

Synchronous Switch Buck Charger for Single-cell Li Battery

1. Features

- Synchronous switch-mode buck charger
- 94% charging efficiency (3.7V/2A)
- Max charging current 3A
- Programmable charging current by external resistor
- Self-regulated input current adaptive to all adaptors
- Support 4.20V/4.30V/4.35V/4.4V battery
- NTC thermal protection
- LED for charging status indication
- Power MOSFETs integrated
- 750kHz switching frequency, support 1.1uH inductor
- Input OV and UV protection
- Over temperature protection
- Charging timeout protection
- ESD 4KV ability

2. Typical Applications

- Single-cell Li/Li-Ion battery charging management

3. Description

HM5152 is a 5V VIN, 2A Single-cell synchronous buck Li/Li-Ion battery charger and system power path management device.

HM5152 is highly-integrated, few peripheral devices is needed in application, delivering small PCB area and low BOM cost.

HM5152 integrate synchronous switching circuit with power FETs at 750kHz switching frequency. The charging efficiency is 94%, and the maximum input charge current 3A (5V Input), Programmable charging current by external resistor

The input charge current is regulated automatically in case that the current is too large to pull the adaptor into overcurrent protection mode.

ESOP8 Package

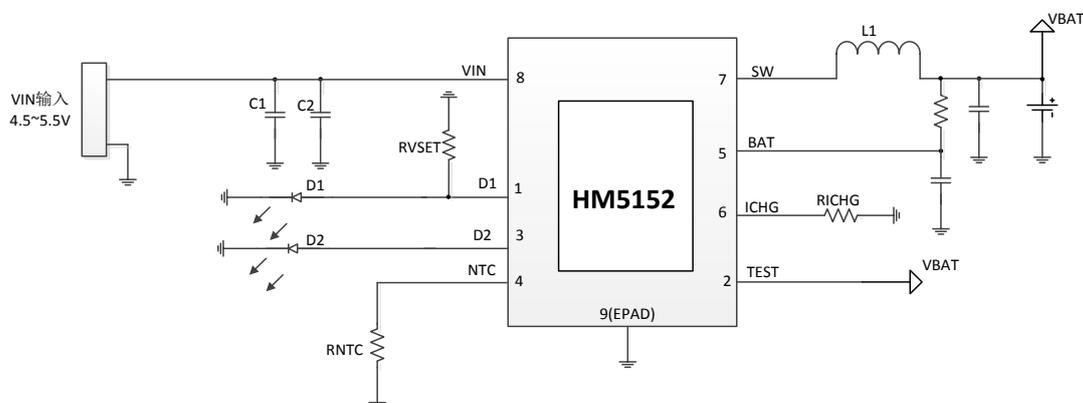


Figure 1 Simplified Application Schematic

4. PIN Description

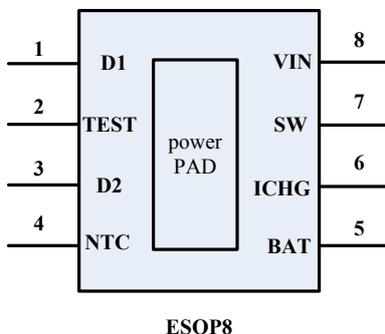


Figure 2 HM5152 Pin Assignment

Pin Name	Pin No.	Pin Description
D1	1	LED charging status indication pin/Battery type set(HM5152_VSET)
TEST	2	For IC test, pull down to GND with a 1kOhm resistor
D2	3	LED charging status indication pin
NTC	4	NTC thermal protection, output 20uA current, connect to NTC resistor
BAT	5	Battery positive pin
ICHG	6	Charge current program pin, pull down to GND with a Resistor to adjust the charging current
SW	7	DC-DC switch pin
VIN	8	5V Input pin
EPAD	--	Ground pin

5. Type Description

Type name	Function
HM5152	Battery fully charged voltage set by applying external resistor to ground on pin1. (4.2V/4.3V/4.35V/4.4V)

6. Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
VIN、SW、BAT Pin withstand Voltage (Pulse less than 10uS)		9	V
VIN、SW、BAT Pin withstand Voltage (Pulse over than 10uS)		6.5	V
D1、D2、NTC、ICHG、TEST Pin withstand Voltage		6	V
Built-in PMOS VDS voltage		-12	V
Built-in PMOS Max continuous current		5	V
Built-in NMOS VDS voltage		12	V
Built-in NMOS Max continuous current		6	V
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	T_{stg}	-60 ~ 150	℃
Junction Temperature(junction to ambient)	θ_{JA}	60	°C/W
Human Body Model (HBM)	ESD	4	KV

*Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

*Voltages are referenced to GND unless otherwise noted.

7. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}	4.5	5	5.5	V
Charge Current	I	0	2.1	3	A

*Devices' performance cannot be guaranteed when working beyond those Recommended Operating Conditions.

8. Electrical Characteristics

Unless otherwise specified, TA=25°C, L=1uH, VIN=5V, VBAT=3.7V

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input Voltage	V _{IN}		4.5	5	5.5	V
Charge Target Voltage	V _{TRGT}		4.15	4.2	4.23	V
Charge Current	I _{CHRG}	V _{IN} =5V, V _{BAT} =3.7V, R _{ICHG} =NC	1.8	2.1	2.4	A
Max Resistance for Charging Current Set	R _{ICHG}		170	175	180	KΩ
Charge Switch Frequency	f _s		650	750	850	KHz
Trickle Charge Current	I _{TRKL}	V _{IN} =5V, V _{BAT} =2.7V	50	100	300	mA
Trickle Charge Cut-off Voltage	V _{TRKL}		2.9	3.0	3.1	V
Recharge Voltage Threshold	V _{RCH}		4.08	4.1	4.13	V
Maximum Charge Time	T _{END}		20	24	28	Hour
Input Under Voltage Protection	V _{IN-UVLO}		4.4	4.5	4.6	V
Input over Voltage Protection	V _{IN-OVP}		5.5	5.6	5.7	V
PMOS On-state Resistance	r _{DSON}		30	35	40	mΩ
NMOS On-state Resistance			25	30	35	mΩ
Standby Current	I _{STB}	V _{IN} =0V, V _{BAT} =3.7V	30	40	50	uA
Control System						
LED Drive Current	I _{L1} I _{L2} I _{L3}		3	5	10	mA
Thermal Shutdown Temperature	T _{OTP}	Rising Threshold	110	135	150	°C
Thermal Shutdown Temperature Hysteresis	ΔT _{OTP}	Falling Threshold	70	85	100	°C

9. Function Description

Functional Block Diagram

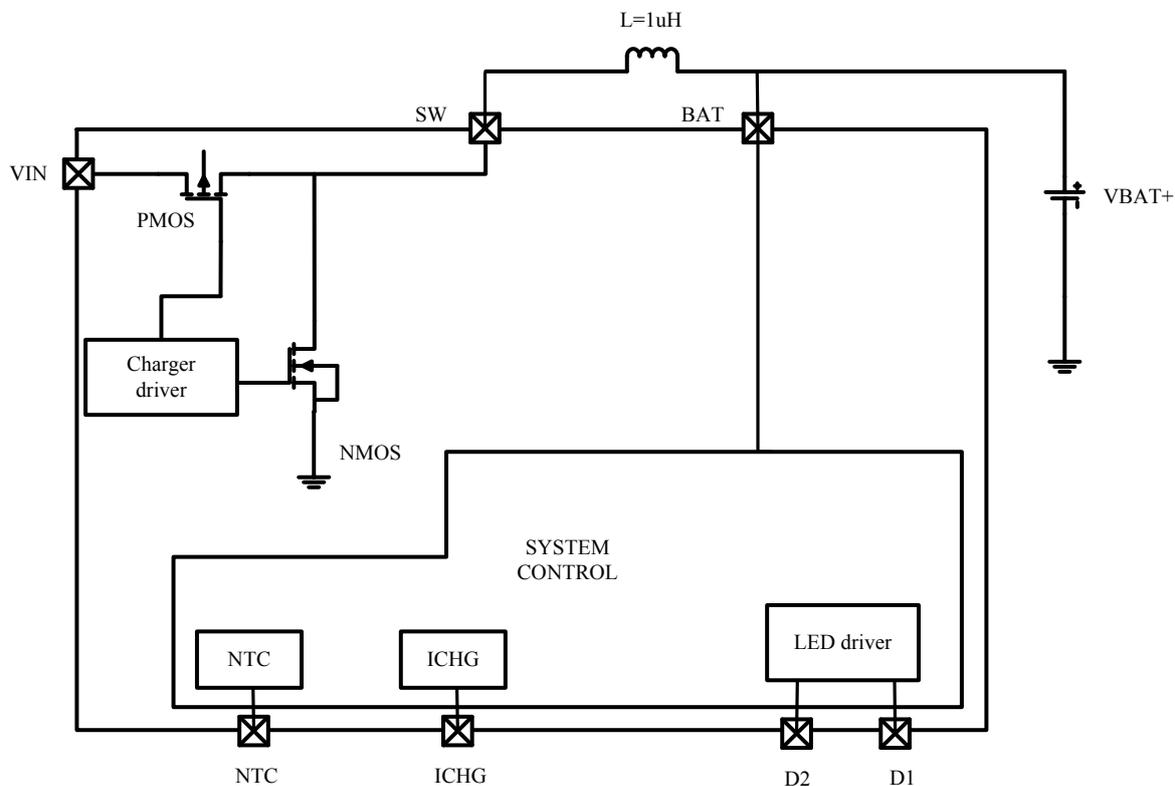
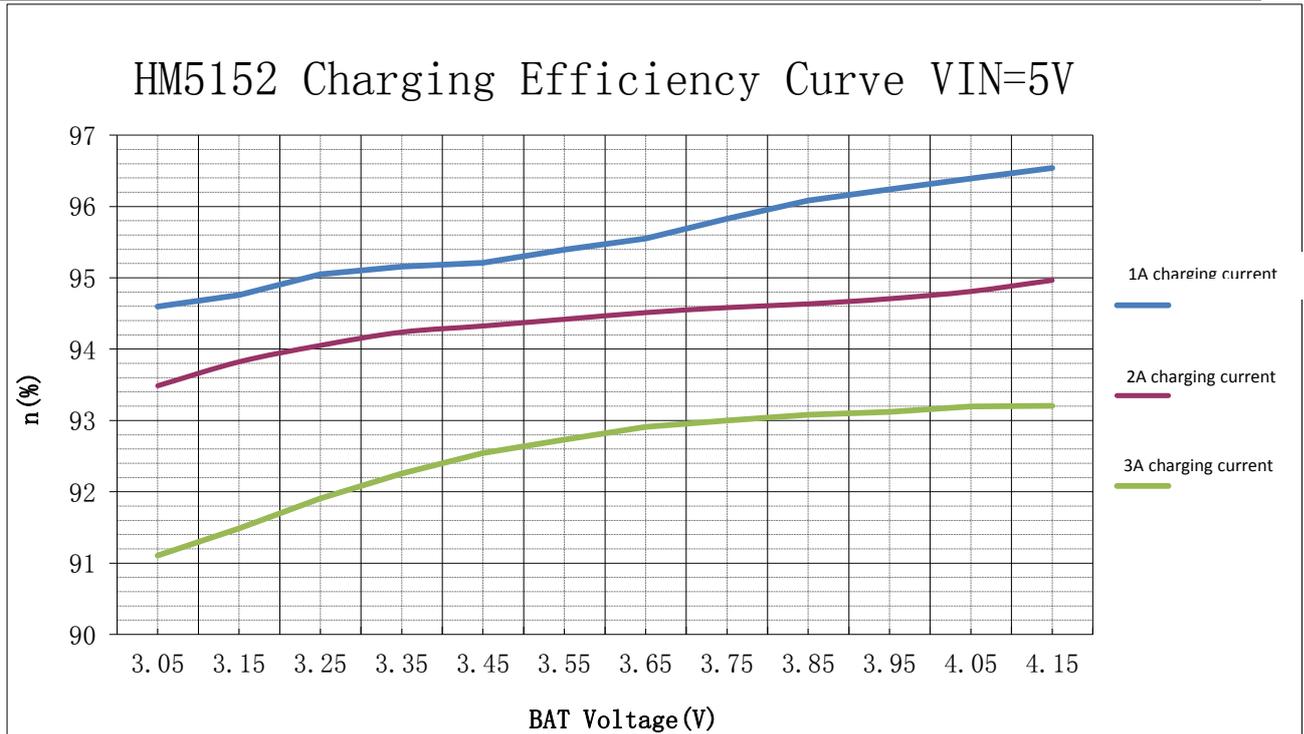


Figure 3 HM5152 Functional Block Diagram

Buck Charge

HM5152 integrated a 5V input synchronous buck charger with 750kHz switching frequency. The efficiency is 94% at 3.7V/2A output.



Charge Process

HM5152 deploy the complete CC (Constant Current)/CV (Constant Voltage) charging mode.

When the battery voltage is under 3V, charge the battery in 100mA current.

When the battery voltage is above 3V, the battery will be charged in tricking current.

When the battery voltage reaches near 4.2V, and the current is under 300mA, the system will enter CV mode.

In the CV mode, the system will pause the charging after 4 minutes and detect if the battery voltage is above 4.15V, if the voltage is detected higher than 4.15V, then the charging process will be terminated; otherwise if the voltage is still under 4.15V, the system will continue the charging process and detect the battery voltage after 4 minutes. The charging process will also be terminated if the charging current is less than 100mA.

When the charging process terminated after battery are fully charged, once the voltage is under 4.1V, the charging process will be start again.

Charge Protection

HM5152 has full protection functions. The power provides soft-start preventing the system rail voltage from overshooting during startup. Output Over-current protection, short-circuit protection, under-voltage protection and thermal protection are integrated for stable working function.

HM5152 integrates VIN input under-voltage protection, VIN input loop charging current is regulated automatically, when HM5152 detects the input voltage under 4.5V, the charging current will decrease to make input voltage stable at 4.5V to prevent pulling the adaptor into overcurrent protection mode.

HM5152 integrates VIN input overvoltage protection, when HM5152 detects the input voltage over 5.6V, it will stop charging.

HM5152 integrates NTC thermal protection, cooperates with NTC thermistor. When the NTC detected

temperature is between 0~43°C, the charging will be in normal working status; when temperature is over 43°C, the charging current will be reduced by half; when temperature is over 45°C, it will stop charging.

HM5152 deploy a charge timeout protection: after in charging state for more than 24 hours, the system will force to stop the charging progress.

HM5152 integrates thermal protection function: when HM5152 detects that the chip temperature reaches 135°C, it will stop charging; when the temperature drops to 85°C, HM5152 restarts charging.

Battery Type Setting

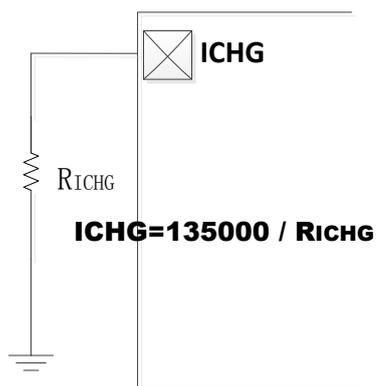
HM5152 support Battery type can be set by the RVSET pin, accordingly, the battery level display threshold voltage and Constant Voltage charging threshold voltage are changed at the same time. VSET resistor and battery type are listed below.

RVSET	Battery type (Battery full voltage)
NC	4.2V
43K 1%	4.3V
75K 1%	4.35V
100K 1%	4.4V

Charge Current

Constant charge current I_{CC} can be programmed by applying external resistor to ground on ICHG pin. The configured current is the maximum charging current at battery port (with $\pm 10\%$ precision).

Max value of RICHG is 170K, which corresponds to the minimum charging current of 0.8A; after RICHG is greater than 170K, it will be considered that there is no resistance (NC), and the charging current is restored to the default value of 2.1A.



Typical current vs. recommended resistor:

Theoretic resistor on RICHG pin (kOhm)	Typical maximum charge current at battery port (A)
135	1
91	1.5
45	3
NC	2.1

Charge NTC

The battery charge system support NTC thermal protection, the NTC pin used to detect the temperature of the battery pack, when the detected temperature is above the pre-set temperature, the charger will be shut down to protect the battery.

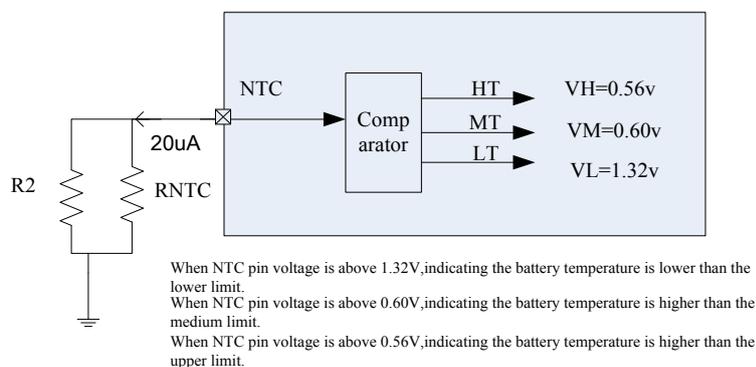


Figure 4 NTC circuit

There are three temperature thresholds: 0℃ for lower limit, 43℃ for medium limit, 45℃ for higher limit. When the NTC detected temperature is between 0~43℃, the charging will be in normal working status. When the temperature is higher than 43℃, the charging current will reduce to half (configurable by register). When the NTC detected temperature is higher than 45℃, the charging will be terminated.

If NTC function is not needed, apply 51KOhm to ground on NTC pin.

NTC pin source 20uA current to the resistor connected between NTC pin and GND, this current will generate a voltage drop on the resistor which is the basis for temperature measurement.

For example, if the RNTC=100kOhm thermistor (B=4100), R2=82K, the corresponding temperature and NTC voltage is listed below:

Temperature (℃)	NTC voltage threshold(V)
-20	1.52
-15	1.49
-10	1.44
0	1.32
45	0.56
50	0.49
55	0.43
60	0.38
65	0.33

Charge Status Indication LED

HM5152 support 1/2 LED indicator.

■ 2 LED

	status	D1	D2
During charging	charging	on	off
	Fully charged	off	on

■ 1 LED

	status	D1
During charging	charging	0.5Hz Flash
	Fully charged	on

10. Typical Application Schematic

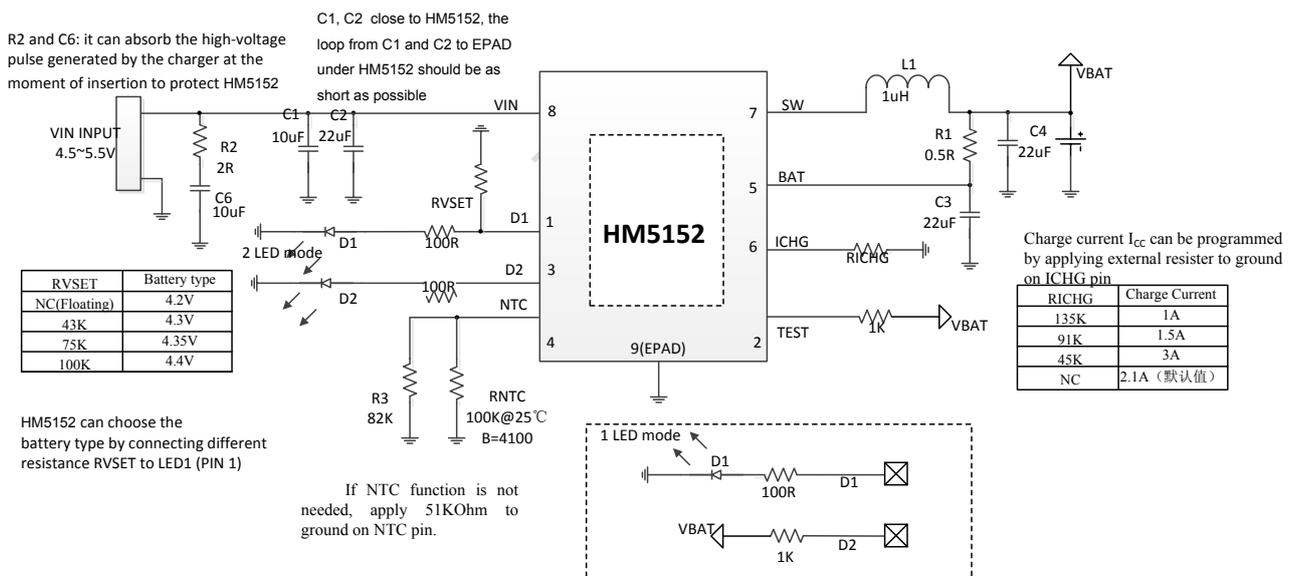
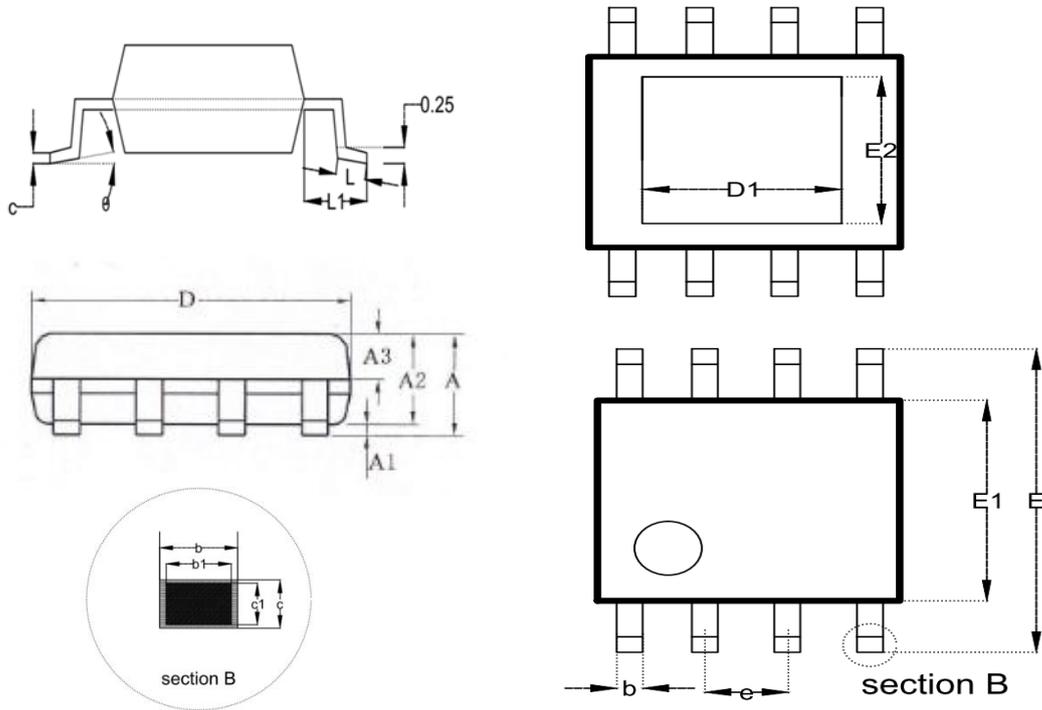


Figure 5 Typical Application Schematic

11. Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.05	--	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	--	0.48
b1	0.38	0.41	0.43
c	0.21	--	0.25
c1	0.19	0.20	0.21
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.50	0.60	0.80
L1	1.05BSC		
θ	0	--	8°
D1	--	2.09	--
E2	--	2.09	--