HM5031 Series- High input Voltage Linear Li-Ion Battery Charger

GENERAL DESCRIPTION

The HM5031 Series is a complete constant current & constant voltage linear charger for single cell lithium-ion batteries. Its SOP package and low external component counts make the HM5031 Series ideally suited for portable applications. Furthermore, the HM5031 Series is specifically designed to work within USB power specifications.

No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. The charge voltage is fixed at 4.2V/4.3V/4.35V/4.4V, and the charge current can be programmed externally with a single resistor. The HM5031 automatically terminates the charge cycle when the charge current drops to 1/10 the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed, the HM5031 automatically enters a low current state, dropping the battery drain current to less than 2uA. The HM5031 can be put into shutdown mode, reducing the supply current to 50uA.

Under-voltage lockout, automatic recharge and two status pins to indicate charge and charge termination.

FEATURES

30V standoff input voltage at VCC pin
Programmable Charge Current Up to 1000mA
No MOSFET, Sense Resistor or Blocking Diode Required
Complete Linear Charger in SOP Package for single Cell Lithium-Ion Batteries
Charges Single Cell Li-Ion Batteries Directly from USB Port
Preset 4.2V/4.3V/4.35V/4.4V Charge Voltage with ±1% Accuracy
Charge Current Monitor Output for Gas Gauging
Automatic Recharge
Charge state pairs of output, no battery and fault status display
CC/10 Charge Termination
50uA Supply Current in Shutdown
2.9V Trickle Charge Threshold
Soft-Start Limits Inrush Current
ESD HBM 2KV
Available in SOP8-PP Package

APPLICATIONS

Cellular Telephones, PDAs, MP3 /MP4 Players
E-cigarettes
Bluetooth
GPS Applications

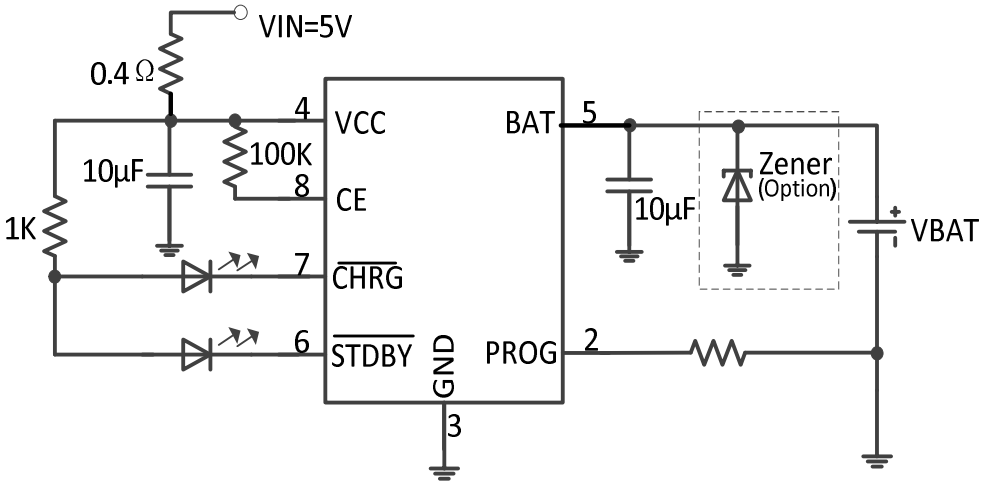


Figure1 .Typical Application Circuit

Note: If CE connect with VCC without 100K resistor, Vin voltage tolerance will be <= 10V.

ORDERING INFORMATION

PART NUMBER （note1）	VBAT	MARK (note2)
HM5031A	4.2V	HM5031A YW
HM5031B	4.3V	HM5031B YW
HM5031C	4.35V	HM5031C YW
HM5031D	4.4V	HM5031D YW

Note1: In HM5031X description, X may be A or B or C or D

Note2: “YW” is manufacture date code, “Y” means the year, “W” means the week

PIN CONFIGURATION

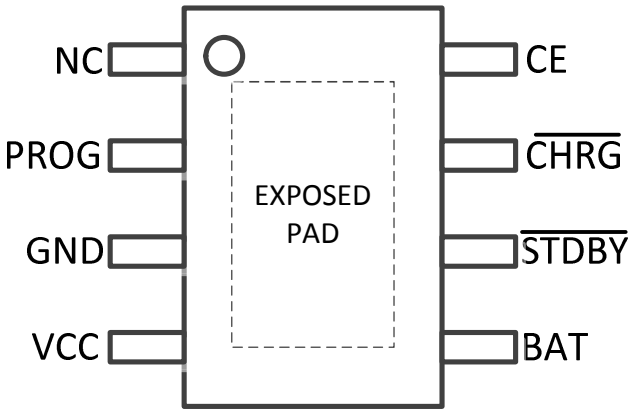


Figure 2. PIN Configuration

PIN DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1,	NC	No Connection.
2	PROG	Charge Current Program, Charge Current Monitor and Shut down Pin.
3	GND	Ground
4	VCC	Positive Input Supply Voltage.
5	BAT	Charge Current Output.
6	$\overline{\text{STDBY}}$	The completion of battery charging instructions side.
7	$\overline{\text{CHRG}}$	Open-Drain Charge Status Output.
8	CE	Chip enable input.
9	EPAD	Ground and EPAD

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
Input Supply Voltage VCC	VSS-0.3 ~ VSS+30	V
PROG pin Voltage Vprog、CE pin Voltage Ven	VSS-0.3 ~ 10	V
BAT pin Voltage Vbat	VSS-0.3 ~ 11	V
$\overline{CHRG}$、$\overline{STDBY}$ pin Voltage Vchrg	VSS-0.3 ~ 10	V
BAT pin Current bat	1.4	A
PROG pin Current Iprog	1.4	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_{CC} = 5.0V,Vbat=3.5V T_A= 25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Tolerance			4.25		26	V
Input over Voltage protection	V_{OVP}			6.8		V
The Hysteresis Voltage of V_{OVP}				0.4		V
Input Voltage Range			4.25		6	V
Input supply current	Icc	Charge mode, RPROG =10K		350	2000	uA
		Standby mode, Vbat=4.3V		150	500	uA
		Shutdown mode(Vcc<Vbat or Vcc<Vuv)		50	200	uA
BAT pin Current	Ibat	R_{PROG} =200k,Current mode	4	5	6	mA
		R_{PROG} =100k,Current mode	8	9.5	11	mA
		R_{PROG} =10k,Current mode	85	95	105	mA
		R_{PROG} =2k,Current mode	425	475	525	mA
		R_{PROG} =1k,Current mode	850	950	1050	mA
		Standby mode, Vbat=4.3V	0	-2.5	-6	uA
		Shutdown mode		1	2.5	uA
		Sleep mode, Vcc=0V		0.3	2.5	uA

Regulated Charge Voltage(HM5031A)	Vfloat	0°C ⩽ TA ⩽ 85°C, Icharge = 40mA	4.158	4.2	4.242	V
Regulated Charge Voltage(HM5031B)			4.257	4.3	4.343	V
Regulated Charge Voltage(HM5031C)			4.307	4.35	4.394	V
Regulated Charge Voltage(HM5031D)			4.356	4.4	4.444	V
PROG pin Voltage	Vprog	R_{PROG} =1k, Current mode	0.93	1.0	1.07	V
Trickle charge current	Itrikl	Vbat<Vtrikl, Rprog=1k	85	95	105	mA
Trickle charge Threshold Voltage	Vtrikl	R_{PROG} =10K，Vbat Rising	2.7	2.9	3.1	V
Trickle voltage hysteresis voltage	Vtrhys	R_{PROG} =10K	0.08	0.12	0.16	V
Recharge Battery threshold Voltage	∆ Vrecg	V_{FLOAT} - V_{RECHRG}		105	150	mV
Under voltage Lockout Threshold	V_{UVLO}	BAT = 3.5V, IN Rising	3.05	3.4	3.75	V
VCC under voltage lockout hysteresis	Vuvhys			600		mV
$\overline{CHRG}$ pin Output low voltage	Vchrg	Ichrg=5mA		1.2	2	V
$\overline{STDBY}$ pin Output low voltage	Vstdby	Istdby=5mA		1.2	2	V
Enable Threshold		VCC=4.25V~6.5V	0.3	1	1.5	V
Enable Leakage Current			-0.1		+0.1	uA
Thermal Shutdown Temperature	T_{SHDN}			140		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}			20		℃

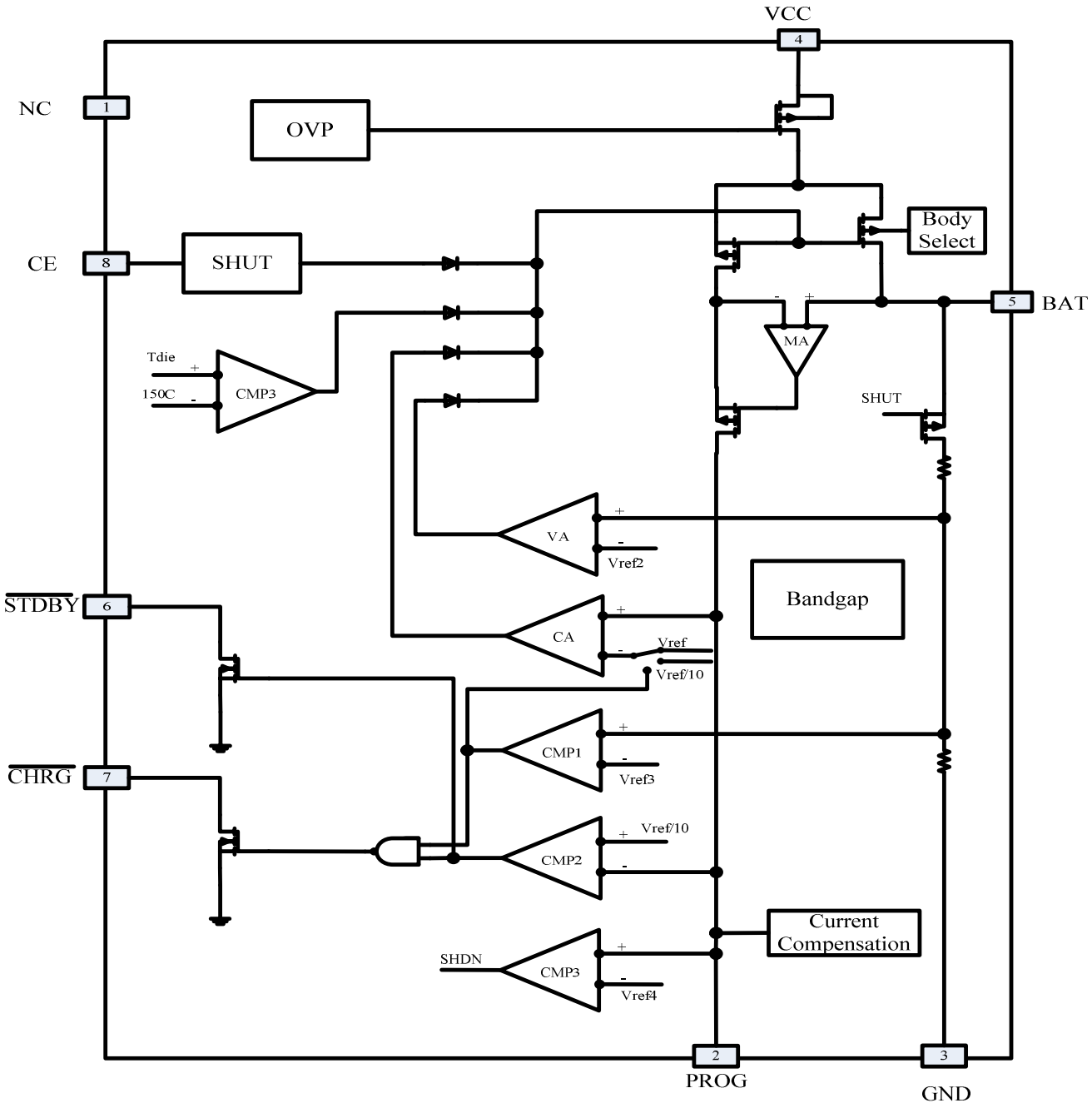


Figure3 Block Diagram

PIN FUNCTION

NC (PIN 1): No Connection.

PROG (PIN 2): Charge Current Program, Charge Current Monitor and Shutdown Pin.

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

IBAT = (VPROG/RPROG) x950.

The PROG pin can also be used to shut down the charger. Disconnecting the program resistor from ground allows a compensated current to pull the PROG pin high. When it reaches the 1.21V shutdown threshold voltage, the charger enters shutdown mode, charging stops and the input supply current drops to 50uA. Reconnecting RPROG to ground will return the charger to normal operation.

GND (PIN 3): Ground.

VCC (PIN 4): Positive Input Supply Voltage.

Provides power to the charger, VCC can range from 4.25V to 6.5V and should be bypassed with at least a 10uF capacitor. When VCC drops to within 30mV of the BAT pin voltage, the HM5031 enters shutdown mode, dropping IBAT to less than 2uA.

BAT (PIN 5): Charge Current Output.

Provides charge current to the battery and regulates the final float voltage to 4.2V/4.3V/4.35V/4.4V. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode.

$\overline{\text{STDBY}}$ (PIN 6): The completion of battery charging instructions side.

When the battery charge is complete, $\overline{\text{STDBY}}$ pulled low by internal switches, indicating the completion of charging. In addition, $\overline{\text{STDBY}}$ pin will be in a high-impedance state.

$\overline{\text{CHRG}}$ (PIN 7): Open-Drain Charge Status Output.

When the battery is charging, the $\overline{\text{CHRG}}$ pin is pulled low by an internal N-channel MOSFET. When the charge cycle is completed, $\overline{\text{CHRG}}$ pin will be in a high-impedance state.

CE (PIN 8): Chip enable input.

High input level will make HM5031 in normal working condition; low input level so that HM5031 is prohibited charging status. CE pin can be TTL or CMOS level-level driver.

OPERATION

CHARGE CYCLE OVERVIEW

When a battery charge cycle begins, the battery charger first determines if the battery is deeply discharged. If the battery voltage is below Vtrikl, typically 2.9V, an automatic trickle charge feature sets the battery charge current to10% of the full-scale value.

Once the battery voltage is above 2.9V, the battery charger begins charging in constant-current mode. When the battery voltage approaches the 4.2V/4.3V/4.35V/4.4V required to maintain a full charge, otherwise known as the float voltage, the charge current begins to decrease as the HM5031 switches into constant-voltage mode.

TRICKLE CHARGE AND CHARGE TERMINATION

Any time the battery voltage is below Vtrikl, the charger goes into trickle charge mode and reduces the charge current to 10% of the full-scale current. If for any reason the battery voltage rises above Vtrikl , the charger will resume charging. When the battery is charging, the $\overline{CHRG}$ pin is pulled low by an internal N-channel MOSFET. When the charge cycle is completed, $\overline{CHRG}$ pin will be in a high-impedance state.

When the battery voltage reach the regulated charge voltage, typically 4.2V/4.3V/4.35V/4.4V and the charger current is below 10% of fast charge setting current, charging of the battery will discontinue and no more current will be delivered

At this time, STDBY pulled low by internal switches, indicating the completion of charging. In addition, STDBY pin will be in a high-impedance state

CHARGE STATUS INDICATION

The $\overline{CHRG}$ pin and the $\overline{STDBY}$ pin indicates the status of the battery charger..Four possible states are represented by charging, complete, fault, floating

Table 1 illustrates the four possible states of them when the battery charger is active.

Charge Status	$\overline{CHRG}$ LED	$\overline{STDBY}$ LED
Charging	ON	OFF
Complete	OFF	ON
Fault UVLO	OFF	OFF
Floating BAT Pin C=10uF and Battery unavailable	$\overline{STDBY}$ LED ON, $\overline{CHRG}$ LED TWINKLE(About 1~4s)	

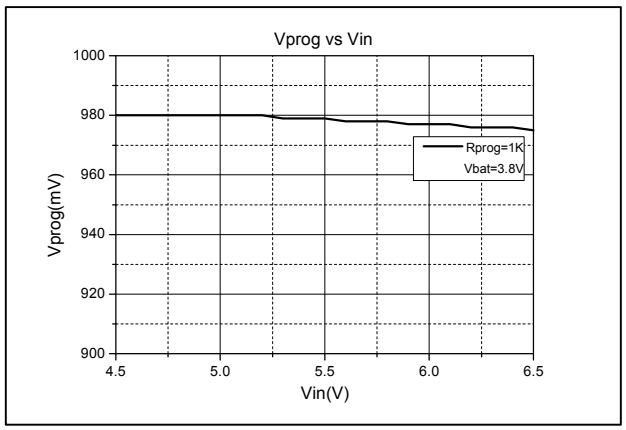
AUTOMATIC RECHARGE

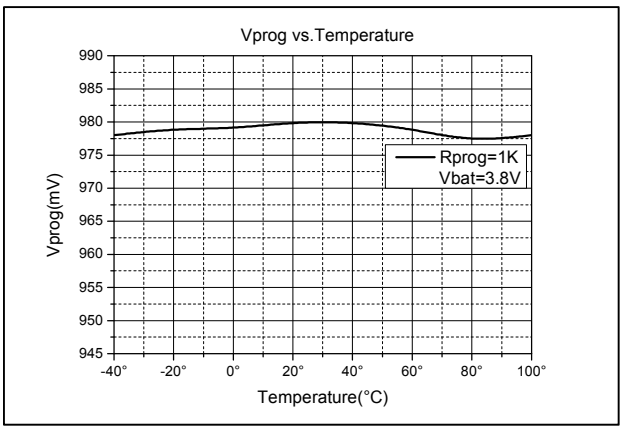
After the battery charger terminates, it will remain off, drawing only microamperes of current from the battery. If the portable product remains in this state long enough, the battery will eventually self discharge. To ensure that the battery is always topped off, a charge cycle will automatically begin when the battery voltage falls below VRECHRG(typically 4.08V).

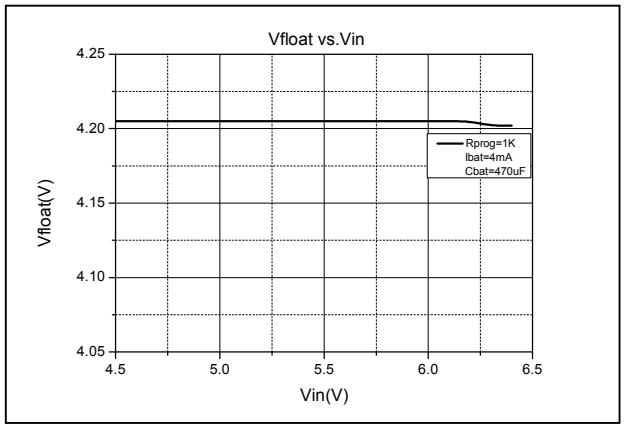
SHUT DOWN

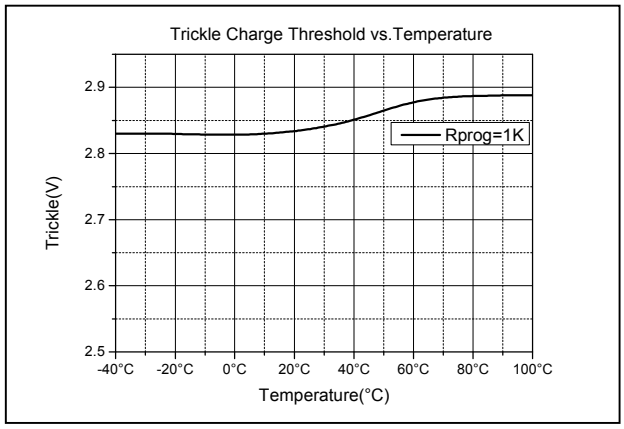
When the Voltage of CE pin is Low, HM5031 will shut down. the shut down current will below 2.5uA

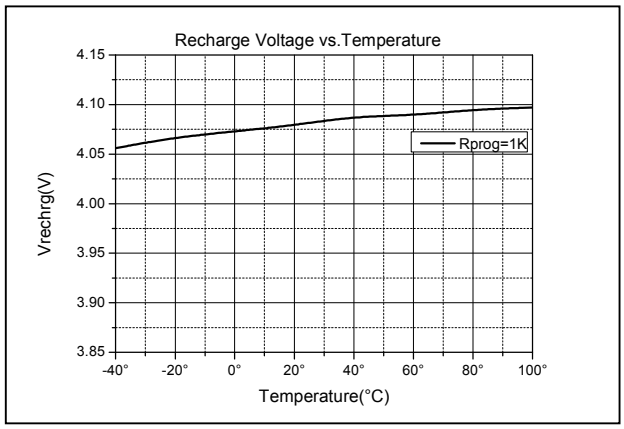
TYPICAL PERFORMANCE CHARACTERISTICS

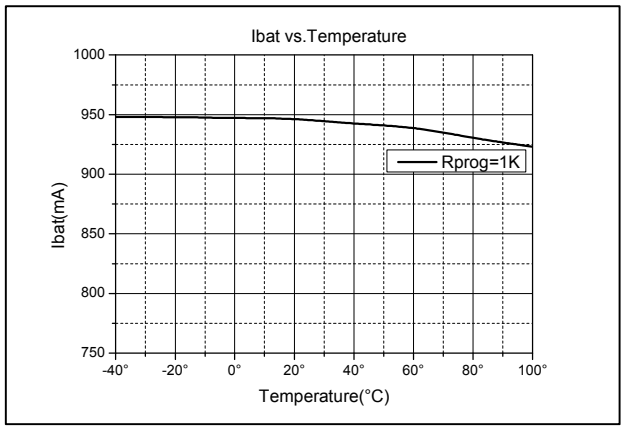


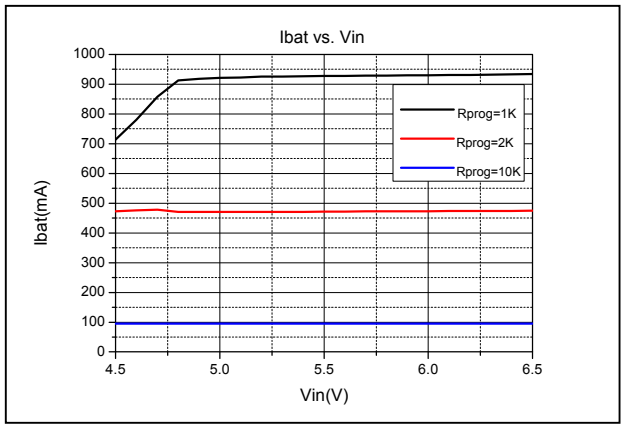


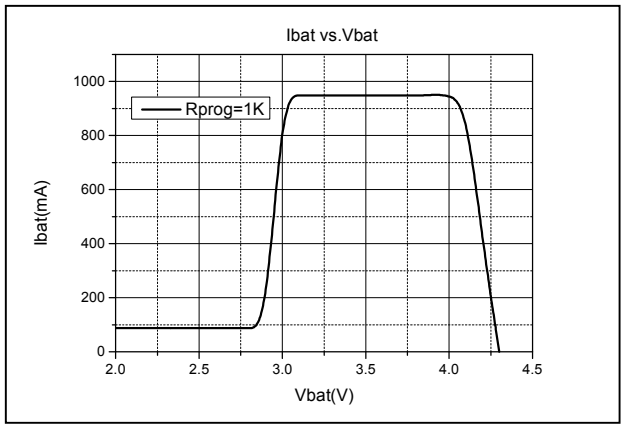






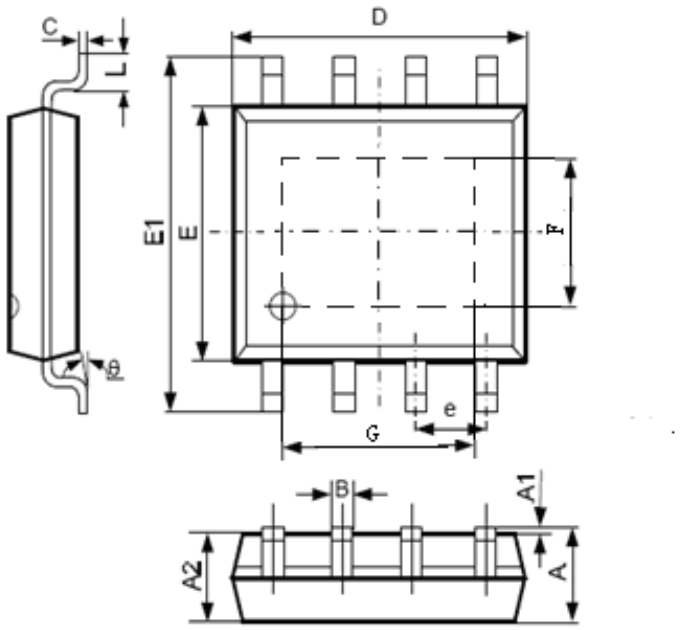



Ibat vs. Vin
Ibat(mA)
Vin(V)
Rprog=1K
Rprog=2K
Rprog=10K
1000
900
800
700
600
500
400
300
200
100
0
4.5
5.0
5.5
6.0
6.5


Ibat vs.Vbat
Ibat(mA)
Vbat(V)
Rprog=1K
1000
800
600
400
200
0
2.0
2.5
3.0
3.5
4.0
4.5

PACKAGE OUTLINE

SOP8-PP PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	Dimension in Millimeters		Dimension in Inches	
	MIN	MAX	MIN	MAX
A	1.300	1.700	0.051	0.067
A1	0.000	0.100	0.0	0.004
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0^o	8^o	0^o	8^o
F	2.313	2.513	0.091	0.099
G	3.202	3.402	0.126	0.134

In order to increase the driver current capability of HM5031 Series and improve the temperature of package, Please ensure Epad and enough ground PCB to release energy.