

XS5603C-SIP of Power Bank Total Solution

GENERAL DESCRIPTION

XS5603C is one SIP that it integrates Li-Battery Charge management、Battery power indicator、WLED Torch controller and Boost converter in only TSSOP16-PP package.

This SIP can charge with 1A current and also can output 5V 1A ~2.5A to load such as smart phone or MID.

It only need few components and can reduce the BOM area and BOM cost.

FEATURES

- Charger input voltage-4.5V to 6V
- Charger current-MAX 1A
- Boost converter-MAX 14V output
- Boost converter- 5V 1A ~2.5A
- Boost converter Frequency-1.2MHz
- Can set current limit with one resistor
- 4 Level battery power indicator
- Max 100mA WLED Torch Out
- BSR control Logic
- Have UVLO、OTP
- 16-Pin TSSOP-PP Package

APPLICATIONS

Power bank for MID、PAD

Power bank for Smart Phone

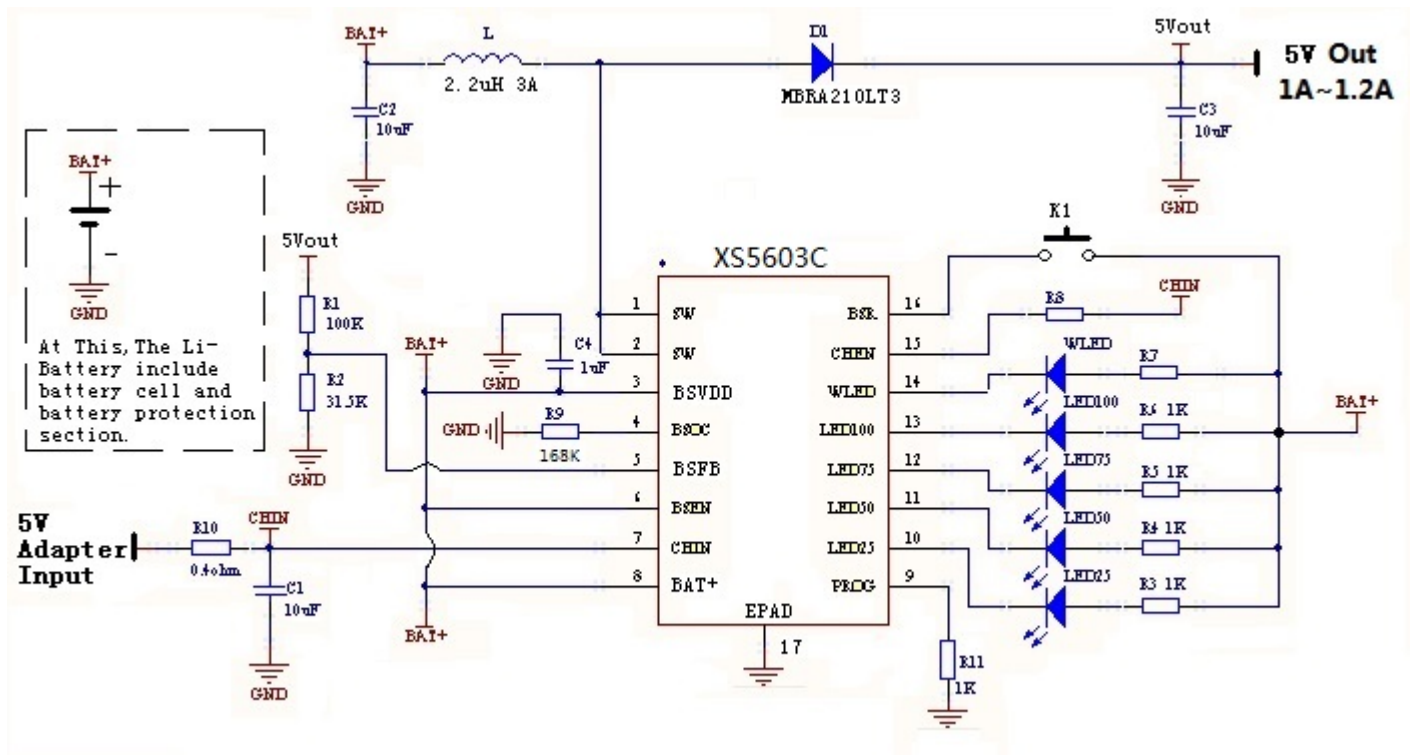


Figure 1. Typical Application Circuit1

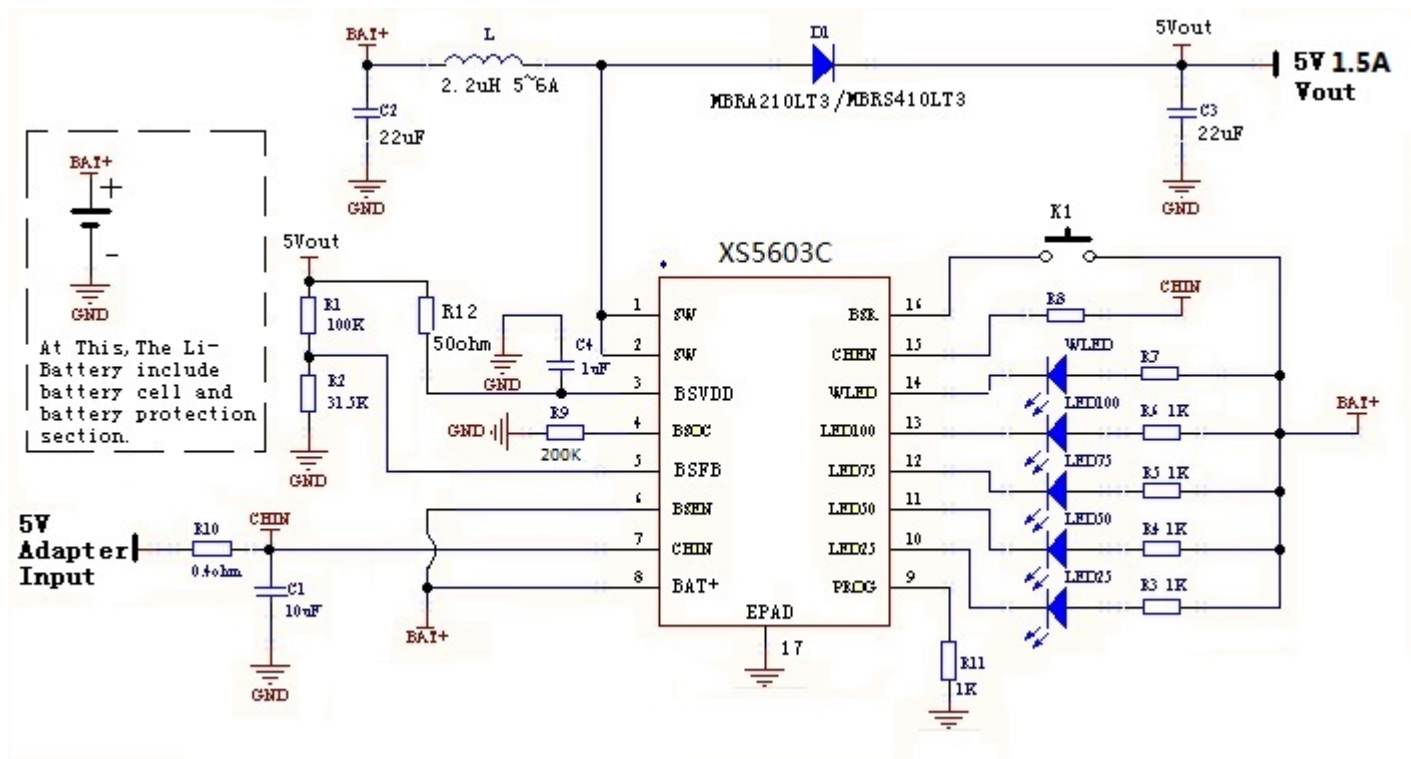


Figure 2. Typical Application Circuit2

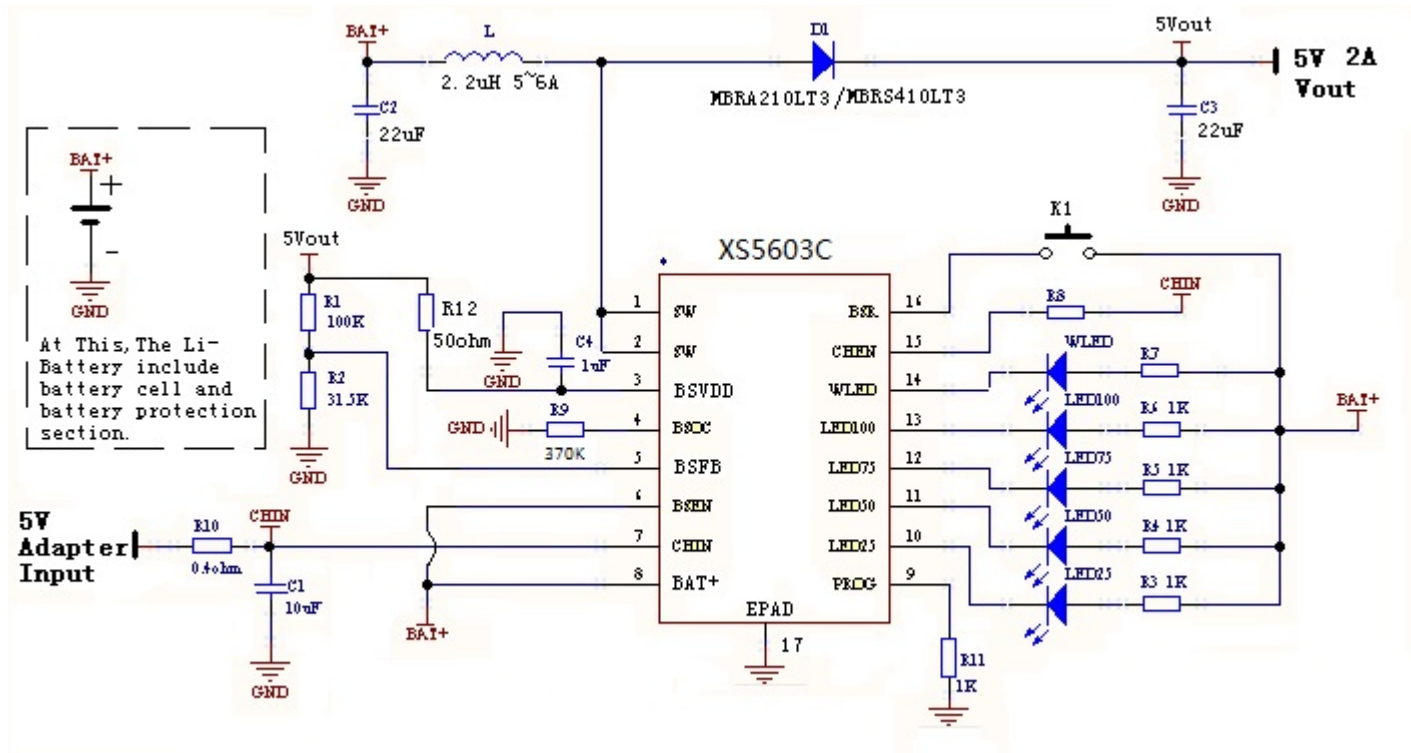


Figure 3. Typical Application Circuit3

Note: For circuit3, it can output 5V 2A($V_{bat}=3.0V$) in the open area. If in sealed box, maybe will be OTP.

ORDERING INFORMATION

PART NUMBER	TEMP RANGE	VIN	OUTPUT VOLTAGE (V)	CHARGE CURRENT	PACKAGE	PINS
XS5603C	-40°C to 85°C	4.5~6V	ADJ	1A	TSSOP-PP	16

PIN CONFIGURATION

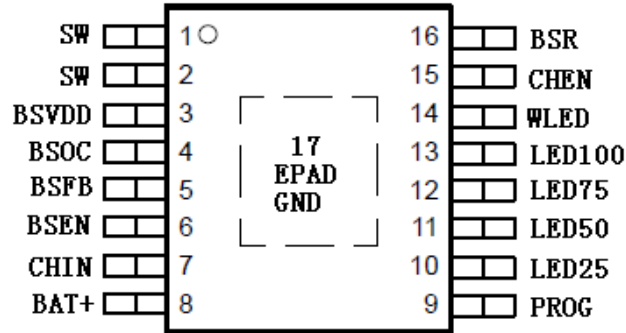


Figure 3. PIN Configuration

PIN DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1, 2	SW	Boost Converter's Switching pin
3	BSVDD	Boost power supply pin, Should connect 1uF to GND as close as possible
4	BSOC	SW current limit setting pin, Set current limit by Rset or analog Voltage
5	BSFB	Boost Converter's Feedback pin. it can set 5Vout with two resistors.
6	BSEN	Boost enable pin, When higher than 1.5V, this pin turns the IC on. When lower than 0.3V, this pin turns the IC off.
7	CHIN	Positive Input Supply Voltage, should be bypassed with at least a 10uF capacitor.
8	BAT+	Li-Battery's Positive Pole, should be bypassed with at least a 10uF capacitor.
9	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin.
10	LED25	Battery power indicator pin1. The resistor sets the current of LED, normally use 1K
11	LED50	Battery power indicator pin2 The resistor sets the current of LED, normally use 1K
12	LED75	Battery power indicator pin3 The resistor sets the current of LED, normally use 1K
13	LED100	Battery power indicator pin4 The resistor sets the current of LED, normally use 1K
14	WLED	WLED Torch out pin. The resistor sets the current of WLED, $I_{wled} = (V_{bat} - V_{thod}) / R_{set}$
15	CHEN	Battery charger enable pin, When higher than 1.5V, this pin turns the IC on. When lower than 0.3V, this pin turns the IC off.
16	BSR	Connect with one tact switch, press the tact switch to see battery power or get on /off WLED.
17	GND	Ground and EPAD, Please connect EPAD/GND with mass metal ground

ABSOLUTE MAXIMUM RATINGS

(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

PARAMETER	VALUE	UNIT
Supply Voltage CHIN;	-0.3 to 7	V
BSFB ; BSVDD; BSOC;BSEN; LEDxx; WLED; BSR	-0.3 to 5	V
SW Voltage	V _{in} +0.3 to 15	V
PROG Voltage	-0.3~V _{cc} +0.3	V
I _{charge}	1.2	A
PROG Pin current	1.2	mA
Operating Ambient Temperature	-40 to 85	°C
Maximum Junction Temperature	150	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	260	°C

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.6V, T_A = 25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range	VCC		4.5		6.0	V
Regulated Charge Voltage	V _{float}	0°C ≤ T _A ≤ 85°C, I _{charge} = 40mA	4.158	4.22	4.260	V
PROG pin Voltage	V _{prog}	R _{PROG} = 1k, Current mode	0.93	1.0	1.07	V
Charge current	I _{charge}	R _{PROG} = 2k, Current mode	450	500	550	mA
		R _{PROG} = 1k, Current mode	900	1000	1100	mA
		Standby mode, V _{bat} = 4.2V	0	-15	-30	uA
Trickle charge current	I _{trikl}	V _{bat} < V _{trikl} , R _{prog} = 1k	90	100	110	mA
Trickle charge Threshold Voltage	V _{trikl}	R _{PROG} = 10K, V _{bat} Rising	2.8	2.9	3.0	V
Trickle voltage hysteresis voltage	V _{trhys}	R _{PROG} = 10K	60	80	110	mV
Recharge Battery threshold Voltage	Δ V _{recg}	V _{FLOAT} - V _{RECHRG}		150	300	mV
WLED torch current	I _{wled}	V _{bat} = 4.2V			100	mA
LEDxx current	I _{led}	V _{bat} = 4.2V			5	mA
Boost output voltage range	V _{out}		14			V
Regulated Feedback Voltage	V _{FB}		1.188	1.2	1.212	V

Inductor Current limit	I_{lim}	Roc=370K Figure3		4.1		A
Inductor Current limit	I_{lim}	Voc=0.6V Figure1		1.75		A
Boost Convert Oscillator Frequency	F_{osc}		0.9	1.2	1.5	MHz

FUNCTIONAL DESCRIPTION

NORMAL OPERATION

XS5603C integrates Li-Battery Charge management、Battery power indicator、WLED Torch controller and Boost converter in only TSSOP16-PP package.

Adapter inputs 5V voltage and charges the battery. After the battery is full, get off the adapter . And then we can boost up to 5V to charge the mobile advices when they is empty.

Li-Battery Charger can set charge current by PROG resistor. Normal charging current is set from 0.5A to 1A. It will go into trickle charge mode to protect Li-Battery when BAT voltage is below 2.9V.

It also integrates battery power indicator with 4 levels. And one WLED Torch controller with about 10~50mA output capacity

Boost section can give us 5V 1A~2.5A capacity to mobile devices.

For 5V 1.5A~2.5A, you can use typical application circuit 2 & 3.

THERMAL OR SHORT-CUT PROTECTION

A thermal shutdown is implemented to prevent damages due to excessive heat and power dissipation. Typically the thermal shutdown threshold is 150℃ .When the thermal shutdown is triggered the device stops switching until the temperature falls below typically 136℃ .Then the device starts switching again.

APPLICATION INFORMATION

INDUCTOR SELECTION

In normal operation, the inductor maintains continuous current to the output. The inductor current has a ripple that is dependent on the inductance value. The high inductance reduces the ripple current.

Selected inductor by actual application:

Manufa cturer	Part Number	Inductance (uH)	DRC max (Ohms)	Dimensions L*W*H(mm3)
Murata	LQH44PN	2.2	0.049	4*4*1.7
		3.3	0.065	
		4.7	0.08	
		10	0.16	
	LQH5BP	2.2	0.030	5*5*2
		3.3	0.044	
		4.7	0.058	
		10	0.106	
TDK	SPM6530T	2.2	0.017	7.1*6.5*3
		3.3	0.027	
		4.7	0.036	
WURT H	744373 24022	2.2	0.061	4.4*4.05
	744777004	4.7	0.025	7.3*7.3*4.5

Table 1. Recommend Surface Mount Inductors

If output voltage is 5V , you can use 2.2uH~ 4.7uH, If output voltage is 12V, 4.7uH~ 10uH is OK,

Normal application: Input 3.3V (3.6V or 4.2V) to Output 5V 9V 12V ;

Input 5V to Output 9V 12V

CAPACITOR SELECTION

The input capacitor C1 and C2 reduces input voltage ripple, low ESR ceramic capacitor is highly recommended. For power bank application, A 10uF ceramic capacitor is at least. The input capacitor should be placed as close as possible to CHIN Pin/ BAT+ Pin and GND. Such as Murata GRM21BR60J106 or TDK C3216X5R1A106M

A low ESR output capacitor is required in order to maintain low output voltage ripple. one 10uF or 22uF ceramic output capacitor C3 is suitable for most applications. Such as GRM21BR60J106 or GRM21BR60J226

If Rset=200K ~370K, need to use 22uF input capacitor –C2 and 22uF output capacitor – C3 at least.

If input capacitor C2 is far away from BSVDD Pin, please add another 1uF capacitor C4 as close as possible.

For typical application circuit 2&3, the 1uF capacitor C4 must be added close to BSVDD as possible as you can. 50ohm~100ohm resistor R12 also must be added close BSVDD. The BSVDD power supply must get from Cout –C3 to reduce spike.

SET CHARGE CURRENT

The charge current is programmed by connecting a 1% resistor, R_{PROG} , PROG pin to ground. When charging in constant-current mode, this pin serves to 1V. In all modes, the voltage on this pin can be used to measure the charge current using the following formula:

$$I_{charge} = (V_{PROG}/R_{PROG}) \cdot 1000.$$

OUTPUT VOLTAGE PROGRAMMING

The output voltage is set by a resistive divider according to the following equation:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{1.2} - 1 \right)$$

For example, you can select $R_2=31.5K$ $R_1=100K$ to set 5Vout

OC SETTING1(SETTING CURRENT LIMIT BY ONE RESISTOR)

XS5603C can be adjusted SW current limit by one resistor connected with BSOC pin. The setting sheet is as below($V_{in}=3.6V$ $V_{out}=5V$)---Only list the typical I_{lim} number, the actual data may be in +/- 20% above them because of some discrete data from IC and resistor.

Please do not let it float.

Rset (ohm)	Ilim(typ)
470K	4.5A
370K	4.1A
300K	3.7A
200K	2.8A
168K	2.2A
150K	1.9A
130K	1.5A
120K	1.3A
100K	0.9A

. For 3V~4.2Vin to 5V 1A~1.2A out , 150K~168K ohm is suitable. Please use typical application as Figure1.

For 3V~4.2Vin to 5V 1.5A~2A out, 200K~370K ohm is suitable. Please use typical application as Figure2 & 3.

For 3.3V~4.2Vin to 5V 2.5A out, 470K ohm is suitable. Please use typical application as Figure2 & 3.

For 5V 2A or 5V 2.5A out, Please pay attention to the PCB layout & Thermal action.

OC SETTING2(SETTING CURRENT LIMIT BY ANALOG VOLTAGE)

XS5603C also can be adjusted SW current limit by one analog voltage connected with OC pin. and One 0.1uF capacitor need to be placed close to OC pin . Analog voltage can be got from MCU I/O output. The setting sheet is as below(Vin=3.6V Vout=5V)---Only list the typical Ilim number, the actual data may be in +/- 20% above them because of some discrete data from IC and the analog voltage.

Please do not let it float.

Analog Volatge (V)	Ilim(typ)
0.75V	3.20A
0.70V	2.75A
0.65V	2.20A
0.60V	1.75A
0.55V	1.35A
0.50V	0.95A
0.45V	0.55A
0.40V	0.20A

For 3V~4.2Vin to 5V 1A out , 0.63~0.65V is suitable.

For 3V~4.2Vin to 5V 1.5A out , 0.75V is suitable. ,(Note: Input/Output capacitor need to be 22uF at least.)

For this application, you can only use typical application as Figure1.

DIODE SELECTION

According to max Iout and max Vout, you can select suitable diode. Normally we select diode $I_f = (1.5 \sim 2) \cdot I_{outmax}$ and $V_R = (1.5 \sim 2) \cdot V_{outmax}$. For high efficiency, suggest that you select low Vf Schottky diode.

For example, 5V 1A ~ 1.5A out power bank application, you can select MBRA210LT3 or SS24. Using MBRA210LT3, you can get higher efficiency.

For 5V 2A or 5V 2.5A output, MBRS410LT3 is prefer.

WLED CURRENT SETTING

The WLED current is effected by Battery voltage、WLED's threshold voltage and setting resistor.

The maxim WLED current is 100mA, Please do not exceed it.

The equation is $I_{wled} = (V_{BAT} - V_{thod}) / R_{set}$.

Normally we set the resistor as 50ohm~100ohm 。 That's enough.

The WLED ON/OFF can work during charging or discharging, the control logic is as below:

ON	OFF
Press BSR tact switch 3s	Press BSR tact switch 3s

The battery voltage is lower, the holding time is longer and maybe exceed 3s.

BATTERY POWER INDICATOR LOGIC

1: LEDxx to Vbat:

	LED25	LED50	LED75	LED100
Vbat	3.6V	3.84V	4.0 V	4.22V
% Power Indicator	25%	50%	75%	100%

2: Charging Status (Adapter present)

% Power Indicator	LED25	LED50	LED75	LED100
0---25%	0.5HZ Twinkle	OFF	OFF	OFF
25%---50%	ON	0.5HZ Twinkle	OFF	OFF
50%---75%	ON	ON	0.5HZ Twinkle	OFF
75%---100%	ON	ON	ON	0.5HZ Twinkle
100% Full	OFF	OFF	OFF	OFF

After Charging finished, the LEDxx will get on for about 6s with logic as above when you press BSR tact switch。 And after last about 6s, the LEDxx will get off.

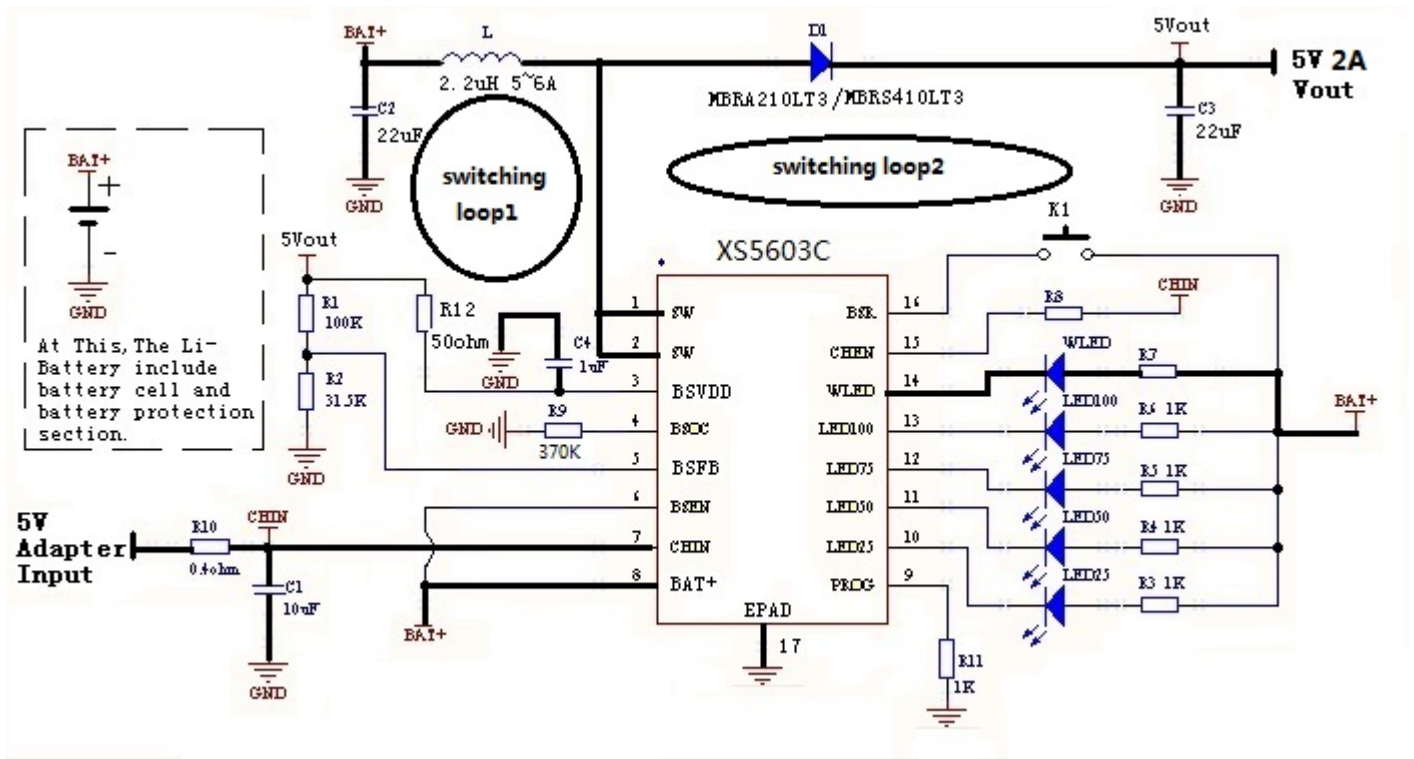
3: No Charging Status(Adapter Not present)

LEDxx will get on after press BSR tact switch(rising edge trigger) and last 6s.

% Power Indicator	LED25	LED50	LED75	LED100
75%以上	ON 6s	ON 6s	ON 6s	ON 6s
50%---75%	ON6s	ON 6s	ON 6s	OFF
25%---50%	ON 6s	ON 6s	OFF	OFF
0%---25%	0.5HZ Twinkle 6s	OFF	OFF	OFF

PCB LAYOUT GUIDE

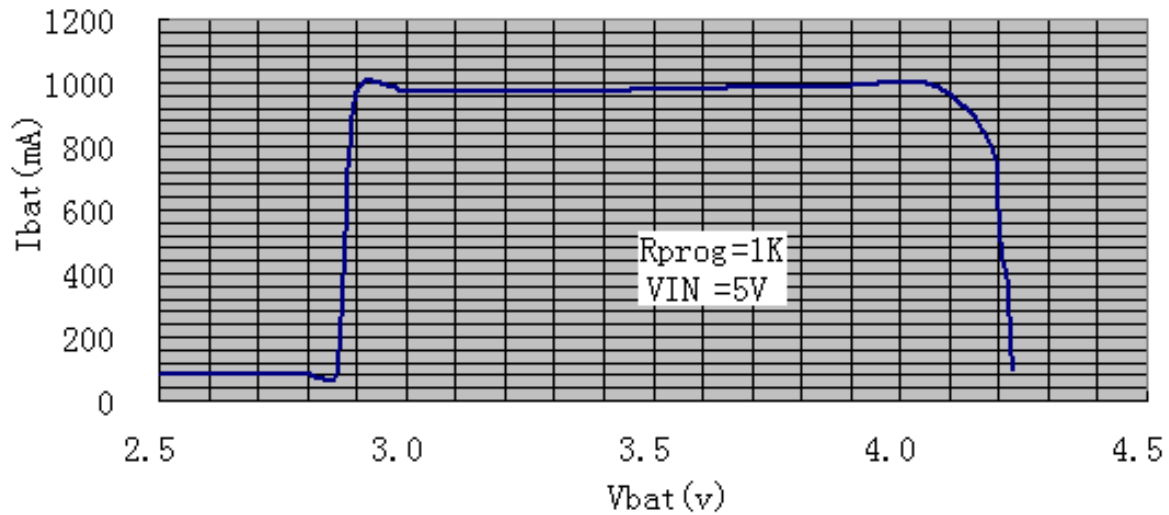
- 1) It is desirable to maximize the PCB copper area connecting to GND/EPAD pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable
- 2) C_1 must be close to Pins CHIN and GND. Also C_4 must be close to Pins BSVDD and GND ,
- 3) The PCB copper area associated with SW pin must be minimized to avoid the potential noise problem. Just like Switching loop1 and Switching loop2, should minimize their area to avoid EMI problem.
- 4) The components R1 and R2, and the trace connecting to the FB pin must NOT be adjacent to the SW net on the PCB layout to avoid the noise problem
- 5) Please make sure that the big current circuits are board and short to reduce the circuit $R_{ds(on)}$
- 6) For typical application circuit 2&3, the $1\mu F$ capacitor must be added close to BSVDD as possible as you can. $50\Omega \sim 100\Omega$ resistor also must be add close to BSVDD. The BSVDD power supply must get from Cout to reduce spike.



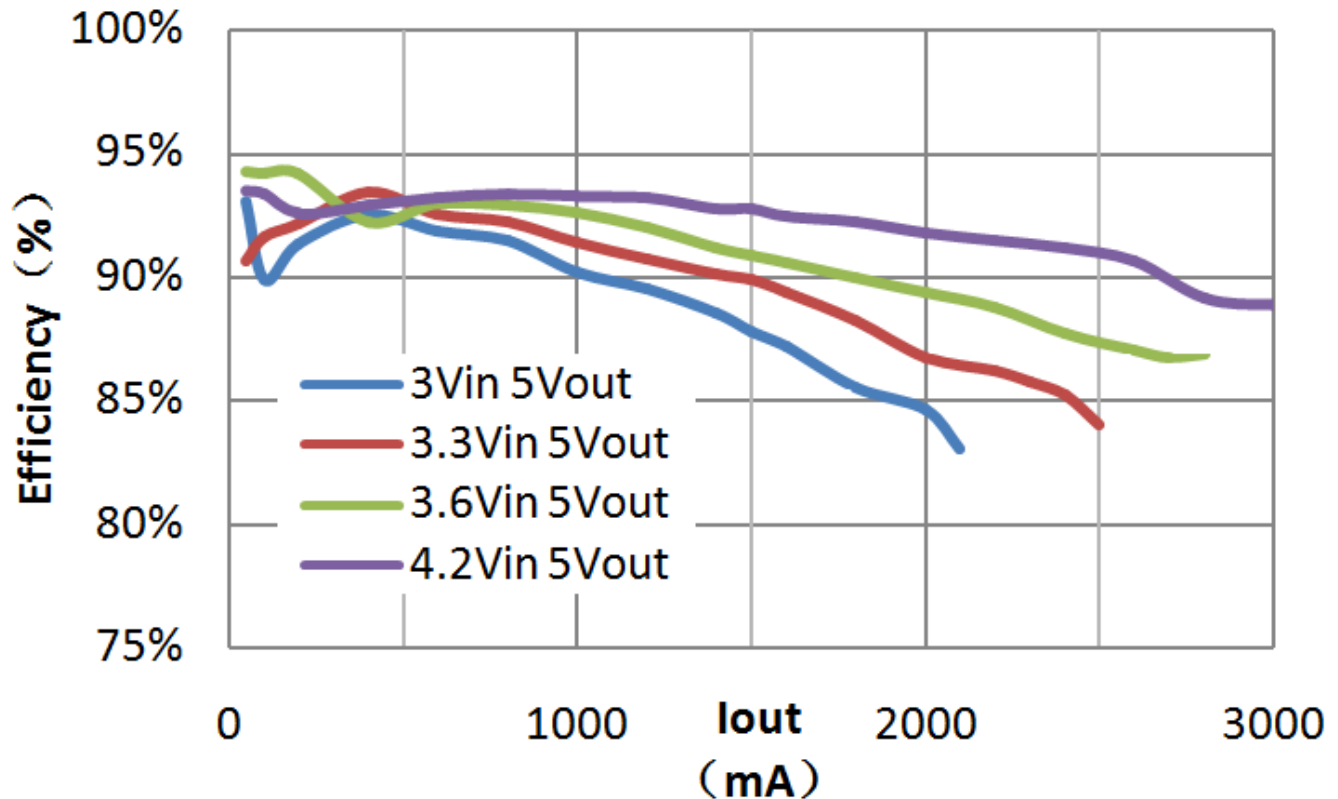
BIG CURRENT CIRCUIT
As above(Heavy Lines)
For Typical Application Circuit 2 & 3

TYPICAL PERFORMANCE CHARACTERISTICS

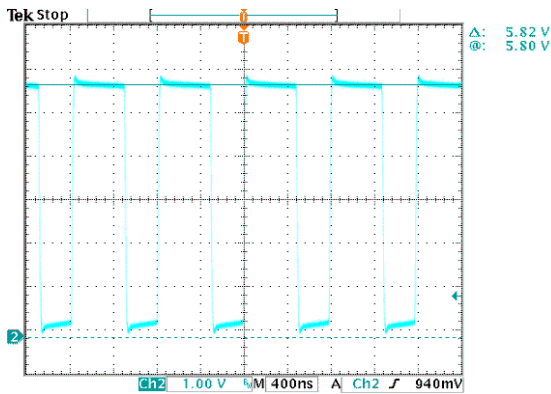
(L=2.2uH-SPM6530T2R2, C1=10uF C2=C3=22uF, D=MBRA210LT3 Vin=5V if not mentioned)



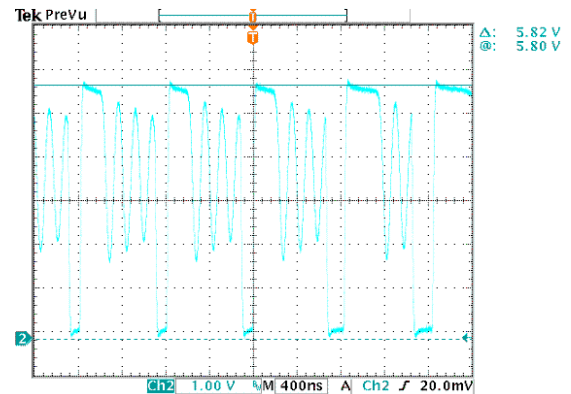
BATTERY CHARGER CURVE



5V_{OUT} EFFICIENCY (R_{SET}=470K TYPICAL APPLICATION CIRCUIT3)



PWM SWITCHING CONTINUOUS
CONDUCTION MODE



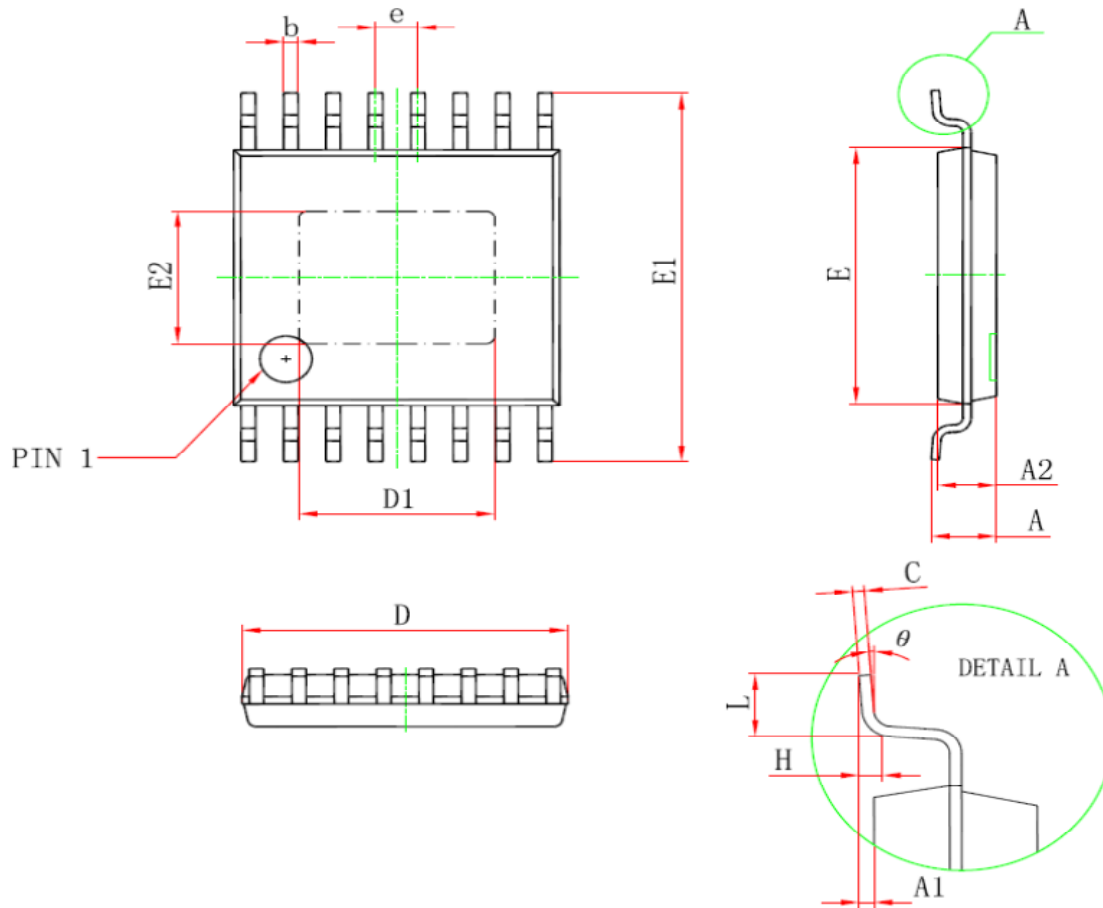
PWM SWITCHING DISCONTINUOUS
CONDUCTION MODE

NOTES:

The efficiency is tested under normal temperature, the actual current driver capability is 70% ~90% of the max current in sheet consider of high temperature surrounding status

PACKAGE OUTLINE

TSSOP16/PP PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	4.900	5.100	0.193	0.201
D1	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
e	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
E2	2.200	2.400	0.087	0.094
A		1.100		0.043
A2	0.800	1.000	0.031	0.039
A1	0.020	0.150	0.001	0.006
e	0.65 (BSC)		0.026 (BSC)	
L	0.500	0.700	0.02	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

In order to increase the driver current capability of XS5603C and improve the temperature of package, Please ensure Epad and enough ground PCB to release energy.

PROUCT CHANGE NOTICE LIST

NO	Updated date	Version update	Update content
1	2013-11-22	Rev 0.1	Create datasheet
2	2013-11-25	Rev 0.2	Add 3.3Vin to 5Vout 2A application