

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## General Description

The MAX8600/MAX8601 single-/dual-input linear battery chargers safely charge single-cell Li+ batteries. The charging rate is optimized to accommodate the thermal characteristics of a given application. There is no need to reduce the maximum charge current or worst-case charger power dissipation. Charging is optimized for Li+ cells using a control algorithm that includes low-battery precharging, voltage and current-limited fast-charging, and top-off charging, while continuously monitoring the battery for overvoltage, over/undertemperature, and charging time. The charger timeout protection is programmable. The charger status is indicated by three open-drain outputs.

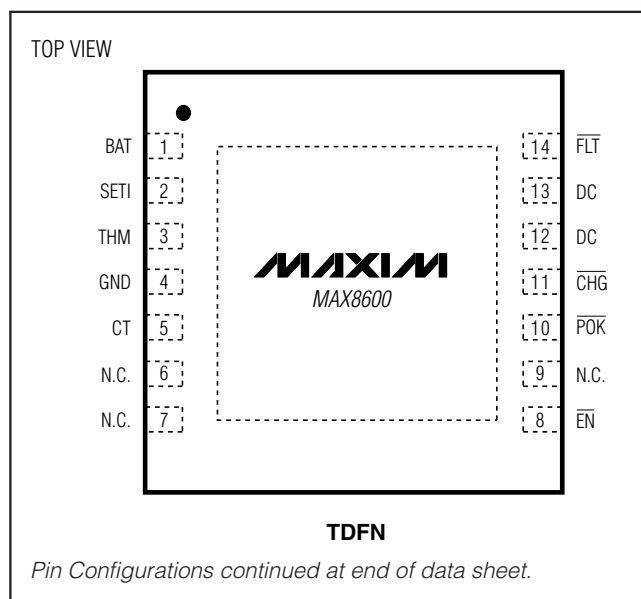
The MAX8601 automatically selects between either a USB or AC adapter input source. The AC adapter charge current is programmable, while USB charge current is set not to exceed either 100mA or 500mA, depending on the USEL input. The MAX8600 is a single-input charger with no USB source input.

The MAX8600/MAX8601 are available in the tiny 3mm x 3mm power-enhanced TDFN package.

## Applications

Cell Phones	Portable Media Players
Digital Cameras	MP3 Players
PDAs	Wireless Appliances

## Pin Configurations



## Features

- ◆ Single- (MAX8600) or Dual- (MAX8601) Input Li+ Charger
- ◆ Up to 1A Programmable Fast-Charge
- ◆ 100mA/500mA USB Select Input (MAX8601)
- ◆  $\pm 5\%$  Fast-Charge Current-Limit Accuracy
- ◆ 14V Input Overvoltage Protection
- ◆ Programmable On-Chip Charge Timers
- ◆ Battery Thermistor Input
- ◆ Charger-Status Outputs
- ◆ Thermally Optimized Charge Rate
- ◆ 14-Pin 3mm x 3mm TDFN Package

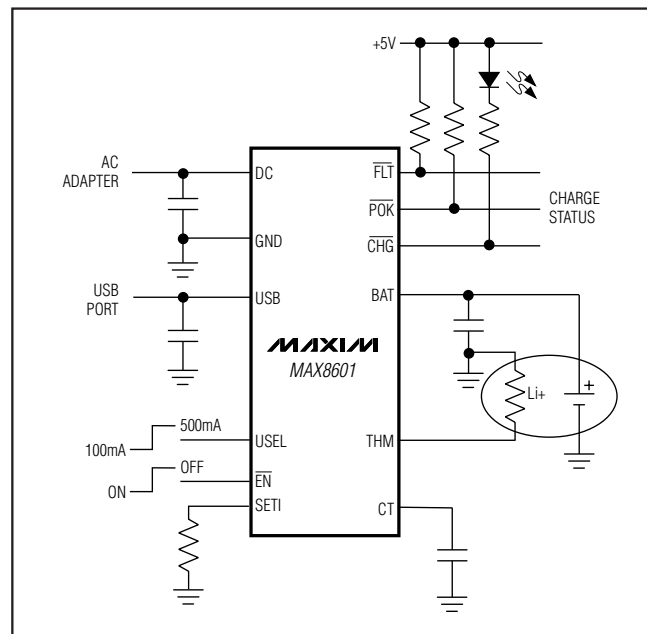
## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX8600ETD*	-40°C to +85°C	14 TDFN-EP** 3mm x 3mm (T1433-2)	ABB
MAX8601ETD	-40°C to +85°C	14 TDFN-EP** 3mm x 3mm (T1433-2)	AAC

\*Future product—contact factory for availability.

\*\*EP = Exposed paddle.

## Typical Operating Circuit



# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## ABSOLUTE MAXIMUM RATINGS

DC, USB to GND .....-0.3V to +16V  
 BAT, CT, CHG, EN, FLT, SETI,  
 POK, THM, USEL to GND.....-0.3V to +5.5V  
 Continuous Power Dissipation (T<sub>A</sub> = +70°C)  
 14-Pin TDFN 3mm x 3mm (derate 18.2mW/°C  
 above +70°C)..... 1454mW

Operating Temperature Range .....-40°C to +85°C  
 Junction Temperature .....+150°C  
 Storage Temperature Range .....-65°C to +150°C  
 Lead Temperature (soldering, 10s) .....+300°C

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(V<sub>DC</sub> = V<sub>USB</sub> = 5V, V<sub>BAT</sub> = 4V, V<sub>EN</sub> = 0V, R<sub>SETI</sub> = 2kΩ, C<sub>CT</sub> = 0.068μF, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C. Note 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
<b>DC OR USB (Note 2)</b>						
Input Voltage Range			0		14	V
Input Operating Range	(Note 3)		4.15		7.00	V
Input Undervoltage Threshold	Input rising, 500mV hysteresis (typ)		3.85	4.0	4.15	V
Input Overvoltage Threshold	Input rising, 200mV hysteresis (typ)		7.2	7.5	7.8	V
Input Overvoltage Delay	From overvoltage event to charger disabled			0.25		s
Input Supply Current	I <sub>BAT</sub> = 0mA, R <sub>THM</sub> = 10kΩ			750	1200	μA
Shutdown Input Current	V <sub>EN</sub> = 5V, T <sub>A</sub> = +25°C			275	435	μA
Input to BAT On-Resistance	Input = 3.7V, V <sub>BAT</sub> = 3.6V			0.5	0.8	Ω
Input to BAT Dropout Voltage	Input falling, 200mV hysteresis (typ)		5	55	120	mV
<b>BAT</b>						
BAT Regulation Voltage	I <sub>BAT</sub> = 0mA	T <sub>A</sub> = +25°C	4.179	4.2	4.221	V
		T <sub>A</sub> = -40°C to +85°C	4.166	4.2	4.234	
BAT Restart Fast-Charge Threshold	From BAT regulation voltage		-180	-150	-120	mV
DC Charging Current	V <sub>USB</sub> = 0V	R <sub>SETI</sub> = 1.5kΩ	950	1000	1050	mA
		R <sub>SETI</sub> = 2kΩ	727	750	773	
		R <sub>SETI</sub> = 5kΩ	280	300	320	
		Prequal, R <sub>SETI</sub> = 2kΩ, V <sub>BAT</sub> = 2.5V	60	75	90	
USB Charging Current	V <sub>DC</sub> = 0V	V <sub>USEL</sub> = 5V	450	475	500	mA
		V <sub>USEL</sub> = 0V	80	95	100	
		Prequal, R <sub>SETI</sub> = 2kΩ, V <sub>BAT</sub> = 2.5V	60	75	90	
Soft-Start Time	Ramp time to fast-charge current			1.2		ms
BAT Prequal Threshold	V <sub>BAT</sub> rising, 180mV hysteresis (typ)		2.9	3	3.1	V
BAT Leakage Current	V <sub>DC</sub> = V <sub>USB</sub> = 0V, V <sub>BAT</sub> = 4.2V			0.001	5	μA
<b>SETI</b>						
R <sub>SETI</sub> Resistance Range	(Note 4)		1.5		5.0	kΩ

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{DC} = V_{USB} = 5V$ ,  $V_{BAT} = 4V$ ,  $V_{\overline{EN}} = 0V$ ,  $R_{SET1} = 2k\Omega$ ,  $C_{CT} = 0.068\mu F$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ . Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>EN, USEL</b>						
Logic Input Thresholds	Rising			1.6	V	
	Falling	0.4				
Logic Input Leakage Current	$V_{\overline{EN}} = V_{USEL} = 0$ to $5.5V$	$T_A = +25^\circ C$	0.001	1	$\mu A$	
		$T_A = +85^\circ C$	0.01			
<b>POK, CHG, FLT</b>						
Logic Output Voltage, Low	$I_{\overline{POK}}, I_{\overline{CHG}} = I_{\overline{FLT}} = 1mA$		12	100	mV	
Logic Output Leakage Current, High	$V_{\overline{POK}} = V_{\overline{CHG}} = V_{\overline{FLT}} = 5.5V$ , $V_{DC} = V_{USB} = 0V$	$T_A = +25^\circ C$	0.001	1	$\mu A$	
		$T_A = +85^\circ C$	0.01			
<b>CHG</b>						
$\overline{CHG}$ /Top-Off Threshold	$I_{BAT}$ falling, battery is charged	$R_{SET1} = 1.5k\Omega$		75	mA	
		$R_{SET1} = 2k\Omega$	37.5	56.25		75.0
		$R_{SET1} = 5k\Omega$		22.5		
<b>THM</b>						
THM Pullup Resistance			10		k $\Omega$	
THM Resistance, Hot	$R_{THM}$ falling, 420 $\Omega$ hysteresis (typ)	3.72	3.94	4.13	k $\Omega$	
THM Resistance, Cold	$R_{THM}$ rising, 2.7k $\Omega$ hysteresis (typ)	26.7	28.3	29.7	k $\Omega$	
THM Resistance, Disabled	$R_{THM}$ falling, 230 $\Omega$ hysteresis (typ)	274	309	337	$\Omega$	
<b>CT</b>						
Timer Accuracy	$C_{CT} = 0.068\mu F$	-20		+20	%	
Prequal Time Limit	From entering prequal to $\overline{FLT}$ low, $V_{BAT} < 3V$		34.8		min	
Charge Time Limit	From entering fast-charge to $\overline{FLT}$ low, $3V < V_{BAT} < 4.2V$		334		min	
Top-Off Time Limit	From $\overline{CHG}$ high to charger disabled		34.8		min	
<b>THERMAL LOOP</b>						
Thermal-Limit Temperature	Junction temperature when the charge current is reduced, $T_J$ rising		+100		$^\circ C$	
Thermal-Limit Gain	Reduction of $I_{BAT}$ for increase of $T_J$ , from $V_{DC}$ , $R_{SET1} = 1.5k\Omega$		-50		mA/ $^\circ C$	

**Note 1:** Limits are 100% production tested at  $T_A = +25^\circ C$ . Limits over the operating temperature range are guaranteed by design and characterization.

**Note 2:** Input refers to either DC or USB.

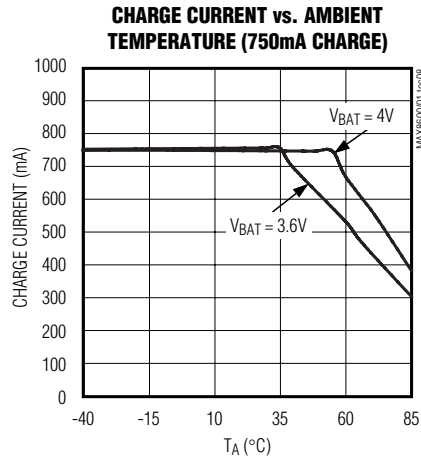
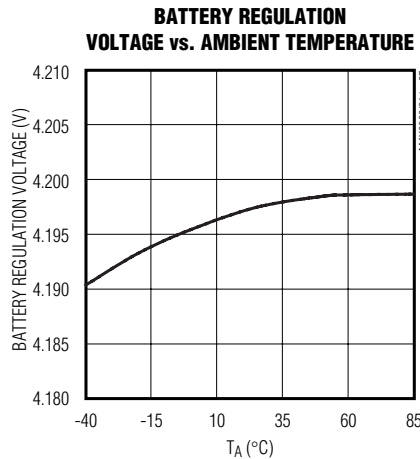
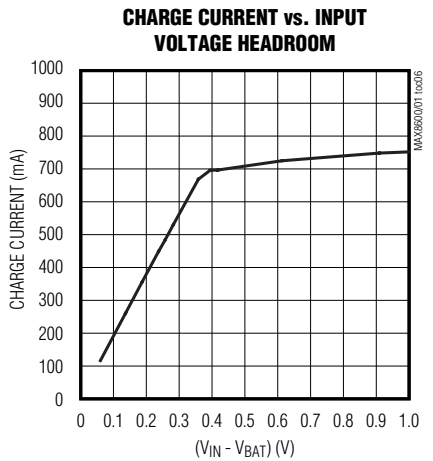
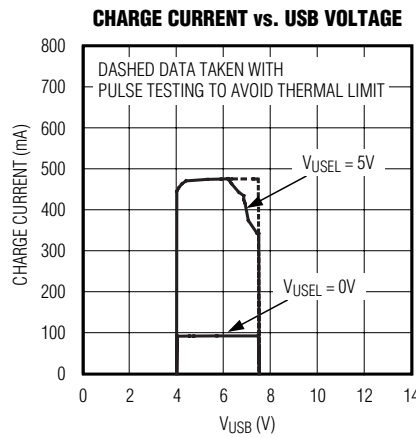
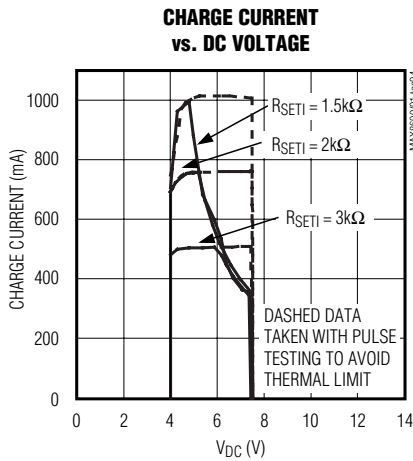
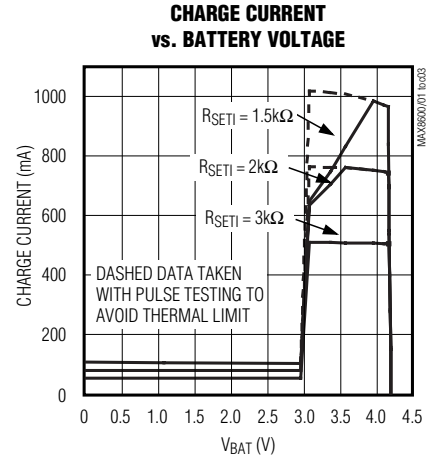
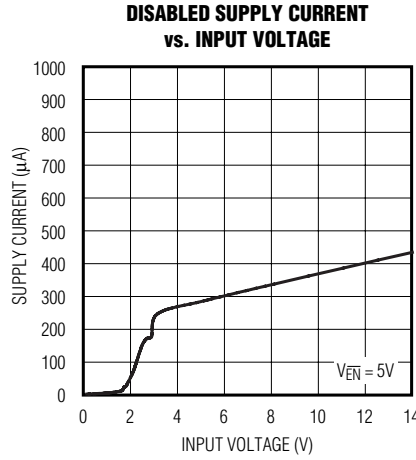
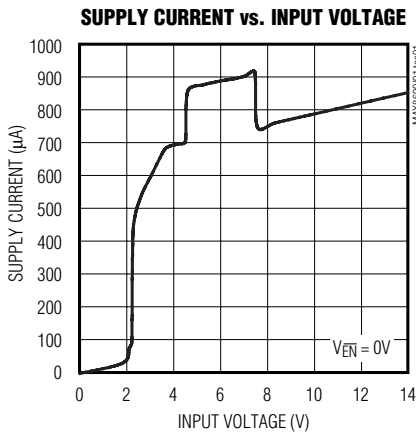
**Note 3:** Guaranteed by undervoltage- and overvoltage-threshold testing. For complete charging, the input voltage must be greater than 4.32V. See the *Applications Information* section.

**Note 4:** Guaranteed by the current-limit test.

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## Typical Operating Characteristics

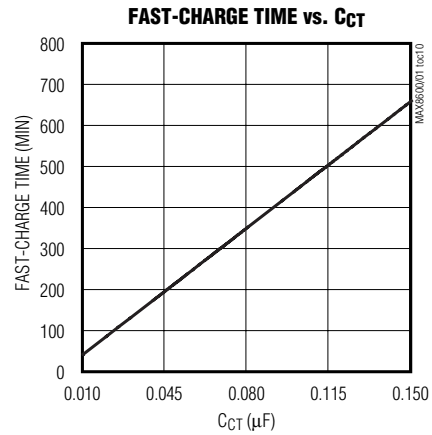
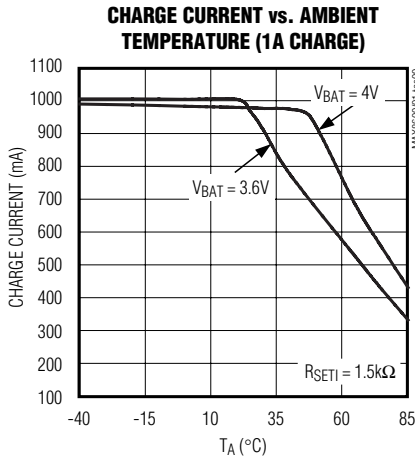
( $V_{DC} = 5V$ ,  $R_{SET1} = 2k\Omega$ ,  $V_{BAT} = 3.6V$ , MAX8601 evaluation kit with thermal resistance of  $50^{\circ}C/W$ .  $T_A = +25^{\circ}C$ , unless otherwise noted.)



# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## Typical Operating Characteristics (continued)

( $V_{DC} = 5V$ ,  $R_{SET1} = 2k\Omega$ ,  $V_{BAT} = 3.6V$ , MAX8601 evaluation kit with thermal resistance of  $50^{\circ}C/W$ .  $T_A = +25^{\circ}C$ , unless otherwise noted.)



## Pin Description

PIN		NAME	FUNCTION
MAX8600	MAX8601		
1	1, 7	BAT	Battery Connection. The IC delivers charging current and monitors battery voltage using BAT. Bypass BAT to GND with a 2.2 $\mu F$ or larger ceramic capacitor. Connect both BAT inputs together externally (MAX8601). BAT is high impedance when the IC is disabled.
2	2	SET1	DC Charge-Current Programming Input. Connect a resistor from SET1 to GND to set the maximum charging current when using the DC input, the prequal current from either input, and the CHG turn-off threshold.
3	3	THM	Thermistor Input. Connect a 10k $\Omega$ NTC thermistor, in close proximity to the battery, from THM to ground to monitor the battery temperature. Connect THM to GND to disable the thermistor functionality. The IC suspends charging when $R_{THM}$ is outside the hot and cold limits.
4	4	GND	Ground
5	5	CT	Timing Capacitor Input. Connect a capacitor from CT to GND to set the precharge timeout, top-off time, and fast-charge timeout. Connect CT to GND to disable the timers.
6, 7, 9	—	N.C.	No Connection. Make no external circuit connection.
8	8	$\overline{EN}$	Active-Low Enable Input. Drive low or connect $\overline{EN}$ to GND to enable the charger. Drive $\overline{EN}$ high to disable the charger.
10	10	$\overline{POK}$	Power-OK Monitor. $\overline{POK}$ is an open-drain output that pulls low when a valid charging source is detected at either DC or USB (MAX8601). $\overline{POK}$ is high impedance when $\overline{EN}$ is high.
11	11	$\overline{CHG}$	Charging-Status Output. $\overline{CHG}$ goes low when the battery is above 3V and being charged with a current greater than 7.5% of the current programmed with $R_{SET1}$ . $\overline{CHG}$ is high impedance when the charger is in prequal, top-off, or disabled.

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## Pin Description (continued)

PIN		NAME	FUNCTION
MAX8600	MAX8601		
12, 13	12, 13	DC	DC Input Supply. Connect DC to a 4.5V to 7V charging source. Bypass DC to GND with a 1μF or larger capacitor. DC takes priority over USB when both are present (MAX8601). Both DC inputs should be connected together externally.
14	14	FLT	Fault Status Output. $\overline{\text{FLT}}$ goes low when either the prequal timer or the fast-charge timers expire and the battery voltage is not above the required threshold. Clear the fault by raising $\overline{\text{EN}}$ or removing input power.
—	9	USB	USB Input Source. Connect to a USB port. Bypass USB to GND with a 1μF or larger capacitor.
—	6	USEL	USB Charge-Select Input. Logic input that determines the maximum charge current drawn from the USB input. $I_{\text{BAT}} = 95\text{mA}$ when USEL = low, and $I_{\text{BAT}} = 475\text{mA}$ when USEL = high.
—	—	EP	Exposed Paddle. Connect to the GND plane for optimum thermal dissipation.

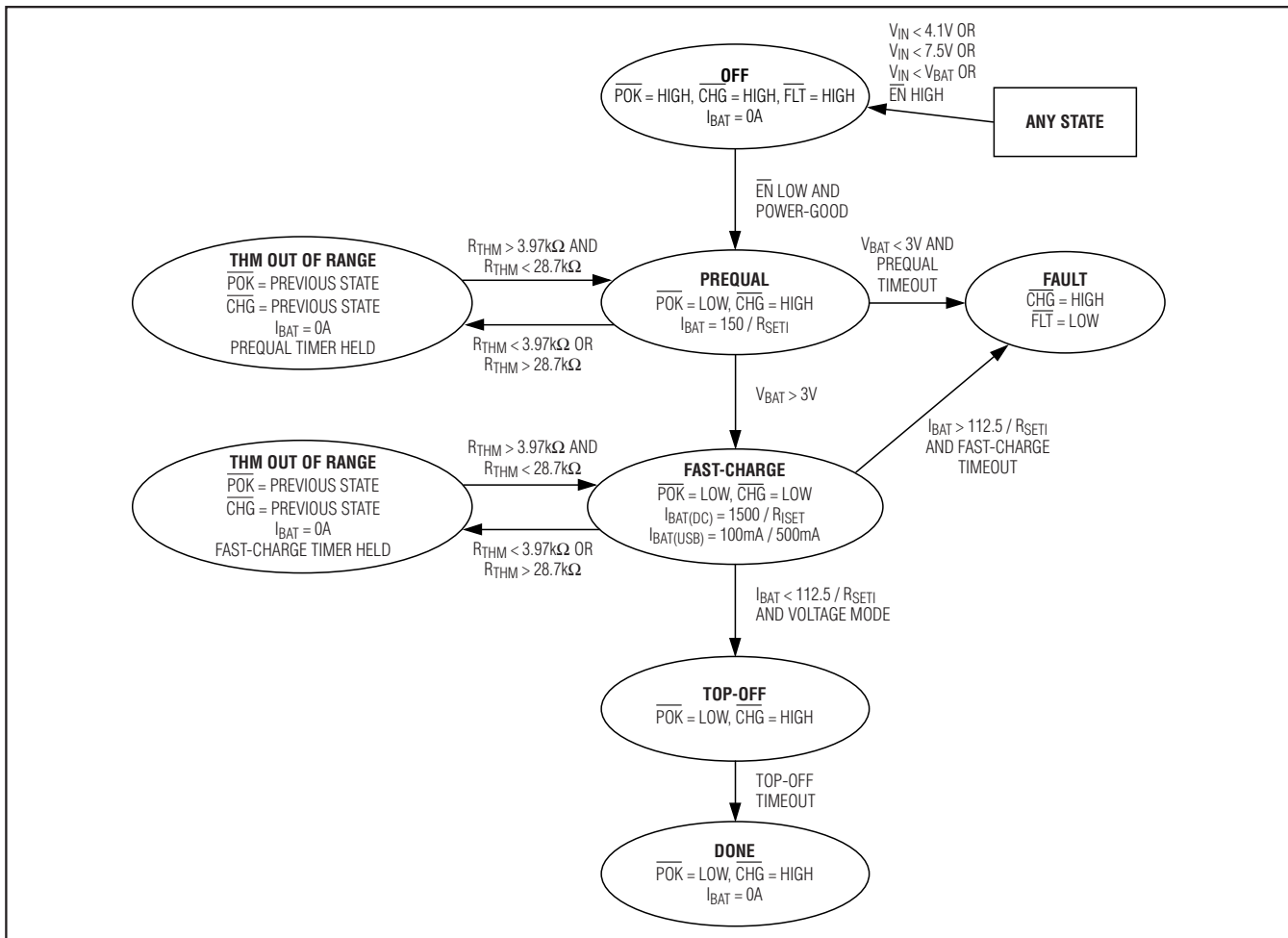


Figure 1. Charger State Diagram

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## Detailed Description

### DC Charging

The MAX8600/MAX8601 are designed to charge a single-cell Li+ battery from a DC source voltage between 4.5V and 7V. The precharge current, charge current, and top-off threshold are programmable with RSETI.

### USB Charging (MAX8601)

The MAX8601 contains a USB input that allows operation from either a DC source or a USB port. A USEL input allows the user to select either a 100mA or 500mA maximum charging current when using the USB input. If both V<sub>USB</sub> and V<sub>DC</sub> are valid, the MAX8601 operates from DC. If V<sub>DC</sub> is invalid (undervoltage/overvoltage), the MAX8601 operates from USB. When charging at 100mA from the USB input, the fast-charge timer is inhibited.

### EN Charger-Enable Input

EN is a logic input (active low) that enables the charger. Drive EN high to disable the charger-control circuitry. Drive EN low or connect to GND for normal operation.

### Soft-Start

To prevent input transients, the rate of change of charging current is limited. When the charger is turned on or when the input source is changed, charge current is ramped from 0 to the set current value in typically 1.2ms. This also means that if charging is taking place from USB, and the DC input is then powered, charge current falls to zero and then is reramped to the DC charge rate. This is done to ensure that the DC source is not subjected to a severe load current step.

Charge-current ramp up is also limited when transitioning from prequal to fast-charge, and when changing the USB charge current from 100mA to 500mA with USEL. There is no di/dt limiting, however, if ISET is changed suddenly using a switch at RSETI.

### Thermal-Limit Control

The MAX8600/MAX8601 feature a thermal limit that reduces the charge current when the die temperature exceeds +100°C. As the temperature increases above +100°C, the IC lowers the charge current by 50mA/°C.

### CHG Charge-Indicator Output

CHG is an open-drain output that indicates charger status. CHG goes low during charge cycles where V<sub>BAT</sub> is greater than 3V and I<sub>BAT</sub> is greater than 7.5% of the maximum charge current set by RSETI. When the MAX8600/MAX8601 are used in conjunction with a microprocessor (μP), connect a pullup resistor between CHG and the logic I/O voltage to indicate charge status

to the μP. Alternatively, CHG can sink up to 20mA for an LED charge indicator.

### Fault Indicator (FLT)

The MAX8600/MAX8601 contain an open-drain FLT output to signal the user when a fault occurs. FLT goes low if the charger is in prequal and the prequal timer expires, or if the charger is in fast-charge and the fast-charge time expires. FLT does NOT go low if the THM thermistor temperature is out of range. Toggle EN or the input power to reset the FLT indicator.

### Power-OK Indicator (POK)

The MAX8600/MAX8601 contain an open-drain POK output that goes low when a valid input source is detected at DC or USB (MAX8601 only). A valid input source is one whose voltage is between 4.5V and 7V and exceeds the battery voltage by 240mV. After a valid input has been established, charging is sustained with inputs as low as 3.5V as long as the input voltage remains above the battery voltage by at least 55mV. POK is high impedance when the charger is disabled.

## Applications Information

Figure 2 shows the typical operating circuit for the MAX8601. The following section describes component changes for different charging current and timer durations.

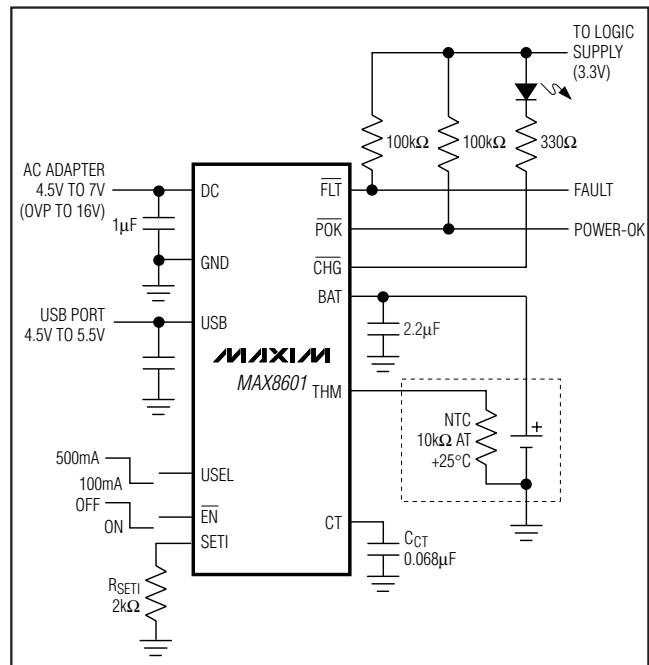


Figure 2. Typical Operating Circuit for USB/AC-Adapter Input Charger. An RSETI of 2kΩ sets an AC adapter fast-charge of 750mA.

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

**Table 1. Fault Temperatures for Different Thermistors**

THERMISTOR BETA	3000	3250	3500	3750
Resistance at +25°C	10,000Ω	10,000Ω	10,000Ω	10,000Ω
Resistance at +50°C	4587.78Ω	4299.35Ω	4029.06Ω	3775.75Ω
Resistance at 0°C	25,140.55Ω	27,148.09Ω	29,315.94Ω	31,656.90Ω
Nominal Hot Trip Temperature	+55.14°C	+52.60°C	+50.46°C	+48.63°C
Nominal Cold Trip Temperature	-3.24°C	-1.26°C	+0.46°C	+1.97°C

### Charge Current Selection

The maximum charging current from a supply connected to DC is programmed by an external resistor ( $R_{SETI}$ ) connected from SETI to GND. Calculate the  $R_{SETI}$  value as follows:

$$R_{SETI} = 1500 / I_{CHARGE(MAX)}$$

where  $I_{CHARGE(MAX)}$  is in amps and  $R_{SETI}$  is in ohms. SETI can also be used to monitor the actual charge-current level. The output voltage at SETI is proportional to the charging current as follows:

$$V_{SETI} = (I_{CHARGE} \times R_{SETI}) / 1000$$

Note that the prequal current for both USB and DC input operation is 1/10 of the fast-charge current set by  $R_{SETI}$ . Also, the top-off charge-current threshold for both USB and DC input operation is set to 7.5% of the fast-charge current set by  $R_{SETI}$ .

$$I_{PREQUAL} = 150 / R_{SETI}$$

$$I_{TOP-OFF} = 112.5 / R_{SETI}$$

### Timer Capacitor Selection

The MAX8600/MAX8601 contain timers for prequal, fast-charge, and top-off operation. These time periods are determined by the capacitance from CT to GND. To set the charge times, calculate  $C_{CT}$  as follows:

$$T_{FASTCHARGE} = 334\text{min} \times (C_{CT} / 0.068\mu\text{F})$$

$$T_{PREQUAL} = T_{TOPOFF} = 34.8\text{min} \times (C_{CT} / 0.068\mu\text{F})$$

Note that when charging at 100mA from the USB input (MAX8601), the fast-charge timer is inhibited. When THM halts charging, the timers stop and hold their value.

### Battery Temperature Control

The MAX8600/MAX8601 monitor battery temperature through a negative TC thermistor which is in close thermal contact with the battery. Select a thermistor resistance that is 10kΩ at +25°C and has a beta of 3500. The IC compares the resistance from THM to GND and suspends charging when it is greater than 28.3kΩ or

less than 3.94kΩ, which translates to a temperature of 0°C to +50°C. Table 1 shows the nominal temperature limits that result from a wide range of available thermistor temperature curves. The curves are defined by the following equation:

$$R_T = R_{25^\circ\text{C}} \times e^{\left\{ \beta \left[ \left( \frac{1}{T+273} \right) - \left( \frac{1}{298} \right) \right] \right\}}$$

where  $\beta$  is the BETA term in Table 1.

Connect THM to GND to disable the temperature-control function. When  $R_{THM}$  disables charging, all timers pause and hold their value.

### Capacitor Selection

Connect a 2.2μF ceramic capacitor from BAT to GND for proper stability. Connect a 1μF ceramic capacitor from DC to GND. If using the USB input for the MAX8601, bypass USB to GND with a 1μF ceramic capacitor. Use a larger input bypass capacitor for high charging currents to reduce supply noise. All capacitors should be X5R dielectric or better. Be aware that some capacitors have large voltage coefficients and should be avoided.

### Thermal Considerations

The MAX8600/MAX8601 are in a thermally enhanced TDFN package with an exposed paddle. Connect the exposed paddle of the package to a large copper ground plane to provide a thermal contact between the device and the circuit board. The exposed paddle transfers heat away from the device, allowing the IC to charge the battery with maximum current, while minimizing the increase in die temperature. Note that the MAX8600/MAX8601s' thermal-limit control allows the charger to be tolerant of thermally restricted PC board layouts that are sometimes unavoidable in compact portable designs. With such non-optimal layouts, the charger still operates, but may reduce charge current to manage temperature rise.



# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

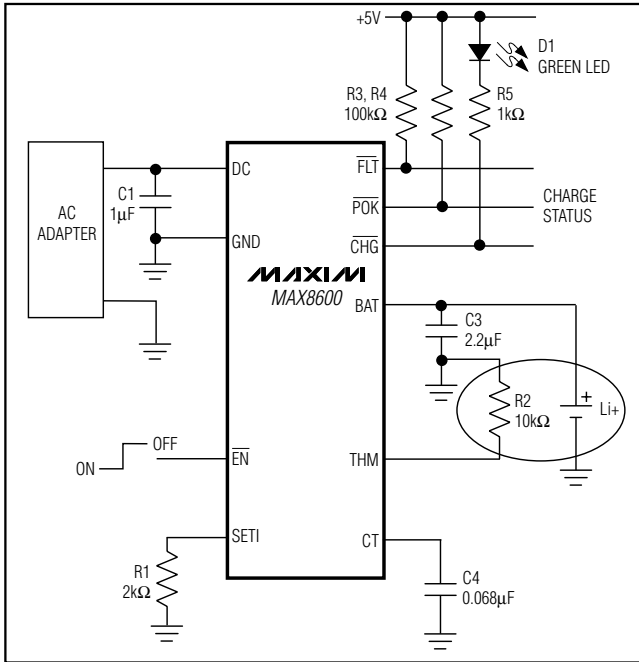


Figure 3. Stand-Alone Li+ Battery-Charger with the MAX8600

### DC Input Sources

The MAX8600/MAX8601 operating input voltage range is 4.15V to 7V. The device survives input voltages up to 16V without damage to the IC. If the input voltage is greater than 7.5V (typ), the IC stops charging. An appropriate power supply must provide at least 4.2V plus the voltage drop across the internal pass transistor when sourcing the desired maximum charging current.

$$V_{IN(MIN)} > 4.2V + I_{CHARGE(MAX)} \times R_{ON}$$

where  $R_{ON}$  is the input-to-BAT resistance (typically 0.5Ω). Failure to meet this requirement results in an incomplete charge or increased charge time.

### Stand-Alone Li+ Charger

The MAX8600 provides a complete Li+ charging solution. Figure 3 shows the MAX8600 as a stand-alone Li+ battery charger. The 2kΩ resistor connected to SET1 sets a charging current of 750mA. The LED indicates when fast-charge has begun. When fast-charge is complete, the LED turns off.

### USB-Powered Li+ Charger (MAX8601)

The universal serial bus (USB) provides a high-speed serial communication port as well as power for the

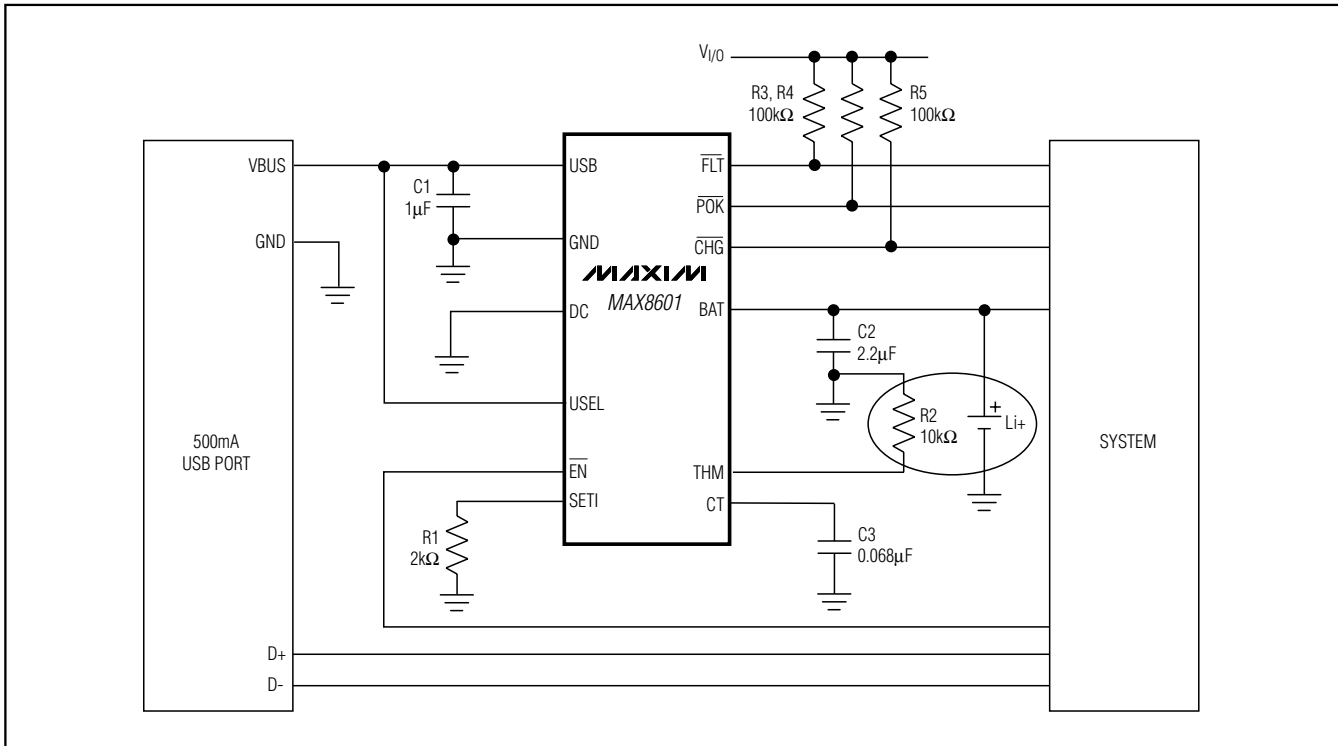


Figure 4. USB Battery Charger with the MAX8601

# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

remote device. The MAX8601 can be configured to charge its battery at the highest current possible from the host port. Figure 4 shows the MAX8601 configured as a USB battery charger. A USEL input sets the maximum charging current from the USB input at 100mA or 500mA.

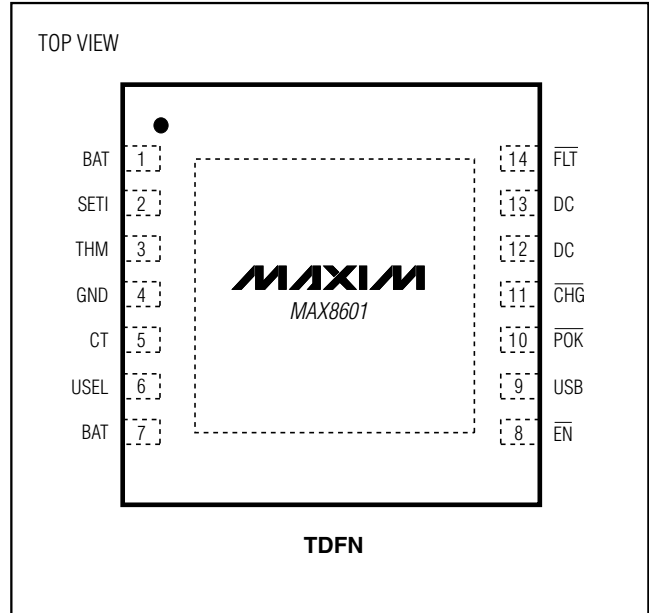
### Layout and Bypassing

Connect the input capacitors as close to the device as possible. Provide a large copper GND plane to allow the exposed paddle to sink heat away from the device. Connect the battery to BAT as close to the IC as possible to provide accurate battery voltage sensing. Make all high-current traces short and wide to minimize voltage drops. For an example layout, refer to the MAX8601 evaluation kit.

### Chip Information

TRANSISTOR COUNT: 6838  
 PROCESS: BiCMOS

### Pin Configurations (continued)

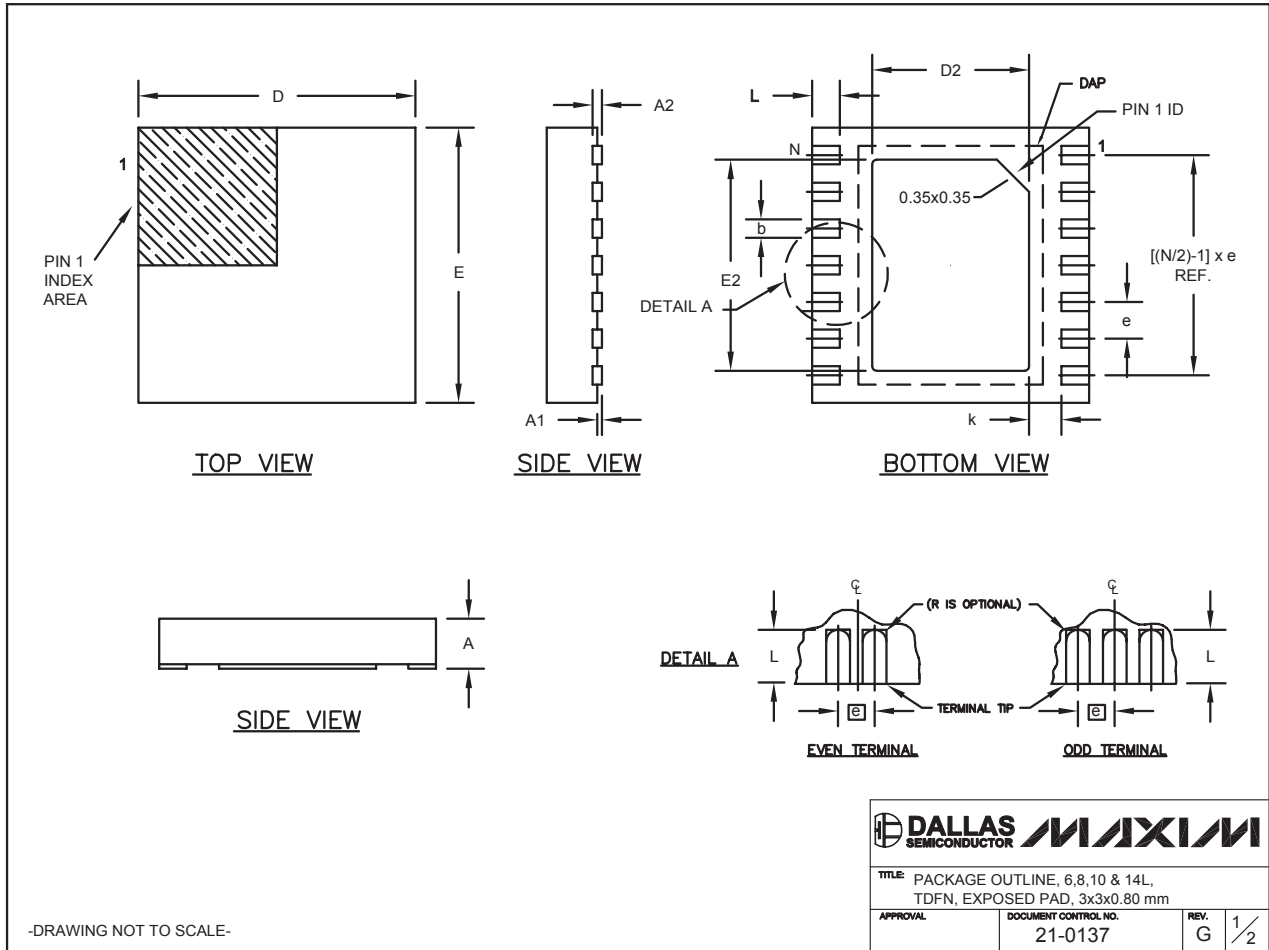


# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

**MAX8600/MAX8601**



# Single-/Dual-Input 1-Cell Li+ Chargers with OVP Protection and Programmable Charge Timer

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

COMMON DIMENSIONS		
SYMBOL	MIN.	MAX.
A	0.70	0.80
D	2.90	3.10
E	2.90	3.10
A1	0.00	0.05
L	0.20	0.40
k	0.25 MIN.	
A2	0.20 REF.	

PACKAGE VARIATIONS								
PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e	DOWNBONDS ALLOWED
T633-1	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF	NO
T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF	NO
T833-1	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF	NO
T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF	NO
T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF	YES
T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF	NO
T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF	YES
T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF	NO

**NOTES:**

- ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
- COPLANARITY SHALL NOT EXCEED 0.08 mm.
- WARPAGE SHALL NOT EXCEED 0.10 mm.
- PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
- DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
- "N" IS THE TOTAL NUMBER OF LEADS.
- NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

-DRAWING NOT TO SCALE-

			
TITLE: PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm			
APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0137	G	2/2

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