

**■ INTRODUCTION:**

The CE3211 is a complete constant-current/constant-voltage linear charger for single cell lithium rechargeable battery. No external sense resistor is needed, and no blocking diode is required due to the internal P-MOSFET architecture. Furthermore, the CE3211 is specifically designed to work within USB power specifications. Its low external component count makes the CE3211 ideally suited for portable applications.

Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge current can be programmed externally with a single resistor. The CE3211 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed, the CE3211 automatically enters a low power sleep mode, dropping the battery drain current to less than 2 $\mu$ A. The CE3211 can be put into shutdown mode, reducing the supply current to 50 $\mu$ A.

Other features include battery pack temperature monitor, undervoltage lockout, automatic recharge and two status pins to indicate charging and charge termination.

The CE3211 is available in thermally enhanced 8-pin SOP package.

**■ FEATURES:**

- Charges Single Cell Lithium Battery Directly from USB Port or AC Adapter
- Input Voltage Range From 4.5V to 6.5V
- No External MOSFET, Sense Resistor or Blocking Diode Required
- Preset 4.20V/4.35V Charge Voltage
- Continuous Programmable Charge Current Up to 1A
- Precharge Conditioning for Reviving Deeply Discharged Cells and Minimizing Heat Dissipation During Initial Stage of Charge
- Constant-Current/Constant-Voltage/Constant-Temp Operation with Thermal Regulation to Maximize Charge Rate Without Risk of Overheating
- Charge Termination:  
CE3211A, C/10  
CE3211B, C/4
- Automatic Recharge
- Battery Temperature Sensing
- Charge state pairs of output, no battery and fault status display
- Charge Current Monitor Output for Gas Gauging
- Automatic Low Power Sleep Mode When Input Supply Voltage is Removed
- Soft-Start Limits Inrush Current
- Chip Enable Input

**■ APPLICATIONS:**

- Cellular phones, PDAs
- Portable Media Players
- Digital Still Cameras
- Bluetooth & GPS Applications
- Mobile Internet Device
- Charging Docks and Cradles

## ■ ORDER INFORMATION

Device No.	Battery Float Voltage	Charge Termination	Package	Packaging
CE3211A420ES	4.20V	C/10	SOP8-PP	3000 parts per reel
CE3211A435ES	4.35V	C/10	SOP8-PP	3000 parts per reel
CE3211B420ES	4.20V	C/4	SOP8-PP	3000 parts per reel
CE3211B435ES	4.35V	C/4	SOP8-PP	3000 parts per reel

## ■ PIN CONFIGURATION

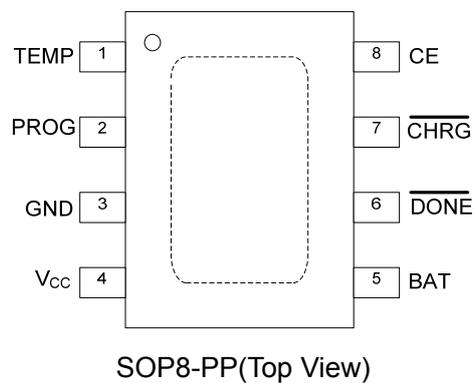


Table 1. Pin Description

PIN NO.	PIN NAME	FUNCTION
1	TEMP	<b>Battery temperature detection input.</b> Connecting TEMP pin to NTC thermistor's sensor output in Lithium ion battery pack. If the TEMP pin's voltage is less than 45% or greater than 80% of the input voltage $V_{CC}$ , this means the battery temperature is too high or too low, charging is suspended. If the TEMP pin's voltage level is between 45% and 80% of the input voltage $V_{CC}$ , battery fault state is released, and charging will resume. If the TEMP pin direct access GND, battery temperature detection canceled, the other charged functioning properly.
2	PROG	<b>Constant Charge Current Setting and Charge Current Monitor Pin.</b> The charge current is set by connecting a 1% accuracy metal film resistor $R_{PROG}$ from this pin to GND. When charging in precharge mode, the PROG pin voltage is regulated to 0.1V. When charging in constant-current mode, the PROG pin voltage is regulated to 1V. In all modes during charging, the voltage on PROG pin can be used to measure the charge current as the following formula: $I_{BAT} = (V_{PROG} / R_{PROG}) \times 1000$
3	GND	<b>Ground Terminal.</b>
4	$V_{CC}$	<b>Positive Input Supply Voltage.</b> $V_{CC}$ is the power supply to the internal circuit. $V_{CC}$ can range from 4.5V to 6.5V and should be bypassed with at least a 4.7 $\mu$ F capacitor. When $V_{CC}$ drops to within 80mv of the BAT pin voltage, CE3211 enters low power sleep mode, dropping BAT pin's current to less than 2 $\mu$ A.
5	BAT	<b>Charger Power Stage Current Output and Battery Voltage Sense Input.</b> BAT pin provides charge current to the battery and regulates the final float voltage. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode. Connect the positive terminal of the battery to BAT pin. Bypass BAT to GND with 10 $\mu$ F to 47 $\mu$ F capacitor. BAT pin draws less than 2 $\mu$ A current in chip disable mode or in sleep mode.
6	$\overline{DONE}$	<b>Open-Drain Charge termination Status Output.</b> In charge termination status, $\overline{DONE}$ is pulled low by an internal switch; Otherwise $\overline{DONE}$ pin is in high impedance state.
7	$\overline{CHRG}$	<b>Open Drain Charge Status Output.</b> When the battery is being charged, the $\overline{CHRG}$ pin is pulled low by an internal switch, otherwise $\overline{CHRG}$ pin is in high impedance state.
8	CE	<b>Chip Enable Input.</b> A high input will put the device in the normal operating mode. Pulling the CE pin to low level will put the CE3211 into disable mode. The CE pin can be driven by TTL or CMOS logic level. The CE pin is high impedance with internal 1.1M Pull-up Resistor in the suspended state.
EP	Thermal PAD	<b>Exposed Paddle (bottom).</b> This pin should be soldered to the PCB ground as close as to the device for electrical contact and rated thermal performance.

■ BLOCK DIAGRAM

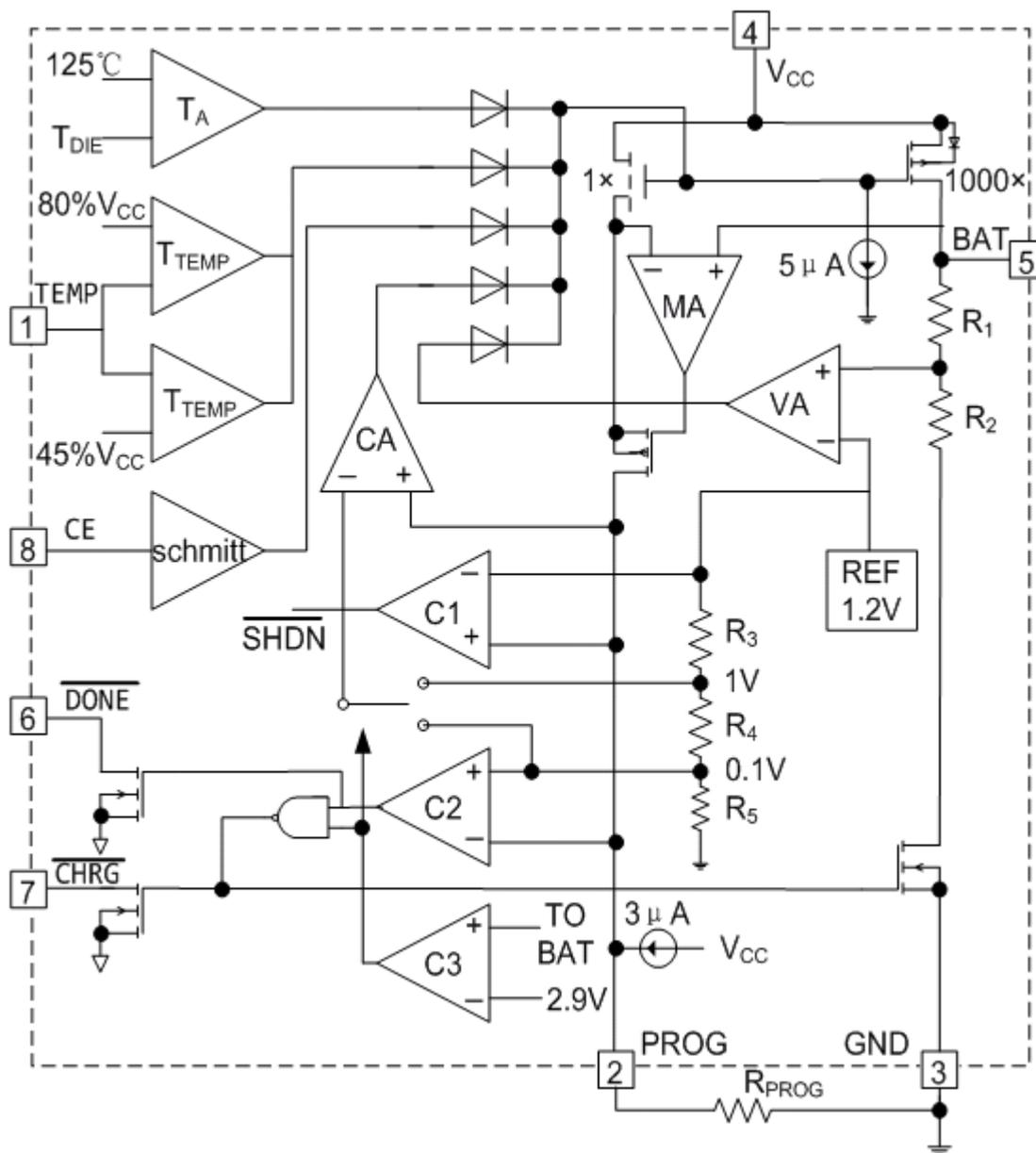


Figure 1 Functional Block Diagram

■ ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

(unless otherwise specified , T<sub>A</sub>=25°C)

PARAMETER	SYMBOL	RATINGS	UNITS
Input Supply Voltage <sup>(2)</sup>	V <sub>CC</sub>	-0.3~10	V
TEMP, CE, PROG Pins Voltage <sup>(2)</sup>		-0.3~V <sub>CC</sub> +0.3	
BAT Pin Voltage <sup>(2)</sup>		-0.3~8	
CHRG, DONE Pins Voltage <sup>(2)</sup>		-0.3~10	
BAT Short-Circuit Duration	-	Continuous	-
BAT Pin Output Current (Continuous)	I <sub>BAT</sub>	1200	mA
Output sink current	I <sub>CHRG</sub> , I <sub>DONE</sub>	10	mA
Power dissipation	P <sub>D</sub>	1200	mW
Operating Ambient Temperature Range <sup>(3)</sup>	T <sub>A</sub>	-40~85	°C
Junction Temperature	T <sub>J</sub>	-40~150	°C
Storage Temperature	T <sub>stg</sub>	-40~125	°C
Lead Temperature (Soldering, 10s)	T <sub>solder</sub>	260	°C
ESD rating <sup>(4)</sup>	HBM JESD22-A114A	4000	V
	MM JESD22-A115A	200	V

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to network ground terminal.

(3) The CE3211 are guaranteed to meet performance specifications from 0°C to 70°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

(4) ESD testing is performed according to the respective JESD22 JEDEC standard.

The human body model is a 100 pF capacitor discharged through a 1.5kΩ resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNITS
Input voltage range <sup>(5)</sup>	V <sub>CC</sub>	4.5	6.5	V
BAT Pin Output Current (Continuous)	I <sub>BAT</sub>		1000 <sup>(6)</sup>	mA
Operating junction temperature range	T <sub>J</sub>	0	70	°C
Fast-charge current programming resistor <sup>(7)</sup>	R <sub>PROG</sub>	1	10	kΩ

(5) If V<sub>CC</sub> is between UVLO and 4.5V, and above the battery voltage, then the IC is active (can deliver some charge to the battery), but the IC will have limited or degraded performance (some functions may not meet data sheet specifications). The battery may be undercharged (V<sub>FLOAT</sub> less than in the specification), but will not be overcharged (V<sub>FLOAT</sub> will not exceed specification).

(6) The thermal regulation feature reduces charge current if the IC's junction temperature reaches 125°C; thus without a good thermal design the maximum programmed charge current may not be reached.

(7) Use a 1% tolerance metal film resistor for R<sub>PROG</sub> to avoid issues with the R<sub>PROG</sub> short test when using the maximum charge current setting.

## ■ ELECTRICAL CHARACTERISTICS

( $V_{CC}=5V$ ,  $T_A=25^{\circ}C$ , Test Circuit Figure2, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{CC}$ Under voltage Lockout Threshold	$V_{UVL}$	$V_{CC}$ from Low to High		3.9		V
$V_{CC}$ Under voltage Lockout Hysteresis	$\Delta V_{UVL}$			150		mV
Input Supply Current	$I_{CC}$	Charge Mode, $R_{PROG}=10K$		150	500	$\mu A$
		Standby Mode (Charge Terminated)		50	100	
		Shutdown Mode: $R_{PROG}$ Not Connected, $V_{CC}<V_{BAT}$ , or $V_{CC}<V_{UVL}$		50	100	
CE "High" Level Voltage	$V_{CEH}$		1.5		$V_{CC}$	V
CE "Low" Level Voltage	$V_{CEL}$				0.4	V
Trickle Charge Threshold	$V_{TRIKL}$	$R_{PROG}=10K$ , $V_{BAT}$ Rising		2.9		V
Trickle Charge Hysteresis	$\Delta V_{TRIKL}$	$R_{PROG}=10K$		100		mV
Trickle Charge Current	$I_{TRIKL}$	$R_{PROG}=1K$ , For CE3211A	90	100	110	mA
		$R_{PROG}=1K$ , For CE3211B	225	250	275	mA
BAT Pin Current	$I_{BAT}$	$R_{PROG}=1K$ , Current Mode( $V_{BAT}=4.0V$ )	900	1000	1100	mA
		$R_{PROG}=2K$ , Current Mode( $V_{BAT}=4.0V$ )	450	500	550	
		Standby Mode, $V_{BAT}=V_{FLOAT}$	0	-2.5	-6.0	$\mu A$
		Shutdown Mode ( $R_{PROG}$ Not Connected)		$\pm 1$	$\pm 2$	
		Sleep Mode, $V_{CC}=0V$		-1	-2	
PROG Pin Voltage	$V_{PROG}$	$R_{PROG}=1K$ , Current Mode	0.9	1.0	1.1	V
PROG Pin Pull-Up Current	$I_{PROG}$			3		$\mu A$
Regulated Output (Float) Voltage	$V_{FLOAT}$	$0^{\circ}C \leq T_A \leq 85^{\circ}C$ , $I_{BAT}=20mA$ , $R_{PROG}=10K$	4.158	4.200	4.250	V
			4.300	4.350	4.400	V
C/10 Termination Current Threshold	$I_{TERM}$	$R_{PROG}=1K$ , For CE3211A		0.1		mA/mA
		$R_{PROG}=1K$ , For CE3211B		0.25		mA/mA
Termination Comparator Filter Time	$t_{TERM}$	$I_{BAT}$ Falling Below $I_{TERM}$	0.8	1.8	4.0	mS
Recharge Battery Threshold	$\Delta V_{RECHG}$	$V_{FLOAT}-V_{RECHG}$		150		mV
Recharge Comparator Filter Time	$t_{RECHARGE}$	$V_{BAT}$ High to Low	0.8	1.8	4.0	mS

■ ELECTRICAL CHARACTERISTICS(continued)

( $V_{CC}=5V$ ,  $T_A=25^{\circ}C$ , Test Circuit Figure2, unless otherwise specified)

$V_{CC} - V_{BAT}$ Lockout Threshold	$A_{MSD}$	$V_{CC}$ from Low to High	100		mV
		$V_{CC}$ from High to Low	80		mV
$\overline{CHRG}$ Pin Voltage	$V_{\overline{CHRG}}$	$I_{\overline{CHRG}}=5mA$	0.3	0.6	V
$\overline{DONE}$ Pin Voltage	$V_{\overline{DONE}}$	$I_{\overline{DONE}}=5mA$	0.3	0.6	V
TEMP High Shift Voltage Level			80	82	% $V_{CC}$
TEMP Low Shift Voltage Level			43	45	
Soft-Start Time	$t_{SS}$	$I_{BAT}=0$ to $I_{BAT}=1000V/R_{PROG}$	20		$\mu S$
Power FET "ON" Resistance (Between $V_{CC}$ and BAT)	$R_{ON}$	$I_{BAT}=1000mA$	400		$m\Omega$
Junction Temperature in Constant Temperature Mode	$T_{J(REG)}$		125		$^{\circ}C$

■ TYPICAL APPLICATION CIRCUIT

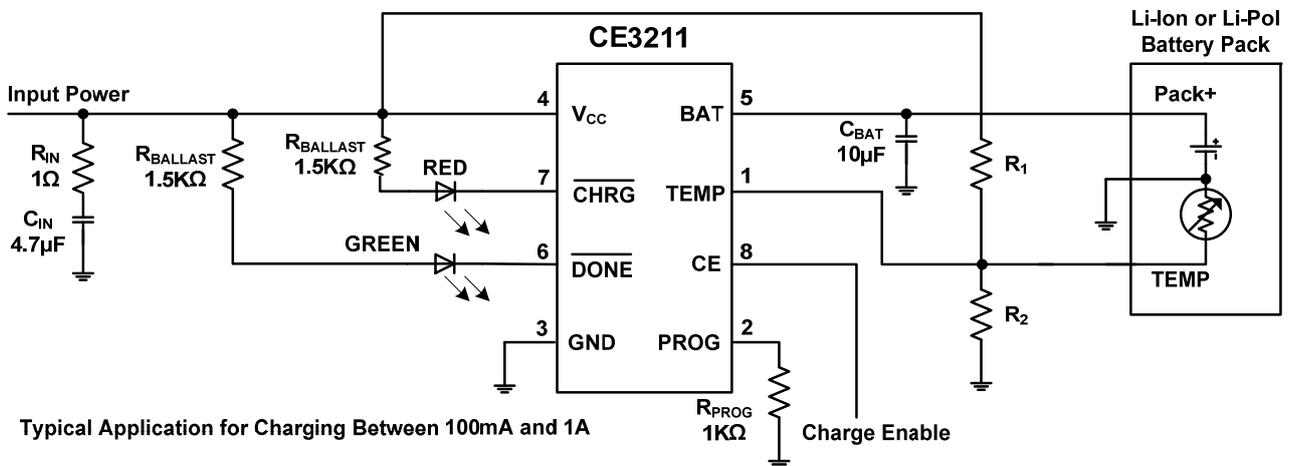


Figure 2 Standard Application Circuit

■ TYPICAL PERFORMANCE CHARACTERISTICS

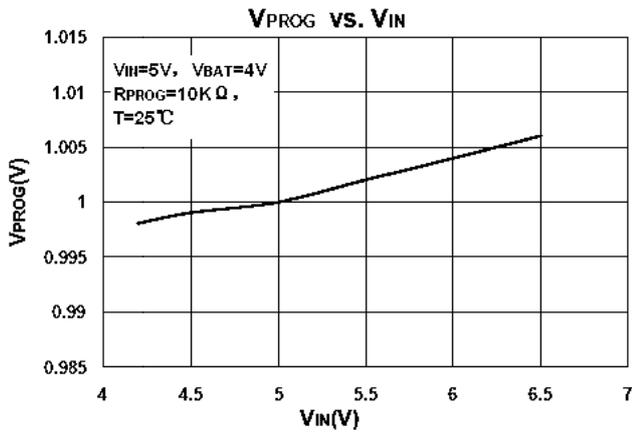


Figure 3

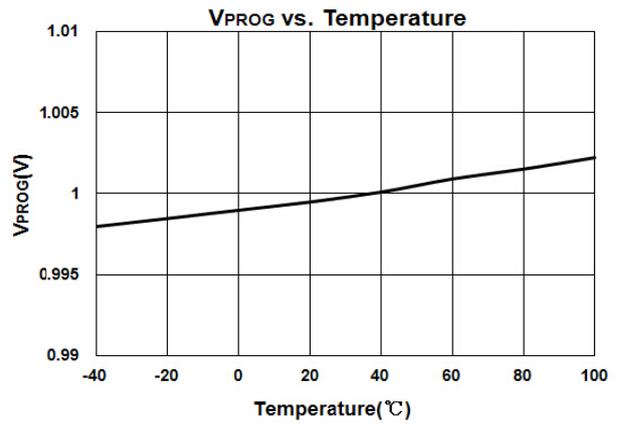


Figure 4

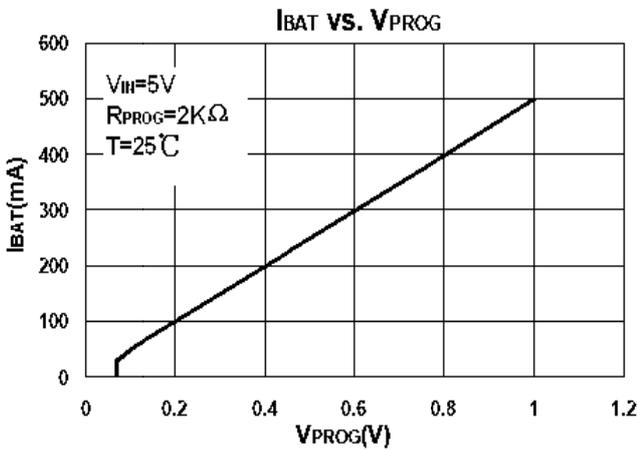


Figure 5

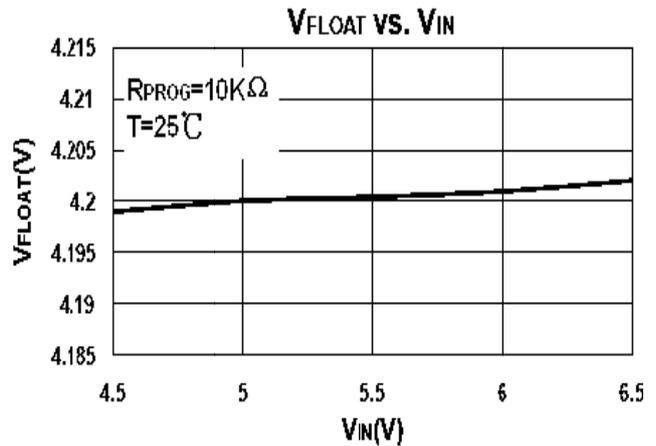


Figure 6

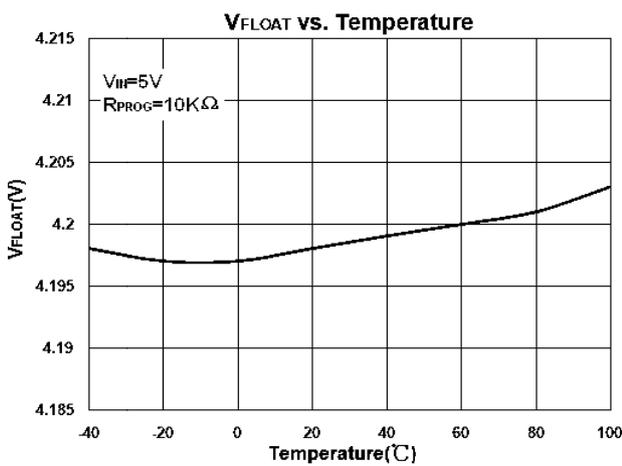


Figure 7

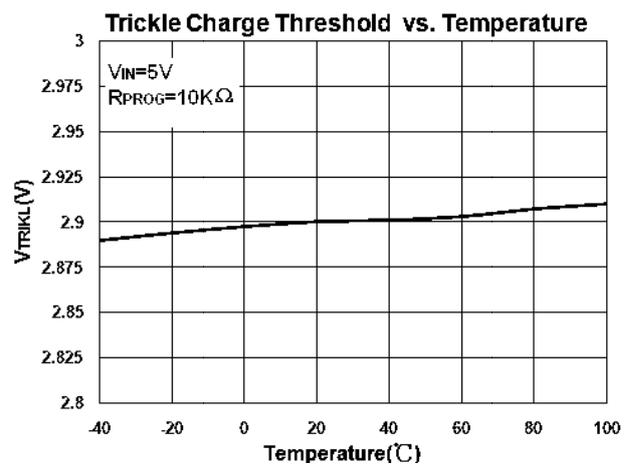


Figure 8

■ TYPICAL PERFORMANCE CHARACTERISTICS(continued)

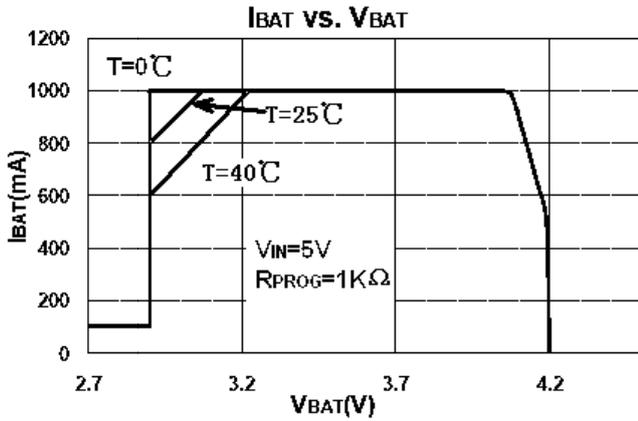


Figure 9

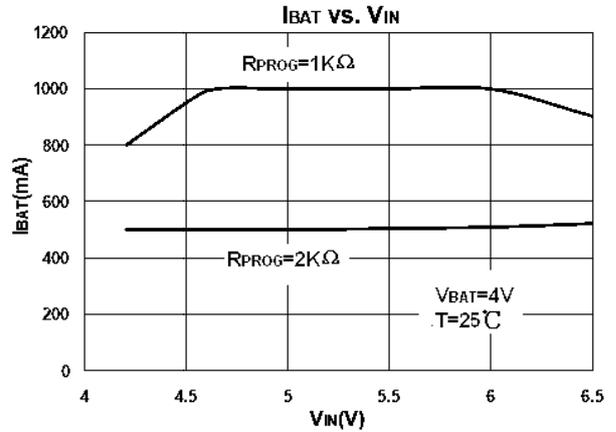


Figure 10

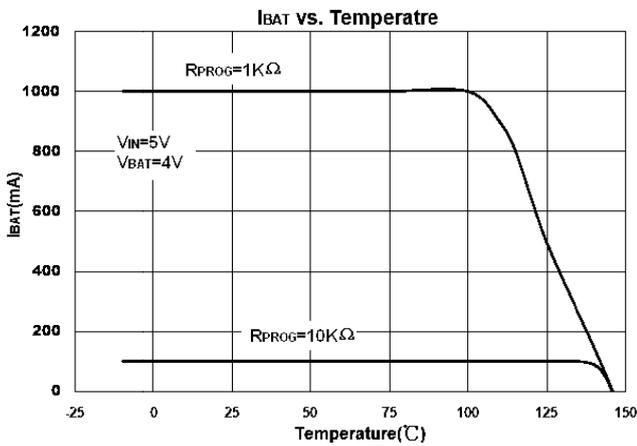


Figure 11

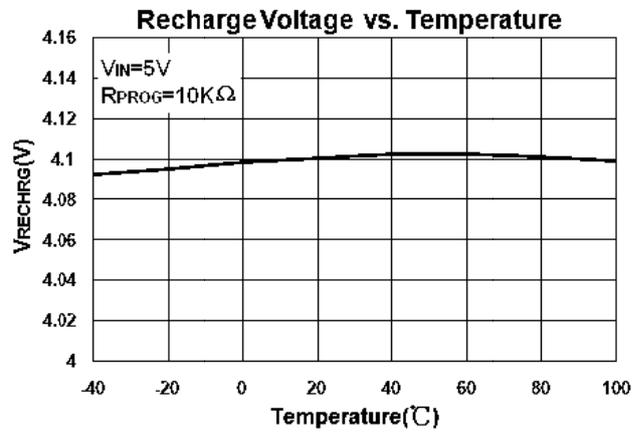
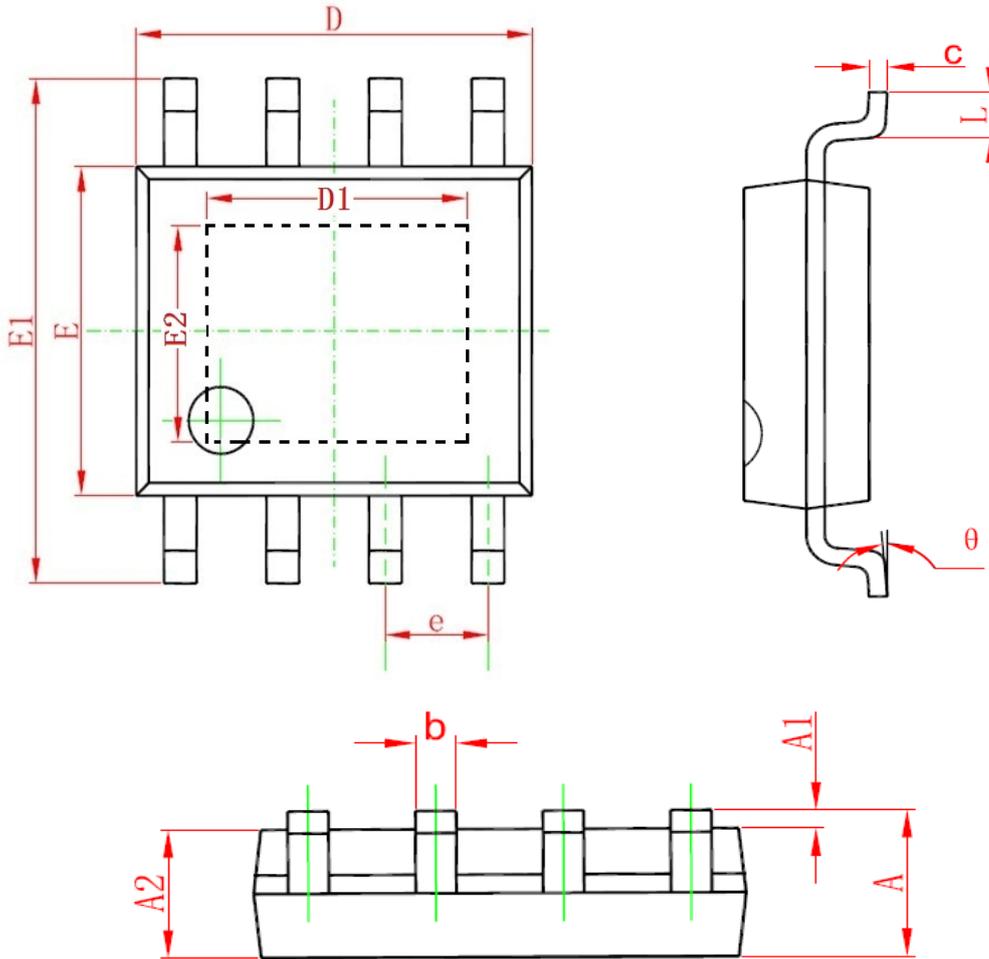


Figure 12

■ PACKAGING INFORMATION

● SOP8-PP Package Outline Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.100	3.500	0.122	0.137
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.200	2.600	0.086	0.102
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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