

General Description

The MAX14631/MAX14633 are USB charger adapter emulators with automatic host-charger identification circuitry for USB-dedicated chargers.

The devices allow USB wall adapters, travel chargers, and other dedicated chargers to identify themselves as a USB dedicated charger to USB devices, an Apple charger to Apple products, and a Samsung Galaxy dedicated charger port to legacy D+/D- short-detection devices that use the D+ pullup of the USB transceiver.

The devices feature a control input that allows for charger mode selection. The MAX14631 supports both Apple 2A and USB Battery Charger (BC) revision 1.2 specification compliant devices in Autodetection 2A mode, while also supporting Apple 1A and USB BC compliant devices in Autodetection 1A mode. The MAX14633 supports Autodetection 1A mode, as well as Samsung Galaxy Tablet 2A devices in SS 2A mode.

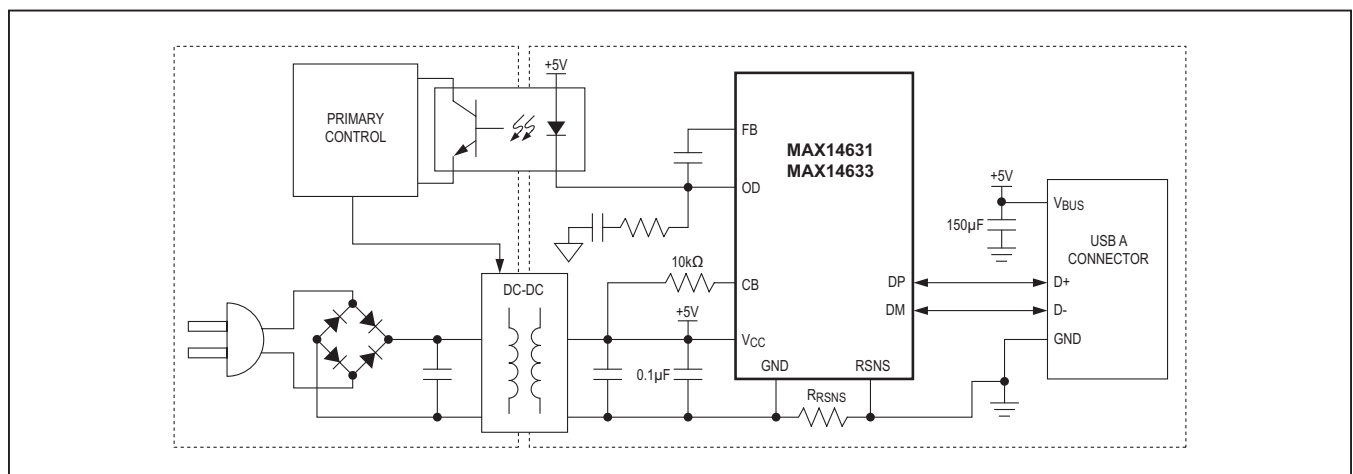
The devices also include an integrated optocoupler driver for secondary feedback, as well as current-limiting capabilities for space-constrained applications.

The devices are available in an 8-pin (2.9mm x 1.62mm) SOT23 package, and are specified over the -40°C to +85°C extended temperature range.

Applications

- USB Wall Chargers and Travel Adapters
- USB Car Chargers and Cigarette Lighter Adapters
- Universal Chargers including iPod®/iPad®/iPhone®

Typical Operating Circuit



iPod, iPad, iPhone are registered trademarks of Apple Inc.

Benefits and Features

- **Optimized for Charging Adapters**
 - Flexible Device and Adapter Connection Order
- **Faster Charging**
 - Apple 2A Charging Capability in Autodetection 2A Mode
 - Samsung Galaxy Tablet 2A Charging Capability (MAX14633)
- **Improved Charger Interoperability**
 - Meets New USB BC Revision 1.2 Specification
 - Backward Compatible with Previous USB BC Revisions
 - Meets China YD/T1591-2009 Charging Specification
- **Greater User Flexibility**
 - Convenient CB Pin Controls the Charging Mode
- **Save Space on Board**
 - 2.9mm x 1.62mm, 8-Pin SOT23 Package
 - High-ESD Human Body Model (HBM) Protection on DP and DM
 - Integrated Optocoupler Driver for Secondary Feedback

Ordering Information appears at end of data sheet.

For related parts and recommended products to use with this part, refer to www.maximintegrated.com/MAX14631.related.

Absolute Maximum Ratings

(All voltages referenced to GND.)

V_{CC} , CB, D+, D-, OD	-0.3V to +6V
FB	-0.3V to ($V_{CC} + 0.3V$)
RSNS	-0.3V to +0.3V
Continuous Current into OD	$\pm 100mA$
Continuous Current into Any Other Terminal	$\pm 50mA$
Continuous Power Dissipation ($T_A = +70^\circ C$)	
SOT23 (derate 5.2mW/ $^\circ C$ above $+70^\circ C$)	412.4mW

Operating Temperature Range	$-40^\circ C$ to $+85^\circ C$
Maximum Junction Temperature	$+150^\circ C$
Storage Temperature Range	$-65^\circ C$ to $+150^\circ C$
Lead Temperature (soldering, 10s)	$+300^\circ C$
Soldering Temperature (reflow)	$+260^\circ C$

Package Thermal Characteristics (Note 1)

SOT23

Junction-to-Ambient Thermal Resistance (θ_{JA}) $194^\circ C/W$

Junction-to-Case Thermal Resistance (θ_{JC}) $70^\circ C/W$

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Electrical Characteristics

($V_{CC} = 3.0V$ to $5.5V$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are at $V_{CC} = +5.0V$, $T_A = +25^\circ C$, unless otherwise noted.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY						
Operating Power-Supply Range	V_{CC}		3		5.5	V
		Apple divider valid range	4.75		5.5	
V_{CC} Supply Current	I_{CC}	$V_{CC} = 5.0V$		75	125	μA
POR				1.5		V
POR Delay	t_{POR}			100		ms
ANALOG SWITCH						
Analog Signal Range	V_{DP} , V_{DM}		0		V_{CC}	V
On-Resistance of DP/DM Short	R_{SHORT}	$V_{DP} = 0.7V$, $I_{DM_SINK} = 100\mu A$ to GND		4.5	11	Ω
OUTPUT SECONDARY FEEDBACK (ERROR AMPLIFIER)						
Regulated OUT Voltage Reference to RSNS		(Note 3)		5		V
Output Accuracy		$R_{RSNS} = 20m\Omega$, $I_{OUT} = 0$ to $2A$ (Note 4)	-3		+3	%
Internal Voltage Reference Accuracy			-2.5		+2.5	%
External Current-Sense Reference Threshold for Current Limit	V_{IL_REF}	$V_{OUT} = 3V$ to $4.75V$	40	50	60	mV
I_{OD} Maximum Current	I_{OD_MAX}	$V_{OUT} = 5.5V$	20	40	60	mA
V_{OD}		$V_{OUT} = 2V$, $V_{RSNS} = 100mV$, $I_{OD} = 10mA$		170	320	mV

Electrical Characteristics (continued)

($V_{CC} = 3.0V$ to $5.5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{CC} = +5.0V$, $T_A = +25^{\circ}C$, unless otherwise noted.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DYNAMIC						
CB Switching Time	t_{ON}	CB = V_{CC} to 0 or 0 to V_{CC}		4		μs
INTERNAL RESISTORS						
DP/DM Short Pulldown	R_{PD}		350	500	700	$k\Omega$
40 V_{CC} Bias			39	40	41	% V_{CC}
54 V_{CC} Bias			52.6	53.6	54.6	% V_{CC}
25 V_{CC} Bias			24	25	26	% V_{CC}
LOGIC INPUT (CB)						
CB Input Logic-High	V_{IH}		1.4			V
CB Input Logic-Low	V_{IL}				0.4	V
CB Input Leakage Current	I_{IN}	$0 \leq V_{IN} \leq V_{IL}$ and $V_{IH} \leq V_{IN} \leq V_{CC}$, $V_{CC} = 5.5V$	-1		+1	μA
ESD PROTECTION						
ESD Protection Level (DP and DM Only)		Human Body Model		± 10		kV
ESD Protection level All Other Pins		Human Body Model		± 2		kV

Comparator Characteristics (Note 5)

($V_{CC} = 4.75V$ to $5.5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{CC} = +5.0V$, $T_A = +25^{\circ}C$, unless otherwise noted.) (Notes 2, 3)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DM1 Comparator Threshold	V_{DM1F}	DM falling	MAX14631: CB = 0	40	41	42	% V_{CC}
			MAX14633: CB = 0				
			MAX14631: CB = 1	31	32	33	
DM1 Comparator Hysteresis					1		%
DM2 Comparator Threshold	V_{DM2F}	DM falling		6.31	7	7.62	% V_{CC}
DM2 Comparator Hysteresis					1		%
DP Comparator Threshold	V_{DPR}	DP rising	MAX14631: CB = 0	45	46	47	% V_{CC}
			MAX14633: CB = 0				
			MAX14631: CB = 1	57	58	59	
DP Comparator Hysteresis					1		%

Note 2: All units are 100% production tested at $T_A = +25^{\circ}C$. Specifications over operating temperature range are guaranteed by design.

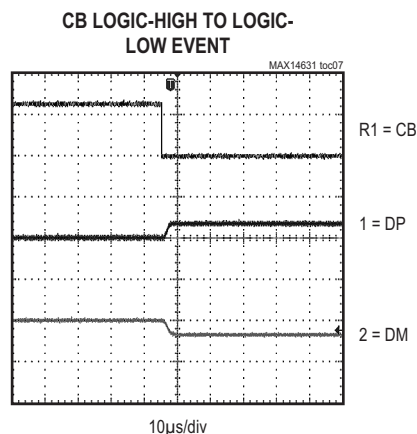
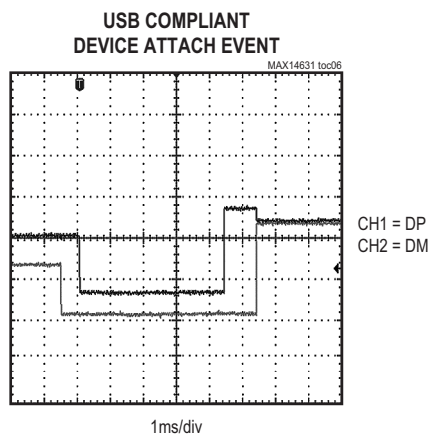
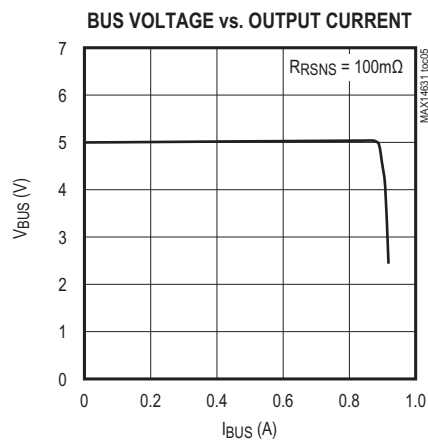
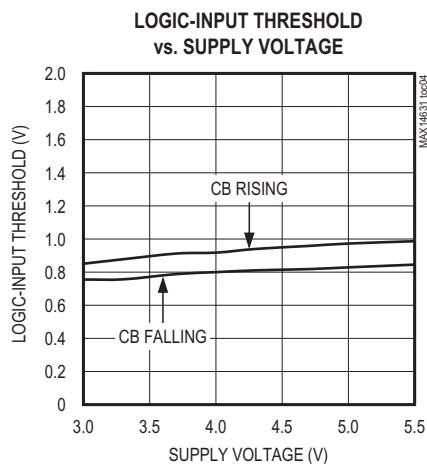
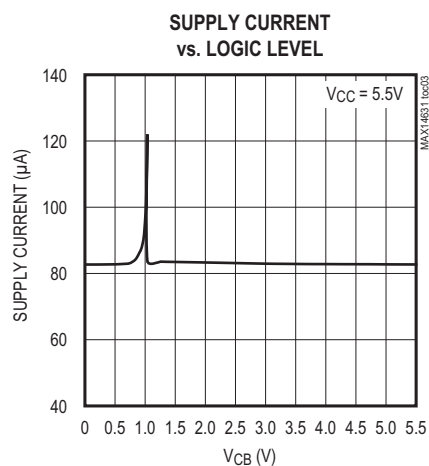
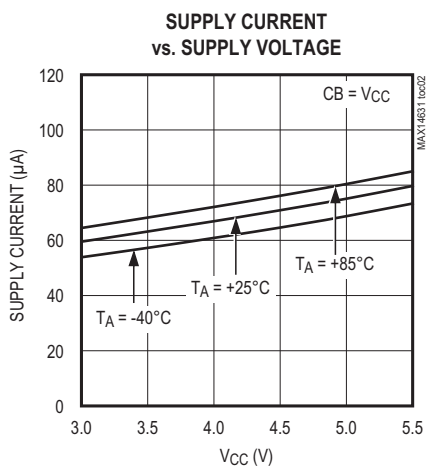
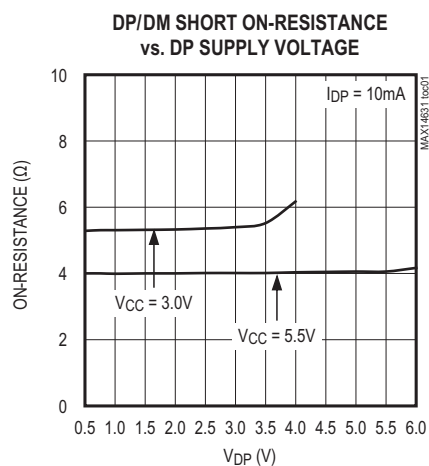
Note 3: V_{CC} is referenced to RSNS.

Note 4: The output accuracy includes internal offset of op amp, as well as the accuracy of the bandgap. This is to be completed by the closed-loop control of the primary switcher.

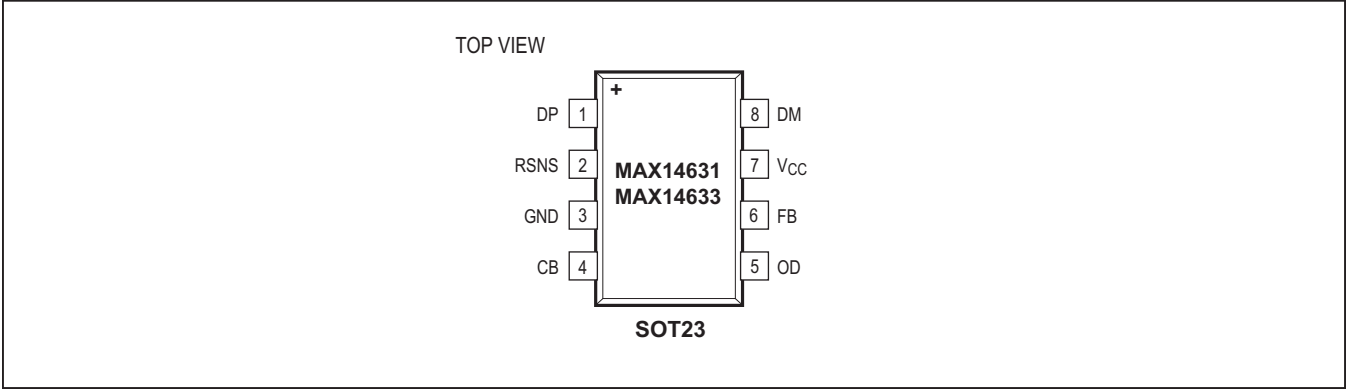
Note 5: The comparators are disabled during the POR delay.

Typical Operating Characteristics

($V_{CC} = +5.0V$, $V_{CB} = 0V$, $T_A = +25^\circ C$, unless otherwise noted.)



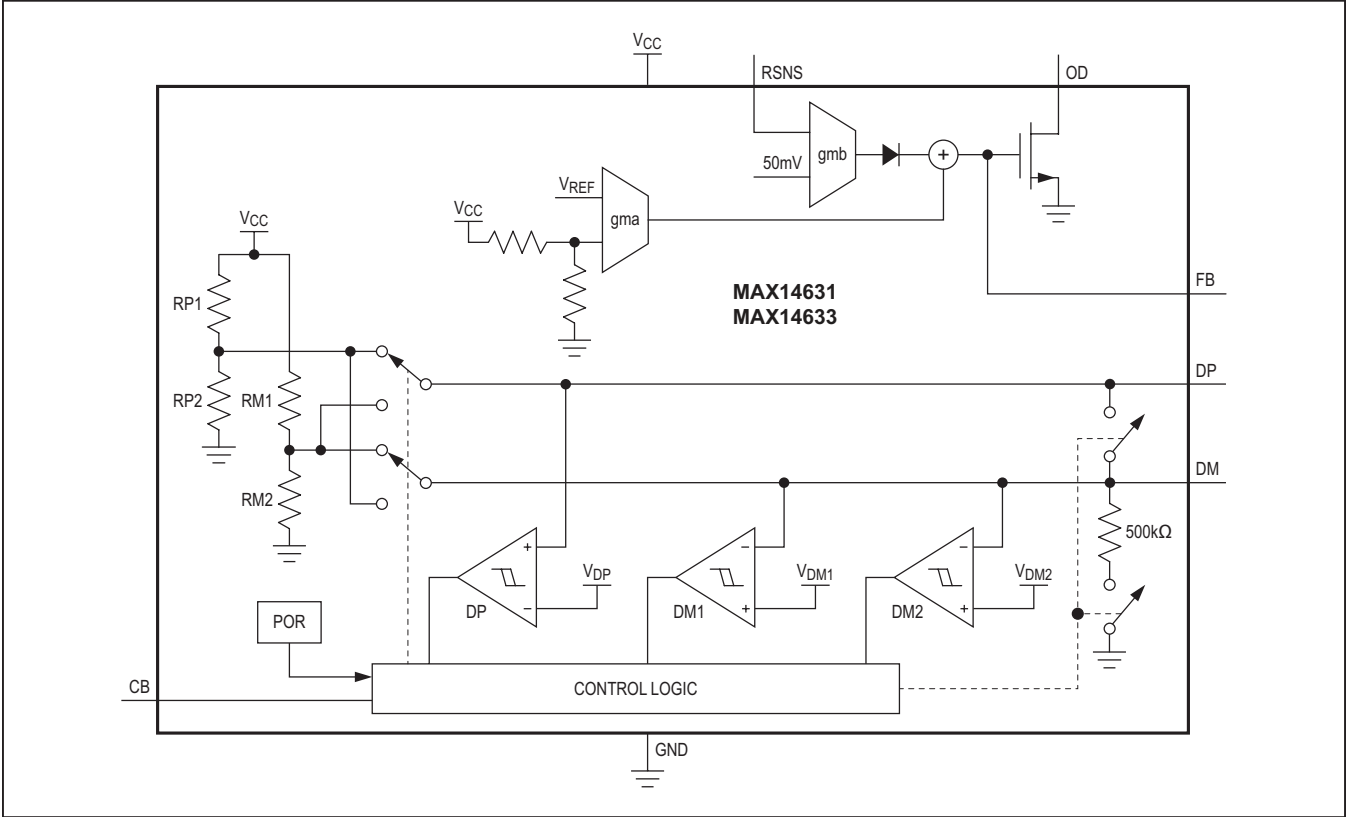
Pin Configuration



Pin Description

PIN	NAME	FUNCTION
1	DP	USB Connector D+ Connection
2	RSNS	Current-Sense Resistor Input; USB Connector Ground
3	GND	IC Ground. Return to the transformer output.
4	CB	Control Bit. See Tables 1 and 2.
5	OD	Optocoupler Driver Output
6	FB	Feedback Control
7	VCC	Power Supply. Bypass VCC with a 0.1μF ceramic capacitor as close as possible to the pin.
8	DM	USB Connector D- Connection

Functional Diagram



Detailed Description

The MAX14631/MAX14633 are USB charger adapter emulators with automatic-host charger identification circuitry for USB-dedicated chargers.

The devices allow USB wall adapters, travel chargers, and other dedicated chargers to identify themselves as a USB-dedicated charger to USB devices, an Apple charger to Apple products, and a Samsung Galaxy dedicated charger port to legacy D+/D- short detection devices that use the D+ pullup of the USB transceiver.

Resistor-Dividers

The MAX14631/MAX14633 feature internal resistor-dividers for biasing data lines to provide support for Apple-compliant devices.

Mode Control

The devices feature a digital input and CB for mode selection. For the MAX14631, connect CB to a logic-level low voltage for autodetection 1A charger mode, or to a logic-level high voltage for autodetection 2A charger mode. See

Table 1. Digital Input State for MAX14631

CB	MODE	STATUS
0	Autodetection 1A	Supports Apple 1A and USB BC Compliant Devices
1	Autodetection 2A	Supports Apple 2A and USB BC Compliant Devices

Table 2. Digital Input State for MAX14633

CB	MODE	STATUS
0	Autodetection 1A	Supports Apple 1A and USB BC Compliant Devices
1	SS 2A	Supports Samsung Galaxy Tablet 2A and USB BC Compliant Devices

Table 1. For the MAX14633, connect CB to a logic-level low voltage for autodetection 1A charger mode. Connect CB to a logic-level high voltage to place the MAX14633 in SS 2A charger mode. See Table 2.

Autodetection

The MAX14631/MAX14633 feature autodetection mode for dedicated chargers. In autodetection charger mode, the device monitors the voltages at DM and DP to determine the type of device attached. With the MAX14631 or MAX14633 in autodetection mode, when the voltage at DM is V_{DM1} or higher, and the voltage at DP is V_{DP} or lower, the voltage remains unchanged. If the voltage at DM is forced below the V_{DM1} threshold, the internal switch disconnects DM and DP from the resistor-divider, and DM and DP are shorted together for dedicated charging mode. Similarly, if the voltage at DP is forced higher than the V_{DP} threshold, the internal switch disconnects DM and DP from the resistor-divider, and DM and DP are shorted together for dedicated charging mode.

Once the charging voltage is removed, the short between DM and DP is disconnected.

Current Limiting

The MAX14631/MAX14633 feature current limiting. The current-sense resistor (R_{RSNS}), connected in the return path of the USB connector between the RSNS pin and ground, sets the current limit. The RSNS input has a typical voltage-trip level (V_{RSNS}) of 50mV. Use the following equation to calculate the value of R_{RSNS} :

$$R_{RSNS} = \frac{V_{RSNS}}{I_{LIM}}$$

where I_{LIM} is the peak current desired. R_{RSNS} values between 20mΩ and 100mΩ are acceptable. If no current sensing is desired, connect the RSNS pin to ground.

Secondary Feedback

The MAX14631/MAX14633 feature an optocoupler driver for secondary feedback in dedicated charger systems. The filtering capacitor, C1, may be necessary to prevent voltage overshoot during initial power-up. A good starting point for C1 is 2.2nF, but adjustments should be made

based on the trade-off between response time and overshoot in a given application. In addition, R1 and C2 can be selected for R-C filtering of the switching noise of the primary PWM converter.

Compensation is highly dependent on the system as a whole. Special care should be taken to ensure stability in each application.

±15kV ESD Protection

As with all Maxim devices, ESD-protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The DP and DM lines have extra protection against static electricity. Maxim's engineers have developed state-of-the-art structures to protect these pins against ESD of ±10kV without damage.

The ESD structures withstand high ESD in normal operation and while the device is powered down. After an ESD event, the MAX14631/MAX14633 keep working without latchup, whereas competing products can latch and must be powered down to remove latchup. ESD protection can be tested in various ways. The DP and DM lines of this product family are characterized for protection to ±10kV using the Human Body Model.

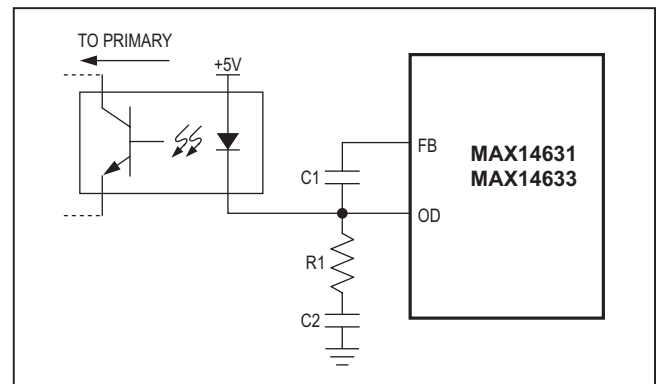


Figure 1. Secondary Feedback Compensation

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX14631EKA+T	-40°C to +85°C	8 SOT23	AESS
MAX14633EKA+T*	-40°C to +85°C	8 SOT23	AEST

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

*Future product—contact factory for availability.

T = Tape and reel.

Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
8 SOT23	K8+2	21-0078	90-0176

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/13	Initial release	—

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

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