Programmable Voltage Detectors

General Description

Maxim's MAX8211 and 8212 are CMOS micropower voltage detectors. Each contains a comparator, a 1.15V bandgap reference, and an open drain N-channel output driver. Two external resistors are used in conjunction with the internal reference to set the trip voltage to the desired level. A Hysteresis output is also included, allowing the user to apply positive feedback for noise-free output switching.

The MAX8211 provides a 7mA current-limited output sink whenever the voltage applied to the Threshold pin is less than the 1.15V internal reference. In the MAX8212, a voltage greater than 1.15V at the Threshold pin turns the output stage on (no current limit).

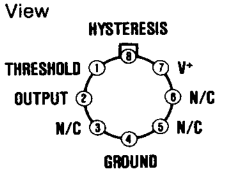
The MAX8211/8212 are plug-in replacements for the bipolar ICL8211/8212 in applications where the maximum supply voltage is less than 16.5V. They offer several performance advantages, including reduced supply current, a more tightly controlled bandgap reference, and more available current from the Hysteresis output.

Applications

Under Voltage Detection
Over Voltage Detection
Battery Backup Switching
Power Supply Fault Monitoring
Low Battery Detection

Pin Configuration

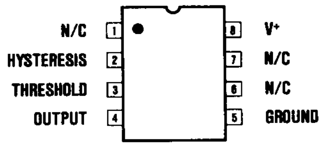
Top View



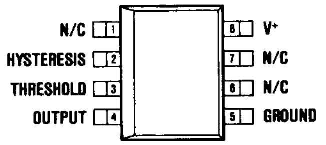
— Case is connected to pin 4 on TV package.

— Case is connected to pin 7 on TY package.

8 Lead TO-99 Metal Can



DIP



8 Lead Small Outline

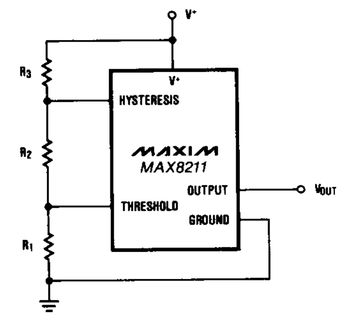
Features

- ♦ Improved 2nd Source for ICL8211/8212
- ♦ Low Power CMOS Design
- ♦ 5μA Quiescent Current
- ♦ Onboard Hysteresis Outputs
- ♦ ±40mV Threshold Accuracy (±3.5%)
- ♦ 2.0V to 16.5V Supply Voltage Range
- ♦ Defined Output Current Limit—MAX8211
- ♦ High Output Current Capability—MAX8212

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX8211CPA	0°C to +70°C	8 lead Plastic DIP
MAX8211EPA	-40°C to +85°C	8 lead Plastic DIP
MAX8211EJA	-40°C to +85°C	8 lead CERDIP
MAX8211MJA	-55°C to +125°C	8 lead CERDIP
MAX8211CSA	0°C to +70°C	8 lead Small Outline
MAX8211CTY	0°C to +70°C	8 lead TO-99 Metal Can
MAX8211ETY	-40°C to +85°C	8 lead TO-99 Metal Can
MAX8211MTV	-55°C to +125°C	8 lead TO-99 Metal Can
MAX8211C/D	0°C to +70°C	Dice
MAX8212CPA	0°C to +70°C	8 lead Plastic DIP
MAX8212EPA	-40°C to +85°C	8 lead Plastic DIP
MAX8212EJA	-40°C to +85°C	8 lead CERDIP
MAX8212MJA	-55°C to +125°C	8 lead CERDIP
MAX8212CSA	0°C to +70°C	8 lead Small Outline
MAX8212CTY	0°C to +70°C	8 lead TO-99 Metal Can
MAX8212ETY	-40°C to +85°C	8 lead TO-99 Metal Can
MAX8212MTV	-55°C to +125°C	8 lead TO-99 Metal Can
MAX8212C/D	0°C to +70°C	Dice

Typical Operating Circuit



Logic Supply Under-Voltage Detector
(Detailed Circuit Diagram—Figure 5)

ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... −0.5V to +18V
Output Voltage .... −0.5V to +18V
Hysteresis Voltage .... +0.5V to −18V w.r.t. V^+
Threshold Input Voltage .... −0.5V to V^+ +0.5V
Operating Temperature
MAX821XC .... 0°C to +70°C
MAX821XE .... −40°C to +85°C
MAX821XM .... −55°C to +125°C
Current into Any Terminal .... ±50mA
Power Dissipation
Plastic DIP (derate 6.25mW/°C above +70°C) 500mW
Small Outline (derate 6mW/°C above +70°C) 480mW
CERDIP (derate 8mW/°C above +70°C) 640mW
TO-99 Metal Can (derate 6.7mW/°C above +70°C) ... 536mW
Lead Temperature (Soldering, 10 seconds) .... 300°C
Storage Temperature Range .... −65°C to +150°C

Stresses above 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 above 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^+ = 5V, T_A = 25°C unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MAX8211 MIN	MAX8211 TYP	MAX8211 MAX	MAX8212 MIN	MAX8212 TYP	MAX8212 MAX	UNITS
Supply Current	I^+	2V ≤ V^+ ≤ 16.5V GND ≤ V_{TH} ≤ V^+ T_A = 25°C T_A = Full Temp Range		5	15 20		5	15 20	µA
Threshold Trip Voltage	V_{TH}	2V ≤ V^+ ≤ 16.5V, V_{OUT} = 2V I_{OUT} = 4mA, T_A = 25°C I_{OUT} = 3mA, T_A = Full Temp Range	1.11 1.05	1.15	1.19 1.25	1.11 1.05	1.15	1.19 1.25	V
Threshold Voltage Disparity Between Output & Hysteresis Output	V_{THP}	I_{OUT} = 4mA I_{HYST} = 1mA		±0.1			±0.1		mV
Guaranteed Operating Supply Voltage Range	V_{SUPP}	T_A = 25°C T_A = Full Temp Range	2.0 2.2		16.5 16.5	2.0 2.2		16.5 16.5	V
Typical Operating Supply Voltage Range	V_{SUPP}	T_A = 25°C	1.5		16.5	1.5		16.5	V
Threshold Voltage Temperature Coefficient	$\Delta V_{TH}/\Delta T$	See Figure 4		-200			-200		ppm/°C
Variation of Threshold Voltage with Supply Voltage	ΔV_{TH}	V^+ = 4.5V to 5.5V		1.0			0.2		mV
Threshold Input Current	I_{TH}	0 ≤ V_{TH} ≤ V^+, T_A = 25°C T_A = Full Temp Range		0.01	10 20		0.01	10 20	nA
Output Leakage Current	I_{OLK}	T_A = Full Temp Range, E and C Grade							µA
		V_{OUT} = 16.5V, V_{TH} = 1.0V						10	
		V_{OUT} = 16.5V, V_{TH} = 1.3V			10				
		V_{OUT} = 5V, V_{TH} = 1.0V						1	
		V_{OUT} = 5V, V_{TH} = 1.3V			1				
		T_A = Full Temp Range, M Grade							
		V_{OUT} = 16.5V, V_{TH} = 0.9V						30	
		V_{OUT} = 16.5V, V_{TH} = 1.3V			30				
		V_{OUT} = 5V, V_{TH} = 1.3V						10	
		V_{OUT} = 5V, V_{TH} = 0.9V			10				
Output Saturation Voltage	V_{SAT}	I_{OUT} = 2mA, V_{TH} = 1.0V		0.17	0.4				V
		I_{OUT} = 2mA, V_{TH} = 1.3V					0.17	0.4	
Max Available Output Current	I_{OH}	0°C to +70°C, V_{OUT} = 5V							mA
		V_{TH} = 1.0V (Note 1)	4	7.0					
		V_{TH} = 1.3V (Note 2)				12	35		
Hysteresis Leakage Current	I_{LHYS}	T_A = Full Temp Range, C and E Grade V^+ = 10V, V_{TH} = 1.0V V_{HYST} = −16.5V w.r.t. V^+			0.1			0.1	µA
		T_A = Full Temp Range, M Grade V^+ = 10V, V_{TH} = 0.9V V_{HYS} = −16.5V w.r.t. V^+			3			3	
Hysteresis Sat Voltage	$V_{HYS\,(max)}$	I_{HYST} = 0.5mA, V_{TH} = 1.3V measured with respect to V^+		−0.1	−0.2		−0.1	−0.2	V
Max Available Hysteresis Current	$I_{HYS\,(max)}$	V_{TH} = 1.3V V_{HYS} = 0V	2	10		2	10		mA

Note 1: The maximum output current of the MAX8211 is limited by design to 30mA under any operating condition. The output voltage may be sustained at any voltage up to +16.5V as long as the maximum power dissipation of the device is not exceeded.
Note 2: The maximum output current of the MAX8212 is not defined, and systems using the MAX8212 must therefore ensure that the output current does not exceed 50mA and that the maximum power dissipation of the device is not exceeded.

Detailed Description

As shown in the block diagrams of Figures 1 & 2, the MAX8211 and MAX8212 each contain a 1.15V reference, a comparator, an open drain n-channel output transistors, and an open drain p-channel hysteresis output. The MAX8211 output n-channel turns on when the voltage applied to the THRESHOLD pin is less than the internal reference (1.15V). The sink current is limited to 7mA (typical), allowing direct drive of an LED without a series resistor. The MAX8212 output turns on when the voltage applied to the THRESHOLD pin is greater than the internal reference. The output of the MAX8212 is not current limited, and will typically sink 35mA.

Compatibility with ICL8211/8212

The CMOS MAX8211/8212 are plug-in replacements for the bipolar ICL8211/8212 in most applications. The use of CMOS technology has several advantages. The quiescent supply current is much less than in the bipolar parts. Higher value resistors can also be used in the networks that set up the trip voltage, since the comparator input (THRESHOLD pin) is a low leakage MOS transistor. This further reduces system current drain. The tolerance of the internal reference has also been significantly improved, allowing for more precise voltage detection without the use of potentiometers.

The available current from the HYSTERESIS output has been increased from 21μA to 10mA making the hysteresis feature easier to use. The disparity between the voltage required at the THRESHOLD pin to switch the OUTPUT compared with the HYSTERESIS output has also been reduced in the MAX8211 from 8mV to 0.1mV to eliminate output "chatter" or oscillation.

Most voltage detection circuits operate with supplies that are 15V or less: in these applications, the MAX8211/8212 will replace ICL8211/8212s with the performance advantages described above. However it should be noted that the CMOS parts have an absolute maximum supply voltage rating of 18V, and should never be used in applications where this rating could be exceeded. Caution should also be exercised when replacing ICL8211/8212s in closed loop applications such as programmable zeners. Although neither the ICL8211/8212 nor the MAX8211/8212 are internally compensated, the CMOS parts have higher gain and may not be stable for the external compensation capacitor values used in lower gain ICL8211/8212 circuits.

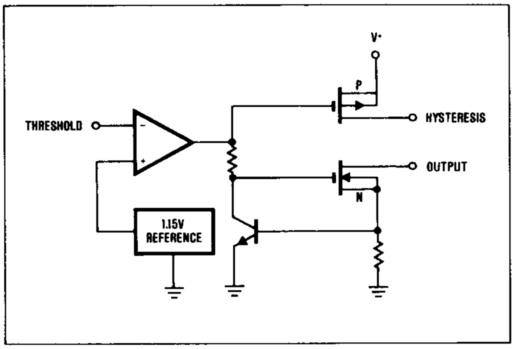


Figure 1. Block Diagram of MAX8211

Typical Applications

Basic Voltage Detectors

Figure 3 shows the basic circuit for both under-voltage detection (MAX8211) and over-voltage detection (MAX8212). For applications where no hysteresis is needed, R_3 should be omitted. The ratio of R_1 to R_2 is then chosen such that, for the desired trip voltage at V_{IN}, 1.15V is applied to the THRESHOLD pin. Since the comparator inputs are very low leakage MOS transistors, the MAX8211/8212 can use much higher resistor values in the attenuator network than the bipolar ICL8211/8212. See Table 1 for Switching Delays.

Table 1. Switching Delays

Typical Delays	MAX8211	MAX8212
$t_{(on)}$	40μs	250μs
$t_{(off)}$	1.5ms	3ms

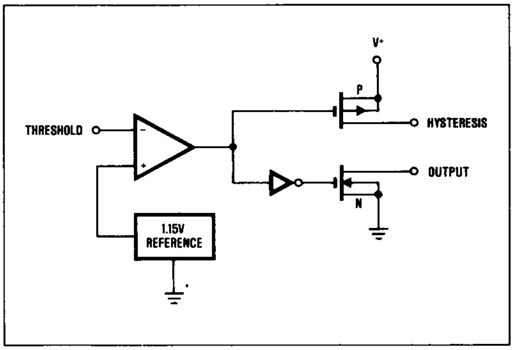


Figure 2. Block Diagram of MAX8212

Voltage Detectors with Hysteresis

To ensure noise-free output switching, hysteresis is frequently used in voltage detectors. For both the MAX8211 and MAX8212, the HYSTERESIS output is ON for THRESHOLD voltages greater than 1.15V. R_3 (Figure 3) controls the amount of current (positive feedback) supplied from the HYSTERESIS output to the mid-point of the resistor divider, and hence the magnitude of the hysteresis, or dead-band.

Resistor values for Figure 3 should be calculated as follows:

1) Choose a value for R_1. Typical values are in the 10kΩ to 10MΩ range.
2) Calculate R_2 for the desired upper trip point V_U using the formula:

$$R_2 = R_1 \times \frac{(V_U - V_{TH})}{V_{TH}} = R_1 \times \frac{(V_U - 1.15V)}{1.15V}$$

3) Calculate R_3 for the desired amount of hysteresis, where V_L is the lower trip point:

$$R_3 = R_2 \times \frac{(V^+ - V_{TH})}{(V_U - V_L)} = R_2 \times \frac{(V^+ - 1.15V)}{(V_U - V_L)}$$

or if $V^+ = V_{IN}$

$$R_3 = R_2 \times \frac{(V_L - V_{TH})}{(V_U - V_L)} = R_2 \times \frac{(V_L - 1.15V)}{(V_U - V_L)}$$

Figure 5 shows an alternate circuit, suitable only when the voltage being detected is also the power supply voltage for the MAX8211 or MAX8212.

Resistor values for Figure 5 should be calculated as follows:

1) Choose a value for R_1. Typical values are in the 10kΩ to 10MΩ range.
2) Calculate R_2

$$R_2 = R_1 \times \frac{(V_L - V_{TH})}{V_{TH}} = R_1 \times \frac{(V_L - 1.15V)}{1.15V}$$

3) Calculate R_3

$$R_3 = R_1 \times \frac{(V_U - V_L)}{1.15V}$$

Low Voltage Detector for Logic Supply

The circuit of Figure 5 will detect when a 5.0V (nominal) supply goes below 4.5V, which is the V_{min} normally specified in logic systems. Resistor values have been selected which ensure that false under-voltage alarms will not be generated even with worst-case Threshold Trip Voltages and resistor tolerances. R_3 provides approximately 75mV of hysteresis.

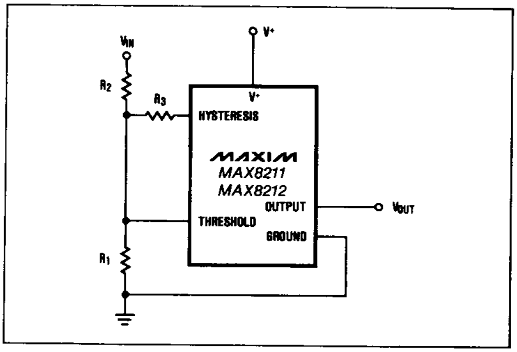


Figure 3. Basic Over-Voltage/Under-Voltage Circuit

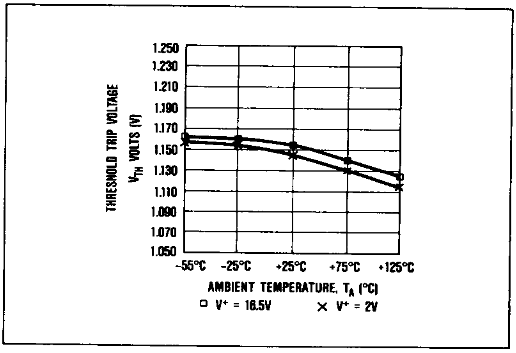


Figure 4. Threshold Trip Voltage vs. Ambient Temperature

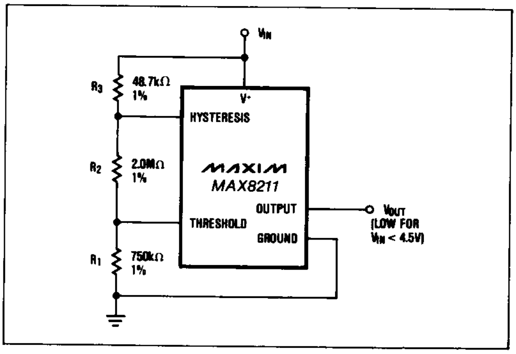


Figure 5. Logic Supply Low Voltage Detector

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