

MAX24011

2.5Gbps Transimpedance Amplifier

General Description

The MAX24011 is a low-power and high-sensitivity 2.5Gbps continuous mode transimpedance amplifier (TIA) optimized for GPON fiber optic applications.

The MAX24011 implements a complete analog front-end, converting the photo-detector current to a differential analog voltage signal.

The MAX24011 has a low-noise front-end, an AGC and typical differential transimpedance of 23k Ω . The MAX24011 also provides a filtered bias current to the photo detector cathode for internally biased PIN applications and a received signal strength indicator (RSSI) output. The RSSI is either derived from the current supplied by the PDC regulator, or represents the average current into the PDA pin for use with externally biased photodetectors, such as an APD.

The MAX24011 is available in die form for mounting on a header to create a ROSA when combined with suitable optics and photo-detector diode.

Applications

- GPON, ONU Receivers
- OC-48 Transceiver Modules

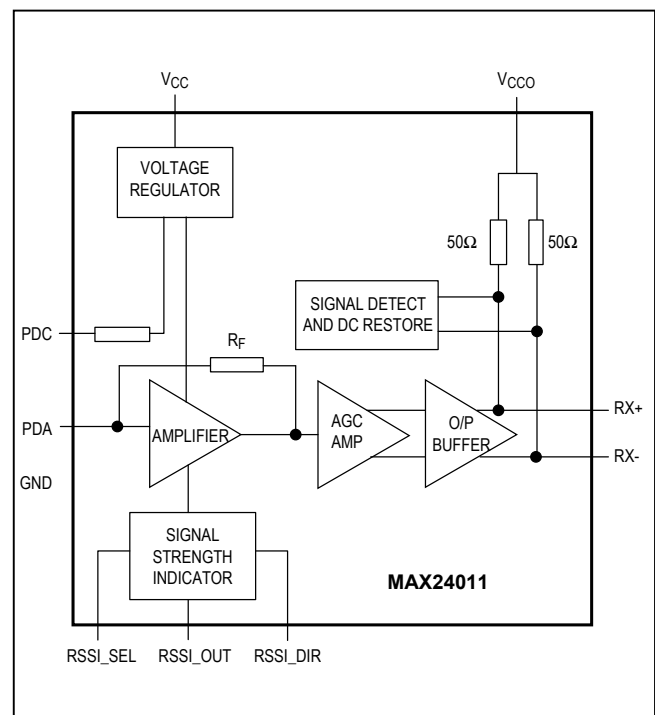
For related parts and recommended products to use with this part, refer to www.maximintegrated.com/MAX24011.related.

Ordering Information appears at end of data sheet.

Benefits and Features

- -33dBm (typ) Sensitivity With APD
- Up to 2.5Gbps (NRZ) Data Rates
- 190nA_{RMS} (typ) Input-Referred Noise
- Automatic Gain Control of Overload
- 31mA (typ) Current Consumption
- Received Signal Strength Indicator Output from PDA or PDC
- -40°C to +95°C Operating Temperature Range

Functional Diagram



Absolute Maximum Ratings

Voltage Range on V _{CC}	-0.3V to +4.0V	Operating Temperature Range.....	-40°C to +95°C
Voltage Range on Any Pad Not Otherwise Specified (with respect to GND).....	-0.3V to (GND x +0.3V)	Junction Temperature.....	-55°C to +150°C
Maximum PDA Input Current V _{CC}	4mA Operating	Storage Temperature Range.....	-55°C to +150°C
Maximum PDA Input Current	4mA	Die Attach Temperature (soldering, 10s).....	+400°C
		Soldering Temperature (reflow).....	+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.

RECOMMENDED DC OPERATING CONDITIONS

(V_{CC} = 2.97V to +3.63V, T_A = -40°C to +95°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage	V _{CC}		2.97	3.3	3.63	V
Operating Temperature			-40		+95	°C
Supply Current		V _{CC} = 3.3V, output open circuit		31		mA

RECEIVER CHARACTERISTICS

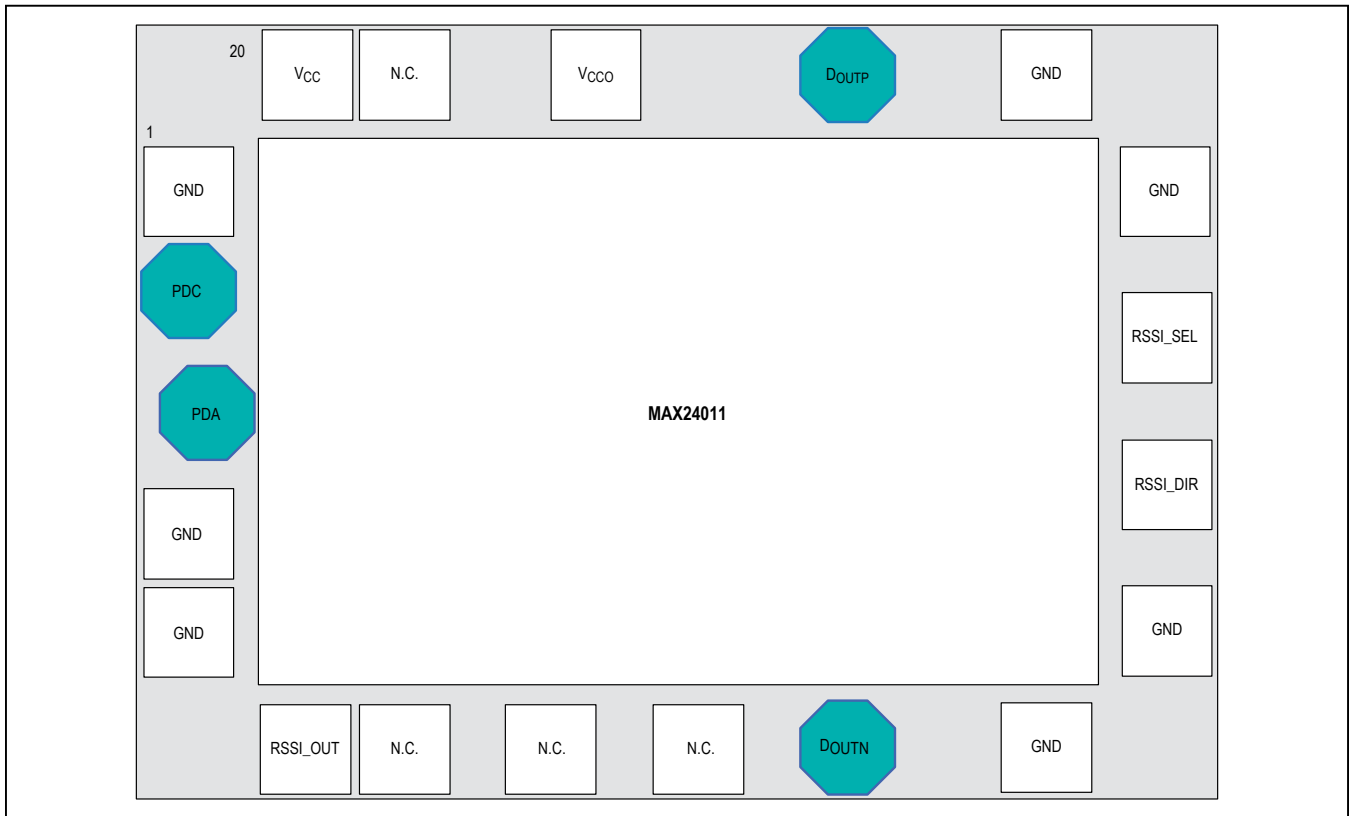
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Power-Supply Rejection Ratio		(V _{DP} - V _{DN})/ΔV _{CC} , 50kHz to 4MHz; no V _{CC} decoupling		15		dB
Input Bias Voltage		PDA voltage		0.85		V
Minimum Photodiode Cathode Bias		PDC voltage		2.5		V
Transimpedance		At 100MHz, input current < 9μA _{P-P}	15	23	32.5	kΩ
Output Resistance		Differential	80	100	120	Ω
-3dB Bandwidth		Input current 2μA _{P-P} , 100Ω differential output load, APD capacitance 0.35pF		1.8		GHz
Input-Referred Noise		Measured into 1.866GHz, 4th order Bessel-Thomson (BT) filter, APD capacitance 0.35pF		190		nA _{RMS}
Input Overload AC		DJ < 220 mUI _{P-P} specification		3.2		mA _{P-P}
Deterministic Jitter		PRBS 15 < 2.5mA _{P-P}		100	200	mUI _{P-P}
Differential Output Swing		Input current 18μA _{P-P} to 3.6mA _{P-P} , overload	200		320	mV _{P-P}

RECEIVER CHARACTERISTICS (continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Low-Frequency -3dB Cutoff		DC-coupled		5	30	kHz
Gain Flatness		100MHz to 1250MHz; flatness referred to 100MHz; input current $\leq 500\mu\text{A}_{\text{P-P}}$		± 2		dB
RSSI Accuracy		DC input current 5 μA to 1.27mA (after single-point calibration)		± 20		%
RSSI Gain				1		mA/mA
Maximum RSSI Compliance Voltage		RSSI sourcing current (RSSI_DIR open circuit)		$V_{\text{CC}} - 0.3$		V
Minimum RSSI Compliance Voltage		RSSI sinking current (RSSI_DIR connected to GND)		GND + 0.45		V

Note 1: Electrical specifications are production tested at $T_A = +25^\circ\text{C}$. Specifications over the entire operating temperature range are guaranteed by design and characterization. Typical specifications are at $T_A = +25^\circ\text{C}$, 3.3V.

Pad Configuration



Pad Description

PIN	NAME	DIR	TYPE	FUNCTION
1, 4, 5, 11, 12, 15, 16	GND	Power	Ground	Connect to ground
2	PDC	O/P	Analog	Supplies bias voltage to internally biased PIN photodiode cathode
3	PDA	I/P	Analog	Amplifier input which accepts input current from photodiode anode
6	RSSI_OUT	O/P	Analog	Outputs a current proportional to mean photodiode input current. Sources current when RSSI_DIR is unconnected.
7	N.C.	I/P	Analog	No connection. Do not connect.
8, 9, 19	N.C.	—	—	No connection. Do not connect.
10	DOUTN	O/P	Analog	Negative CML Output. Positive current into PDA causes voltage to fall on DOUTN pad.

Pad Description (continued)

PIN	NAME	DIR	TYPE	FUNCTION
13	RSSI_DIR	I/P	Analog	Selects RSSI_OUT pad to source current when unconnected and sink current when connected to ground.
14	RSSI_SEL	I/P	Analog	Connecting this pad to ground causes the RSSI current to be measured from the photodiode cathode and the PDC regulator to be enabled. This option can only be used when the PDC pad is connected to the photodiode cathode.
17	D_OUTP	O/P	Analog	Positive CML output. Positive current into PDA causes voltage to rise on D_OUTP pad
18	V _{CCO}	Power	Supply	Connect to power supply
20	V _{CC}	Power	Supply	Connect to power supply

Detailed Description

Photodiode Connection

A PIN photodiode should be connected to the MAX24011 as shown in Figure 1, using the internal voltage reference to bias the photodiode.

The voltage across the photodiode is equal to V_{PDC} minus the base emitter voltage of the input transistor on the MAX24011, equal to V_{PDA} . The anode voltage, V_{PDA} is sensitive to temperature and has a typical value of 0.85V. To enable the internal regulator, pad 14 (RSSI_SEL) needs to be bonded to ground.

External connection of a PIN photodiode cathode to an external power supply can produce inconsistent sensitivity and bandwidth operation.

If an avalanche photodiode is to be used this is connected as shown in Figure 2, filtering of the bias voltage must be provided externally to the MAX24011 to avoid damaging the device. Decoupling of the supply must also be provided in the optical assembly or host board. The

input current applied to the PDA pad with V_{CC} off ($< 3.0V$) must not exceed the value given in the maximum ratings, if exceeded damage may occur to the PDA input circuitry.

Decoupling

For optimum sensitivity performance decoupling of power-supply noise must be provided on the supply to the MAX24011 either in the optics assembly or on the main board that supplies power to the optics. Further decoupling and appropriate layout of the RSSI support on the host board is also recommended to minimize noise injection into the receive optical assembly.

Transimpedance Amplifier (TIA)

The transimpedance (current to voltage) stage is a very low noise amplifier with a feedback resistor to set the gain. This ensures that the output does not overload the subsequent stage in the signal path.

An internal voltage regulator is used to power the front-end transimpedance amplifier to improve the rejection of power-supply noise.

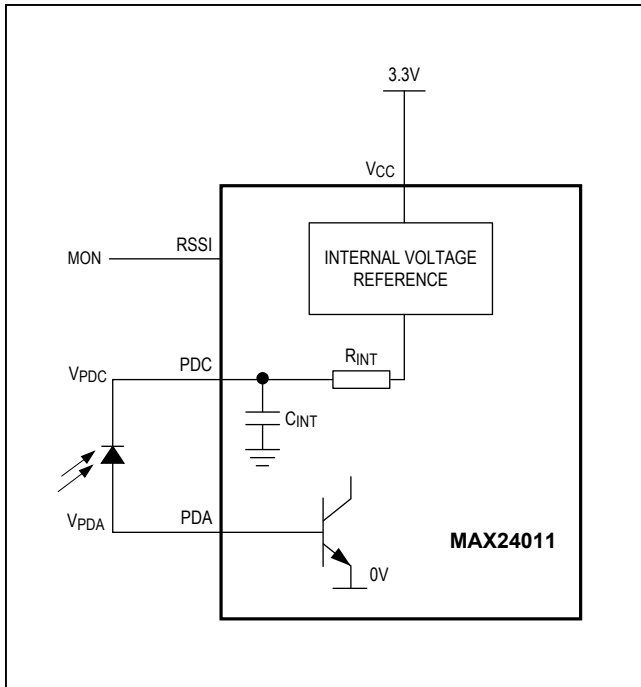


Figure 1. Photodiode Biased by Internal Voltage Regulator

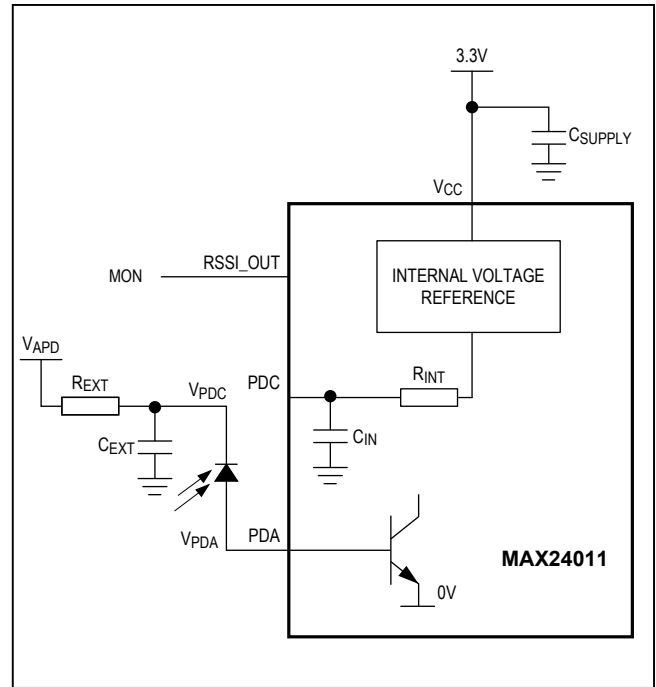


Figure 2. Connection of an Avalanche Photodiode

Output Gain Stage

The output gain stage features a voltage amplifier, a single ended to differential converter and a supply-referenced differential output buffer.

The MAX24011 has a 50Ω single-ended output impedance, which is suitable for the majority of applications. For optimum supply-noise rejection, the MAX24011 should be terminated differentially.

Received Signal Strength Indication (RSSI)

The MAX24011 provides a RSSI output, which measures the strength of the received optical signal. The photodiode current is proportional to the received optical power. The MAX24011 generates an output current that is a copy of the photodiode current. This is configured for internal or external biased photodiodes using RSSI_SEL. The RSSI output is a current sink or a current source.

The direction of current flow is selected by using the RSSI_DIR bond. Leaving this bond pad unconnected selects a current source, connecting this bond pad to ground selects a current sink.

Application Diagrams

The MAX24011 can be bonded in 5-pin (no RSSI) or 6-pin (with RSSI) headers using an externally biased APD. Alternatively, it can be bonded in 4-pin (no RSSI) or 5-pin (with RSSI) headers using an internally biased PIN photodiode.

Keep the DoutP bondwire as orthogonal as possible to VCC power bondwires to reduce coupling. The capacitor C2 is needed for decoupling of the APD voltage and should be appropriately rated for maximum VAPD.

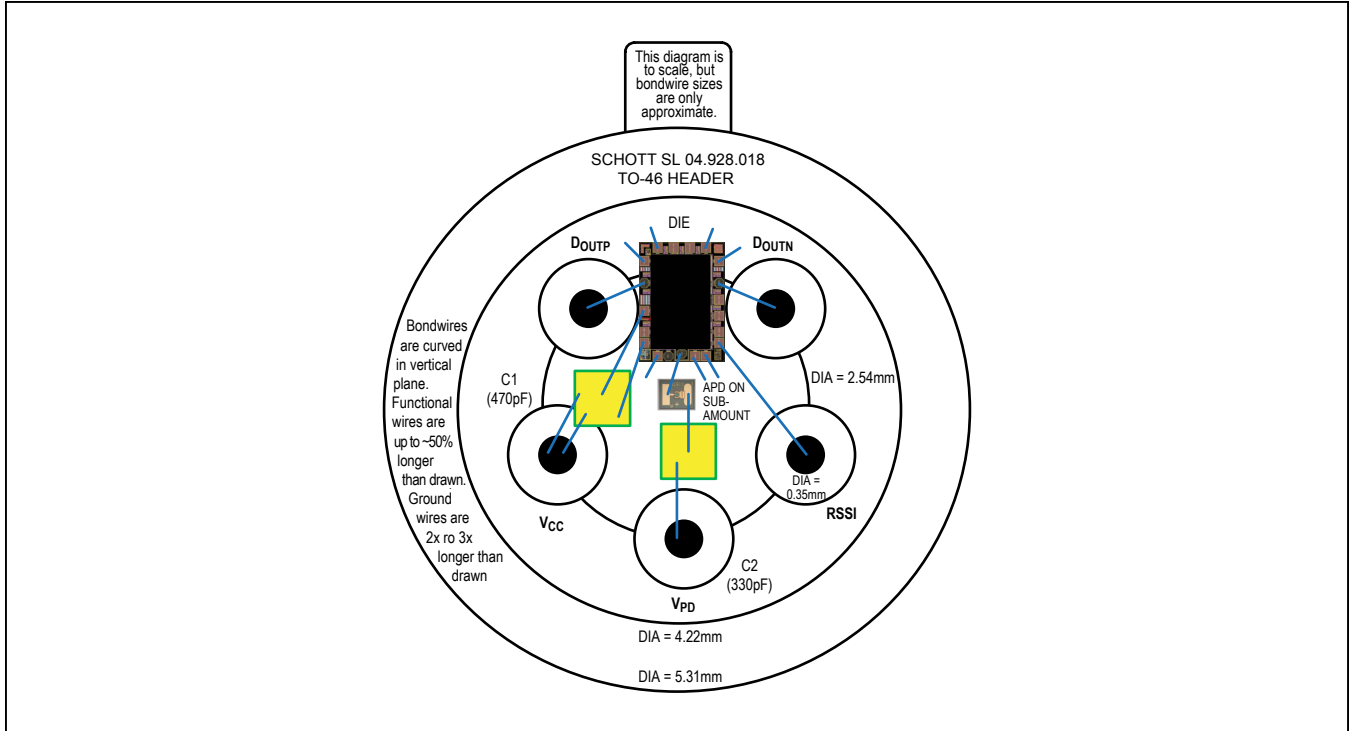


Figure 3. Externally Biased APD Mounted on a 6-Pin TO-Can Header with RSSI Output

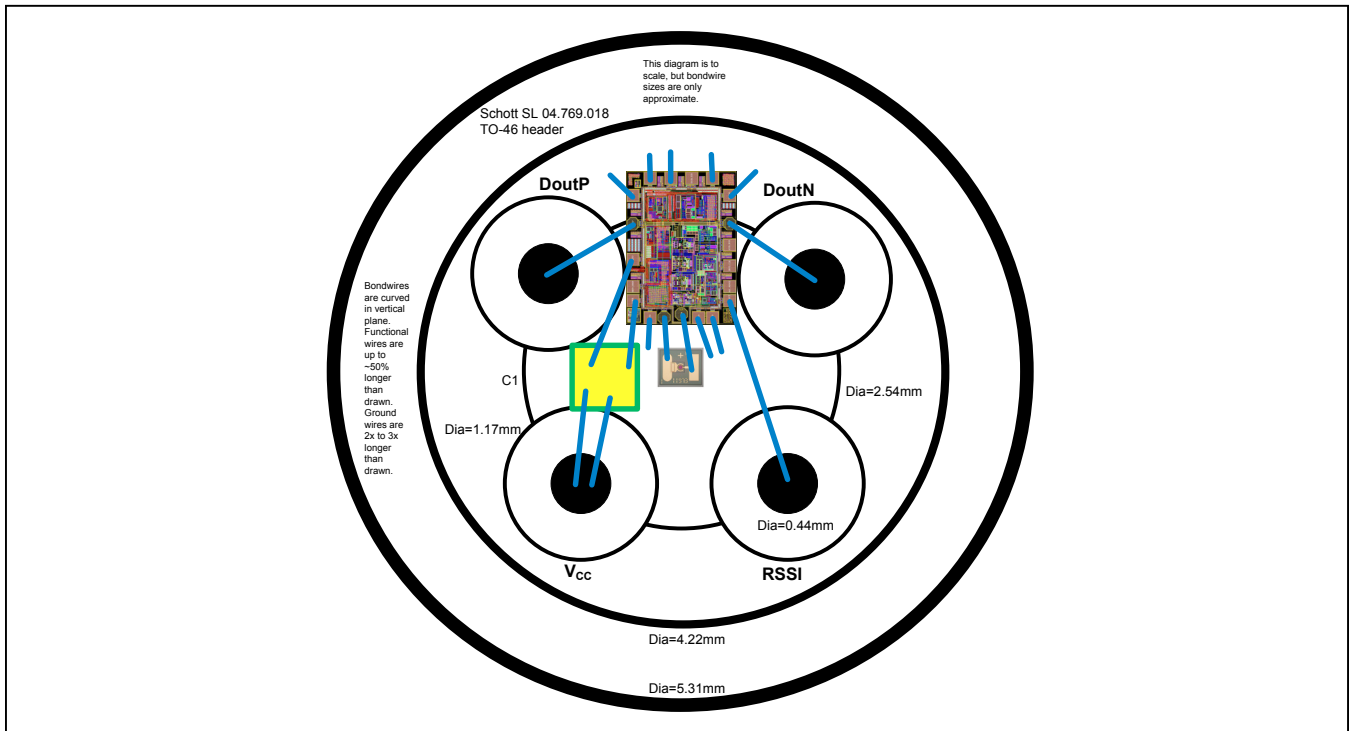


Figure 4. Internally Biased PIN Photodiode Mounted on a 5-Pin TO-Can Header with RSSI Output

Pad Position and Sizes

Typical sawn die size (chip extent): 1211 um x 901 um

NUMBER	NAME	PAD CENTERS	
		X	Y
1	GND	45	603
2	PDC	45	505
3	PDA	70	384
4	GND	45	263
5	GND	45	165
6	RSSI_OUT	165	45
7	N.C.	263	45
8	N.C.	409	45
9	N.C.	555	45
10	D _{OUT} N	705	45
11	GND	903	45
12	GND	1023	165
13	RSSI_DIR	1023	311
14	RSSI_SEL	1023	457
15	GND	1023	603
16	GND	903	723
17	D _{OUT} P	705	723
18	V _{CC}	454	723
19	N.C.	263	723
20	V _{CC}	165	723

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX24011E/D+	-40°C to +95°C	Dice

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

Chip Information

PROCESS: BiCMOS

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/13	Initial release	—
1	9/13	Revised Figure 4	7
2	5/14	Made corrections in <i>Electrical Characteristics</i>	2, 3

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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