芯伯乐®
XINBOLE

Product Specification

XBLW XLMV331/XLMV393

General-purpose Low-voltage Comparators

WEB | www.xinboleic.com

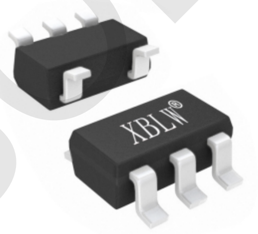
RoHS

Descriptions

The XLMV331/393 are General-purpose Low-voltage Comparators.
The devices with open-drain output offer the ultimate combination of high speed (100 ns propagation delay) and very low power consumption (37 μA), and feature such as rail-to-rail inputs, low offset voltage (typically 1 mV), large output drive current, and a wide range of supply voltages from 1.8 V to 5.5 V. The devices are very easy to implement in a wide variety of applications where require critical response time, power-sensitive, low-voltage, and/or tight board space. Advantages of the XLMV331/393 also include the added benefit of internal hysteresis provide noise immunity, preventing output oscillations even with slow-moving input signals. Designed with the most modern techniques, the XLMV331/393 achieve superior performance over BiCMOS or bipolar versions on the market.
The XLMV331 (single) adopts SOT23-5 and SC70-5 packaging, while XLMV393 (dual) adopts SOP-8 packaging.

Features

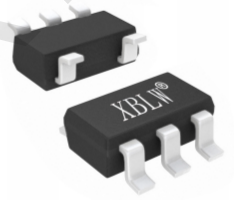
- Micro-power Operating Current (37 μA) Preserves Battery Power
- Fast 100 ns Propagation Delay (100mV Overdrive)
- Single 1.8 V to 5.5 V Supply Voltage Range
  - Can be Powered From the Same 1.8V/2.5V/3.3V/5V System Rails
- Rail-to-Rail Input
- Open-Drain Output Current Drive: 30 mA Typically at 5V Supply
- Internal Hysteresis for Clean Switching
- Internal RF/EMI Filter
- Operating Temperature Range:-40°C to +125°C
- Pin to Pin for the LMV331 and LMV393



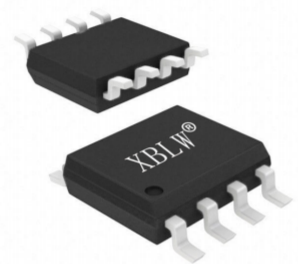
SC70-5

Applications

- Consumer Accessories
- Portable and Battery-Powered Devices
- Alarms and Monitoring Circuits
- Threshold Detectors and Discriminators
- Logic Level Shifting or Translation
- Zero-Crossing Detectors
- Window Comparators
- IR Receivers
- Line ReceiversPin Description



SOT23-5

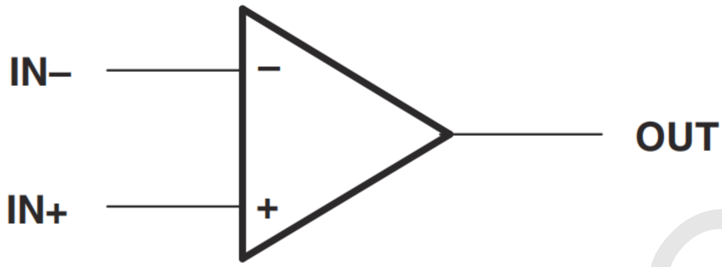


SOP-8

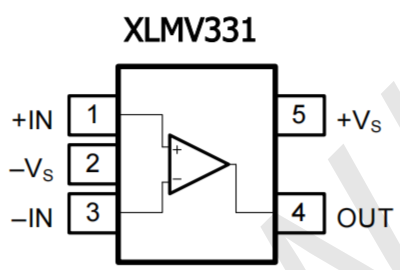
Ordering Information

Product Model	Package Type	Marking	Packing	Packing Qty
XLMV331IDCKR	SC70-5	R2F	Tape	3000Pcs/Reel
XLMV331IDBVR	SOT23-5	R1IF	Tape	3000Pcs/Reel
XLMV393IDR	SOP-8	LMV393	Tape	4000Pcs/Reel

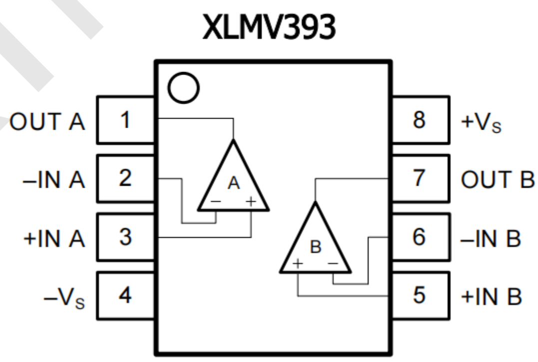
Simplified Schematic Diagram



Pin Configurations



SOT23-5/ SC70-5



SOP-8

Pin Description

Symbol	Description
–IN	Negative input. The voltage range is from (V_{S-} – 0.1V) to (V_{S+} + 0.1V)
+IN	Positive input. This pin has the same voltage range as –IN.
+V_S	Positive power supply.
–V_S	Negative power supply.
OUT	Comparator output.

Absolute Maximum Ratings（TA=25℃）

In accordance with the Absolute Maximum Rating System (IEC 60134).

Parameter	Absolute Maximum Rating
Supply Voltage, V_{S+} to V_{S-}	10.0 V
Signal Input Terminals: Voltage, Current	V_{S-} - 0.3 V to V_{S+} + 0.3 V, ±10 mA
Output Short-Circuit	Continuous
Storage Temperature Range, T_{stg}	-65 °C to +150 °C
Junction Temperature, T_J	150 °C
Lead Temperature Range (Soldering 10 sec)	260 °C

Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

Parameter	MIN	MAX	UNIT
Supply voltage,VS	1.8	5.5	V
Specified temperature	–40	125	°C

ESD Rating

Parameter	Item	Value	Unit
Electrostatic Discharge Voltage	Human body model (HBM), per MIL-STD-883J / Method 3015.9 (1)	±5000	V
	Charged device model (CDM), per ESDA/JEDEC JS-002-2014 (2)	±2000	
	Machine model (MM), per JESD22-A115C	±250	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process

Electrical Characteristics

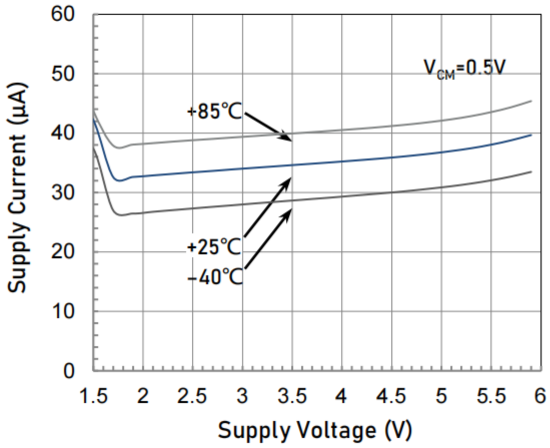
V_S = 5.0V, T_A = +25°C, unless othe rwise noted.
Boldface limitsapply over the specified temperature range, T_A = -40 to+125°C.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
OFFSET VOLTAGE						
V_{OS}	Input offset voltage	V_{CM} = 0		±1.0	±5.0	mV
V_{OS} TC	Offset voltage drift	T_A = -40 to +125 °C		±2.0		μV/°C
PSRR	Power supply rejection ratio	T_A = -40 to +125 °C	66			dB
		V_S = 1.8 to 5.5 V, V_{CM} < (V_{S+} - 1V)	70	82		
Hyst	Input hysteresis	V_{CM} = 0		3.0		mV
INPUT BIAS CURRENT						
I_B	Input bias current	V_{CM}= V_{S+}/2		5	30	pA
		T_A= -40 to +125 °C			800	
I_{OS}	Input offset current	V_{CM}= V_{S+}/2		10	50	pA
		T_A= -40 to +125 °C			1000	
INPUT VOLTAGE RANGE						
V_{CM}	Common-mode voltage range	T_A = -40 to +85 °C	V_{S-} −0.1		V_{S+}+0.1	V
		T_A = -40 to +125 °C	V_{S-} +0.1		V_{S+}-0.1	V
CMRR	Common-mode rejection ratio	VS = 5.5 V, V_{CM} = -0.1 to 5.5 V	61	78		dB
		V_{CM} = 0 to 5.3 V, T_A = -40 to +125 °C	58			
		V_S = 1.8 V, V_{CM} = -0.1 to 1.8 V	58	77		
		V_{CM} = 0 to 1.6 V, T_A = -40 to +125 °C	55			
INPUT IMPEDANCE						
R_{IN}	Input resistance		100			GΩ
C_{IN}	Input capacitance	Differential		2.0		pF
		Commonmode		3.5		
OUTPUT						
V_{OL}	Low output voltage swing	I_{SINK} = 1 mA		50	80	mV
		T_A = -40 to +125 °C			90	
I_{SC}	Output short-circuit current	Sink current		–30	–25	mA

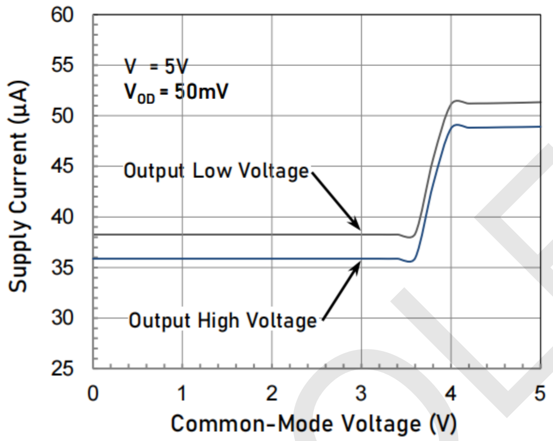
POWER SUPPLY						
V_S	Operating supply voltage		1.8		5.5	V
I_Q	Quiescent current (per comparator)	V_S = 1.8 V, V_{CM} = 0.5V, I_O = 0		32	40	μA
		T_A = -40 to +125 °C			50	
		V_S = 5.5 V, V_{CM} = 0.5V, I_O = 0		37	45	
		T_A = -40 to +125 °C			60	
SWITCHING CHARACTERISTICS						
t_{PD-}	Propagation delay time, High to low	Input overdrive = 20 mV, C_L = 15 pF		240		ns
		Input overdrive = 100 mV, C_L =15 pF		100		
t_F	Fall time	Input overdrive = 20 mV, C_L = 15 pF		20		ns
		Input overdrive = 100 mV, C_L =15 pF		10		
THERMAL CHARACTERISTICS						
T_A	Operating temperature range		-40		+125	°C
θ_{JA}	Package Thermal Resistance	SOT23-5		190		°C/W
		SOP-8		125		
		SC70-5		333		

Typical Performance Characteristics

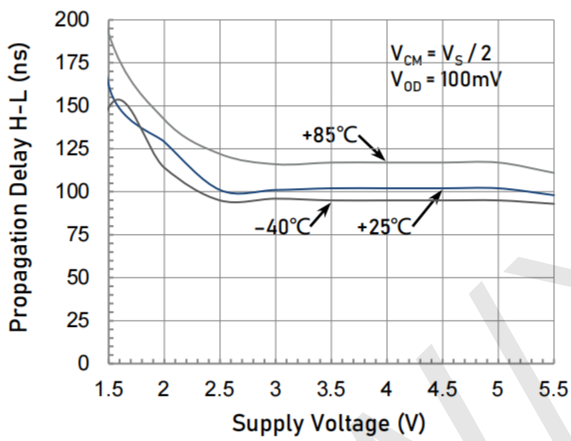
At T_A = +25°C, V_S=±2.5V,V_{CM}=V_S/2, R_L=10kΩ connectedto V_S/2, and C_L=15pF, unless othe rwise noted.



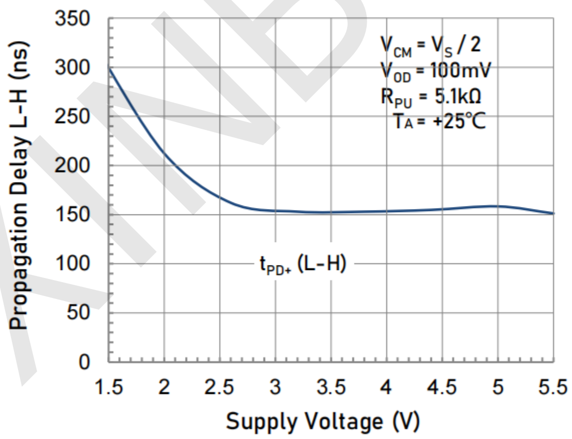
Supply Current vs. Supply Voltage



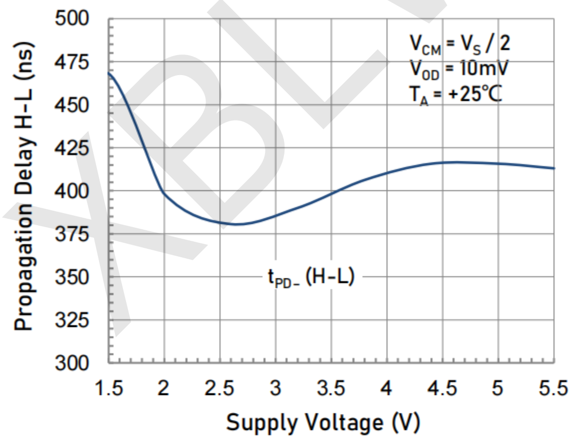
Supply Current vs. Common-Mode Input



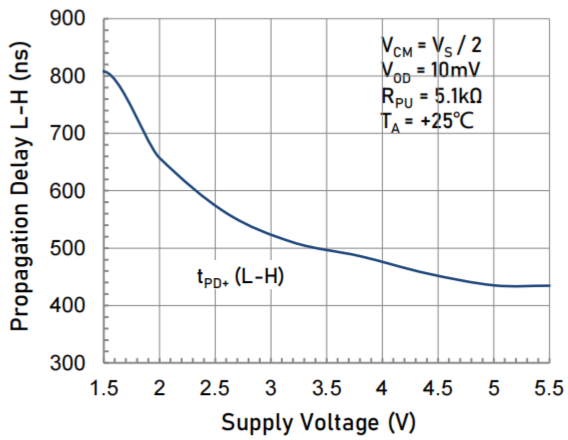
Propagation Delay (t_{PHL}) vs. Supply Voltage



Propagation Delay (t_{PLH}) vs. Supply Voltage



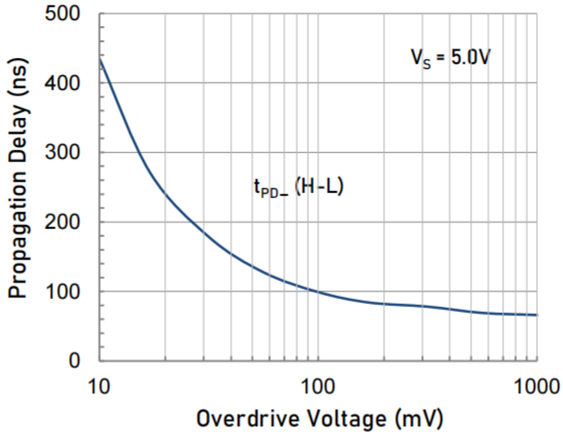
Propagation Delay (t_{PHL}) vs. Supply Voltage



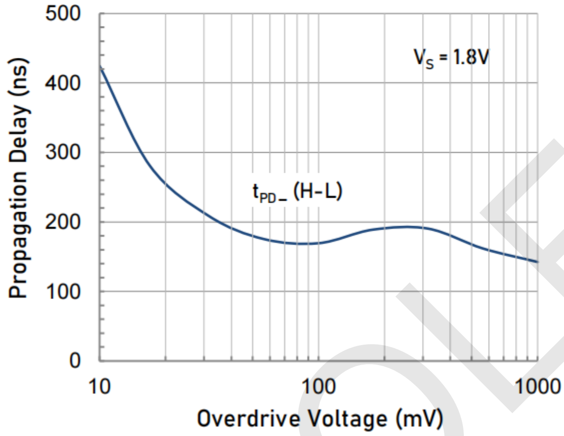
Propagation Delay (t_{PLH}) vs. Supply Voltage

Typical Performance Characteristics

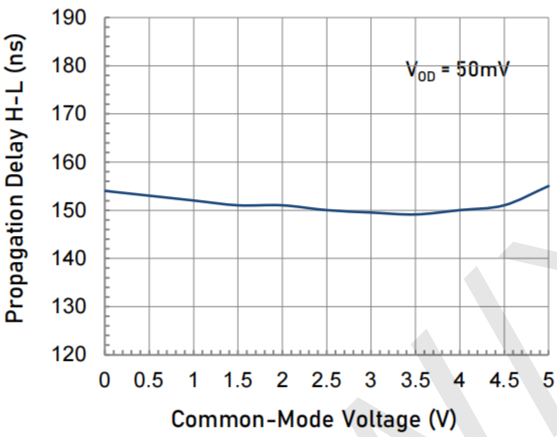
At T_A = +25°C, V_S=±2.5V,V_{CM}=V_S/2, R_L=10kΩ connectedto V_S/2, and C_L=15pF, unless othe rwise noted.



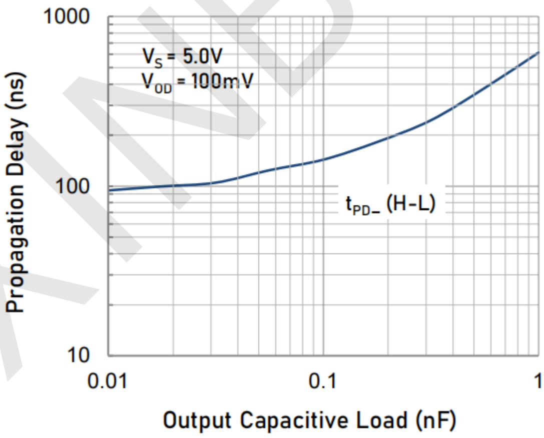
Propagation Delay (t_{PHL}) vs. Input Overdrive



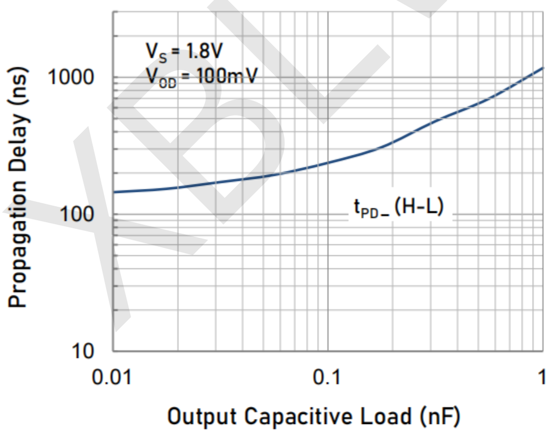
Propagation Delay (t_{PHL}) vs. Input Overdrive



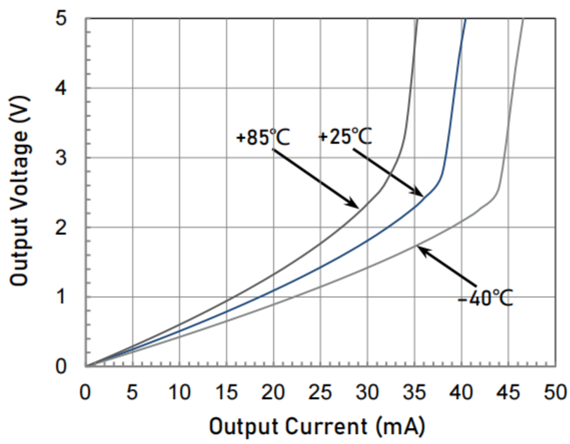
Propagation Delay (t_{PHL}) vs. Input Common-Mode



Propagation Delay (t_{PHL}) vs. Capacitive Load



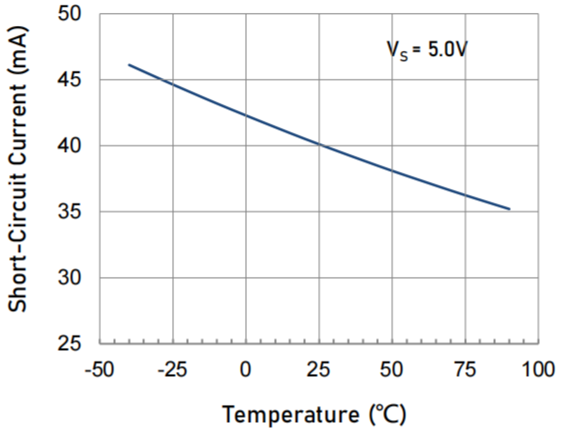
Propagation Delay (t_{PHL}) vs. Capacitive Load



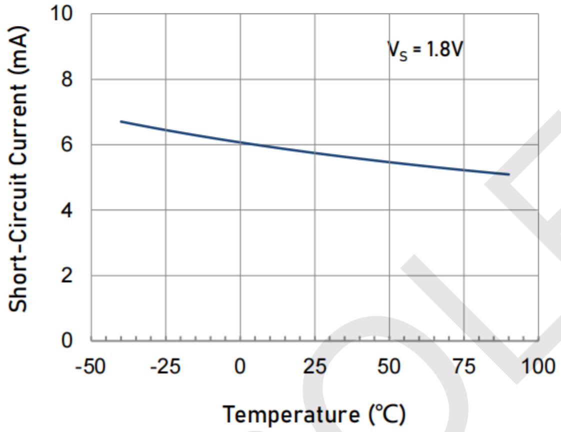
Output Voltage vs. Output Sinking Current

Typical Performance Characteristics

At T_A = +25°C, V_S=±2.5V, V_{CM}=V_S/2, R_L=10kΩ connected to V_S/2, and C_L=15pF, unless otherwise noted.



Short Circuit Current vs. Temperature



Short Circuit Current vs. Temperature

Application Notes

OPERATING VOLTAGE

The XLMV331/393 micro-power comparators of open-drain output are fully specified and ensured for operation from 1.8 V to 5.5 V and offers an excellent speed-to-power combination with a propagation delay of 100 ns and a quiescent supply current of 37 μA. This combination of fast response time at micro- power enables power conscious systems to monitor and respond quickly to fault conditions.
In addition, and many specifications apply over the industrial temperature range of –40°C to +125°C . Parameters that vary significantly with operating voltages or temperature are illustrated in the Typical Characteristics graphs.

INPUT VOLTAGE

The input common-mode voltage range of the XLMV331/393 family extends 100mV beyond the supply rails. This performance is achieved with a complementary input stage: an N-channel input differential pair in parallel with a P-channel differential pair. The N-channel pair is active for input voltages close to the positive rail, typically V_{S+} – 1.4V to the positive supply, whereas the P-channel pair is active for inputs from 100mV below the negative supply to approximately V_{S+}–1.4V. There is a small transition region, typically V_{S+}–1.2V to V_{S+}–1V, in which both pairs are on. This 200mV transition region can vary up to 200mV with process variation. Thus, the transition region (both stages on) can range from V_{S+}–1.4V to V_{S+}–1.2V on the low end, up to V_{S+}–1V to V_{S+}–0.8V on the high end. Within this transition region, PSRR, CMRR, offset voltage, offset drift, and THD can be degraded compared to device operation outside this region.

INPUT VOLTAGE

The XLMV331/393 comparator family uses CMOS transistors at the inputs which prevent phase inversion when the input pins exceed the supply voltages.

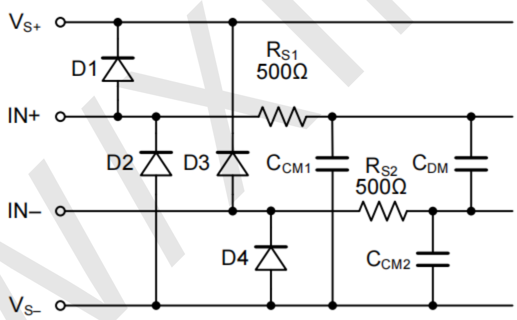


Figure1.Input EMI Filterand Clamp Circuit

The XLMV331/393 comparators have internal ESD protection diodes (D1, D2, D3, and D4) that are connected between the inputs and each supply rail. These diodes protect the input transistors in the event of electrostatic discharge and are reverse biased during normal operation. This protection scheme allows voltages as high as approximately 300mV beyond the rails to be applied at the input of either terminal without causing permanent damage. See the table of Absolute Maximum Ratings for more information.

EMI REJECTION RATIO

Circuit performance is often adversely affected by high frequency EMI. When the signal strength is low and transmission lines are long, an amplifier must accurately amplify the input signals. However, all comparator pins — the non-inverting input, inverting input, positive supply, negative supply, and output pins — are susceptible to EMI signals. These high frequency signals are coupled into an comparator by various means, such as conduction, near field radiation, or far field radiation. For example, wires and printed circuit board (PCB) traces can act as antennas and pick up high frequency EMI signals.
Amplifiers do not amplify EMI or RF signals due to their relatively low bandwidth. However, due to the nonlinearities of the input devices, comparators can rectify these out of band signals. When these high frequency signals are rectified, they appear as a dc offset at the output.
The XLMV331/393 comparators have integrated EMI filters at their input stage. A mathematical method of measuring EMIRR is defined as follows:

$$EMIRR = 20 \log(V_{IN\_PEAK}/\Delta V_{OS})$$

INTERNAL HYSTERESIS

Most high-speed comparators oscillate in the linear region because of noise or undesired parasitic feedback. This tends to occur when the voltage on one input is at or equal to the voltage on the other input. To counter the parasitic effects and noise, the devices have an internal hysteresis of 3 mV.

The hysteresis in a comparator creates two trip points: one for the rising input voltage and one for the falling input voltage. The difference between the trip points is the hysteresis. The average of the trip points is the offset voltage. When the comparator's input voltages are equal, the hysteresis effectively causes one comparator input voltage to move quickly past the other, thus taking the input out of the region where oscillation occurs. Standard comparators require hysteresis to be added with external resistors. To increase hysteresis and noise margin even more, add positive feedback with two resistor s as a voltage divider from the output to the non -inverting input.Figure 2 illustrates the case where IN- is fixed and IN+ is varied. If the inputs were rev ersed, the figure would look the same, except the output would be inverted.

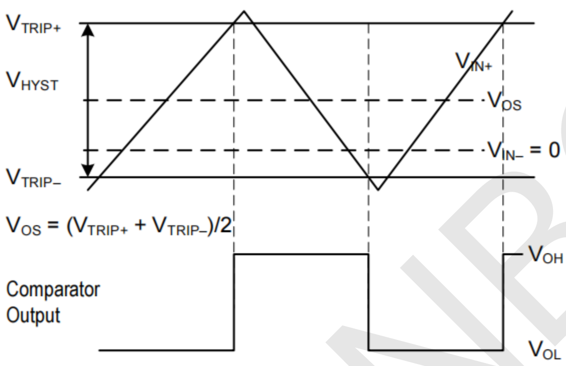


Figure2.Inputand OutputWaveform,Non-inverting InputVaried

MAXIMIZING PERFORMANCE THROUGH PROPER LAYOUT

To achieve the maximum performance of the extremely high input impedance and low offset voltage of the XLMV331/393 devices, care is needed in laying out the circuit board. The PCB surface must remain clean and free of moisture to avoid leakage currents between adjacent traces. Surface coating of the circuit board reduces surface moisture and provides a humidity barrier, reducing parasitic resistance on the board. The use of guard rings around the comparator inputs further reduces leakage currents. Figure 3 shows proper guard ring configuration and the top view of a surface-mount layout. The guard ring does not need to be a specific width, but it should form a continuous loop around both inputs. By setting the guard ring voltage equal to the voltage at the non-inverting input, parasitic capacitance is minimized as well. For further reduction of leakage currents, components can be mounted to the PCB using Teflon standoff insulators.

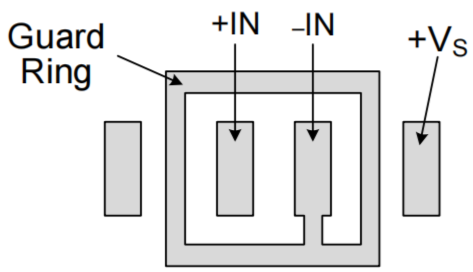


Figure3. Useaguardringaroundsensitivepins

Other potential sources of offset error are thermo-electric voltages on the circuit board. This voltage, also called Seebeck voltage, occurs at the junction of two dissimilar metals and is proportional to the temperature of the junction. The most common metallic junctions on a circuit board are solder-to- board trace and solder-to-component lead. If the temperature of the PCB at one end of the component is different from the temperature at the other end, the resulting Seebeck voltages are not equal, resulting in a thermal voltage error. This thermocouple error can be reduced by using dummy components to match the thermoelectric error source. Placing the dummy component as close as possible to its partner ensures both Seebeck voltages are equal, thus canceling the thermocouple error. Maintaining a constant ambient temperature on the circuit board further reduces this error. The use of a ground plane helps distribute heat throughout the board and reduces EMI noise pickup.

INPUT-TO-OUTPUT COUPLING

To minimize capacitive coupling, the input and output signal traces should not be parallel. This helps reduce unwanted positive feedback.

Typical Application Circuits

IR RECEIVERAFE AND WAKE- UP CIRCUIT

Infrared (IR) communication is inherently immune to long as there is a line-of-sight path between the transmitter and the receiver. It is also one of the lowest cost communication schemes. This makes it a good choice for implementing wireless communications in applications such as utility metering. A common system topology to is to use a power efficient IR receiver analog front end (AFE) that is always on and wakes up the host only when there is a valid IR signal detected as shown in Figure 4.

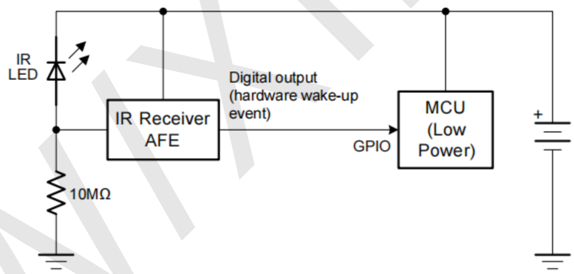


Figure 4. Coin Cell Battery Powered IR Receiver

Power efficient comparators such as the XLMV331/393 can be used in the IR receiver AFE to increase battery life. The XLMV331/393 device is responsible for two major tasks:

1. IR signal conditioning,
2. Host system wake-up.

The XLMV331/393 device is constantly powered to always be ready to receive IR signals and wake up the host microcontroller (MCU) when data is received. The short working distance (approx 5 cm) is suitable for a virtual-contact operation where the IR transmitter and receiver are closely placed with an optional mechanical alignment guide.

Figure 4 shows the IR receiver system block diagram .The host MCU is normally in the shutdown mod e (during which the quiescent current is less than 1 μ A)except when data is being transferred.

Figure 5 shows the detailed circuit design. The circuit establishes a threshold through R_2 and C_1 which automatically adapts to the ambient light level. To further reduce BOM cost, this example uses an IR LED as the IR receiver. The IR LED is reverse-biased to function as a photodiode (but at a reduced sensitivity).

The low input bias current allows a greater load resistor value (R_1) without sacrificing linearity, which in turn helps reduce the always-on supply current.

The load resistor R_1 converts the IR light induced current into a voltage fed into the inverting input of the comparator. R_2 and C1 establish a reference voltage V_{REF} which tracks the mean amplitude of the IR signal. The non-inverting input is connected to V_{REF} through R_3. And finally R_3 and R_4 are used to introduce additional hysteresis to keep the output free of spurious toggles.

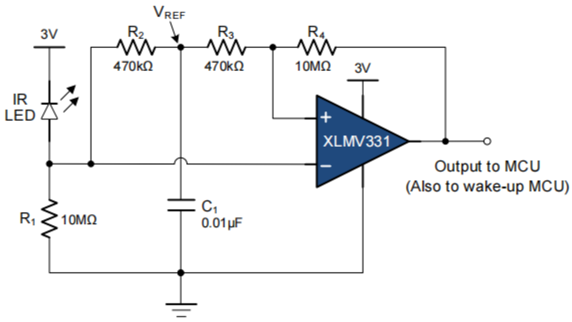


Figure 5.XLMV331 IR Receiver AFE Using

USE WINDOW COMPARATOR TO DETECT UNDER-VOLTAGE AND OVER-VOLTAGE

Window comparators are commonly used to detect undervoltage (UV) and overvoltage (OV) conditions. Figure 6 shows a simple window comparator circuit.

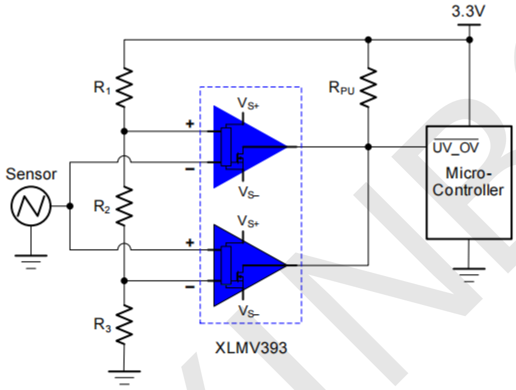


Figure 6. Window Comparator

For this design, follow these design requirements:

- Alert (logic low output) when an input signal is less than 1.1 V
- Alert (logic low output) when an input signal is greater than 2.2 V
- Alert signal is active low
- Operate from a 3.3-V power supply

Configure the circuit as shown in Figure 6. Connect V_{S+} to a 3.3-V power supply and V_{S-} to ground. Make R_1, R_2 and R_3 each 10-MΩ resistors. These three resistors are used to create the positive and negative thresholds for the window comparator (V_{TH+} and V_{TH-}). With each resistor being equal, V_{TH+} is 2.2 V and V_{TH-} is 1.1 V. Large resistor values such as 10-MΩ are used to minimize power consumption. The sensor output voltage is applied to the inverting and non-inverting inputs of the 2-channel XLMV393's. The XLMV393 is used for its open-drain output configuration. Using the XLMV393 allows the two comparator outputs to be Wire-ORed together. The respective comparator outputs will be low when the sensor is less than 1.1 V or greater than 2.2 V. V_{OUT} will be high when the sensor is in the range of 1.1 V to 2.2 V. See the application curve in Figure 7.

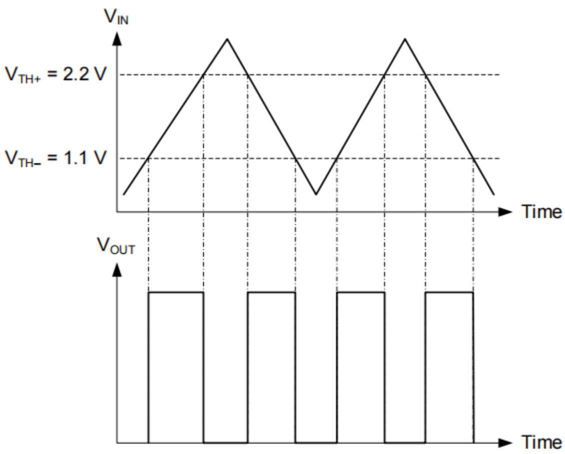
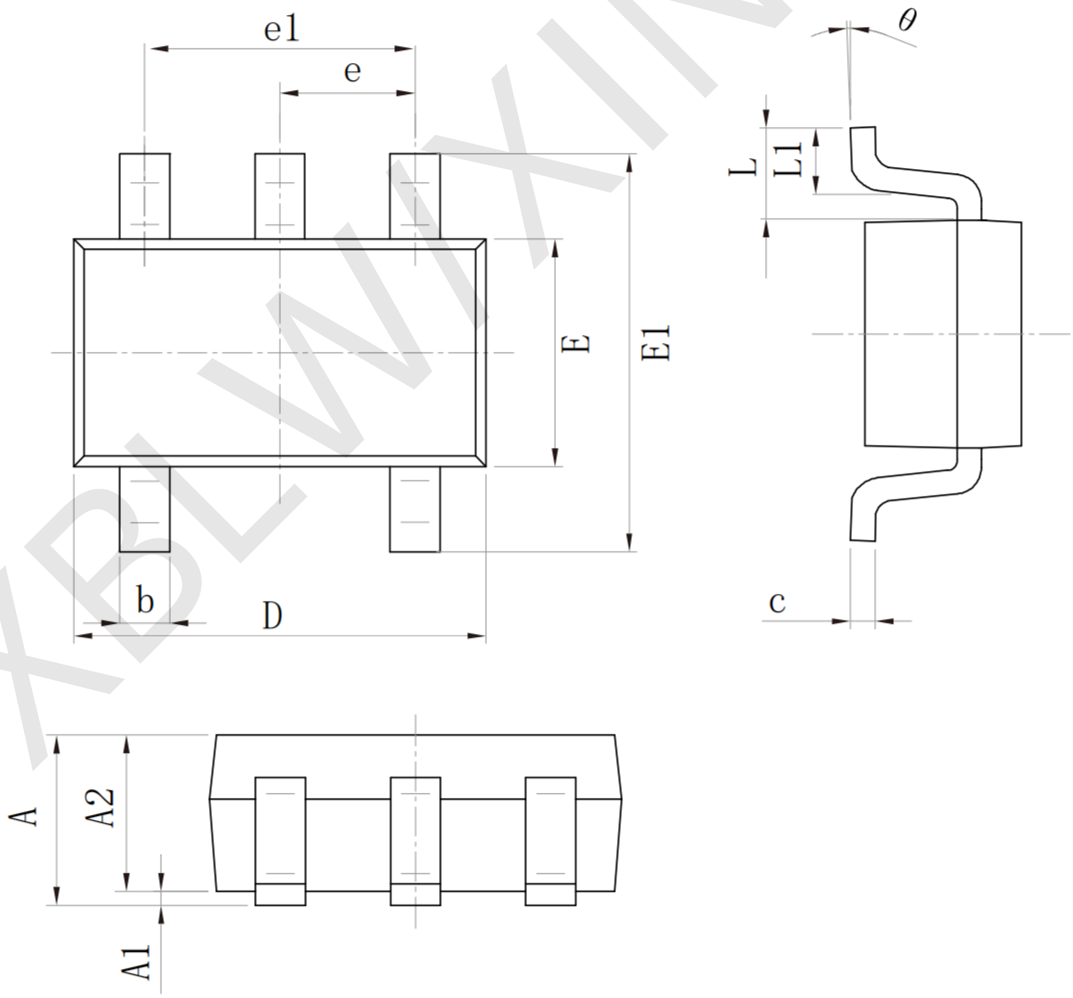


Figure 7.Window Comparator Results

Package Information

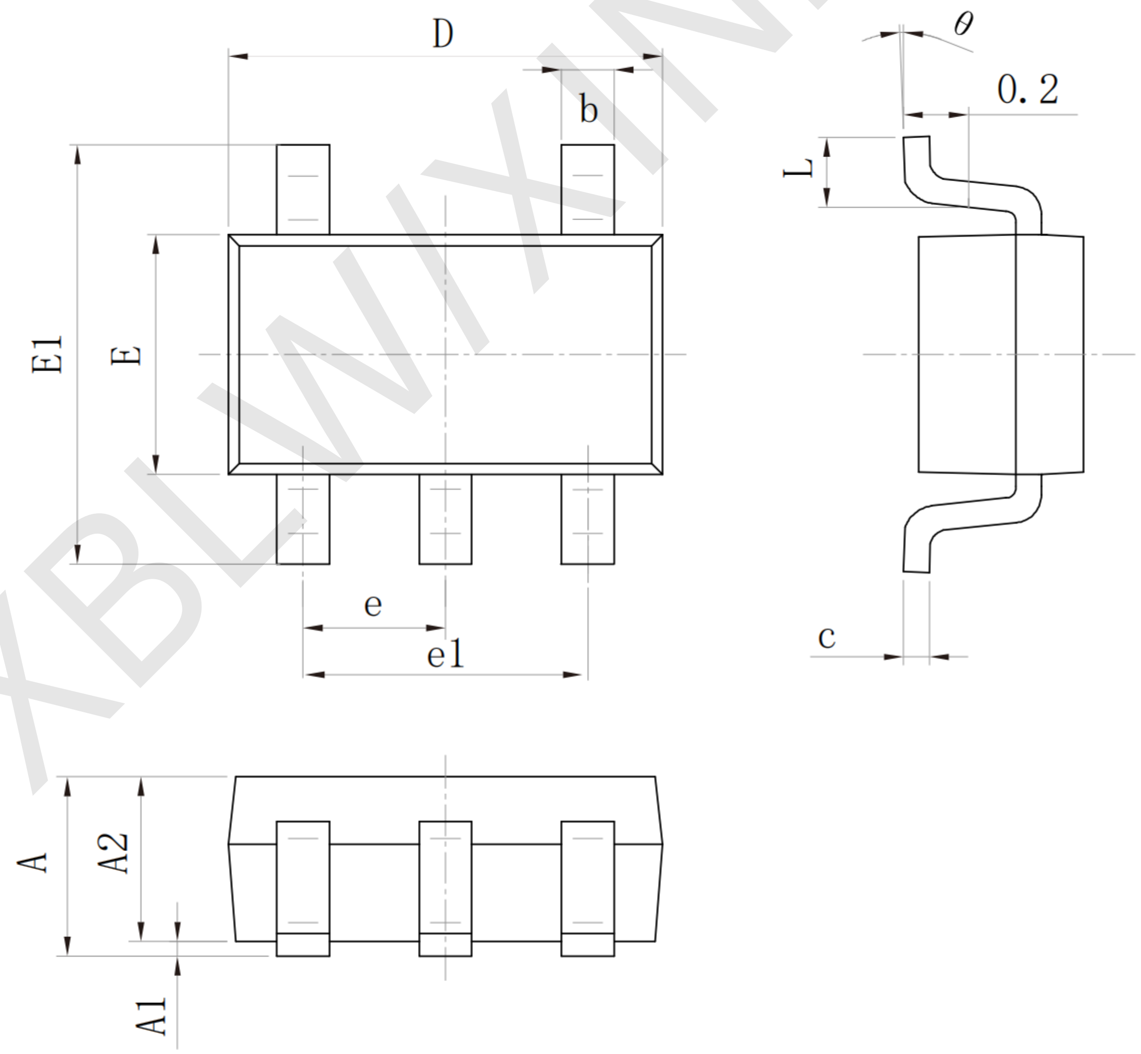
- SC70-5

Symbol \ Size	Dimensions In Millimeters		Symbol \ Size	Dimensions In Inches	
	Min (mm)	Max (mm)		Min (in)	Max (in)
A	0.800	1.100	A	0.035	0.043
A1	0.000	0.100	A1	0.000	0.004
A2	0.800	0.900	A2	0.035	0.039
b	0.150	0.350	b	0.006	0.014
C	0.080	0.150	C	0.003	0.006
D	1.850	2.150	D	0.079	0.087
E	1.100	1.400	E	0.045	0.053
E1	1.950	2.200	E1	0.085	0.096
e	0.85 (typ)		e	0.026 (typ)	
e1	1.200	1.400	e1	0.047	0.055
L	0.42 (ref)		L	0.021 (ref)	
L1	0.260	0.460	L1	0.010	0.018
θ	0°	8°	θ	0°	8°



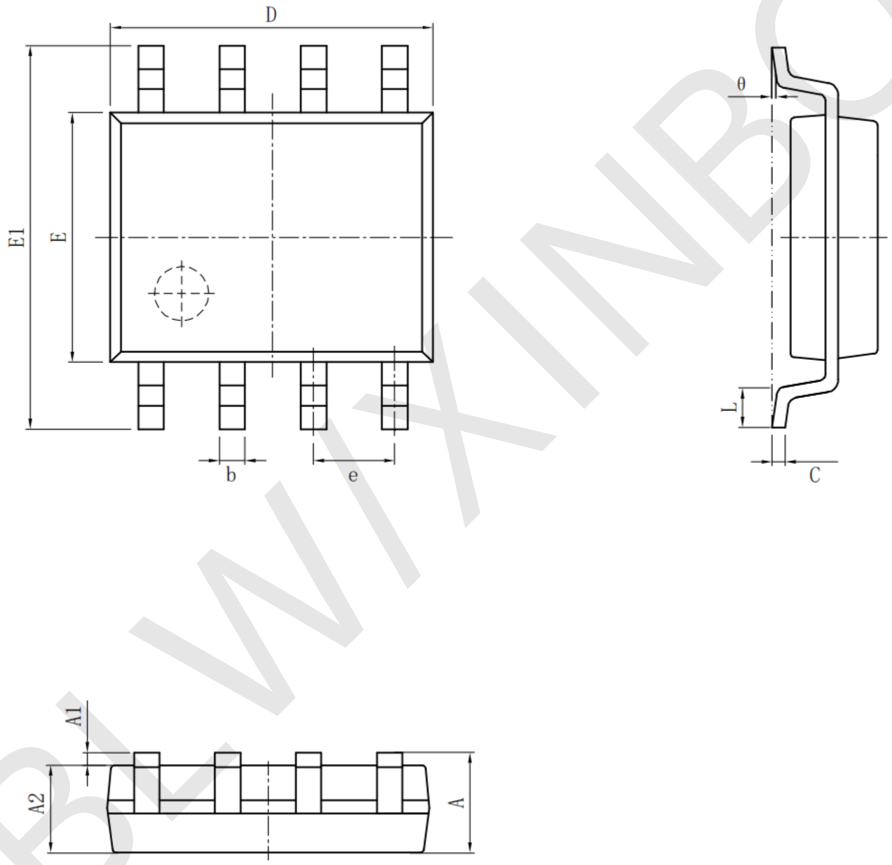
• SOT23-5

SIZE / SYMBOL	Dimensions In Millimeters		SIZE / SYMBOL	Dimensions In Inches	
	MIN(mm)	MAX(mm)		MIN(in)	MAX(in)
A	1.050	1.250	A	0.041	0.049
A1	0.000	0.100	A1	0.000	0.004
A2	1.050	1.150	A2	0.041	0.045
b	0.300	0.500	b	0.012	0.020
c	0.100	0.200	c	0.004	0.008
D	2.820	3.020	D	0.111	0.119
E	1.500	1.700	E	0.059	0.067
E1	2.650	2.950	E1	0.104	0.116
e	0.95(BSC)		e	0.037(BSC)	
e1	1.800	2.000	e1	0.071	0.079
L	0.300	0.600	L	0.012	0.024
θ	0°	8°	θ	0°	8°



- SOP-8

Symbol \ Size	Dimensions In Millimeters		Symbol \ Size	Dimensions In Inches	
	Min(mm)	Max(mm)		Min(in)	Max(in)
A	1.350	1.750	A	0.053	0.069
A1	0.100	0.250	A1	0.004	0.010
A2	1.350	1.550	A2	0.053	0.061
b	0.330	0.510	b	0.013	0.020
c	0.170	0.250	c	0.006	0.010
D	4.700	5.100	D	0.185	0.200
E	3.800	4.000	E	0.150	0.157
E1	5.800	6.200	E1	0.228	0.224
e	1.270(BSC)		e	0.050(BSC)	
L	0.400	1.270	L	0.016	0.050
θ	0°	8°	θ	0°	8°



Statement:

- XBLW reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.
- Any semiconductor product may malfunction under specified conditions. When using XBLW products for system design and overall manufacturing, the buyer is responsible for complying with safety standards and taking appropriate safety measures to avoid risks that may cause personal injury or property damage.
- XBLW products have not been licensed for life support, military, and aerospace applications, and therefore XBLW is not responsible for any consequences arising from the use of this product in these areas.
- If any or all XBLW products (including technical data, services) described or contained in this document are subject to any applicable local export control laws and regulations, they may not be exported without an export license from the relevant authorities in accordance with such laws.
- The specifications of any and all XBLW products described or contained in this document specify the performance, characteristics, and functionality of said products in their standalone state, but do not guarantee the performance, characteristics, and functionality of said products installed in Customer's products or equipment. In order to verify symptoms and conditions that cannot be evaluated in a standalone device, the Customer should ultimately evaluate and test the device installed in the Customer's product device.
- XBLW documentation is only allowed to be copied without any alteration of the content and with the relevant authorization. XBLW assumes no responsibility or liability for altered documents.
- XBLW is committed to becoming the preferred semiconductor brand for customers, and XBLW will strive to provide customers with better performance and better quality products.