

ALD2321A/ALD2321B ALD2321

ULTRA LOW VOS EPAD® DUAL CMOS ANALOG VOLTAGE COMPARATOR

GENERAL DESCRIPTION

The ALD2321A/ ALD2321B/ ALD2321 is a monolithic Precision Dual Voltage Comparator, each having integrated dual complementary output drivers. It is constructed using advanced silicon gate CMOS technology. Key features of the ALD2321A/ ALD2321B/ ALD2321 include very high input impedance, very low offset voltage utilizing onchip e-trim (EPAD[®] electronic-trimming) technology, flexible multiple output configurations and fast response time with small overdrive voltage. It is designed for ultra low level signal detection from high impedance sources. For many applications the ALD2321A/ ALD2321B/ ALD2321 can eliminate an input amplification stage, a precision input bias stage, a signal level shift stage and an output buffer stage, and do the entire job from low level input signal detection to high output driver ---- all on a single chip.

The input voltage includes ground, making this voltage comparator ideal for single supply +5V or dual supply +/- 5V powered systems. For dual supply applications, GND pin is connected to the most negative supply instead of Ground (0.0V). The negative supply voltage can be at any value between 0.0V and -5V. Each voltage comparator is individually trimmed at the factory for minimum offset voltage at ground voltage potential, making the ALD2321A/ALD2321B/ALD2321 at its best offset voltage and ready to compare very low signal level voltages at or near ground potential. Typically a signal less than 1 mV can be resolved and detected reliably without requiring amplification. Sensor or detector signals with signal power as low as 0.004 pW(4 x 10⁻¹⁵ Watt) can be readily detected.

Each voltage comparator has two complementary output pins, one for Source Output (OUT_H)and the other for Sink Output (OUT). This dual complementary output allows maximum circuit design flexibility. The outputs can be used as Single-Ended Driver, Multiple WIRED-OR Outputs, Push-Pull Outputs or Complementary Outputs. The Sink Output can be used as an open drain output, which has current sink capability of up to 50 mA. It can also be connected to an external voltage higher or lower than V+, which provide level shift of the output swing levels from other than V+ to GND.

ORDERING INFORMATION

Operating Temperature Range*							
0°C to +70°C	0°C to +70°C	-55°C to +125°C					
16-pin	16-Pin	16-Pin					
Small Outline Package	Plastic DIP Package	Ceramic DIP Package					
(SOIC)	(PDIP)	(CDIP)					
ALD2321ASC	ALD2321APC	ALD2321ADC					
ALD2321BSC	ALD2321BPC	ALD2321BDC					
ALD2321SC	ALD2321PC	ALD2321DC					

* Contact factory for industrial temperature range

© 2004 Advanced Linear Devices, Inc. 415 Tasman Drive, Sunnyvale, California 94089 -1706 Tel: (408) 747-1155 Fax: (408) 747-1286 http://www.aldinc.com

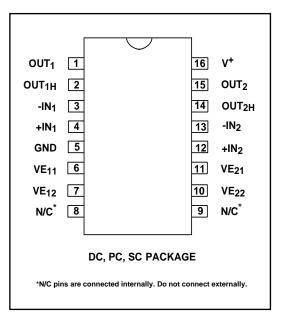
PRODUCT FEATURES

- * Ultra low signal power of 4 fW detectable
- * Ultra low offset voltage of max. 0.2 mV
- * Ultra low input bias currents of typ. 0.01pA
- * Low supply current of 110 µA typical
- * Virtually eliminates source impedance effects
- * Low operating supply voltage of 3V to 10V
- * Single +5V and dual supply \pm 5V operation
- * High speed for both small and large level signals 300ns typical for TTL inputs
- * CMOS, NMOS and TTL compatible
- * Each comparator has separate push and pull outputs
- * High output sink current typically 50mA
- * Low supply current spikes
- * Fanout of 30 TTL loads

APPLICATIONS

- * Low level signal detector
- * Dual limit window comparator
- * Power supply voltage monitor
- * Photo-detector sensor circuit
- * Relay or LED driver
- * Oscillators
- * Battery operated instruments
- * Remote signal detection

PIN CONFIGURATION



GENERAL DESCRIPTION (cont'd)

The Source Output can source up to 2 mA and can be used to drive the base terminal of an external NPN bipolar device or the gate of a N-channel MOSFET device. Alternatively, the two outputs, Source Output and Sink Output, can be connected together to form a push-pull output which has the combined output capabilities of both channels.

In the dual complementary output mode, each comparator can be used to drive separate loads. Due to the complementary nature of the two outputs, only one output is active at any a given time, except for a limited crossover time. When OUT (sink output) is active ON, the OUT pin is sinking current and the OUT_H pin is OFF and in high impedance mode. Conversely, if OUT_H pin is ON and sourcing current, OUT pin is OFF. To configure push-pull output, simply connect OUT (sink output) pin to OUT_H pin.

Since each voltage comparator has its own complementary outputs, each comparator can be configured to have a different output type. For example, one comparator output can be connected as Open Drain output while the other comparator can be wired as push-pull output. If used to drive capacitive loads, the output DC current levels are at a very low level, at essentially leakage current levels, which can be a power saving feature.

The ALD2321A/ALD2321B/ALD2321 can detect and resolve very low voltage levels at high speed, with little or no overdrive voltage. Compared with other voltage comparator devices that require 100 mV overdrive voltages, or multiple stage circuits that include input preamp, etc., the ALD2321A/ALD2321B/ALD2321 can perform all input to output functions in one device with minimal delay time and with as low as a 1mV signal.

The ALD2321A/ ALD2321B/ ALD2321 is supplied with 4 external e-trim pins, VE11, VE12, VE21 and VE22. These pins are used for trimming of the voltage comparator offset voltages

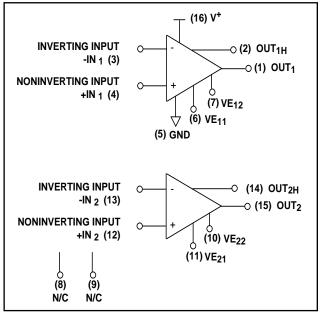
ALD2321 PIN IDENTIFICATION

at the factory, and normally should be left open unconnected. However, in some cases these pins can be used as positive/ negative feedback pins, since these pins have a positive/ negative factor on the offset voltage. For example, see TYPI-CAL APPLICATIONS section titled "Voltage Comparator With Output Feedback to Provide Hysteresis."

In printed circuit board layout, it is suggested that these pins, along with no connect (N/C) pins 8 and 9, be surrounded with ground traces to prevent any possible crosstalk and noise coupling from other signal sources.

Although not required for most applications, if necessary, small valued capacitors of approximately 1000 pF can be mounted at these pins to ground to further reduce noise. For information on customized trimming under different biasing and power supply conditions, please contact factory.

BLOCK DIAGRAM



PIN #	SYMBOL	FUNCTION	SIGNAL PROPAGATION			
1	OUT1	COMPARATOR 1 SINK OUTPUT	OUTPUT			
2	OUT1H	COMPARATOR 1 SOURCE OUTPUT	OUTPUT			
3	-IN1	COMPARATOR 1 INVERTING INPUT	INPUT			
4	+IN1	COMPARATOR 1 NON-INVERTING INPUT	INPUT			
5	GND	GROUND / V- SUPPLY	-			
6	VE11	- VOS E-Trim COMPARATOR 1	INPUT			
7	VE ₁₂	+ VOS E-Trim COMPARATOR 1	INPUT			
8	N/C	No Connect/Do Not connect externally	-			
9	N/C	No Connect/Do Not connect externally	-			
10	VE22	+VOS E-Trim COMPARATOR 2	INPUT			
11	VE ₂₁	- VOS E-Trim COMPARATOR 2	INPUT			
12	+IN2	COMPARATOR 2 NON-INVERTING INPUT	INPUT			
13	-IN2	COMPARATOR 2 INVERTING INPUT	INPUT			
14	OUT2H	COMPARATOR 2 SOURCE OUTPUT	OUTPUT			
15	OUT ₂	COMPARATOR 2 SINK OUTPUT	OUTPUT			
16	V+	V+ SUPPLY	-			

ABSOLUTE MAXIMUM RATINGS

Supply voltage, V+	+10.6V
Differential input voltage range	-0.3V to V++0.3V
Power dissipation	600 mW
Operating temperature range PC, SC package	0°C to +70°C
DC package	55°C to +125°C
Storage temperature range	65°C to +150°C
Lead temperature, 10 seconds	+260°C

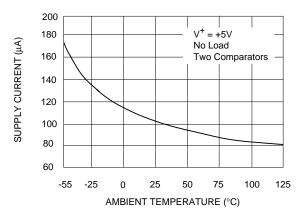
OPERATING ELECTRICAL CHARACTERISTICS $T_A = 25^{\circ}C V^+ = +5V$ unless otherwise specified

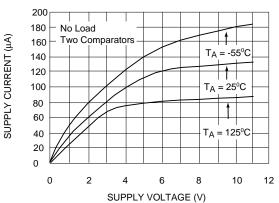
Parameter		2321A		2321B			2321					
	Symbol	Min	Тур	Max	Min	Тур	Max	Min	Тур	Max	Unit	Test Conditions
Supply Voltage	V +	3		10	3		10	3		10	V	
Supply Current	IS		110	180		110	180		110	180	μA	No Load Two Comparators
Voltage Gain	AVD	50	150		50	150		50	150		V/mV	RLOAD ≥ 15K
Input Offset Voltage	Vos		0.05	0.2		0.2	0.5		0.5	1.0	mV	RLOAD ≥ 1.5KΩ
Input Offset Current ¹	IOS		0.01	20		0.01	20		0.01	20	pА	
Input Bias Current ¹	IB		0.01	20		0.01	20		0.01	20	рА	
Common Mode Input Voltage Range ²	VICR	-0.3		V+ -1.5	-0.3		V+ -1.5	-0.3		V+ -1.5	V	
Low Level Sink Output Voltage	VOL		0.15	0.4		0.15	0.4		0.15	0.4	V	ISINK = 12mA VINPUT = 1V Differential
Low Level Sink Output Current	IOL	24	50		24	50		24	50		mA	V _{OL} = 1.0 V SINK OUTPUT ON
High Level Source Output Voltage	VOH	3.5	4.5		3.5	4.5		3.5	4.5		V	ISOURCE = -2mA SOURCE OUTPUT ON
Source Output Leakage Current	IHL		0.01	1		0.01	1		0.01	1	nA	VOH = 0.0V SOURCE OUTPUT OFF
Sink Output Leakage Current	١L		0.01	20		0.01	20		0.01	20	nA	VOUT = 5.0 V SINK OUTPUT OFF
Response Time ²	^t RP		1.1			1.1			1.1		μs	$\label{eq:RL} \begin{array}{l} R_L = 5.1 K \Omega, \ C_L = 15 p F \\ \\ 5 m V \ Input \ Step / \\ \\ 0 m V \ Overdrive \end{array}$
	^t RP		2.4			2.4			2.4		μs	RL = 5.1KΩ ,CL =15pF 1mVInput Step/ 0mV Overdrive
Common Mode Rejection Ratio	CMRR		80			80			80		dB	VINPUT = 0V to 2.5V
Power Supply Rejection Ratio	PSRR		75			75			75		dB	V+ = 4V to 5V
Change of Vos / VExx	$\frac{\Delta VOS}{\Delta VE}$		5			5			5		mV/V	VE pins No Load

Notes: ¹ Consists of junction leakage currents ² Sample test parameter

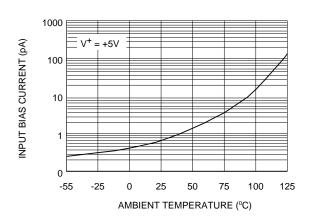
TYPICAL PERFORMANCE CHARACTERISTICS

SUPPLY CURRENT vs.TEMPERATURE





INPUT BIAS CURRENT vs. TEMPERATURE



vs. TEMPERATURE 0.5 ISINK = 12mA 0.4 VINPUT = 1V Differential ۷+ = +3.5V 0.3 0.2 V⁺ = +5V 0.1 V^+ = +10V 0.0 75 125

25

50

AMBIENT TEMPERATURE (°C)

100

LOW LEVEL OUTPUT VOLTAGE

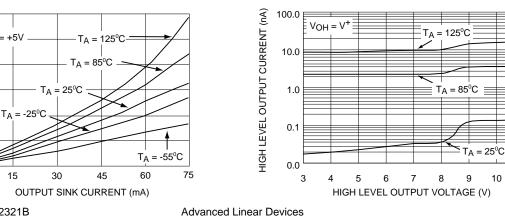


-55

-25

0

LOW LEVEL OUTPUT VOLTAGE (V)



ALD2321A/ALD2321B ALD2321

0

OUTPUT SATURATION VOLTAGE (V)

3.0

2.5

2.0

1.5

1.0

0.5

0.0

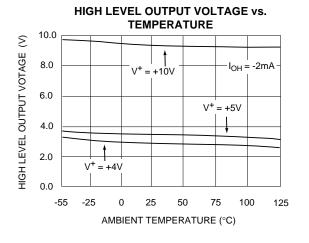
4

10

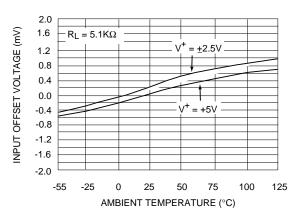
11

SUPPLY CURRENT vs. SUPPLY VOLTAGE

TYPICAL PERFORMANCE CHARACTERISTICS

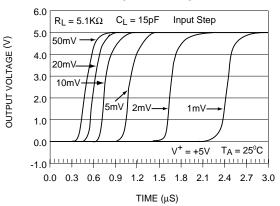


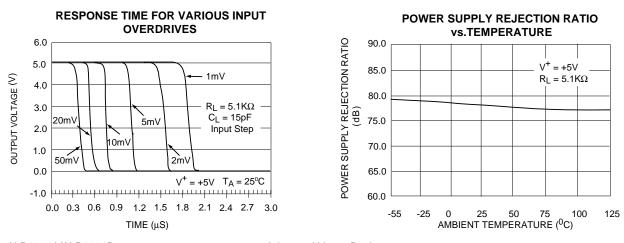
INPUT OFFSET VOLTAGE vs. TEMPERATURE



COMMON MODE REJECTION RATIO vs. TEMPERATURE 90.0 COMMON MODE REJECTION MODE $V^{+} = +5V$ 85.0 $R_L = 5.1 K\Omega$ 80.0 <u>କ</u> 75.0 70.0 65.0 60.0 -55 -25 0 25 50 75 100 125 AMBIENT TEMPERATURE (°C)

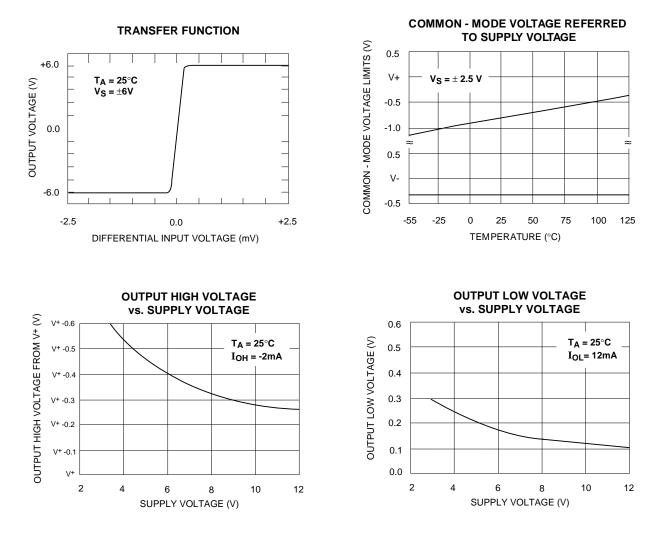
RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES





ALD2321A/ALD2321B ALD2321

Advanced Linear Devices

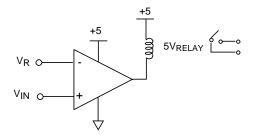


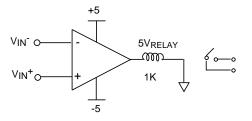
TYPICAL PERFORMANCE CHARACTERISTICS



PRECISION SINGLE SUPPLY VOLTAGE COMPARATOR WITH DIRECT RELAY DRIVER

VOLTAGE COMPARATOR WITH +/-5V SUPPLY AND +5V RELAY DRIVE





Q VA= 1V to +30V

R_{Load2}=1K

2N2222

 \forall

VOLTAGE COMPARATOR WITH COMPLEMENTARY OUTPUT DRIVERS

γ +5V

15K

 $\begin{cases} R_{Load1} \\ = 2000 \end{cases}$ =200Ω

Q+5V

ç

-5V

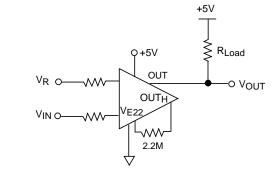
OUTH

VIN O

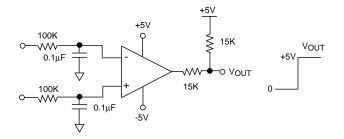
VIN⁺

С

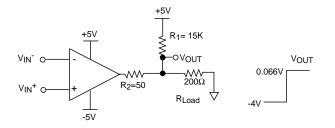
VOLTAGE COMPARATOR WITH OUTPUT FEEDBACK TO PROVIDE HYSTERSIS



VOLTAGE COMPARATOR WITH +/-5V SUPPLY AND OUTPUT LEVEL SHIFT

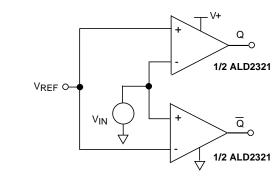


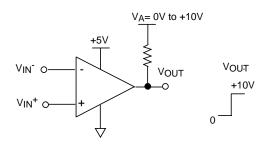
VOLTAGE COMPARATOR WITH OUTPUT LEVEL SHIFT AND HIGH CURRENT LOAD DRIVER



VOLTAGE COMPARATOR WITH SINGLE SUPPLY AND OUTPUT LEVEL SHIFT

VOLTAGE COMPARATOR WITH COMPLEMENTARY OUTPUTS



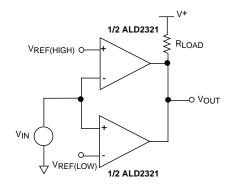


ALD2321A/ALD2321B ALD2321

Advanced Linear Devices

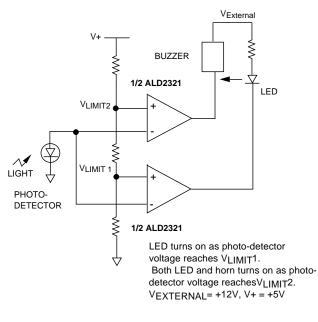
TYPICAL APPLICATIONS

DUAL LIMIT WINDOW COMPARATOR



 $[\]label{eq:rload} \begin{array}{l} \mathsf{R}_{LOAD} = 1.5 \mathrm{K}\Omega \\ \\ \mathsf{OUTPUT} \ \mathsf{HIGH} \ \mathsf{FOR} \ \mathsf{V_{IN}} < \mathsf{V}_{\mathsf{REF}(\mathsf{HIGH})} \\ \\ \mathsf{AND} \ \mathsf{V_{IN}} > \mathsf{V}_{\mathsf{REF}(\mathsf{LOW})} \end{array}$

DUAL LIMIT PHOTO DETECTOR MONITOR



RESPONSE TIME MEASUREMENT CIRCUIT

Response time is defined as the internal between the application of an input step function and the instant when the output reaches 50% of its maximum value as measured by the following test circuit:

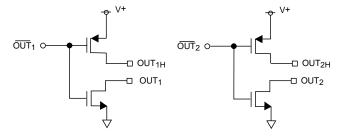
√₩ 1KΩ +5V

≷

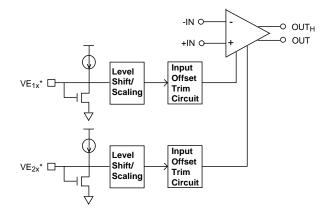
5.1KΩ

-O OUT

PINS OUT1, OUT1H, OUT2, OUT2H, INTERNAL CIRCUIT CONFIGURATIONS







* These pins should be isolated by surrounding them with ground trace in user's applications.

10X INPUT STEP

VIN O-