19-4405; Rev 0; 3/09

28V Linear Li+ Battery Chargers with Battery Detection and Overvoltage Protected Output

General Description

The MAX8845Z/MAX8845Y are intelligent, stand-alone constant-current, constant-voltage (CCCV), thermally regulated linear chargers designed for charging a single-cell lithium-ion (Li+) battery. The MAX8845Z/MAX8845Y integrate a current-sense circuit, MOSFET pass element, thermal-regulation circuitry, and eliminates the external reverse-blocking Schottky diode to create the simplest and smallest charging solutions for handheld equipment.

The ICs control the charging sequence from the prequalification state through constant current fast-charge, top-off charge, and full-charge indication. Proprietary thermal-regulation circuitry limits the die temperature during fast-charging or when the ICs are exposed to high ambient temperatures, allowing maximum charging current without damaging the ICs.

The MAX8845Z/MAX8845Y achieve high flexibility by providing adjustable fast-charge currents (SETI) and an adjustable top-off current threshold (MIN) through external resistors. The MAX8845Z/MAX8845Y feature a booting assistant circuit that distinguishes input sources and battery connection and provides an enable signal (ABO—MAX8845Z and $\overline{\text{ABO}}$—MAX8845Y) for system booting.

The MAX8845Z/MAX8845Y also integrate an overvoltage-protected output (SAFEOUT) for low voltage-rated USB or charger inputs in system, and a battery-pack detection circuit (DETBAT) that disables the charger when the battery pack is absent. Other features include an active-low control input ($\overline{\text{EN}}$), an active-low input power source detection output ($\overline{\text{POK}}$), and a fully charged top-off threshold detection output ($\overline{\text{CHG}}$).

The MAX8845Z/MAX8845Y accept an input supply range from 4.25V to 28V, but disables charging if the supply voltage exceeds +7.5V to protect against unqualified or faulty AC adapters. The IC's operate over the extended temperature range (-40°C to +85°C) and are available in a compact 12-pin, thermally enhanced thin QFN, 3mm x 3mm package (0.8mm max height).

Applications

- Cellular and Cordless Phones
- Smart Phones and PDAs
- Digital Still Cameras
- MP3 Players
- USB Appliances
- Charging Cradles and Docks
- Bluetooth® Equipment

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Features

- ♦ **CCCV, Thermally Regulated Linear 1-Cell Li+ Battery Charger**
- ♦ **No External MOSFET, Reverse Blocking Diode, or Current-Sense Resistor**
- ♦ **Programmable Fast-Charge Currents (1A_{RMS} max)**
- ♦ **Programmable Top-Off Current Threshold (MIN)**
- ♦ **Input Overvoltage Protected 4.7V Output (SAFEOUT)**
- ♦ **Proprietary Die Temperature Regulation Control (+115°C)**
- ♦ **4.25V to 28V Input Voltage Range with Input Overvoltage Protection Above +7.5V**
- ♦ **Low-Dropout Voltage (300mV at 500mA)**
- ♦ **Input Power-Source Detection Output ($\overline{\text{POK}}$), Charge Status Output ($\overline{\text{CHG}}$), Charge-Enable Input ($\overline{\text{EN}}$)**
- ♦ **Output for Autobooting (ABO—MAX8845Z, $\overline{\text{ABO}}$—MAX8845Y)**
- ♦ **Tiny, 3mm x 3mm 12-Pin Thin QFN Package, 0.8mm Height (max)**

Ordering Information

PART	PIN-PACKAGE	TOP MARK	ABO ACTIVE STATE
MAX8845ZETC+	12 Thin QFN-EP*	ABL	Active high
MAX8845YETC+	12 Thin QFN-EP*	ABM	Active low

Note: *All devices are specified over the -40°C to +85°C operating temperature range.*

+Denotes a lead(Pb)-free/RoHS-compliant package.

**EP = Exposed pad.*

Typical Operating Circuit and Pin Configurations appear at end of data sheet.

28V Linear Li+ Battery Chargers with Battery Detection and Overvoltage Protected Output

ABSOLUTE MAXIMUM RATINGS

IN to GND ....-0.3V to +30V
ABI, BATT, $\overline{EN}$, $\overline{POK}$, ABO, $\overline{ABO}$, $\overline{CHG}$, DETBAT, SETI, MIN,
SAFEOUT to GND ....-0.3V to +6V
IN to BATT Continuous Current ....$1A_{RMS}$
Continuous Power Dissipation (T_A = +70°C)
12-Thin QFN (derate 14.7mW/°C above +70°C)
(multilayer PCB) 1176.5mW

BATT Short-Circuit Duration ....Continuous
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_{IN} = 5V, V_{BATT} = 4V, $R_{\overline{POK}}$ = 1MΩ to BATT, $\overline{EN}$ = unconnected, R_{SETI} = 2.8kΩ to GND, V_{DETBAT} = 0, C_{BATT} = 2.2µF, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Supply Voltage Range			0		28	V
Input Supply Operating Voltage Range			4.25		7.00	V
Overvoltage Lockout Trip Threshold	V_{IN} rising, 100mV hysteresis (typ)		7.0	7.5	8.0	V
Input Current	Constant current charging I_{IN} - I_{BATT}, I_{BATT} = 0			0.22	0.50	mA
	Constant current charging I_{IN} - I_{BATT}, I_{BATT} = 500mA			1		
	IC disabled, $V_{\overline{EN}}$ = 5V			0.20	0.50	
	V_{IN} = 4V, V_{BATT} = 4.2V	T_A = +25°C		0.02		
		T_A = +85°C		0.03		
BATT, $\overline{CHG}$, $\overline{POK}$						
Minimum BATT Bypass Capacitance				2.2		µF
V_{BATT} Prequalification Threshold Voltage	V_{BATT} rising, 100mV hysteresis (typ)		2.3	2.5	2.7	V
Battery Regulation Voltage	I_{BATT} = 0	T_A = -40°C to +85°C	4.175	4.200	4.225	V
			4.158	4.200	4.242	
Regulator Dropout Voltage (V_{IN} - V_{BATT})	V_{BATT} = 4.1V, I_{BATT} = 425mA			260		mV
BATT Input Current	V_{IN} = 0 to 4V, V_{BATT} = 4.2V			5	10	µA
	IC disabled			3		
Current-Sense Amplifier Gain (I_{BATT} to I_{SETI})	I_{BATT} = 500mA			1016		µA/A
Fast-Charge Current	V_{BATT} = 3.5V, R_{SETI} = 2.8kΩ	T_A = 0°C to +85°C	460	500	540	mA
		T_A = -40°C to +85°C	425	500	575	
	V_{BATT} = 3.5V, R_{SETI} = 14kΩ	T_A = 0°C to +85°C	85	100	115	
$\overline{CHG}$ Top-Off Threshold	I_{BATT} falling, battery is charged R_{MIN} = 1.75kΩ			106		mA
$\overline{CHG}$ Hysteresis	I_{BATT} rising after top-off is detected, R_{MIN} = 1.75kΩ			38		mA
$\overline{CHG}$ Detection Delay	I_{BATT} falls below top-off threshold		4.0	6.2	10.7	ms

ELECTRICAL CHARACTERISTICS (continued)

(V_{IN} = 5V, V_{BATT} = 4V, $R_{\overline{POK}}$ = 1MΩ to BATT, $\overline{EN}$ = unconnected, R_{SETI} = 2.8kΩ to GND, V_{DETBAT} = 0, C_{BATT} = 2.2µF, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Prequalification Charge Current	Percentage of the fast-charge current, V_{BATT} = 2.2V	T_A = 0°C to +85°C	5	10	15	%
$\overline{CHG}$, $\overline{POK}$ Output Low Threshold	$I_{\overline{POK}}$ = 5mA , $I_{\overline{CHG}}$ = 5mA				0.4	V
$\overline{CHG}$, $\overline{POK}$ Output High Leakage Current	$V_{\overline{POK}}$ = 5.5V, $V_{\overline{CHG}}$ = 5.5V	T_A = +25°C			1	µA
		T_A = +85°C		0.01		
POK Threshold	V_{IN} - V_{BATT}	V_{IN} rising		40		mV
		V_{IN} falling		30		
DETBAT, SAFEOUT						
DETBAT Logic-Input Low Threshold					0.4	V
DETBAT Logic-Input High Threshold			1.3			
DETBAT Pullup Resistor	DETBAT to V_L = 3V			470		kΩ
Minimum SAFEOUT Bypass Capacitance				1		µF
SAFEOUT Regulated Output	$I_{SAFEOUT}$ = 30mA, V_{IN} = 5V, T_A = 0°C to +85°C		4.5	4.7	4.9	V
SAFEOUT Current Limit				100		mA
$\overline{EN}$, ABI, ABO, $\overline{ABO}$						
$\overline{EN}$, ABI Internal Pulldown Resistor			100	200	400	kΩ
$\overline{EN}$ Logic-Input Low Threshold	4.25V ≤ V_{IN} ≤ 7V				0.4	V
$\overline{EN}$ Logic-Input High Threshold	4.25V ≤ V_{IN} ≤ 7V		1.3			V
ABI Logic-Input Low Threshold	V_{BATT} = 4V, V_{IN} = 0				0.4	V
ABI Logic-Input High Threshold	V_{BATT} = 4V, V_{IN} = 0		1.3			V
$\overline{ABO}$ Output Low Threshold (MAX8845Y)	Open drain, $I_{\overline{ABO}(SINK)}$ = 1mA				0.4	V
$\overline{ABO}$ Output High Threshold (MAX8845Y)	Open drain, 100kΩ pullup to BATT		V_{BATT} - 0.4V			V
ABO Output Low Threshold (MAX8845Z)	$I_{ABO(SINK)}$ = 1mA				0.4	V
ABO Output High Threshold (MAX8845Z)	$I_{ABO(SOURCE)}$ = 1mA		V_{BATT} - 0.4V			V
THERMAL						
Die Temperature Regulation Threshold				115		°C

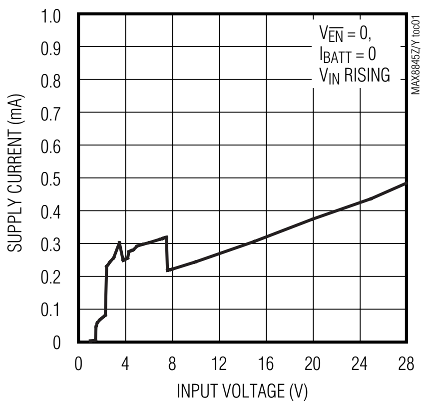
Note 1: Specifications are 100% production tested at T_A = +25°C. Limits over the operating temperature range are guaranteed by design and characterization.

28V Linear Li+ Battery Chargers with Battery Detection and Overvoltage Protected Output

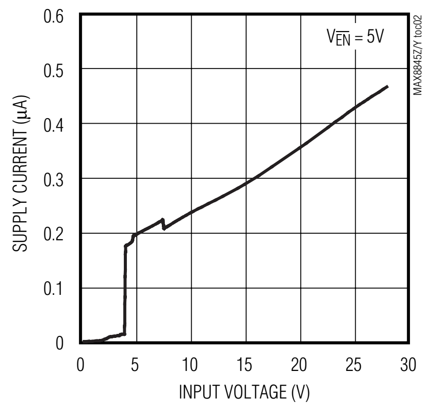
Typical Operating Characteristics

(V_{IN} = 5V, V_{BATT} = 4V, $R_{\overline{POK}}$ = $R_{\overline{CHG}}$ = 200kΩ to 5V, $\overline{EN}$ = unconnected, R_{SETI} = 2.8kΩ to GND, R_{MIN} = 1.74kΩ to GND, R_{DETBAT} = 4.7kΩ to GND, C_{BATT} = 2.2µF, T_A = +25°C, unless otherwise noted.)

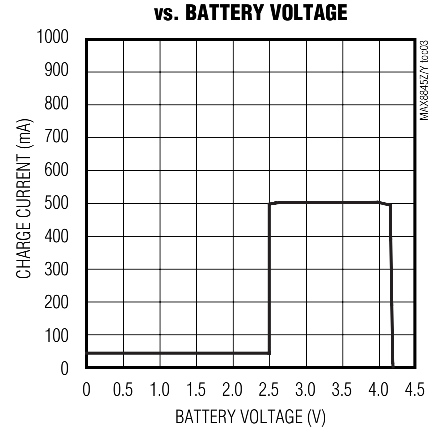
SUPPLY CURRENT vs. INPUT VOLTAGE



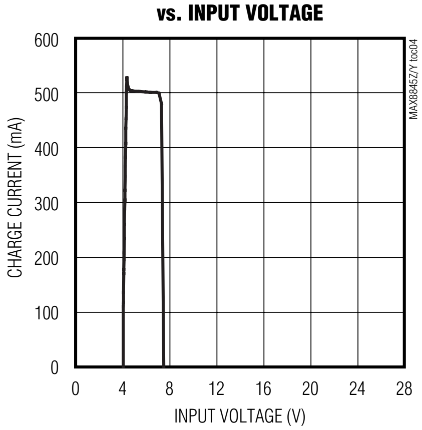
DISABLED MODE SUPPLY CURRENT vs. INPUT VOLTAGE



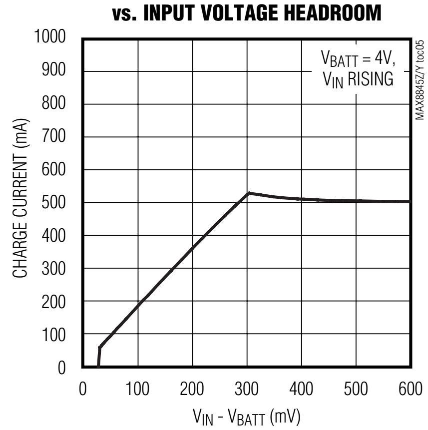
CHARGE CURRENT vs. BATTERY VOLTAGE



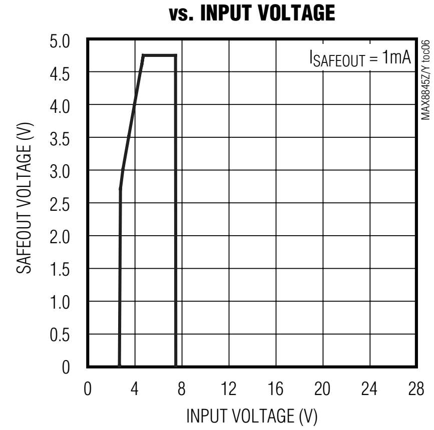
CHARGE CURRENT vs. INPUT VOLTAGE



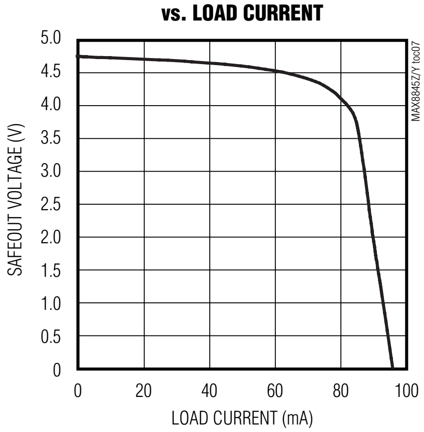
CHARGE CURRENT vs. INPUT VOLTAGE HEADROOM



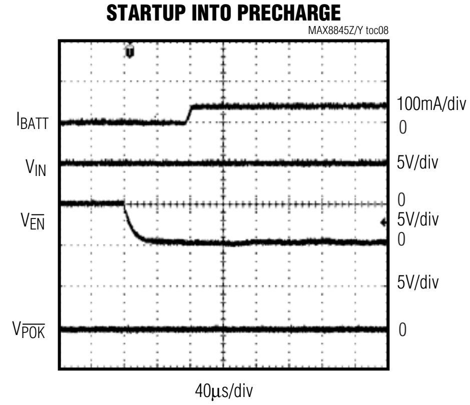
SAFEOUT OUTPUT VOLTAGE vs. INPUT VOLTAGE



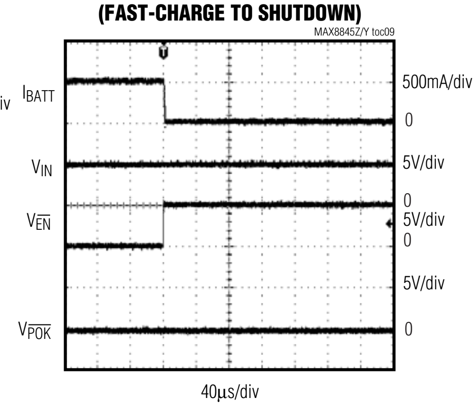
SAFEOUT OUTPUT VOLTAGE vs. LOAD CURRENT



STARTUP INTO PRECHARGE



SHUTDOWN (FAST-CHARGE TO SHUTDOWN)

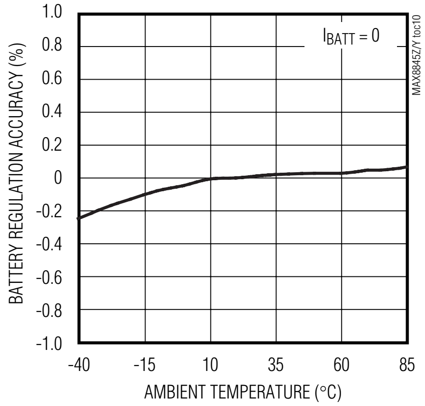


28V Linear Li+ Battery Chargers with Battery Detection and Overvoltage Protected Output

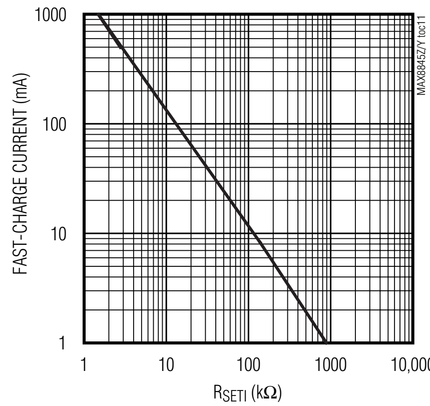
Typical Operating Characteristics (continued)

(V_{IN} = 5V, V_{BATT} = 4V, $R_{\overline{POK}}$ = $R_{\overline{CHG}}$ = 200kΩ to 5V, $\overline{EN}$ = unconnected, R_{SETI} = 2.8kΩ to GND, R_{MIN} = 1.74kΩ to GND, R_{DETBAT} = 4.7kΩ to GND, C_{BATT} = 2.2µF, T_A = +25°C, unless otherwise noted.)

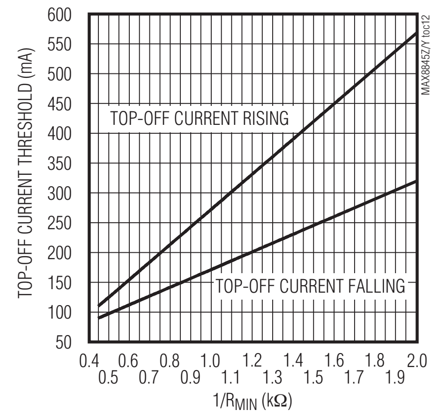
BATTERY REGULATION ACCURACY vs. AMBIENT TEMPERATURE



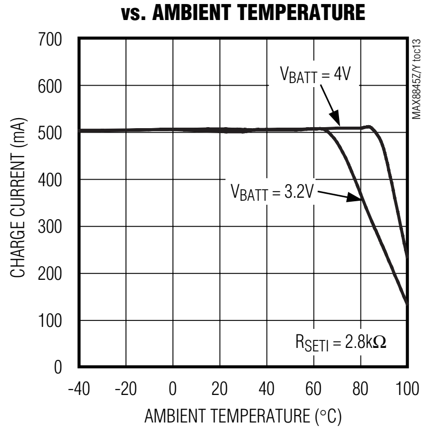
FAST-CHARGE CURRENT vs. R_{SETI}



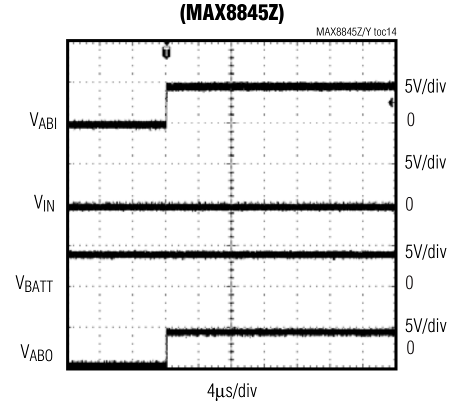
TOP-OFF CURRENT THRESHOLD vs. $1/R_{MIN}$ (kΩ)



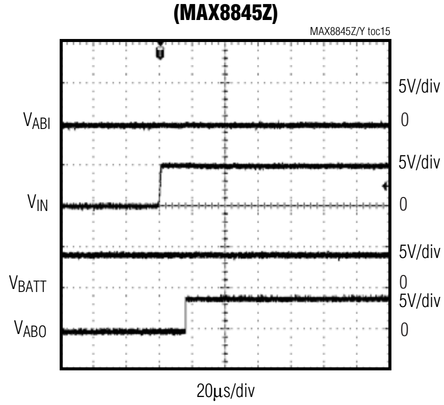
CHARGE CURRENT vs. AMBIENT TEMPERATURE



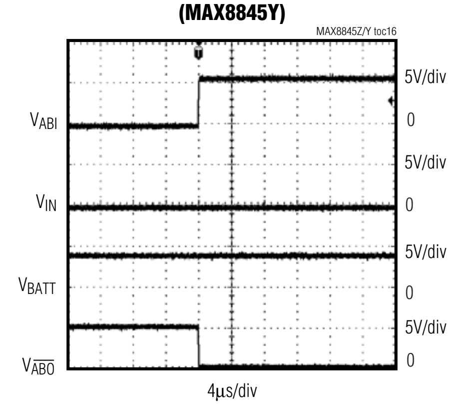
AUTOBOOT ENABLED BY ABI SIGNAL (MAX8845Z)



AUTOBOOT ENABLED BY INPUT VOLTAGE (MAX8845Z)



AUTOBOOT ENABLED BY ABI SIGNAL (MAX8845Y)



Pin Description

PIN		NAME	FUNCTION
MAX8845Z	MAX8845Y		
1	1	SETI	Charge-Current Program and Fast-Charge Current Monitor. Output current from SETI is 1016µA per ampere of battery charging current. Set the charging current by connecting a resistor (R_{SETI} in Figure 3) from SETI to GND. $I_{FAST\text{-}CHARGE}$ = 1400V/R_{SETI}. To configure the MAX8845Z/MAX8845Y as a USB charger, see Figure 5.
2	2	DETBAT	Battery Pack ID Resistor Detection Input. If DETBAT is pulled low through a pulldown resistor less than 51kΩ the charger is enabled. If DETBAT is left unconnected, the charger is disabled.
3	3	ABI	Autobooting External Input. See the *Autobooting Assistant* section and Table 1 for autobooting conditions. ABI is pulled to GND through an internal 200kΩ resistor.
4	4	$\overline{EN}$	Active-Low, Logic-Level Enable Input. Drive $\overline{EN}$ high to disable charger. Drive $\overline{EN}$ low or leave unconnected for normal operation. $\overline{EN}$ has an internal 200kΩ pulldown resistor.
5	5	GND	Ground. Connect GND and the exposed pad to a large copper ground plane for maximum power dissipation. Connect GND to the exposed pad directly under the IC.
6	6	$\overline{POK}$	Active-Low, Input Voltage Status Indicator. $\overline{POK}$ is an open-drain output that asserts low when 2.35V < V_{IN} < 7V and (V_{IN} - V_{BATT}) ≥ 40mV. If V_{IN} > +7.5V or V_{BATT} > V_{IN} the IC is shut down and $\overline{POK}$ becomes high impedance. Connect a pullup resistor to the microprocessor's I/O voltage when interfacing with a microprocessor logic input.
7	—	ABO	Active-High, Autobooting Logic Output. See the *Autobooting Assistant* section and Table 1 for autobooting conditions.
—	7	$\overline{ABO}$	Active-Low, Open-Drain Logic Output. See the *Autobooting Assistant* section and Table 1 for autobooting conditions.
8	8	BATT	Li+ Battery Connection. Bypass BATT to GND with a 2.2µF ceramic capacitor.
9	9	MIN	Top-Off Current Threshold Programmable Input. I_{MIN} (mA) falling = 148V/R_{MIN} (kΩ) + 22 (mA).
10	10	$\overline{CHG}$	Active-Low, Charging Indicator. $\overline{CHG}$ is an open-drain output that is pulled low once charging begins. $\overline{CHG}$ is high impedance when the battery current drops below MIN, or when the IC is disabled. Connect a pullup resistor to the microprocessor's I/O voltage when interfacing with a microprocessor logic input.
11	11	IN	Input Supply Voltage. Bypass IN to GND with a 1µF or larger ceramic capacitor to improve line noise and input transient rejection.
12	12	SAFEOUT	4.7V Regulated LDO Output with Input Overvoltage Protection. Bypass SAFEOUT to GND with a 1µF or larger ceramic capacitor. SAFEOUT can be used to supply low voltage-rated USB systems.
—	—	EP	Exposed Pad. Connect the exposed pad to a large ground plane for maximum power dissipation. Connect GND to the exposed pad directly under the IC.

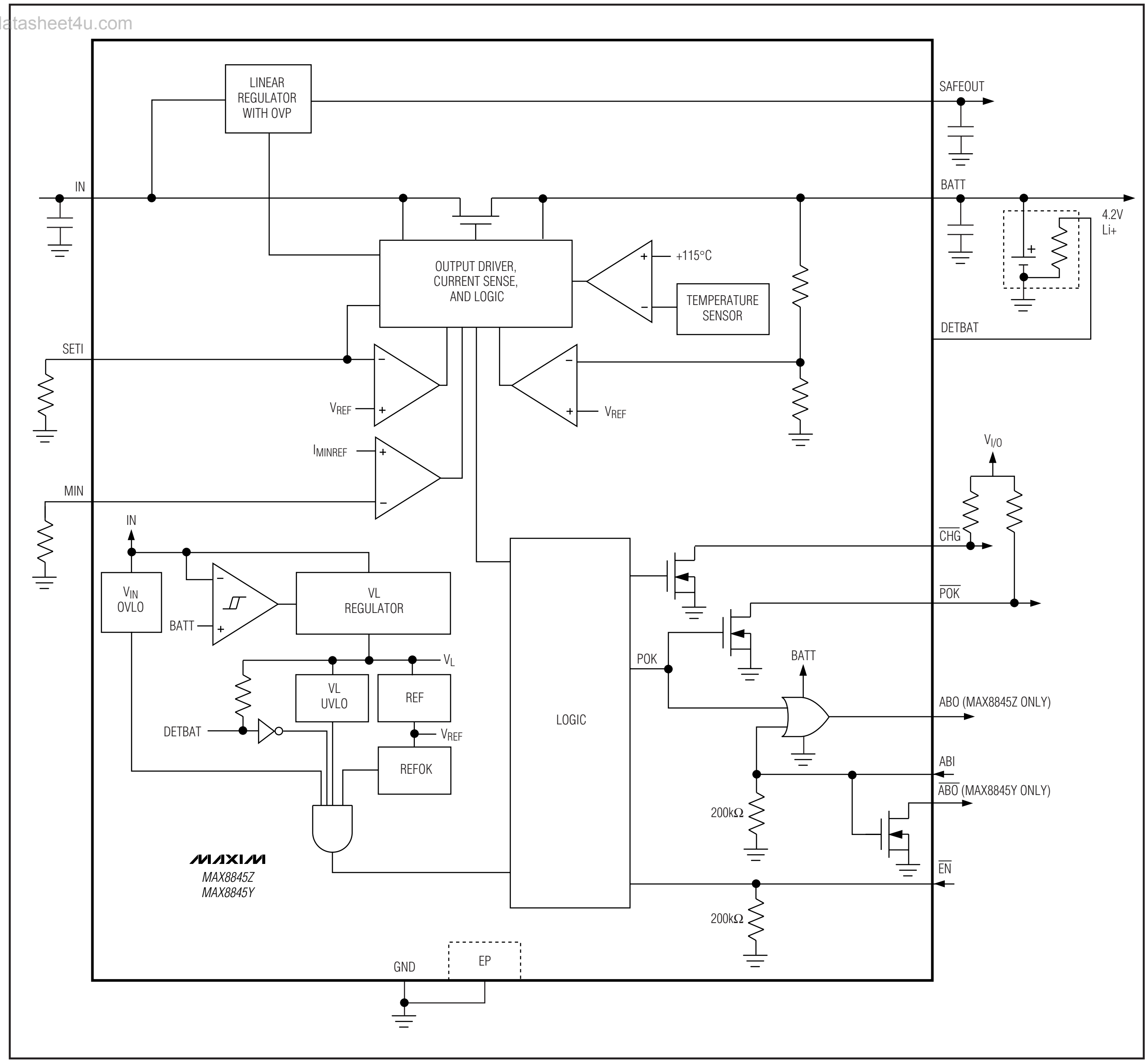


Figure 1. MAX8845Z/MAX8845Y Functional Diagram

Detailed Description

The MAX8845Z/MAX8845Y chargers use voltage, current, and thermal-control loops to charge a single Li+ cell and protect the battery (Figure 1). When a Li+ battery with a cell voltage below 2.5V is inserted, the MAX8845Z/MAX8845Y chargers enter a prequalification stage where it precharges that cell with 10% of the user-programmed fast-charge current (Figure 2). The $\overline{CHG}$ indicator is driven low to indicate entry into the prequalification state. When the battery voltage exceeds 2.5V, the charger soft-starts as it enters the fast-charge stage. The fast-charge current level is programmed through a resistor from SETI to GND. As the battery voltage approaches 4.2V, the charging current

28V Linear Li+ Battery Chargers with Battery Detection and Overvoltage Protected Output

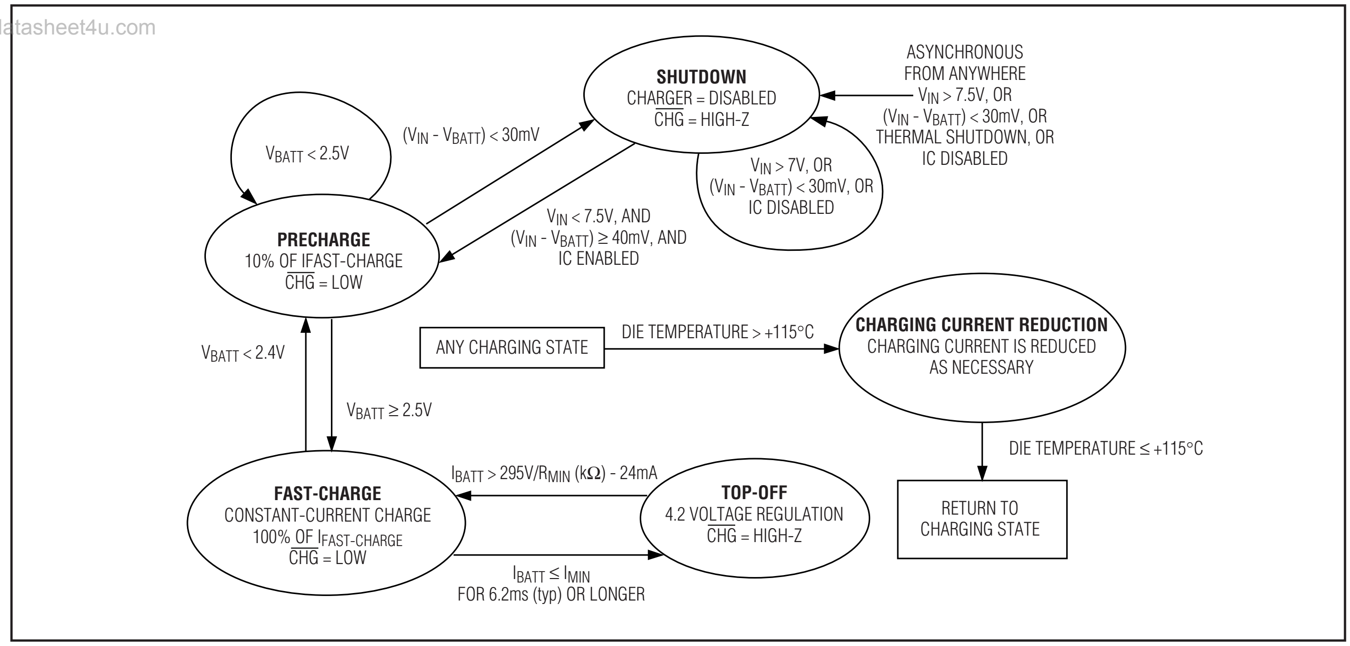


Figure 2. Charge-State Diagram

is reduced. If the battery current drops to less than the top-off current threshold set by R_{MIN}, the charger enters top-off mode and the $\overline{CHG}$ indicator goes high impedance signaling that the battery is fully charged.

Overvoltage-Protected Output (SAFEOUT)

SAFEOUT is a linear regulator that provides an output voltage of 4.7V and can be used to supply low voltage-rated USB systems. The SAFEOUT linear regulator turns on when V_{IN} ≥ 4.25V regardless of $\overline{EN}$ and is disabled when V_{IN} is greater than the overvoltage threshold (7.5V typ).

Battery-Pack Detection Input (DETBAT)

DETBAT is a battery-pack ID resistor detector that enables the battery charger if pulled low through a resistor that is less than 51kΩ. If DETBAT is left unconnected or the pulldown resistor is 51kΩ or greater the battery charger is disabled. If DETBAT is not used connect DETBAT to GND for normal operation.

$\overline{POK}$ Output

The open-drain $\overline{POK}$ output asserts low when 2.35V ≤ V_{IN} ≤ 7V, (V_{IN} - V_{BATT}) ≥ 40mV (typ V_{IN} rising), and DETBET is pulled low through a resistor that is less than 51kΩ. $\overline{POK}$ is high impedance during shutdown. When interfacing with a microprocessor logic input, a pullup resistor to the microprocessor's I/O voltage may be required.

Autobooting Assistant

The MAX8845Z/MAX8845Y contain autobooting assistant circuits that generate an enable signal for system booting (ABO—MAX8845Z, $\overline{ABO}$—MAX8845Y). For the MAX8845Z, the booting assistant functions as an internal OR gate (Figure 1). The first input is dependant on the input voltage (V_{IN}) and DETBAT while the second input is an external signal applied to ABI. The first input ($\overline{POK}$) is driven high once DETBAT is pulled low through a resistor less than 51kΩ, 2.35V ≤ V_{IN} ≤ 7V, and (V_{IN} - V_{BATT}) ≥ 40mV (typ V_{IN} rising).

The second input signal (ABI) is driven by an external source (Table 1). ABI enables an autoboot signal when a battery is connected at BATT and is independent of $\overline{POK}$. If $\overline{POK}$ is pulled low, the booting assistant always drives ABO high regardless of ABI. ABI is pulled to GND through an internal 200kΩ resistor. If ABI is supplied from an outside exposed pin, a RC filter (Figure 4) is required for ESD protection and noise filtering. If ABI is supplied by a system's internal GPIO, or logic, the RC filter is not required. For the MAX8845Y, the output $\overline{ABO}$ is only dependent on the state of ABI (Table 1).

$\overline{CHG}$ Charge Indicator Output

$\overline{CHG}$ is an open-drain output that indicates charge status. Table 2 describes the state of $\overline{CHG}$ during different stages of operation. $\overline{CHG}$ is suitable for driving a charge indication LED. If the MAX8845Z/MAX8845Y are

Table 1. Autobooting Output States

ABI	BATT	$\overline{\text{POK}}$	CHARGER STATE	ABO (MAX8845Z)	$\overline{\text{ABO}}$ (MAX8845Y)
Low	Present	High-Z	Shutdown	Low	High-Z
High	Present	High-Z	Shutdown	High	Low
Low	Not present	Low	CC/CV mode	High	High-Z
Low	Present	Low	Fast-charge/top-off	High	High-Z
High	Present	Low	Fast-charge/top-off	High	Low

Note: *Present indicates that $V_{BATT} \geq 2V$ and Not Present indicates that the battery is not connected.*

Table 2. $\overline{\text{CHG}}$ States

$\overline{\text{EN}}$	V_{IN}	V_{BATT}	I_{BATT}	$\overline{\text{CHG}}$	STATE
High	X	X	0	High-Z	Disabled
Low	> 7.5V	X	0	High-Z	Shutdown
	X	> V_{IN} - 30mV			
Low	$4.25V \leq V_{IN} \leq 7.5V$	< 2.4V	10% of $I_{FAST\text{-}CHARGE}$*	Low	Precharge
Low	$4.25V \leq V_{IN} \leq 7.5V$	≥ 2.5V	100% of $I_{FAST\text{-}CHARGE}$*	Low	Fast-charge
Low	$4.25V \leq V_{IN} \leq 7.5V$	4.2V	< I_{MIN}	High-Z	Top-off

X = Don't care.

**$I_{FAST\text{-}CHARGE}$ is reduced as necessary to prevent the die temperature from exceeding +115°C.*

used in conjunction with a microprocessor, a pullup resistor to the logic I/O voltage allows $\overline{\text{CHG}}$ to indicate charge status to the microprocessor instead of driving an LED.

Thermal Regulation

The thermal-regulation loop limits the MAX8845Z/MAX8845Y die temperature to +115°C by reducing the charge current as necessary. This feature not only protects the IC from overheating, but also allows a higher charge current without risking damage to the system.

Charger Enable Input

The MAX8845Z/MAX8845Y contain active-low logic input ($\overline{\text{EN}}$) used to enable the chargers. Drive $\overline{\text{EN}}$ low, leave unconnected, or connect to GND to enable the charge-control circuitry. Drive $\overline{\text{EN}}$ high to disable the charger-control circuitry. $\overline{\text{EN}}$ has an internal 200kΩ pulldown resistor.

Soft-Start

The soft-start algorithm activates when entering fast-charge mode. When the prequalification state is complete (V_{BATT} exceeds +2.5V), the charging current ramps up in 250μs to the full charging current. This reduces the inrush current demand on the input supply.

Applications Information

Fast Charge-Current Setting

The maximum charging current is programmed by an external resistor connected from SETI to GND (R_{SETI}). Use the following equation to determine the fast-charge current (I_{FAST_CHARGE}):

$$I_{FAST\_CHARGE} = \frac{1400V}{R_{SETI}}$$

where I_{FAST_CHARGE} is in amps and R_{SETI} is in ohms. R_{SETI} must always be 1.4kΩ or higher due to the continuous charging current limit of $1A_{RMS}$.

Top-Off Current Threshold Setting

The top-off current threshold is programmed by an external resistor connected from MIN to GND (R_{MIN}). Use the following equation to determine the top-off current (I_{MIN}):

$$I_{MIN}\ (\text{falling}) = 148V/R_{MIN}\ (k\Omega) + 22mA$$

$$I_{MIN}\ (\text{rising}) = 295V/R_{MIN}\ (k\Omega) - 24mA$$

where I_{MIN} is in mA and R_{MIN} is in kΩ. Use $R_{MIN} \leq$ 2.2kΩ.

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Capacitor Selection

Connect a ceramic capacitor from BATT to GND for proper stability. Use a 2.2µF ceramic capacitor for most applications. Connect a 1µF ceramic capacitor from IN to GND. A larger input capacitor can be used for high charging current to reduce input voltage ripple.

Connect a 1µF ceramic capacitor from SAFEOUT to GND. A larger bypass capacitor for SAFEOUT can be used for optimum noise immunity. Ceramic capacitors with X5R or X7R dielectric are highly recommended due to their small size, low ESR, and small temperature coefficients.

Thermal Considerations

The MAX8845Z/MAX8845Y are available in thermally enhanced Thin QFN packages with exposed pads. Connect the exposed pad to a large copper ground plane to provide a thermal contact between the device and the circuit board for increased power dissipation. The exposed pad transfers heat away from the device, allowing the IC to charge the battery with maximum current, while minimizing the increase in die temperature.

DC Input Sources

The MAX8845Z/MAX8845Y operate from well-regulated DC sources. The full charging input voltage range is 4.25V to 7.5V. The device can withstand up to 28V on the input without damage to the IC. If V_{IN} is greater than 7.5V, the internal overvoltage-protection circuitry disables charging until the input falls below 7.5V. An appropriate power supply must provide at least 4.25V at the desired peak charging current and stay below 7V when unloaded.

Typical Application Circuits

AC Adapter Application

Figure 3 shows the MAX8845Z as a Li+ battery charger with an AC adapter. The MAX8845Z detects the presence of an input supply and DETBET, resulting in $\overline{\text{POK}}$ pulled low. Once $\overline{\text{POK}}$ is pulled low, the autobooting assistant drives ABO high (MAX8845Z) and enables the power supplies of the system to boot up. The MAX8845Z begins charging the battery when $\overline{\text{EN}}$ is low or unconnected. By monitoring $\overline{\text{CHG}}$, the system can detect the top-off threshold and terminate the charge through $\overline{\text{EN}}$. The MAX8845Z/MAX8845Y also provide an overvoltage-protected SAFEOUT to the system.

Factory System Interface Connector Application

Figure 4 shows the MAX8845Z as an autoboot assistor with the factory system interface connector. The MAX8845Z detects the ABI input even though there is no input voltage available and generates an ABO signal to turn on power supplies to boot up the system. The configuration in Figure 4 is used for system development, testing, and calibrations in production or design stage.

USB-Powered Li-Ion Charger

The universal serial bus (USB) provides a high-speed serial communication port as well as power for the remote device. The MAX8845Z/MAX8845Y can be configured to charge batteries at the highest current possible from the host port. Figure 5 shows the MAX8845Z as a USB battery charger. To make the circuit compatible with either 100mA or 500mA USB ports, the circuit initializes at 100mA charging current. The microprocessor then enumerates the host to determine its current capability. If the host port is capable, the charging current is increased to 450mA to avoid exceeding the 500mA USB specification through GPIO control. The MAX8845Z/MAX8845Y also provide an overvoltage-protected SAFEOUT to the system.

Recommended PCB Layout and Routing

Place all bypass capacitors for IN, BATT, and SAFEOUT as close as possible to the device. Connect the battery to BATT as close as possible to the device to provide accurate battery voltage sensing. Provide a large copper ground plane to allow the exposed pad to sink heat away from the device. Make all high-current traces short and wide to minimize voltage drops. A sample layout is available in the MAX8845Z Evaluation Kit to speed designs.

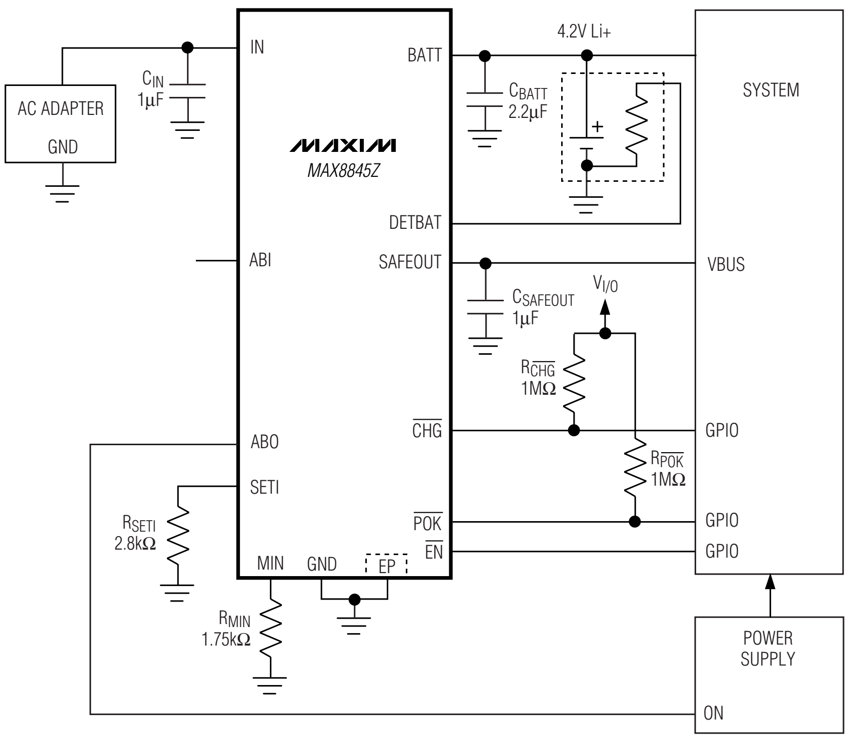

Figure 3. AC Adapter Application

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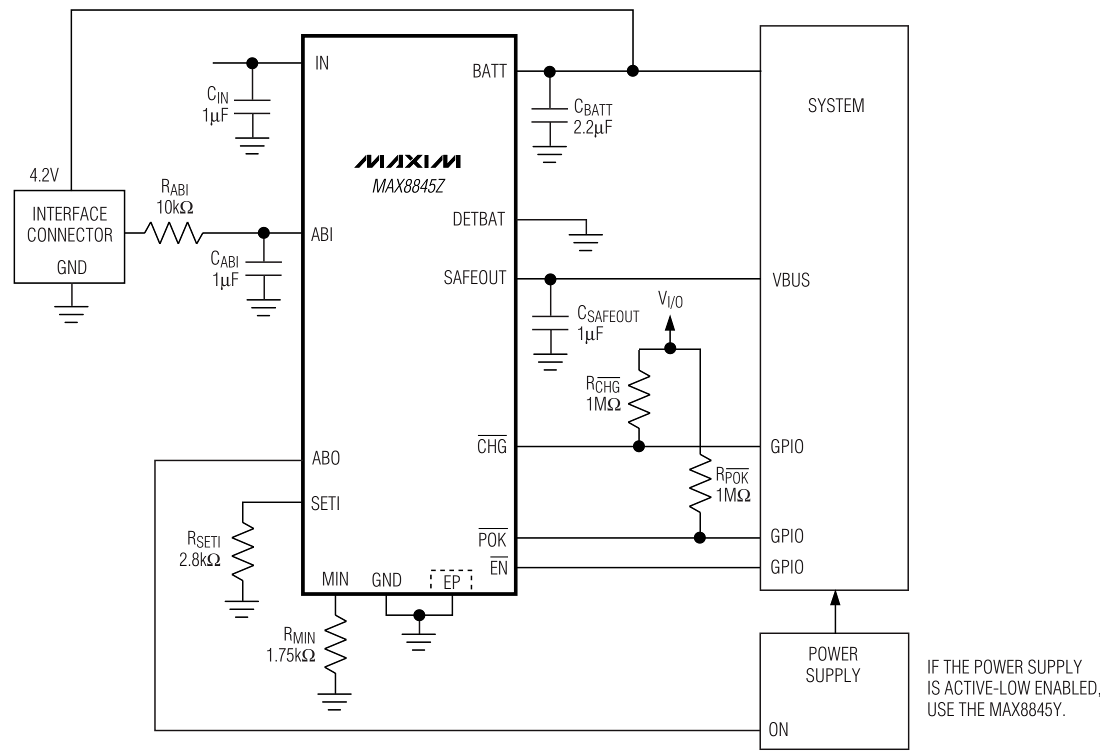

Figure 4. Factory System Interface Connector Application

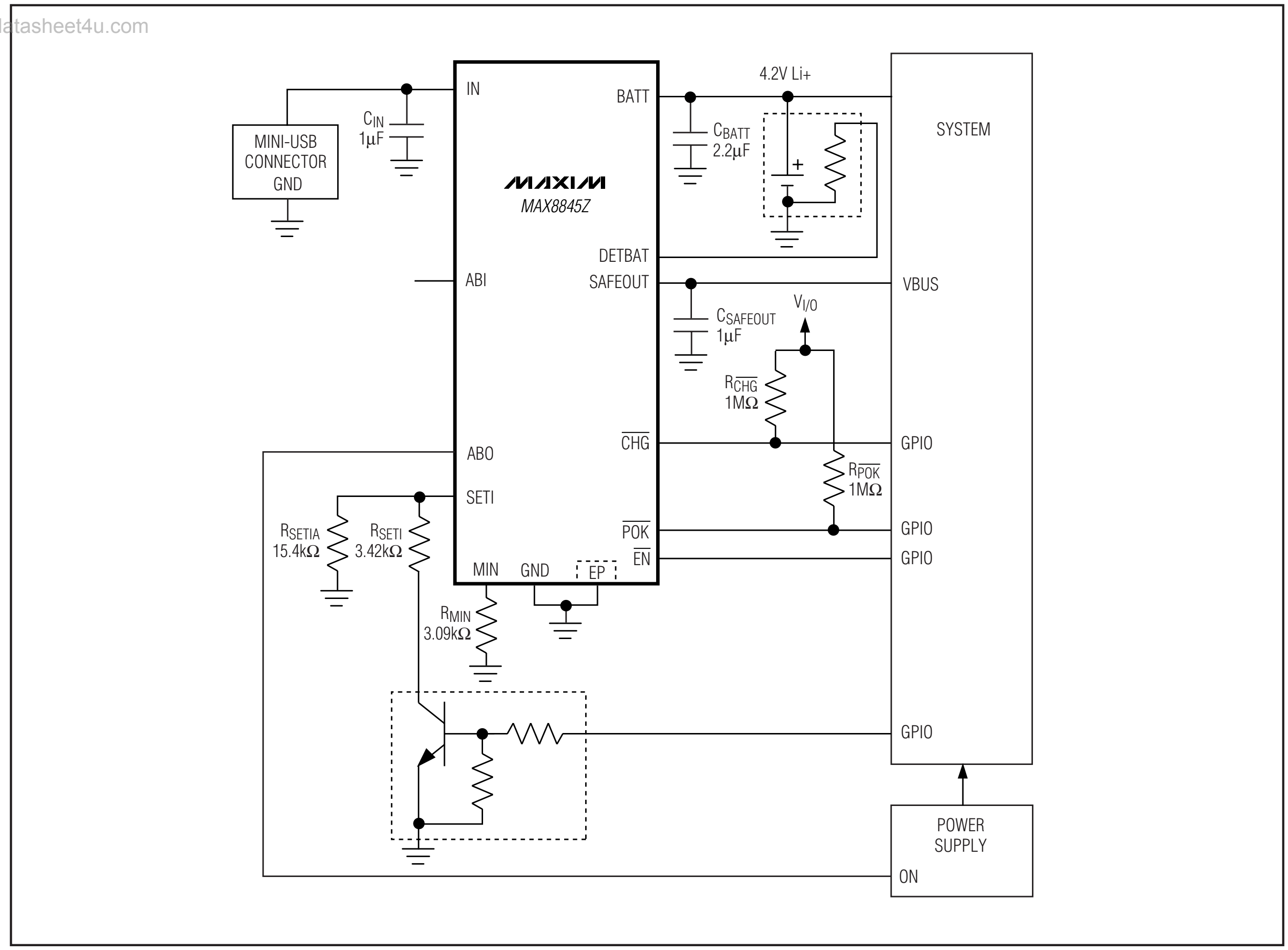

Figure 5. Mini USB Battery Charger

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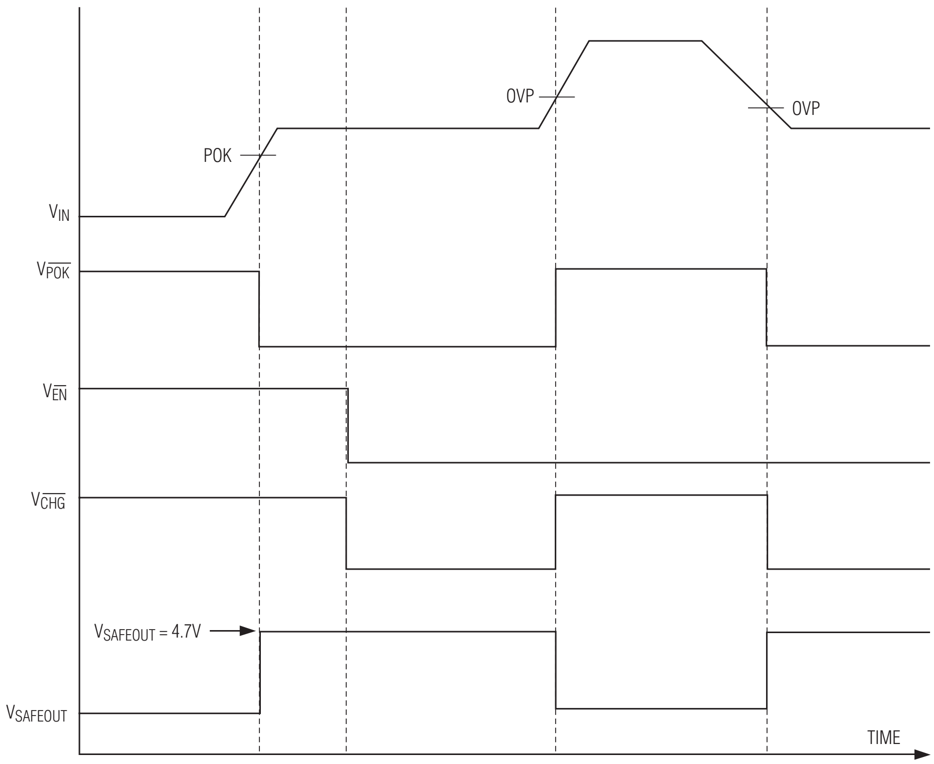
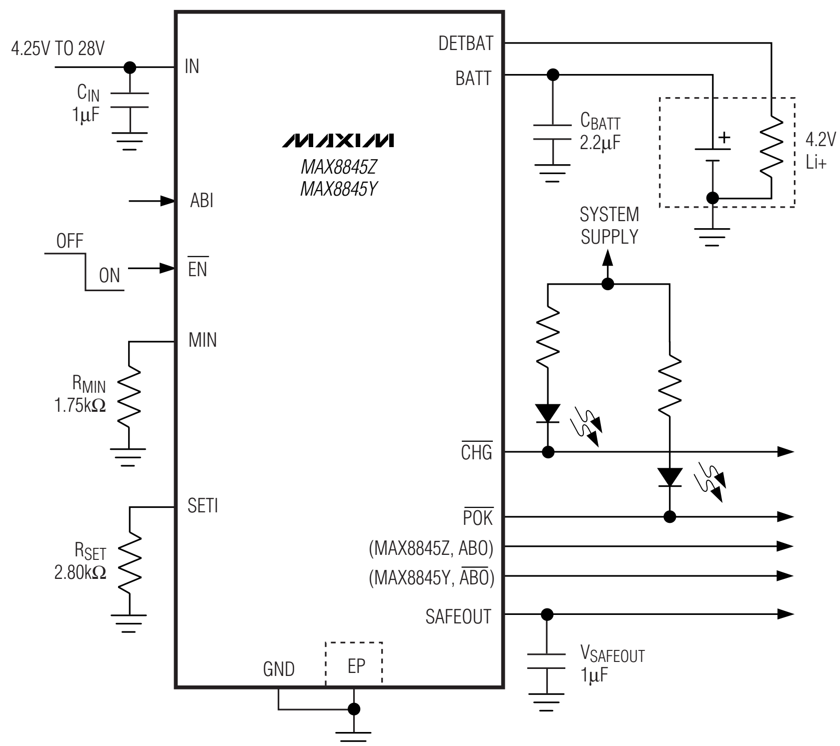


Figure 6. Timing Diagram

Typical Operating Circuit



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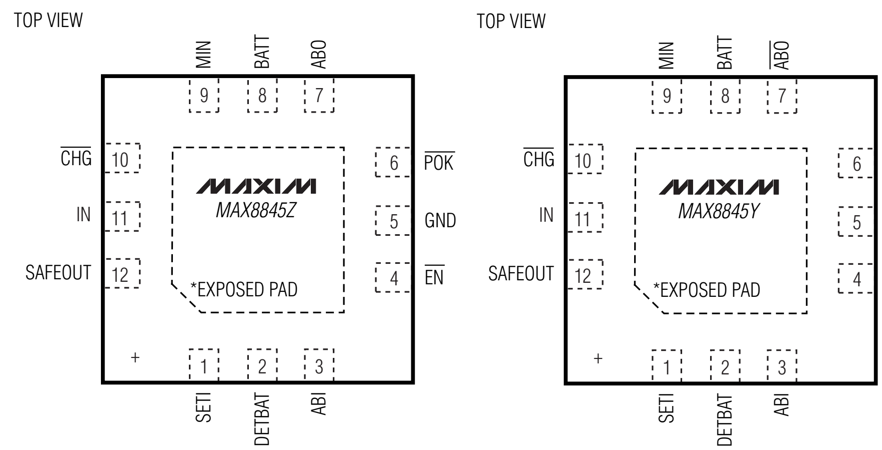
Pin Configurations



Chip Information

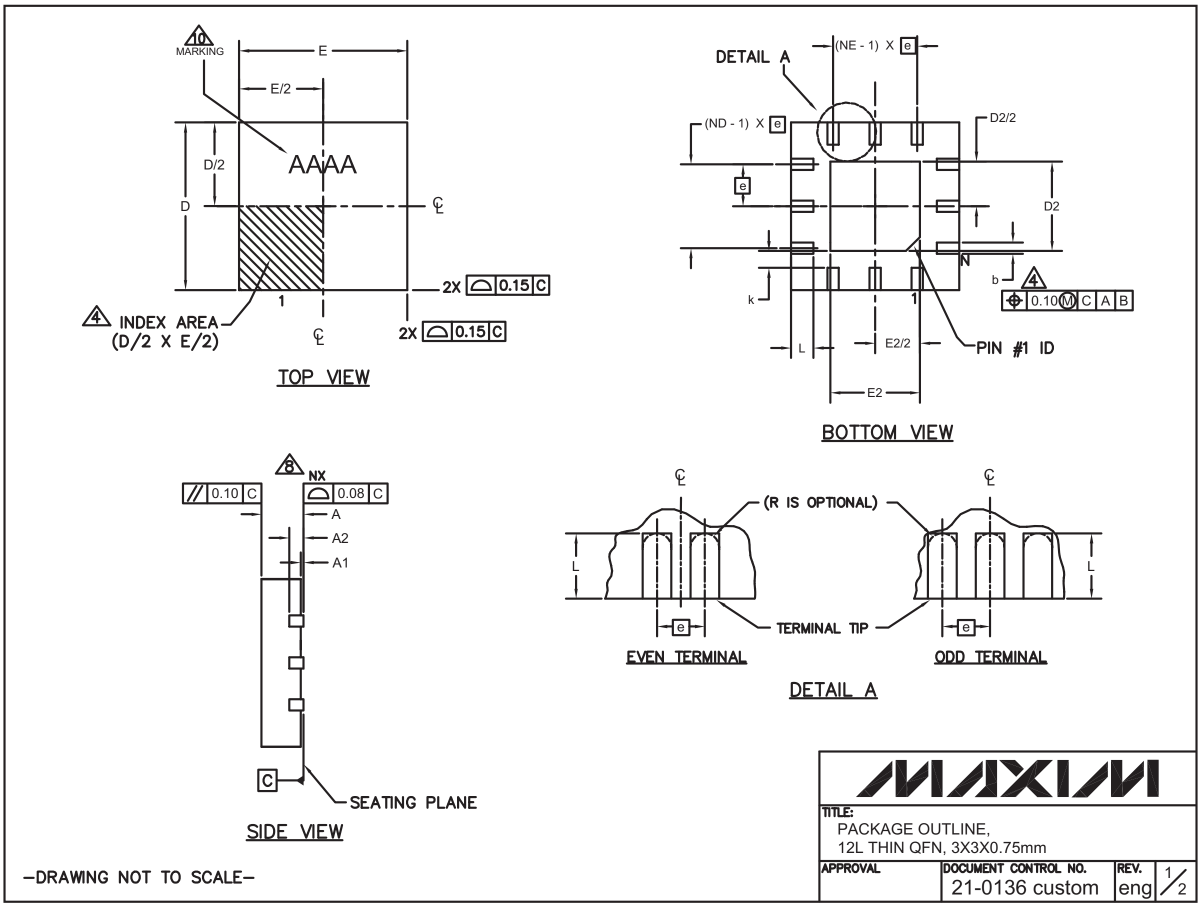
PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
12 Thin QFN-EP (3mm x 3mm)	T1233-4	21-0136

THIN QFN.EPS



28V Linear Li+ Battery Chargers with Battery Detection and Overvoltage Protected Output

Package Information (continued)

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**.

PKG	12L 3x3		
REF.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
b	0.20	0.25	0.30
D	2.90	3.00	3.10
E	2.90	3.00	3.10
e	0.50 BSC.		
L	0.45	0.55	0.65
N	12		
ND	3		
NE	3		
A1	0	0.02	0.05
A2	0.20 REF		
k	0.25	-	-

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2			PIN ID	JEDEC
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.		
T1233-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1
T1233-3	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1
T1233-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.20 mm AND 0.25 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220 REVISION C.
10. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
11. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
12. WARPAGE NOT TO EXCEED 0.10mm.

-DRAWING NOT TO SCALE-

MAXIM

TITLE: PACKAGE OUTLINE, 12L THIN QFN, 3X3X0.75mm

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