4.2A 同步整流開關型移動電源管理方案

產品概述

VAS5189 是一款鋰電池充電管理與升壓 DC/DC 的單晶片專用 IC，其應用時僅需極少的週邊器件，有效降低 BOM 成本，適用于單節鋰離子/鋰聚合物電池的移動電源充放電管理。它集成高效 1.0MHZ 同步 BUCK 鋰電池充電管理，使用小尺寸的電感和電容最大可以達到 3.0A 的充電電流，自我調整充電管理可以搭配各種形態的 5V 電源進行快速充電，可程式設計電池電壓可以匹配不同型態的電芯達到電量的優化；升壓 DC/DC 采同步整流工作在 600KHz，依輸出功率選擇外置功率 MOS，實現高放電效率，IC 本體溫度低大幅提高可靠度，輸出最大達到 5V/4.2A，可程式設計的限流點可使輸出達限流時維持恒定電流，不隨電池電壓與輸出電壓變化; 支援智慧判斷負載插入和拔除，進行自動升壓和自動關機，電池放電時電壓低電與過溫保護，輸出過流/短路保護等電路，確保晶片和系統安全工作；集成 4 段的電池電量檢測和顯示，可以在充電還是升壓放電的狀態下有效地指示電池當前剩餘的電量，負載補償設計有效解決電量顯示因為負載變化引起跳變或回彈的問題。手電筒 LED 可以輸出最大 150mA 的電流，可通過按鍵控制手電筒的開關。

充電特點

- 10V 輸入耐壓
- 開關型充電電流
- 涓流，恒流，恒壓和滿充指示管理
- 1.0MHz 開關頻率, 支援 1.5uH 電感
- 高達 94%效率
- 支援 4.20V, 4.30V, 4.35V 電池
- 1.5hr 背景尾電流充電
- 自我調整充電管理(VIN-DPM)
- 4 段 LEDs 電量顯示(兩種模式)
- 異常報錯顯示
- 支持邊充邊放
- 可啟動手電筒功能
- 多重保護:
  - 6.6V 輸入過壓保護(OVP)
  - 電池短路與電池過壓保護(BOVP)
  - 電池溫度檢測(50℃)

應用領域

- 移動電源
- 備用電源

升壓特點

- 小於 30uA 電池存放漏電流
- 600KHz 開關頻率，共用 1.5uH 電感
- 5.10V 恒壓輸出, 5.82V 輸出過壓保護
- 高達 92%效率
- 真實的2.1A+1.0A與2.1A+2.1A同步整流輸出
- 電池電壓3.15V以下低電量提示
- 電池電壓 2.80V 以下自動關閉輸出
- 快速動態回應，支援全陶瓷電容應用
- 在升壓模式下輕載自動關斷
- 支援負載插入自動啟動升壓
- 4 段 LEDs 電量顯示(帶負載補償)
- 過電流以 CC 模式輸出，恒流點可調
- 多重保護:
  - 過電流限流輸出/短路保護
  - 驅動外接 N 溝道 MOSFET 可完全斷開 USB-A 口
  - 電池溫度檢測(60℃)

封裝

- TQFN4x4-24
- TSSOP24

Typical Application Circuits

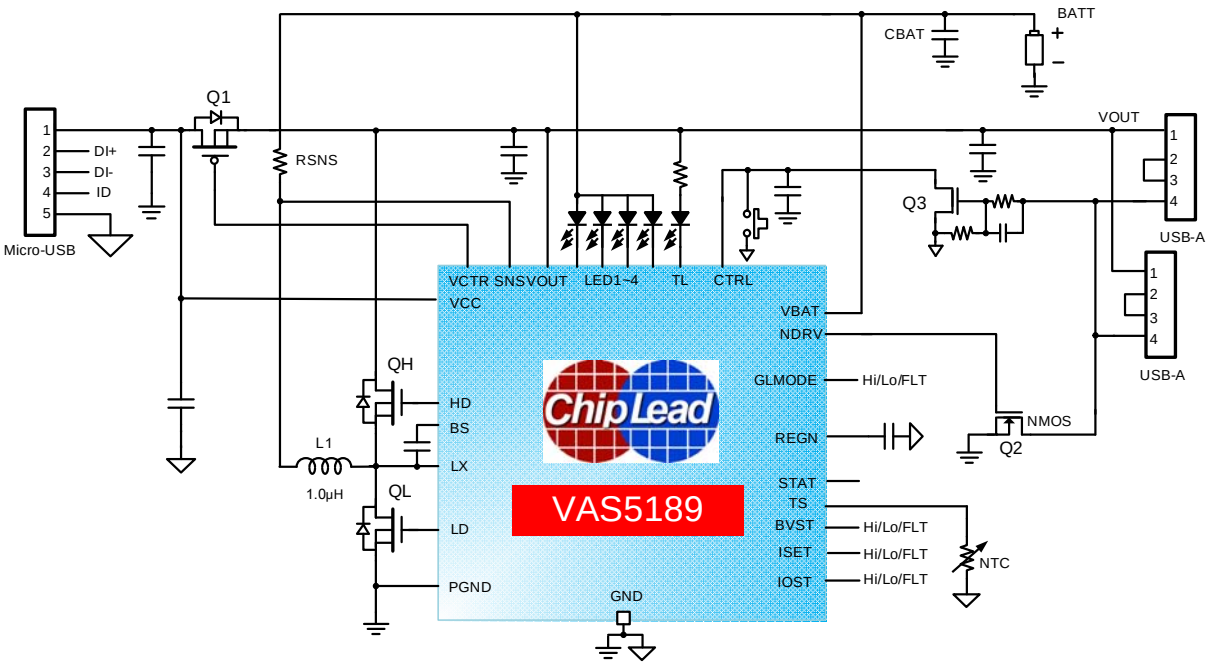
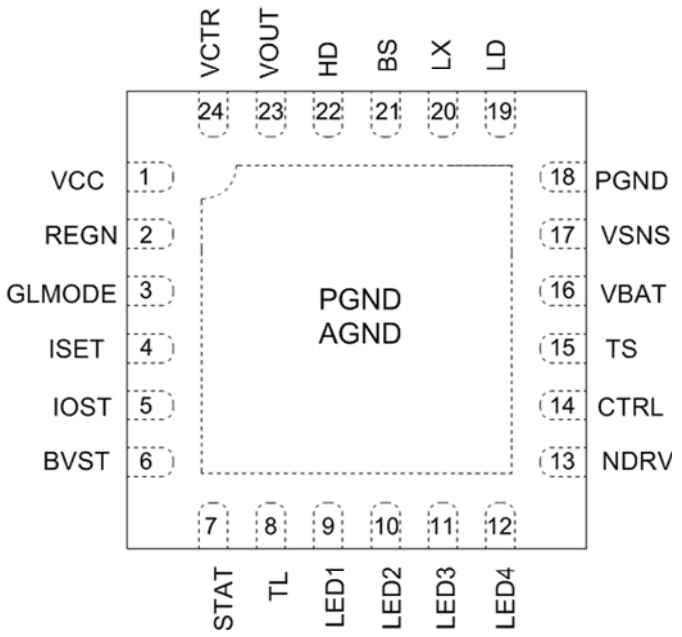


Figure1. Typical Application Schematic

PIN Configuration

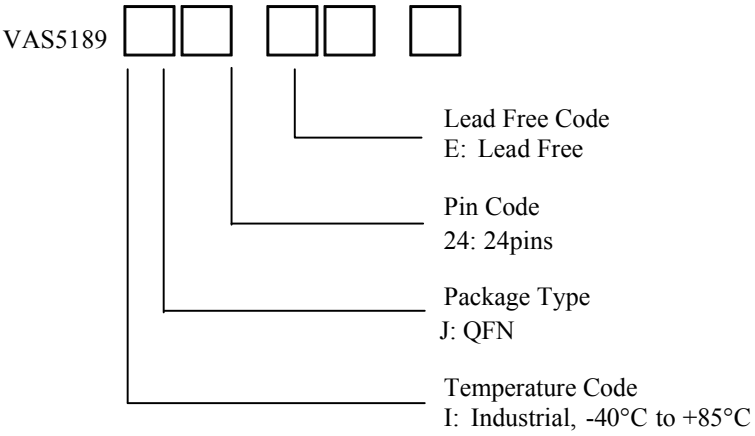
Package	PIN-OUT
QFN-24	

PIN Description

TQFN PIN NO.	Name	Description
1	VIN	USB 或 AC 適配器輸入。當 VIN 存在時，充電和電源管理路徑工作，使用 10uF 陶瓷電容連接 VIN 與 PGND.
2	REGN	5V 電源輸出，通過一個 4.7uF 陶瓷電容旁路到地。
3	GLMODE	電量顯示模式選擇引腳。 FLOAT / Hi / Lo CHG: Wave(跑馬燈) BOOST: ON / CHG: Flash(閃燈) BOOST: ON / CHG: Wave BOOST: ON(5sec) -> OFF
4	ISET	快充電流設置，設置VSNS與VBAT之間的採樣量以控制快充電流量。 Lo: 15mV / FLT: 30mV / Hi: 45mV
5	IOST	升壓恒流點設置。設置VBAT與VSNS之間的採樣量以控制升壓恒流點。 Lo: 75mV / FLT: 100mV / Hi: 125mV
6	BVST	恒壓電壓設置。 Lo: 4.30V / FLT: 4.20V / Hi: 4.35V
7	STAT	狀態指示(Open drain) Hi-Z / Low / Blinking 充電完成或休眠模式 / 充電中 / 異常
8	TL	手電筒驅動輸出。TL 引腳接地可以遮罩手電筒功能。
9,10, 11,12	LED1-4	電池電量顯示。內置 1kohm 限流。
13	NDRV	驅動外接 N 溝道 MOSFET 進行短路和漏電保護。升壓啟動 NDRV 為高電平, VOUT 電壓過高過低或者過流檢測發生時, NDRV 轉低電平。待機時, NDRV 維持低電平。
14	CTRL	按鈕輸入，連接按鈕到地，此埠內部通過一個200kMΩ的電阻上拉到電池。按按鈕啟動升壓,長按按鈕5秒可強制關閉升壓；空載時,按按鈕啟動LED1-4電量顯示，將持續5秒顯示。充電與放電模式下, 1.7秒以內連續兩次按鈕啟動手電筒,再按一次關閉手電筒。
15	NTC	電池溫度採樣埠，連接到電池溫度調節器端子(NTC)，如果不連接到電池，可以連接至地以遮罩NTC功能。推薦選料10K NTC (B-Constant=3950K)。
16	VBAT	電池輸入與充電恒壓調節埠。電感連接至電池的正級需使用22uF低ESR和ESL陶瓷電容旁路到地。
17	VSNS	充電電流與放電過流採樣輸入。 通過 RSNS 電阻檢測充放電電流。
18	PGND	功率地。連接內部低端 MOSFET 驅動地。
19	LD	低端 MOSFET 驅動輸出。
20	LX	外部開關與電感的連接埠，高端 MOSFET 驅動地。
21	BS	Bootstrap 引腳輸入，使用 22nF 陶瓷電容連接 LX 與 BS.
22	HD	高端 MOSFET 驅動輸出。
23	VOUT	輸出埠。通過低 ESR 和 ESL 陶瓷電容旁路到地，電容 44uF~470uF 可以穩定。
24	VCTR	驅動外接P溝道MOSFET防止反向電流。電源輸入時, VCTR為低電平，電源移除時, VCTR為高電平。
25	EP	底部焊盤。連接到 PCB 的地。

Order Information

Order Number	Package Type	QTY/Reel	Green Status	Operation temp range
VAS5189IJ24E	QFN24	2500	RoHS	-40 °C to 85°C



Absolute Maximum Ratings

Parameters	Maximum Ratings
VIN, VCTR, VOUT, STAT, TL LED1, LED2, LED3, LED4	-0.3V to 12V
LX	-2V to 10V
REGN, VBAT, CTRL, NDRV, VSNS ISET, BVST, IOST, GLMODE, TS, LD	-0.3V to 7V
HD, BS	-0.3V to 12V
GND, PGND	-0.3V to +0.3V
Junction temperature range	-40°C to +150°C
Storage temperature range	-65°C to +150°C
Lead Temperature	260°C
Maximum Power Dissipation	2W
ESD (HBM)	2000V

Electrical Characteristics

PARAMETERS		TEST CONDITIONS	MIN	TYP	MAX	UNITS
OPERATING CONDITIONS						
V_{VIN_OP}	VIN input voltage operating range during charging.		4.5		6	V
QUIESCENT CURRENT						
I_{IN}	Adapter supply current	V_{IN}=5V		1.5	2	mA
I_{BAT}	Battery discharge current	V_{BAT}=4.2V, standby mode		20	50	μA
CHARGE VOLTAGE REGULATION						
V_{BAT_REG}	BAT regulation voltage	Measured on BAT		4.2		V
	Charge voltage regulation accuracy	TJ = -20°C to 85°C	–1%		1%	
V_{BAT_ADJ}	Regulation voltage Adjustment	BVST=FLT,		4.20		V
		BVST=Lo		4.30		V
		BVST=Hi		4.35		V
CURRENT REGULATION						
I_{CHG}	Fast charge current	Programmable Mode(Max)		3.0		A
	Charge current regulation accuracy	TJ = -20°C to 85°C	–10%		10%	
$V_{VSNS-VBAT}$	Charge Current Full Scale Sense Voltage	ISET=FLT, RSNS=15mΩ		30		mV
		ISET=Lo, RSNS=15mΩ		15		mV
		ISET=Hi, RSNS=15mΩ		45		mV
	Output “fast charge” formula	$V_{BAT\_REG} > V_{BAT} > V_{LOWV}$;	$V_{VSNS-VBAT}$ / RSNS			A
V_{IN_DPM}	Input voltage drop to reduce charge current	Measured on VIN		4.70		V
CURRENT REGULATION –PRE- CHARGE						
$\%_{PRECHG}$	Pre-charge current, default setting	$V_{BAT} < V_{LOWV}$		10		$\%_{IOUT-CC}$
CHARGE TERMINATION						
$\%_{TERM}$	Termination threshold current, default setting	$V_{BAT} > V_{RECHG}$	5	10	15	$\%_{IOUT-CC}$
t_{TERM_DEG}	Deglitch time termination (both edges)	$V_{BAT} > V_{RECHG}$ and $I_{CHG} < I_{TERM}$		100		ms
BAT LOWV COMPARATOR						
V_{LOWV}	Precharge to fast charge transition threshold	Measured on BAT	2.90	2.95	3.00	V
RECHARGE COMPARATOR						
V_{RECHG}	Recharge threshold, below regulation voltage limit, V_{BAT_REG}-V_{BAT}	Measured on BAT	75	100	150	mV

PARAMETERS		TEST CONDITIONS	MIN	TYP	MAX	UNITS
BAT OVER-VOLTAGE COMPARATOR						
V_{BOV_RISE}	Battery over-voltage rising threshold	As percentage of V_{BAT_REG}		110		%
V_{BOV_FALL}	Battery over-voltage falling threshold	As percentage of V_{BAT_REG}		105		%
BAT SHORT COMPARATOR						
V_{BSHORT_RISE}	Battery short hysteresis	V_{BAT} rising		2.4	2.5	V
V_{BSHORT_FALL}	Battery short threshold	V_{BAT} falling	2.0	2.2		V
I_{BSHORT}	Battery short weakly pull high current	$V_{BAT} < V_{BSHORT}$, measure I_{BAT}	10	15	20	mA
INPUT OVER-VOLTAGE COMPARATOR (ACOV)						
V_{ACOV}	AC over-voltage rising threshold to disable charge	V_{IN} rising	6.2	6.4	6.6	V
V_{ACOV_HYS}	AC over-voltage falling hysteresis	V_{IN} falling		300		mV
INPUT UNDER-VOLTAGE LOCK-OUT COMPARATOR (UVLO)						
V_{UVLO}	AC under-voltage rising	Measure on V_{IN}		4.0		V
$V_{UVLO-HSY}$	AC under-voltage hysteresis	Measure on V_{IN}		300		mV
SLEEP COMPARATOR(REVERSE DISCHARGING PROTECTION)						
V_{SLEEP}	SLEEP mode threshold	$V_{IN} - V_{BAT}$ falling		100		mV
V_{SLEEP_HYS}	SLEEP mode hysteresis	$V_{IN} - V_{BAT}$ rising		200		mV
V_{CTRL_LO}	VCTRL output low voltage	$V_{IN} < V_{BAT}+V_{SLEEP}$			0.1	V
V_{CTRL_HI}	VCTRL output high voltage	$V_{IN} > V_{BAT}+V_{SLEEP\_HYS}$	VOUT -0.1			V
THERMISTOR COMPARATOR						
I_{TS}	NTC bias current		72	80	88	μA
V_{LTF}	Cold temperature threshold, TS pin voltage rising threshold	Charger suspends charge		3.0		V
V_{LTF_HYS}	Cold temperature hysteresis, TS pin voltage falling threshold	Charger recovery charge		2.6		V
V_{HTF}	Hot temperature TS pin voltage falling threshold	Charger suspends charge		300		mV
V_{HTF_HYS}	Hot temperature hysteresis, TS pin voltage rising threshold	Charger recovery charge		400		mV

PARAMETERS		TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{BT_HTF}	Boost mode, hot temperature TS pin voltage falling threshold	Booster suspends output		200		mV
$V_{BT\_HTF\_HYS}$	Boost mode, hot temperature hysteresis, TS pin voltage rising threshold	Booster recovery output		300		mV
$V_{TS\_DISABLE}$	Disable TS pin threshold	$V_{TS} < V_{TS\_DISABLE}$	30	50	70	mV
REGN REGULATOR						
V_{REGN_REG}	REGN regulator voltage	$V_{VIN} > 7V$	5.4	5.6	5.9	V
I_{REGN_LIM}	REGN current limit	$V_{REGN} = 0$ V, $V_{VIN} > 7V$		100		mA
INTERNAL PWM						
F_{SW_CHG}	PWM Switching Frequency	Measure at LX	900	1000	1100	kHz
SAFETY TIMER						
$T_{PRE\text{-}CHARGE}$	Pre-charge timer		4822	5400	6048	Sec
$T_{TAPER\text{-}CHARGE}$	Taper-charge timer		4822	5400	6048	Sec
DC/DC STAGE						
V_I	Input voltage range	V_{BAT} input voltage	2.8		4.5	V
V_{OUT}	Output voltage range	Measure at V_{OUT}	5.00	5.10	5.20	V
V_{OUT_VO}	Output overvoltage threshold	V_{OUT} rising, NDRV off		6.0		V
$V_{OUT\_VO\_HYS}$	Output overvoltage threshold	V_{OUT} falling, NDRV on		5.82		V
$t_{VOUT\_OV\_DEG}$	Output overvoltage deglitch	$V_{OUT} > V_{OUT\_VO}$ to NDRV off		2		ms
V_{OUT_UV}	Output under-voltage threshold	V_{OUT} falling, NDRV off		4.15		V
$V_{OUT\_UV\_HYS}$	Output under-voltage threshold	V_{OUT} rising, NDRV on		4.25		V
$t_{VOUT\_UV\_DEG}$	Output under-voltage deglitch	$V_{OUT} < V_{OUT\_UV}$ to NDRV off		20		µs
V_{OUT_SHORT}	Output short threshold	V_{OUT} falling, Boost off		3.8		V
f_{SW}	Oscillator frequency		550	600	650	kHz
I_{STDBY}	Standby current	VBAT = 4.2 V, Boost off		20	50	µA
OUTPUT CURRENT REGULATION						
$V_{VBAT\text{-}VOUT1}$	Battery output current limit sense voltage @ V_{BAT}=3V	IOST=FLT, RSNS=15mΩ		100		mV
		IOST=Lo, RSNS=15mΩ		75		mV
		IOST=Hi, RSNS=15mΩ		125		mV

PARAMETERS		TEST CONDITIONS	MIN	TYP	MAX	UNITS
$V_{VBAT-VOUT2}$	Battery output current limit sense voltage @ V_{BAT}=4V	IOST=FLT, RSNS=15mΩ		75		mV
		IOST=Lo, RSNS=15mΩ		56		mV
		IOST=Hi, RSNS=15mΩ		100		mV
	Battery output “current limit” formula	4.20V > V_{BAT} > V_{VBAT_UVLO};	$V_{VBAT-VSNS}$ / RSNS			A
CONTROL STAGE						
V_{BAT_LOW}	Battery low to boost enter standby mode	VBAT voltage decreasing	3.08	3.15	3.22	V
F_{LOW_FLASH}	Battery low, LED1 flash frequency	VBAT<V_{BATLOW}, LED1 start flash frequency	1.2	1.4	1.6	Hz
V_{BAT_UVLO}	Battery low voltage lockout	VBAT voltage decreasing, Boost off	2.75	2.8	2.85	V
V_{NDRV_OL}	NDRV output low voltage				0.1	V
V_{NDRV_HI}	NDRV output high voltage		VOUT -0.1			V
V_{IL}	CTRL logic low threshold		0.4			V
V_{IH}	CTRL logic high threshold				VOUT -0.7	V
t_{CTRL_DEG}	CTRL logic low deglitch time			15	50	mS
LED INDICATOR & TORCH LIGHT						
V_{LED_OL}	LEDs output low voltage	LEDs sink 1mA			1	V
F_{LED_CHG}	LEDs wave frequency at charge mode	LED N-1 to N switch frequency	1.2	1.4	1.6	Hz
T_{LED_HOLD}	Gauge on hold time at boost mode	CTRL goes low, LEDs on to LEDs off GLMODE=Lo		5		Sec
$T_{MANUALOFF}$	CTRL cont. low to boost enter standby mode deglitch	CTRL goes cont. low to boost turn off		3		Sec
T_{TL_EN}	Effective interval for two CTRL low pulses to enable or disable torch light		1.2	1.7	2	Sec
I_{TL_LIM}	TL sink current limit	Torch light on, VTL =2V		150		mA
$I_{NOLOADDOFF}$	No load detection current			80		mA
T_{LEDOFF}	No load to LEDs off delay	No load to gauge LEDs turn off		5		Sec
$T_{NOLOADOFF}$	No load to Boost off delay	No load to Boost turn off		15		Sec

Operation State Diagram

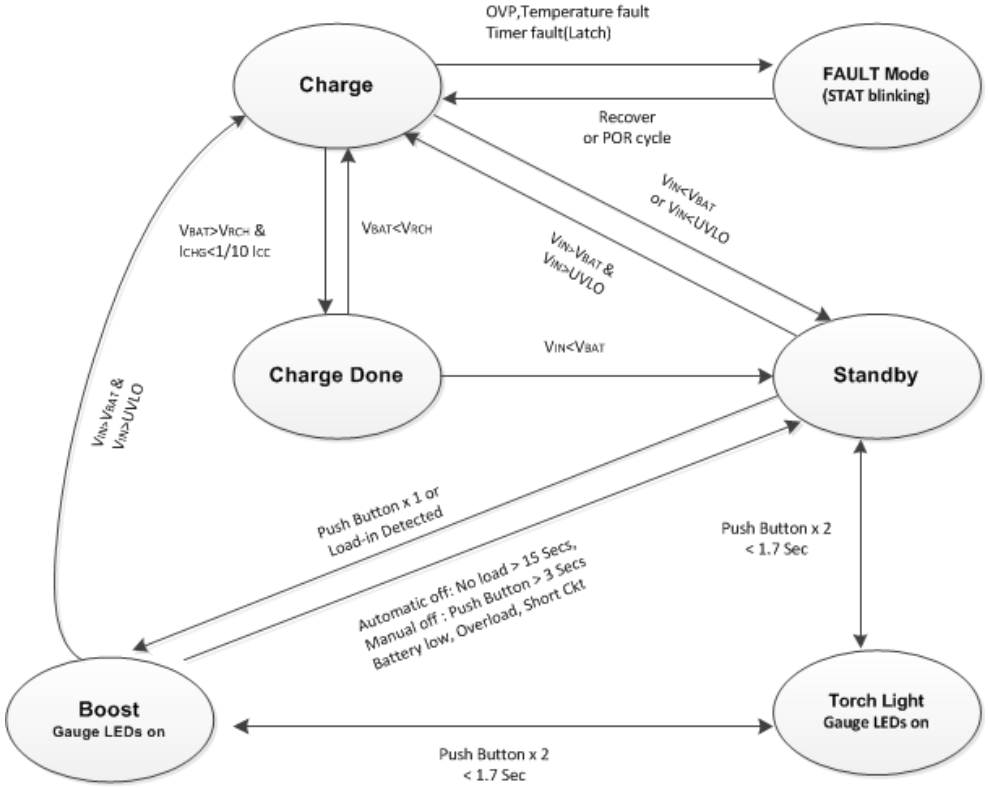


Figure 3. State Diagram

Gauge Light Indication

MODE	VBAT	LED1	LED2	LED3	LED4	STAT
CHARGE	BAT<3.75V	WAVE	WAVE	WAVE	WAVE	ON
	3.75V<BAT<3.90V	ON	WAVE	WAVE	WAVE	ON
	3.90V<BAT<4.15V	ON	ON	WAVE	WAVE	ON
	4.15V<BAT	ON	ON	ON	WAVE	ON
	Termination	ON	ON	ON	ON	OFF
BOOST (No Load)	BAT< 2.8V	OFF	OFF	OFF	OFF	OFF
	2.80V<BAT<3.32V	Blink	OFF	OFF	OFF	OFF
	3.32V<BAT<3.55V	ON	OFF	OFF	OFF	OFF
	3.55V<BAT<3.82V	ON	ON	OFF	OFF	OFF
	3.82V<BAT<4.00V	ON	ON	ON	OFF	OFF
	4.00V< BAT	ON	ON	ON	ON	OFF
BOOST (Load)	BAT< 2.8V	OFF	OFF	OFF	OFF	OFF
	2.80V<BAT<3.05V	Blink	OFF	OFF	OFF	OFF
	3.05V<BAT<3.42V	ON	OFF	OFF	OFF	OFF
	3.42V<BAT<3.69V	ON	ON	OFF	OFF	OFF
	3.69V<BAT<3.82V	ON	ON	ON	OFF	OFF
	3.82V< BAT	ON	ON	ON	ON	OFF
STANDBY		OFF	OFF	OFF	OFF	OFF

CTRL Control

Mode	Function	One pulse	Double pulse <1.7sec	One more pulse during Torch ON	Pulse> 5Sec during Boost ON
CHARGE	BOOST	OFF			
	GAUGE	ON			
	TORCH	OFF	ON or OFF	Delay 1.7sec then OFF	OFF
	NDRV ON	ON			
BOOST VBAT>3.0V VIN<VBAT	BOOST	ON Keep 30Secs ON then OFF (if no load)	ON	ON	OFF
	GAUGE	ON Keep 6sec ON then OFF(if no load)	ON	ON	OFF
	TORCH	OFF	ON or OFF	Delay 1.7sec then OFF	OFF
	NDRV ON	ON	ON	ON	OFF

1. CTRL can turn flashlight no during charging mode, but the boost converter keep off and the load (USB-A) is disconnected from battery power.
2. In standby mode, click the CTRL button can start the BOOST and battery power indicator, such as the no-load input, the power indicator off after 5 seconds, BOOST turn off automatically after 15 seconds.
3. If battery voltage is lower than 2.8V, click the button will not weak BOOST up, the LED1 flash 5secs then off, the power bank keep stay at the standby mode.
4. Double-click the button to turn on or off the flashlight, and power display always on when flashlight function is activated, in this mode, click the button again, flashlight off automatically after 1.7 seconds delay.
5. In boost mode, press button 3 seconds can manually turn off BOOST, and disconnect the load circuit.

Application Information

◆ Charge Management

1. Typical Operation Theory

The charger of VAS5189 is optimized for charging 1-cell Li-ion or Li-polymer batteries. It charges a battery with constant current (CC) and constant voltage (CV) profile. In CV mode, if charge current reaches 1/10 constant current threshold, fuel gauge 4 LEDs are turned on. The typical charge profile is illustrated as below.

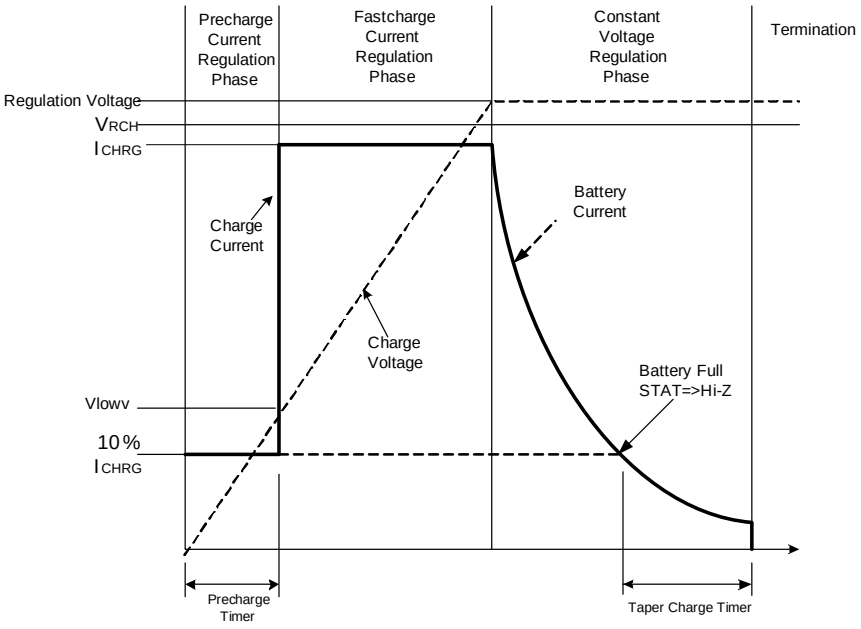


Figure 4. Typical Charging Profile

2. Battery Voltage Regulation

The VAS5189 offers a high accuracy voltage regulator for the charging voltage. Battery regulation voltage could be adjusted by setting BVST level for 4.2V, 4.30V and 4.35V selection, see “Electrical Characteristics Table” for the detail.

3. Battery Current Regulation

The ISET input sets the maximum charging current. The ISET level selects charge current sense voltage as 15mV, 30mV or 45mV, see “Electrical Characteristics Table” for the detail. The equation for charge current is:

$$I_{CHG} = \frac{V_{VSNS-VBAT}}{R_{SNS}}$$

Give a 15mΩ RSNS and set ISET level to float low for a 30mV $V_{VSNS-VBAT}$ will be able to get 2.0A charge current, for instance.

4. Battery Pre-charge Current Regulation

If the battery voltage is below the V_{BSHORT} threshold, the switching loop stop and the VAS5189 applies a weak 15mA charge current to the battery. This weak charge feature is intended to revive deeply discharged cells. If the battery voltage is greater than VBSHORT and less than V_{LOWV} threshold, the battery will be charged by pre-charge cycle with a 1/10 of fast charge current. If battery is not reached V_{LOWV} within 90 minutes of initiating pre-charge, the charger turns off and a FAULT is indicated on the status pins.

5. Input Over Voltage Protection

Input OVP provides protection to prevent device damage due to high input voltage. The threshold of input OVP is 6.4V typ., once input above threshold, the charger is disabled and STAT indicated FAULT.

6. Input Voltage Regulation

The input voltage can be limited in order to avoid overloading of DC adapter or USB power source, when the voltage on VIN pin drops and hits the threshold voltage of 4.7V, the charging current will be decreased and input voltage will be clamped to this value.

7. Charge Termination

The charger monitors the charging current during the voltage regulation phase. Termination is detected when the charge taper down to 1/10 of the fast charge rate.

8. Re-Charge

A new charge cycle is initiated when one of the following conditions occurs:

- The battery voltage falls below the recharge threshold
- A power-on-reset (POR) event occurs

9. Timers

As a safety backup, the charger also provides an internal fixed 90 minutes pre-charge safety timer. And fixed 90minutes taper charge timer for additional charge capacity, it start once termination is happened.

10. Soft-Start Charger Current

The charger automatically soft-starts the charger regulation current every time the charger goes into fast-charge to ensure there is no overshoot or stress on the output capacitors or the power converter.

11. Temperature Qualification

The TS pin output a zero TC current to bias a negative temperature coefficient thermistor (NTC) which connect to AGND. The controller continuously monitors battery temperature by measuring the voltage between the TS pin and AGND, it compares this voltage against its internal thresholds to determine if charging is allowed. To initiate a charge cycle, the battery temperature must be within the VLTF to VHTF thresholds. If battery temperature is outside of this range, the controller suspends charge and waits until the battery temperature is within the VLTF to VHTF range. The controller suspends charge by turning off the PWM MOSFETs. In the Boost mode, battery cell

temperature qualification still works with a different VHTF threshold, typically more 10 degree C range compare to charge cycle. A 10K NTC with B-Constant around 3950k is recommended for application.

◆ Boost Converter

1. Typical Operation Theory

The VAS5189 integrates a boost converter powered by a one-cell Li-Ion or Li-polymer battery. The converter generates a stable 5.10V output voltage, it provides high efficient power conversion with two external low on resistance NMOSFETs and is capable of delivering output currents up to 4.2 A at 5 V while a supply voltage down to 3.0 V. The implemented boost converter is based on a fixed frequency, pulse-width- modulation (PWM) controller.

2. Soft Start

The boost automatically soft-starts the switching current to load to ensure there is no overshoot or inrush stress on the output capacitors, the boost switch current limit is set to 50% of its normal value to avoid high peak current at battery during soft-start period. When the output voltage is reached, the voltage regulator takes control and switch current limit is set back to 100%.

3. Over-current and Short Protection

The maximum peak current in the boost switch is set by the resistance of RSNS and sense voltage $V_{VBAT-VSNS}$ that according to IOST level, the unique input and output voltage compensation peak current detection help to control maximum IOUT in constant current mode regardless of input/output voltage variation if it reached to maximum tripped value. The sense voltage $V_{VBAT-VSNS}$ limit the boost input current at 3.0V VBAT, with the gradual increase in VBAT voltage, current limit will be gradually reduced, in order to achieve the first stage input constant power control, the controller continuously monitors VOUT voltage add compensation to sense current to achieve the second stage output constant current control. In other words, with $V_{VBAT-VSNS}$ and RSNS decide the current limit if VBAT equal to 3.0V, consider converting efficiency can get output current limit tripped point. With this setup, the VBAT and VOUT voltage vary will change current limit very small, can be regarded as a constant current mode.

If the output current reaches the over-current point, output current begins to start limiting and then voltage fall down, when the voltage dropped below 3.8V, NDRV shut down immediately and disconnect the output, but boost does not latch-off, but if output consistently below 4.25V for more than 2ms, the boost circuit locked and needed to be restart.

4. Over-voltage protection

The controller continuously monitors the output voltage, if the voltage is higher than 6.0V, NDRV disconnect the load immediately, PWM control will stop output until the output sinks to 5.8V below, NDRV will re-connect the load in order to protect the device.

5. Automatic Load-in Detection

Design an external resistor connect USB-A ground to system ground, when a load is connected to USB-A port, the load and ext. resistor construct a resistor divider from VOUT to ground. If the resistance of load is small enough to pull divided voltage high and turn on NMOS, the CTRL could be pulled low to enable boost converter. For example, set ext. resistor to 100kΩ, and a load with less than 200kΩ resistance is connected, the divided voltage from a 3.0V VOUT can as high as 1.0V and be able to turn a NMOS on.

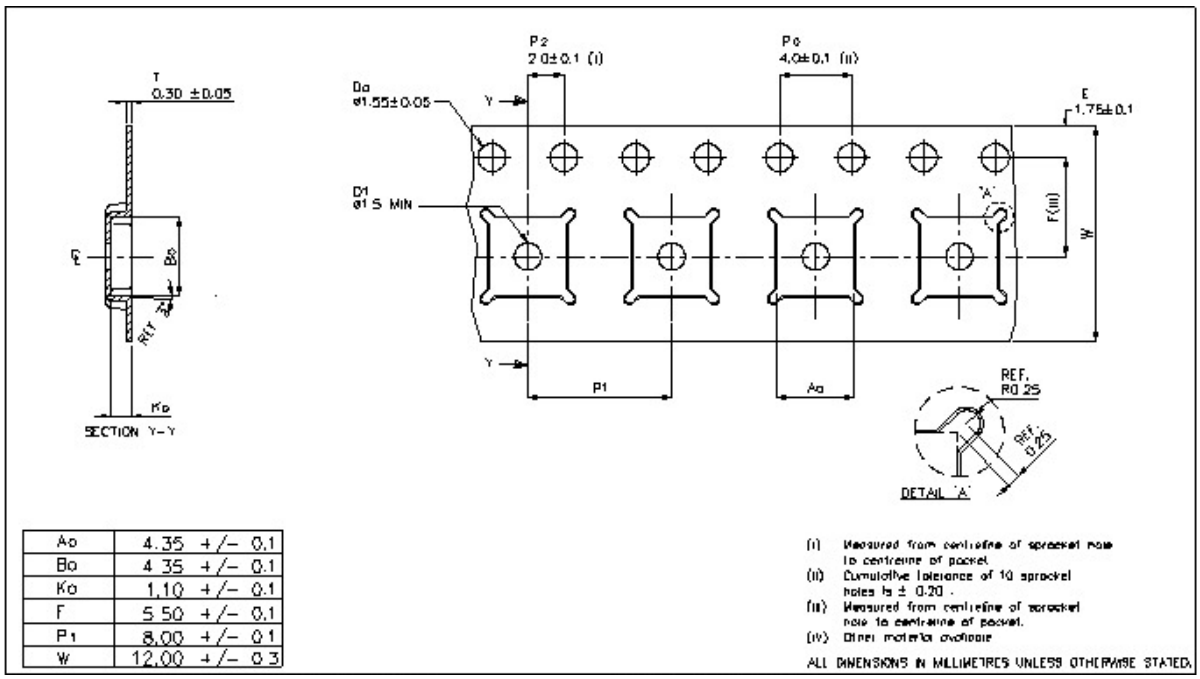
6. Light Load Automatic Shutdown

The boost converter detects average current to load, if average current fall below 80mA for 5sec., the fuel gauge LEDs are turning off and start 15secs go standby timer. Once 30secs timer expired, and average current never go back above 80mA, then the boost enter automatic shutdown.

◆ Fuel Gauge LEDs Indication

The VAS5189 integrated with four LED constant current drive ports for intelligent battery level indication, the chip built-in state lock function to prevent indicate the status of instability. See “Gauge Light Indication” table for detail fuel gauge level and LEDs behavior.

Tape and Reel Information

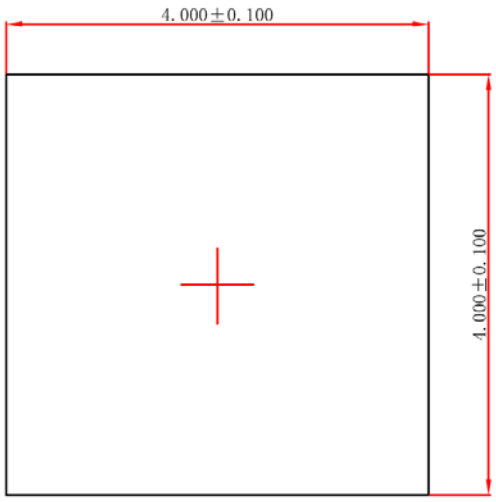


Ao	4.35 +/- 0.1
Bo	4.35 +/- 0.1
Ko	1.10 +/- 0.1
F	5.50 +/- 0.1
P1	8.00 +/- 0.1
W	12.00 +/- 0.3

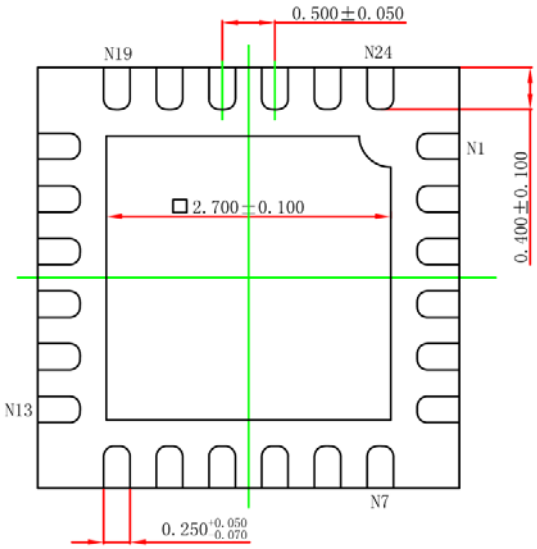
(i) Measured from centreline of sprocket hole to centreline of pocket.
(ii) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(iii) Measured from centreline of sprocket hole to centreline of pocket.
(iv) Other material available

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

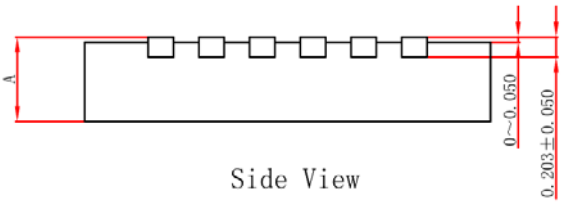
Package Information



Top View



Bottom View



Side View

	MIN.	NORM.	MAX.
A	0.700	0.750	0.800
	0.800	0.850	0.900

Classification Reflow Profiles

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

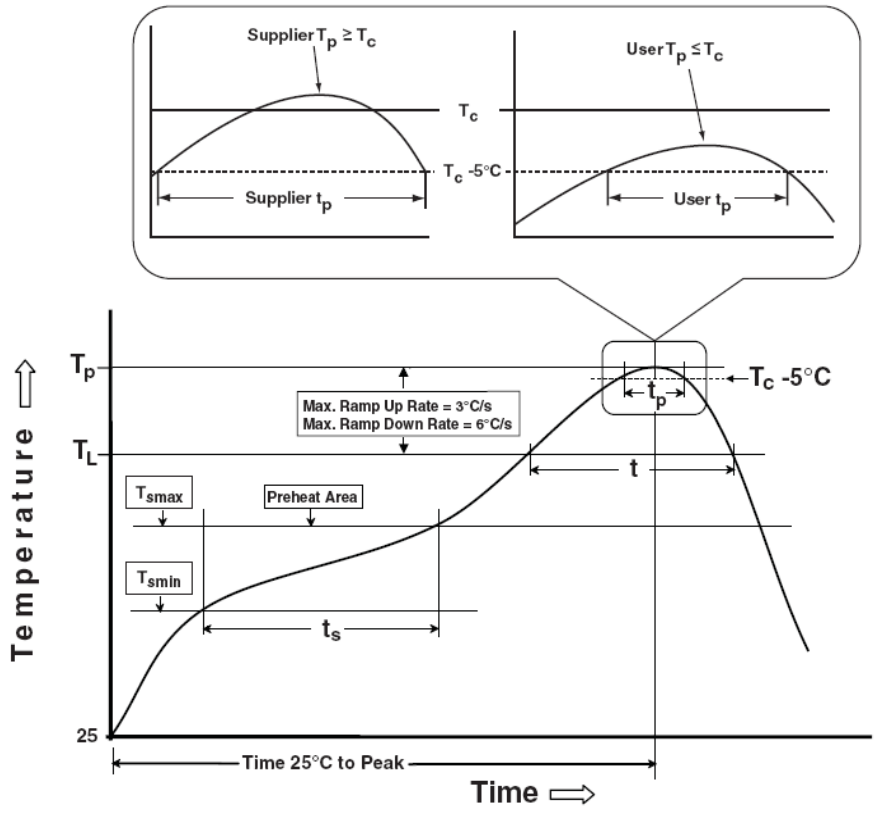


Figure 21. Classification Profile

CAUTION

Storage Conditions

1) This product should be used within 12 months after delivered. Store in manufacturer's package keeping the seal of aluminum coated baggage or tightly re-closed box with the following conditions. [Temperature:8℃...30 ℃,Humidity:30%...70% R.H.]

2) Keep the seal of aluminum coated baggage immediately before usage.

3) After breaking the seal of aluminum coated baggage, this product should be used within 1 week on the following conditions.
[Temperature:≤30℃, Humidity: ≤60% R.H.]