz flash	off
25%≤C＜50%	on	0.5Hz flash	off	off
C＜25%	0.5Hz flash	off	off	off

2 Led option 1 display during charging

Battery charge（%）	D1	D2
Full 100%	off	on
66%≤C＜100%	off	0.5Hz flash
33%≤C＜66%	0.5Hz flash	0.5Hz flash
C＜33%	0.5Hz flash	off

2 灯模式 2 的显示方式为：

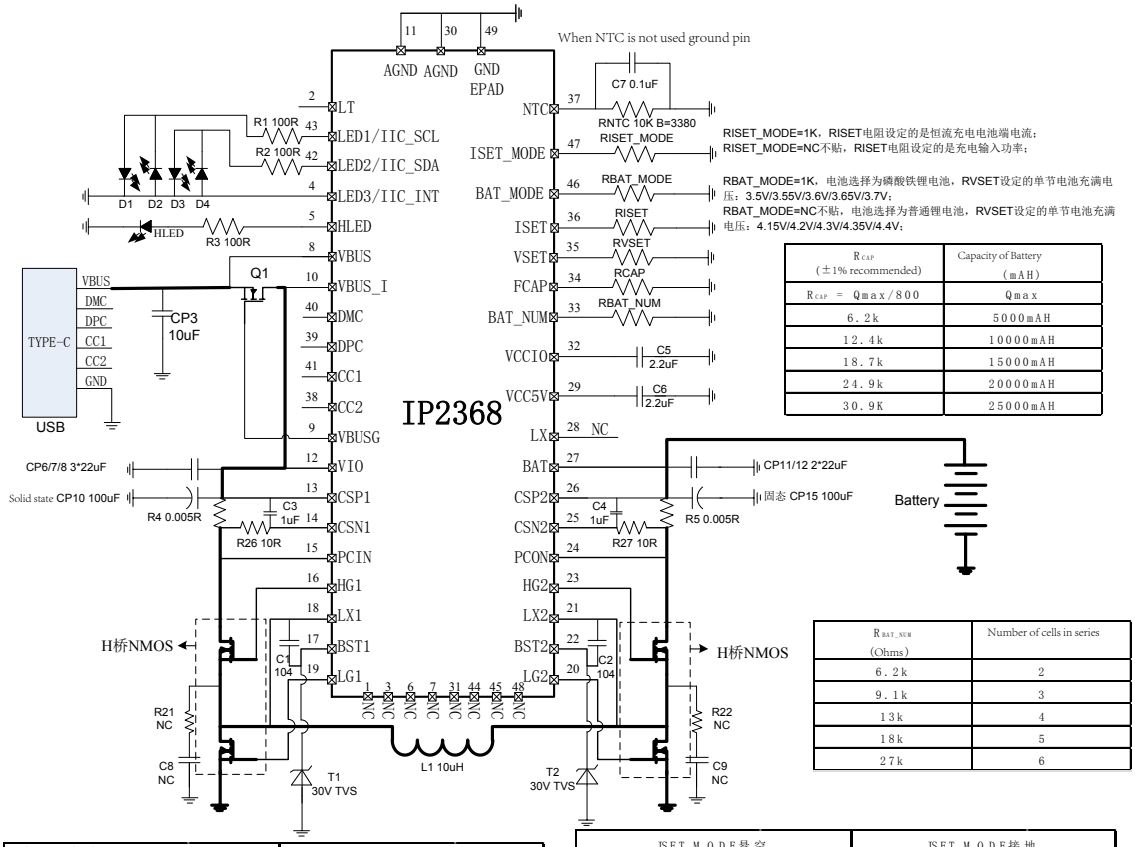
充电中 D1 亮 D2 灭，充满后 D1 灭 D2 亮；充电异常 D1 和 D2 同时闪烁（250ms 亮 250ms 灭）

1 灯模式的显示方式为：
充电中 D1 闪烁（1s 亮 1s 灭），充满后，D1 常亮；充电异常 D1 快速闪烁（250ms 亮 250ms 灭）

HLED 脚指示快充状态，处于输入或输出快充时，HLED 脚输出高电平，否则输出低电平；

IP2368 可以定制其他灯显或 188 数码管方案；

7. Application schematic



R_{CAP} (±1% recommended)	Capacity of Battery (mAH)
R_{CAP} = Qmax/800	Qmax
6.2k	5000mAH
12.4k	10000mAH
18.7k	15000mAH
24.9k	20000mAH
30.9K	25000mAH

RISET_MODE=1K，RISET电阻设定的是恒流充电电池端电流；
RISET_MODE=NC不贴，RISET电阻设定的是充电输入功率；

RBAT_MODE=1K，电池选择为磷酸铁锂电池，RVSET设定的单节电池充满电压：3.5V/3.55V/3.6V/3.65V/3.7V；
RBAT_MODE=NC不贴，电池选择为普通锂电池，RVSET设定的单节电池充满电压：4.15V/4.2V/4.3V/4.35V/4.4V；

R_{BAT_NUM} (Ohms)	Number of cells in series
6.2k	2
9.1k	3
13k	4
18k	5
27k	6

Lithium mode, Floating BAT_MODE		Lithium iron phosphare mode, Ground BAT_MODE	
Single Cell charge voltage $V_{TRGT}=4000+0.02*R_{VSET}$ Unit mV step=10mV	R_{VSET}	Single Cell charge voltage $V_{TRGT}=3500+0.01*R_{VSET}$ Unit mV step=10mV	R_{VSET}
4.15V	7.5K	3.55V	5K
4.20V	10K	3.60V	10K
4.30V	15K	3.65V	15K
4.35V	17.5K	3.70V	≥ 20K
4.40V	≥ 20K		

ISET_MODE悬空 RISET设置恒流最大输入功率		ISET_MODE接地 RISET设置恒流最大电池电流	
max input charing power $P_{CCIN}=4*R_{ISET}$ unit mW step=1W	R_{ISET}	max input charing current $I_{CHRG}=0.2*R_{ISET}$ unit mA step=100mA	R_{ISET}
20W	5K	1A	5K
30W	7.5K	2A	10K
45W	11.2K	2.5A	12.5K
60W	15K	3A	15K
100W	≥ 25K	5A	≥ 25K

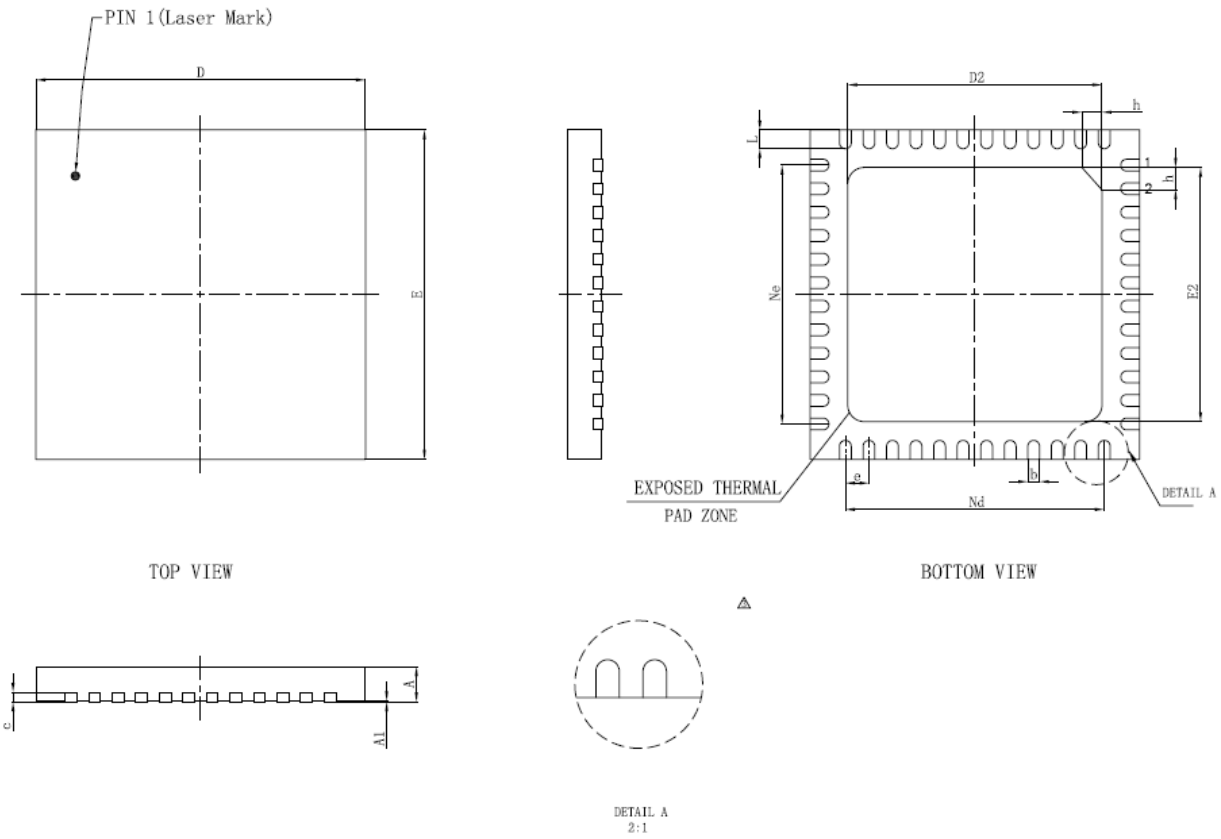
Figure 13 Application Schematic

8. BOM

	Component	Model/ Name	Location	Quanity	Notes
1	SMD IC	QFN48 7*7 IP2368	U1	1	
2	Capacitor	0603 100nF 10% 50V	C1 C2 C7	3	
3	Capacitor	0603 1uF 10% 16V	C3 C4	2	
4	Capacitor	0603 2.2uF 10% 16V	C5 C6	2	
5	Capacitor	0805 10uF 10% 25V	CP3	1	
6	Capacitor	0805 22uF 10% 25V	CP6 CP7 CP8 CP11 CP12	5	
7	Capacitor	100uF 35V 10%	CP10 CP15	2	
8	Resistor	1206 0.005R 1%	R4 R5	2	Requires high precision & low temp drift
9	Resistor	0603 100R 5%	R1 R2 R3	3	
10	LED	0603 LED	D1 D2 D3 D4 HLED	5	
11	Resistor	0603 10R 1%	R26 R27	2	
12	NTC Thermistor	10K@25℃ B=3380	RNTC	1	NTC resistor
13	Inductor	10uH 6A R_{DC}<0.01R	L1	1	
14	MOSFET	RU3030M2	Q1	1	Optional
15	USB C Socket	Generic	USB3	1	
16	MOSFET	RU30J30M	Half bridge dual NMOS	2	
17	Resistor	0603	R_{ISET} R_{VSET} R_{CAP} R_{BAT_NUM} R_{BAT_MODE} R_{ISET_MODE}	6	Value based on specifics of projects
18	TVS Diode	30V TVS	T1 T2	2	30V TVS tubes
19			C8 C9 R21 R22		NC

9. Package Information

Chip Packaging



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.18	0.25	0.30
b1	0.11	0.16	0.21
c	0.18	0.20	0.23
D	6.90	7.0	7.10
D2	5.30	5.40	5.50
e	0.5 BSC		
Ne	5.50BSC		
Nd	5.50BSC		
E	6.90	7.0	7.10
E2	5.30	5.40	5.50
L	0.35	0.40	0.45
h	0.30	0.35	0.40

10. IC printing instructions

Figure 15 Silkscreen Layout

11. Liability and copyright notice

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