

General Description

The MAX30031–MAX30034 are patent-pending protection devices intended to (with the help of external, energy-rated resistors) absorb repetitive defibrillation and other high-energy pulses to protect sensitive electronic circuitry in ECG and other medical/industrial equipment. The devices can withstand over 100,000 defib pulses without failure.

The devices are intended to replace the gas-discharge tubes and transient absorbers in applications where its significant reduction in size is beneficial and its lower, well-defined on-voltage can offer higher degrees of protection to sensitive electronics.

The devices use a combination of a rugged integrated-circuit process and high-speed circuitry to ensure very fast turn-on times with trigger voltages low enough to not require secondary clamping circuitry. A low hold current of approximately 175mA ensures protection is maintained for the entire length of the high-energy transient event.

The MAX30031–MAX30034 are available in a small, 3mm x 5mm μ MAX-8 package and are specified over the 0°C to +70°C temperature range.

Benefits and Features

- Low Leakage Defibrillation Protection IC Helps ECG Systems
- Low Capacitance $\sim 3\text{pF}$
- Low Leakage $\sim 20\text{pA}$ at +70°C
- Fast Turn-On $< 2\text{ns}$
- Low On-Voltage 3.9V (typ)
- High Peak Current in Excess of 4A
- Withstands Over 100k Defibrillation Pulses Without Failure
- 0°C to 70°C Temperature Range
- Small, 3mm X 5mm μ MAX® Package

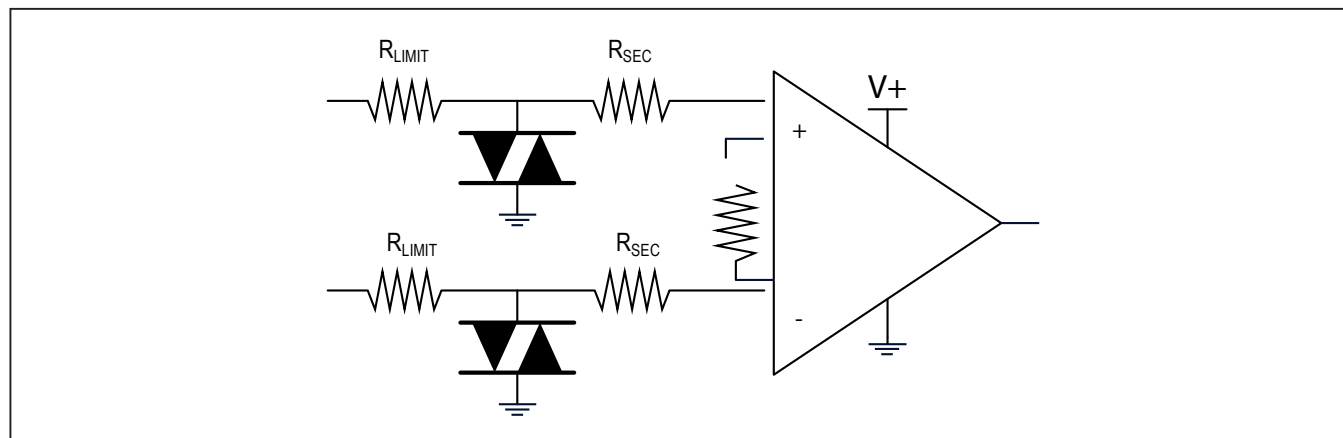
Applications

- AED Units
- Wearable Medical
- Clinical Patient Monitoring
- Industrial Equipment Protection
- Fixed Broadband Wireless Access

Ordering Information appears at end of data sheet.

μ MAX is a registered trademark of Maxim Integrated Products, Inc.

Typical Application Circuit



Absolute Maximum Ratings

Peak Energy per Event 40mJ
Continuous (> 1s) Current into Any Pin $\pm 50\text{mA}$
Junction Temperature $T_{J\text{MAX}}$ 150°C
Continuous Power Dissipation (at $T_A = 70^{\circ}\text{C}$) 953mW

Operating Temperature Range 0°C to 70°C
Storage Temperature Range -40°C to $+150^{\circ}\text{C}$
Reflow Soldering Peak Temperature (Pb-free) 260°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.

Package Thermal Characteristics (Note 1)

μMAX

Junction-to-Ambient Thermal Resistance (θ_{JA}) 206°C/W
Junction-to-Case Thermal Resistance (θ_{JC}) 8°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

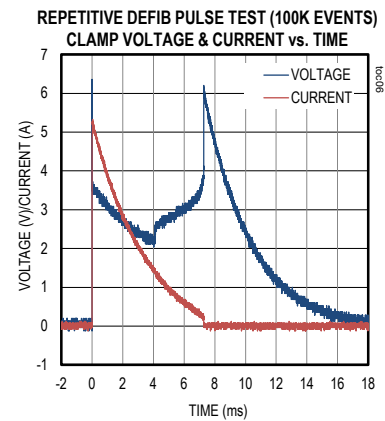
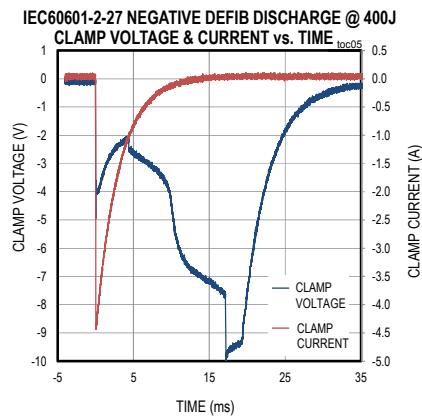
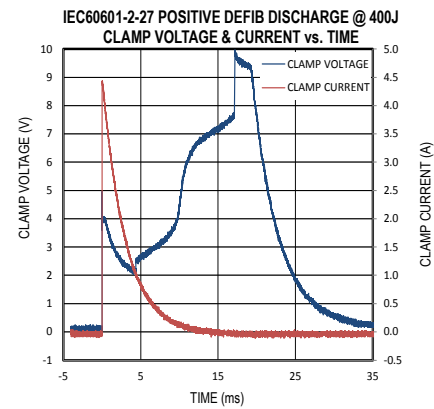
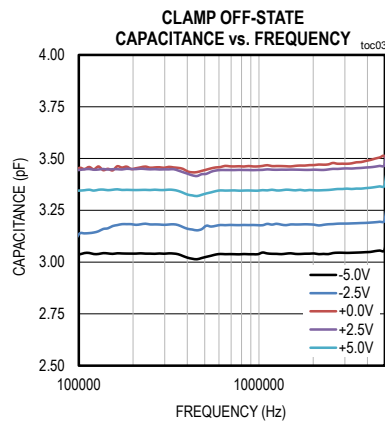
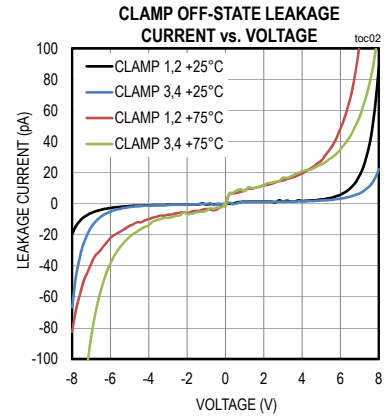
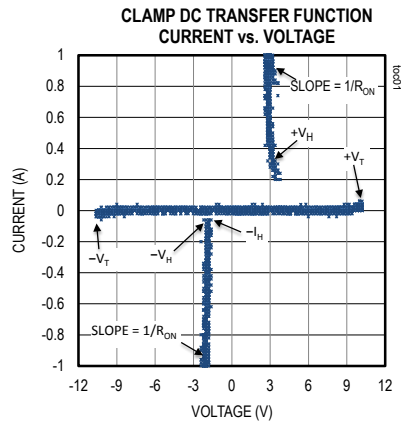
($T_A = T_{\text{MIN}}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25^{\circ}\text{C}$. See VI curve (TOC1) for reference) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
STATIC PERFORMANCE						
Input Off-State Operating Voltage				± 8		V
Input Trigger Voltage	V_T	Either polarity		± 10.3		V
Triggered Slope Resistance	R_{ON}	Slope above the holding current and voltage		0.4		Ω
Holding Current	$+I_H$			+175		mA
	$-I_H$			-70		mA
Holding Voltage	$+V_H$			+3.7		V
	$-V_H$			-1.9		V
On-Voltage		At 1A, low duty-cycle, pulse tested		3.9		V
Input Capacitance		2V applied		2		pF
Input Leakage	I_L	5V applied		0.003	1	nA
DYNAMIC PERFORMANCE						
Immunity Triggering		Either polarity, above this level of input slew rate will trigger the device when below the trigger voltage		1		V/ns
Turn-On Time		Input starts at 3.6V DC, then rises at $2\text{V}/\mu\text{s}$. Turn-on time is from the start of the ramp to the time at which $> 100\text{mA}$ is flowing		2		ns
Release Time		35mA to $< 1\mu\text{A}$		100		μs

Note 2: Limits are 100% tested at $T_A = +25^{\circ}\text{C}$, unless otherwise noted. Limits over the operating temperature range are guaranteed by design and characterization.

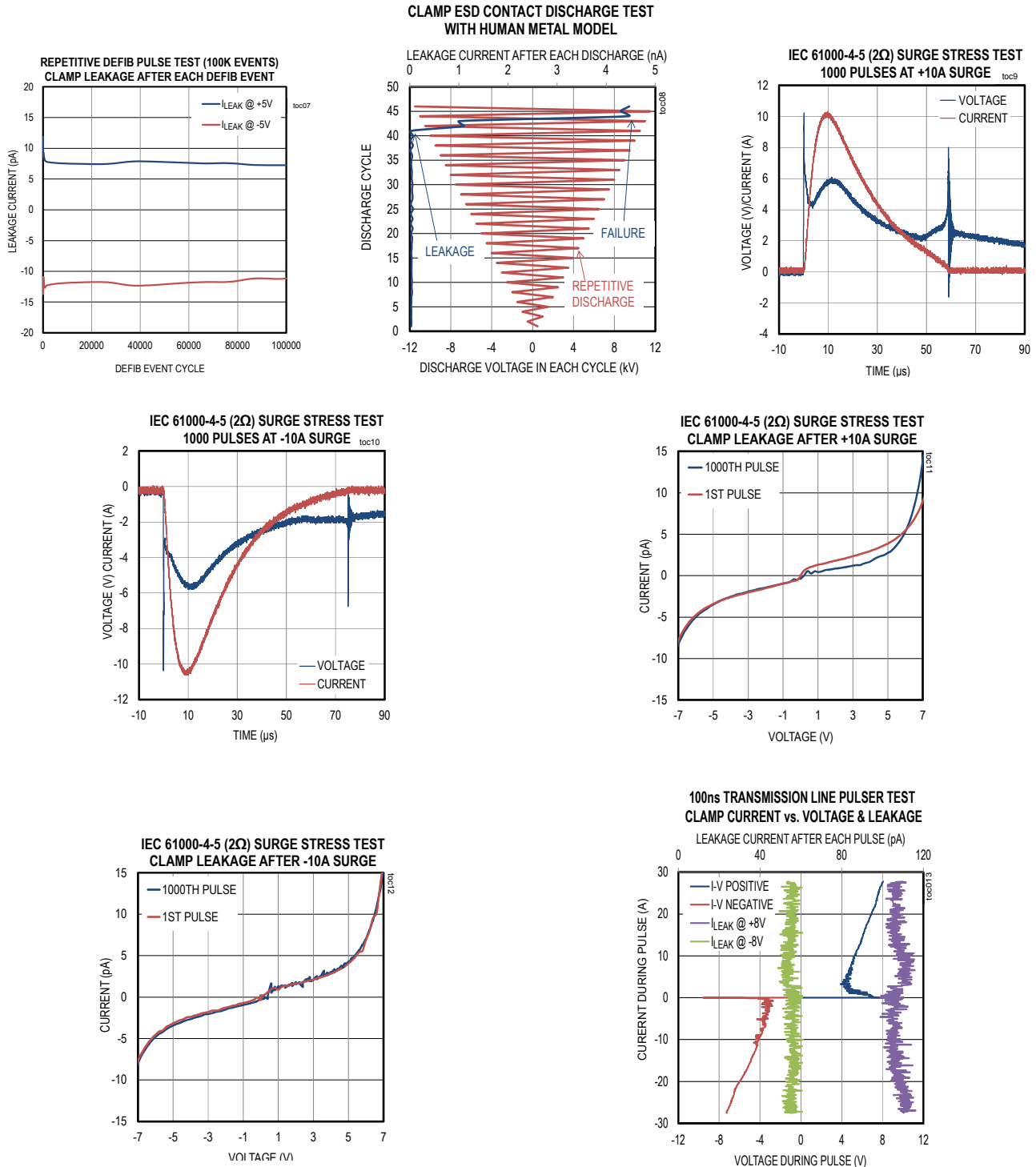
Typical Operating Characteristics

$T_A = +25^\circ\text{C}$, unless otherwise noted.

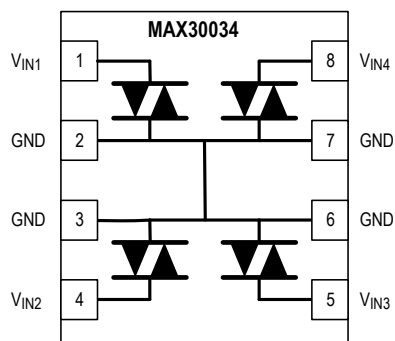
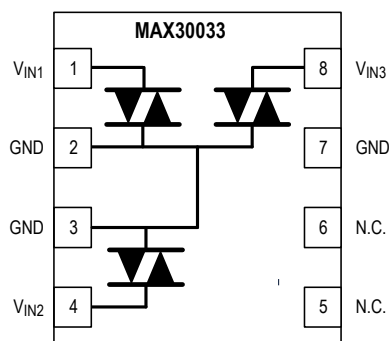
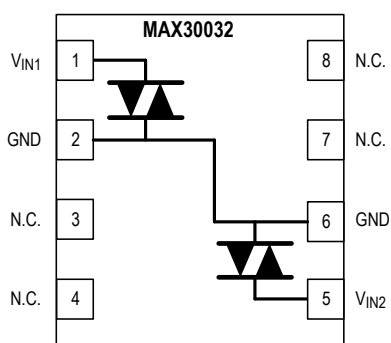
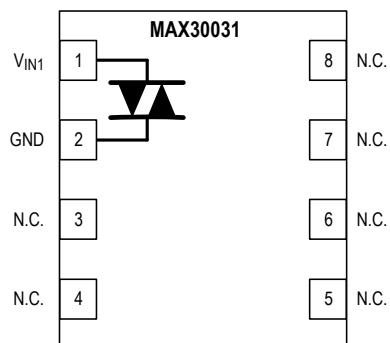


Typical Operating Characteristics (continued)

$T_A = +25^\circ\text{C}$, unless otherwise noted.



Pin Configurations



Pin Descriptions

PIN	NAME	FUNCTION	COMMENTS
MAX30031			
1	V _{IN1}	Clamp input 1	Tie to the input voltage to be clamped
2	GND	Ground	Tie to board GND
3	N.C.		
4	N.C.		
5	N.C.		
6	N.C.		
7	N.C.		
8	N.C.		
EP	GND	Exposed paddle	Tie to board GND
MAX30032			
1	V _{IN1}	Clamp input 1	Tie to the input voltage to be clamped
2	GND	Ground	Tie to board GND
3	N.C.		
4	N.C.		
5	V _{IN2}	Clamp input 2	Tie to the input voltage to be clamped
6	GND	Ground	Tie to board GND
7	N.C.		
8	N.C.		
EP	GND	Exposed paddle	Tie to system GND
MAX30033			
1	V _{IN1}	Clamp input 1	Tie to the input voltage to be clamped
2	GND	Ground	Tie to board GND
3	GND	Ground	Tie to board GND
4	V _{IN2}	Clamp input 2	Tie to the input voltage to be clamped
5	N.C.		
6	N.C.		
7	GND	Ground	Tie to board GND
8	V _{IN3}	Clamp input 3	Tie to the input voltage to be clamped
EP	GND	Exposed paddle	Tie to board GND
MAX30034			
1	V _{IN1}	Clamp input 1	Tie to the input voltage to be clamped
2	GND	Ground	Tie to board GND
3	GND	Ground	Tie to board GND
4	V _{IN2}	Clamp input 2	Tie to the input voltage to be clamped
5	V _{IN3}	Clamp input 3	Tie to the input voltage to be clamped
6	GND	Ground	Tie to board GND
7	GND	Ground	Tie to board GND
8	V _{IN4}	Clamp input 4	Tie to the input voltage to be clamped
EP	GND	Exposed paddle	Tie to board GND

Detailed Description

The MAX3003_ defibrillation pulse protectors are specifically designed to protect the input of ECG and respiration detection circuits from a maximum discharge of 400J with the maximum allowable shunted energy into the ECG protection circuit. These devices operate as bidirectional voltage trigger clamps. When the voltage across the terminals of the device goes above approximately +10.3V or below -10.3V, the impedance across the device drops from well over $10^{10}\Omega$ to less than 1Ω . This drop of impedance across the device conducts sufficient current so as to clamp the voltage across its terminals to protect the input of sensitive electronics. TOC1 illustrates the VI characteristic of the MAX3003_.

The MAX3003_ do not dissipate the majority of the defibrillation pulse energy, rather they clamp the voltage at the input to a low voltage, forcing the majority of the defib energy to be dissipated in an external energy rated resistor, R_{LIMIT} . This external energy-rated resistor should be sized to limit the energy absorbed by the ECG system to within the limits specified by IEC and AAMI requirements.

The voltage across the MAX3003_, when triggered on, is approximately $V_{ON} = 3.5V + I_{CLAMP} \times R_{ON}$, where I_{CLAMP} is the current flowing through the MAX3003_ and will be given by $I_{CLAMP} = V_{APPLIED}/R_{LIMIT}$. R_{ON} is the MAX3003_ on state impedance given in the electrical characteristics table. Thus the current in the MAX3003_, produces a power dissipation in the device of $P_{MAX3003_} = 3.5V \times I_{CLAMP} + R_{ON} \times I_{CLAMP}^2$. The peak energy per defib pulse must be kept below the maximum shown in the absolute maximum ratings.

Before the MAX3003_ go into a clamp state, the voltage can briefly exceed 10.3V (typ). So a secondary protection resistor (R_{SEC}) between the MAX3003_ and the ECG input circuit is recommended. Virtually all modern circuitry have ESD protection at their inputs to clamp the input to an acceptably low voltage. These clamps are generally designed to protect the input against limited ESD and latch-up events. Thus R_{SEC} should be sized to limit the current into the ECG input to levels below the absolute maximum rating of the device and would typically be part of the input filtering network. Generally R_{SEC} would be as low as a few hundred ohms and dissipate very little energy during a defib event. For example, if the instrumentation amplifier supply is 3V, then $R_{SEC} > (10.3V - 3.7V)/I_{MAX}$, where I_{MAX} is the maximum current specified in the instrumentation amplifier data sheet.

MAX3003_ will fall out of the conduction state and return to a low-leakage off-state once the terminal current drops below the hold current, of approximately +175mA or -55mA. When in the off state, the MAX3003_ exhibit extremely low leakage, typically less than 10pA at room temperature as well as low capacitance, typically 3.3pF. Thus the device has little or no impact on the characteristics of the ECG input signal-conditioning network.

In addition to defib protection, the MAX3003_ is an extremely fast device. Thus, it is capable of also serving as an IEC61000-4-2 high ESD protection device, eliminating the need for multiple protection components at the front-end of an ECG system. TOC8 illustrates multiple direct ($R_{LIMIT} = 0\Omega$) HMM ESD hits at various voltages. The HMM ESD model is essentially an IEC61000-4-2 ESD model with a hard GND connection and contact discharge. Thus, it represents a worst-case IEC61000-4-2 scenario. As can be seen from TOC8, the MAX3003_ are able to tolerate a worst case IEC61000-4-2 contact discharge to well over 8kV without damage.

The MAX3003_ are “snap-back” type clamp structures and are specifically designed for applications where the normal circuit impedance is high enough that the minimum hold current cannot be supported, such as ECG defib protection. In such a case the MAX3003_ are guaranteed to turn off when the transient condition is removed and will not remain in a clamp condition causing potential damage.

If the MAX3003_ were to be used in an application where the circuit impedance was low enough to support the minimum hold current, such as a power supply clamping application, then the devices could result in excessively high DC current to flow once triggered by an overdrive condition. In such a situation, the MAX3003_ could be destroyed and could destroy other circuitry in the process.

To ensure that the intended circuit is appropriate for use with the MAX3003_, analyze the target circuit with a short circuit in place of the MAX3003_. If the current in that short circuit is less than the minimum hold current, then the MAX3003_ would work for that application.

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX30031CUA+*	0°C to +70°C	8 μ MAX
MAX30032CUA+*	0°C to +70°C	8 μ MAX
MAX30033CUA+*	0°C to +70°C	8 μ MAX
MAX30034CUA+	0°C to +70°C	8 μ MAX

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

*Future product—contact factory for availability.

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.
TDFN	U8+4	21-0036	90-0092

Chip Information

PROCESS: CMOS

MAX30031/MAX30032/
MAX30033/MAX30034

Defibrillation/Surge/ESD Protector

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/16	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.

Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.