USER MANUAL

FOR

THE LM2901 QUAD VOLTAGE COMPARATOR

FUNCTIONAL MODULE

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Introduction

Comparators have many practical applications which mostly include implementation of instrumentation systems. However, comparators may also be used for timing and vibration.

Many of the internal components of a voltage comparator are transistors. Every transistor has a base, emitter, and collector. The output of the comparator is connected to the collector of the last transistor in the chip. If a pull-up resistor is not connected to the output, the comparator will not function properly. This is called an *open collector output*.

For the situation in this module, the input voltage is a DC signal. The purpose of the comparator circuit is to evaluate the difference between the input voltage and the reference voltage. In a comparator, different input voltages yield different outputs. For input voltages that are significantly larger than the reference voltage, the output voltage will be high—the LED will illuminate. For input voltages that are smaller than the reference voltage, the output of the comparator will be low—the LED will be off. For the purposes in this laboratory, the comparator becomes a light ‘switch.’

Comparators, however, are not mainly used for illumination. The LED serves as a tool to visualize what is happening. Without the LED, the output could still be quantified. However, an LED allows observation of the output without making specific measurements. For practical applications, a microcontroller is connected to the output from a comparator. The high or low voltage input to the microcontroller will cause different responses.

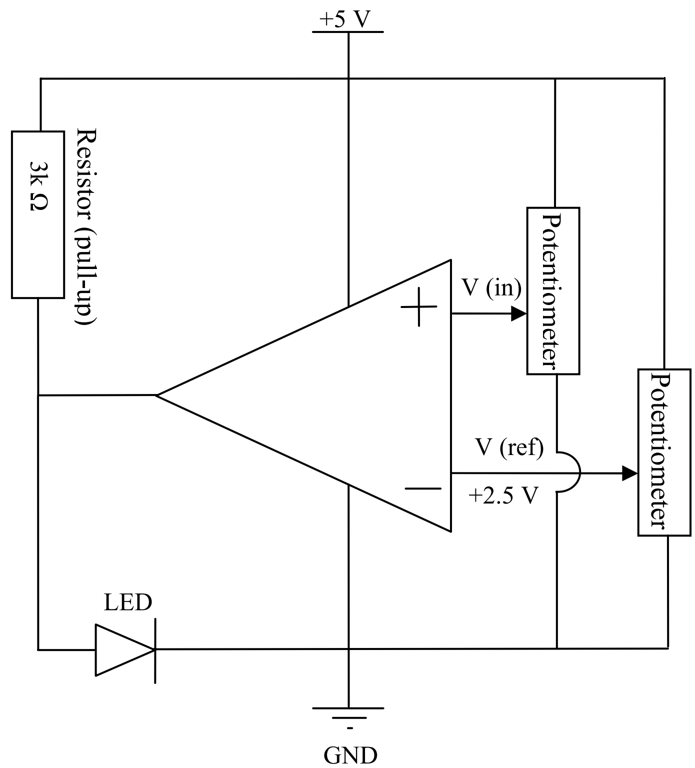


Figure 1. Circuit diagram for basic comparator function—module application

Theory and Predictions

The internal composition of a voltage comparator is, in essence, a modified operational amplifier (op-amp) circuit. A more detailed explanation of op-amps is provided in the corresponding module. An important note about op-amps is that they are integrated circuits. An integrated circuit is a collection of individual and electronic circuits that are composed on a single wafer. For the purposes of this module, a thorough discussion of these contents is not necessary. For a comparator application, as opposed to ground (in a non-inverting operational amplifier), a reference voltage is applied to the negative terminal.

In this module, and for most applications, the reference voltage is held constant. The comparator allows a current to flow through the LED if the difference between the input voltage and the reference voltage has a quantity greater than zero.

The value of the output voltage is dependent on the value of the voltage the pull-up resistor is connected to, as well as the static value of the pull-up resistor. If the input voltage is less than the reference voltage, the current from the pull-up resistor will enter the comparator and flow to ground, thus leaving the LED turned off. Be careful: the current through the LED must not exceed its maximum capacity, or the LED will burn out. Also, when calculating the reference voltage theoretically, the voltage drop across the LED is approximately 1.7 V.

Note: there is a buffer zone in which the comparator will not function if the input voltage is greater but very close to the reference voltage. Therefore, in order for the circuit to operate properly, there must be a significant difference between the two. For example: observe the experimental results (table 5)—for an input voltage .06 V above the reference voltage, the LED experiences no current.

Functional Module Description

The functional module consists of: the LM2901 Quad Voltage Comparator chip, a static resistor, two potentiometers, and one small light emitting diode (LED). The comparator chip requires a supply voltage (5 V) and ground (0 V), as well as the input and reference voltages. The potentiometers are used to vary the input voltage by changing its internal resistance so as to set the reference and input voltages. Resistors are used to protect the circuit, as well as vary the output.

Wiring Instructions

Table 1: Outline for circuit connections.

Red	Supply to the comparator, 5V
	Input to the potentiometers
	Supply to 3kΩ resistor
Black	Comparator to ground, 0V
	Potentiometers to ground
	LED to ground
Yellow	Potentiometers to input and reference terminals
	Output to resistor
	Resistor to LED

LM2901 Chip Specifications

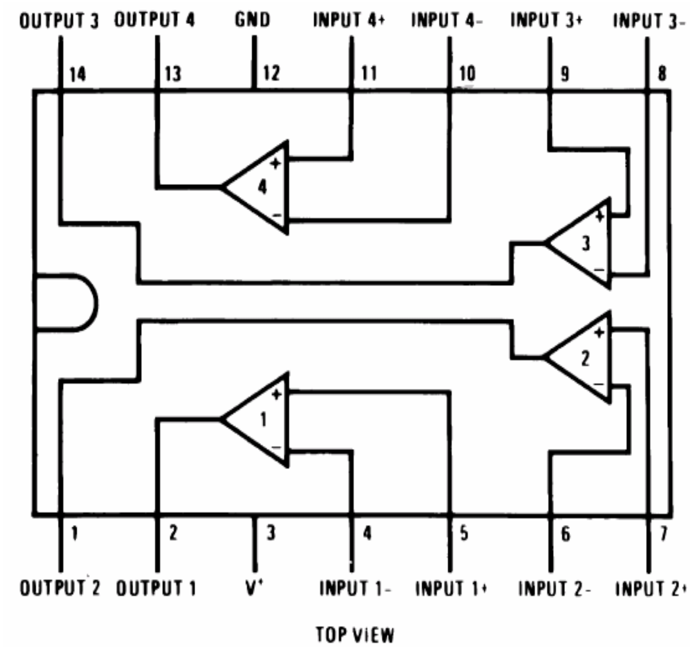
Table 2: Comparator performance features.

LM2901 Comparator Features	
Voltage Range	2-36 Vdc or ±1- ±18 Vdc
Supply Current Drain	.8 mA
Input Biasing Current	25 nA
Input Offset Current	±5 nA
Offset Voltage	±3 mV
Output Saturation Voltage	250 mV at 4 mA

Table 3: Maximum comparator ratings.

Absolute Maximum Ratings	
Supply Voltage	36 Vdc or ±18 Vdc
Differential Input Voltage	36 Vdc
Storage Temperature Range	-65 °C to 150 °C
Lead Temperature (soldering 10 sec)	260 °C
Operating Temperature Range	-40 °C to 85 °C

LM2901 Connection Diagram



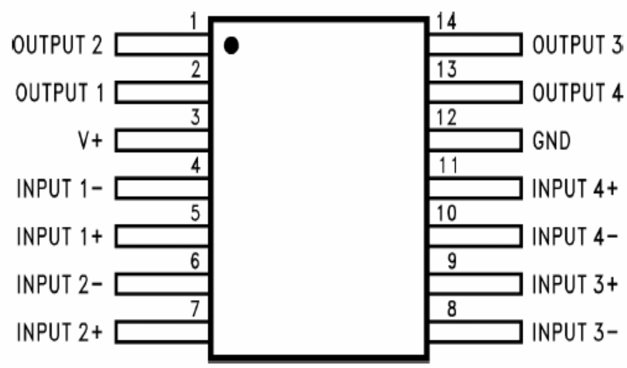


Figure 2: Comparator chip layout. **Figure 3: Comparator connection diagram**

Apparatus

Table 4: Functional equipment list.

Digital multimeter or equivalent voltmeter
Power source
Voltage box with 5V outlet and 0V ground
Constructed comparator circuit box

Testing Sequence

Once the comparator is connected to a power supply, the circuit is ready for experimentation. The reference voltage is set at half of the supply voltage (2.5V). Connect the voltmeter to the input voltage and ground. Adjust the input voltage, while monitoring its level. Notice the voltage at which the LED illuminates—when the ‘switch’ is ‘on.’ A table representing these results is found in table 5.

Table 5: Testing sequence results for a varying input voltage.

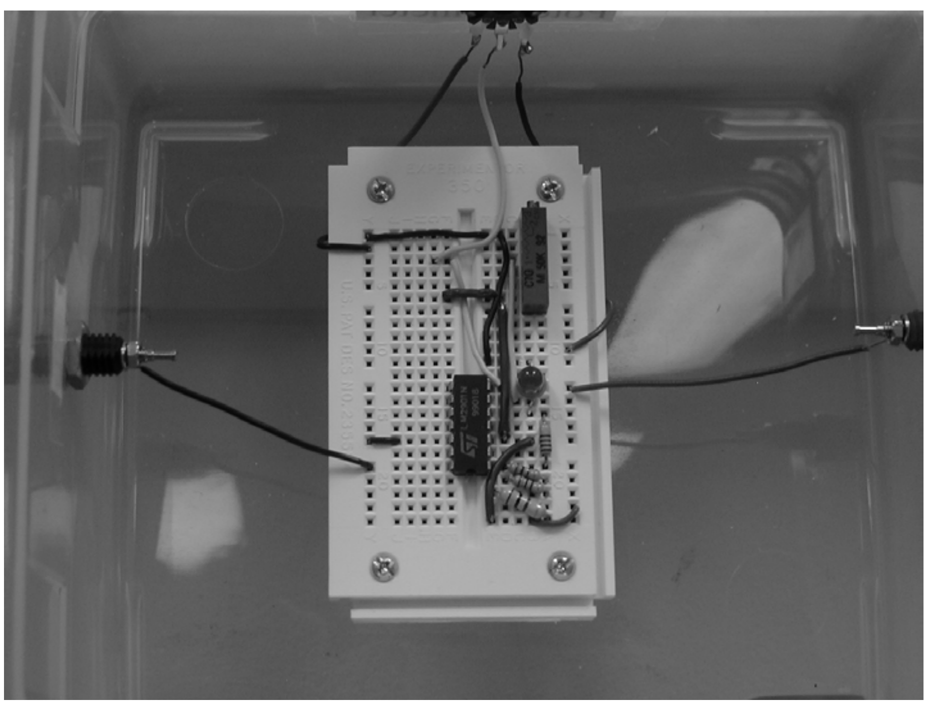
V(ref) [Volts]	V(in) [Volts]	V(out) [Volts]	LED on?
2.5	1	0.14	no
2.5	2.5	0.14	no
2.5	2.57	3.08	yes
2.5	4	3.08	yes

List of Parts

Table 6: Comparator circuit supply list.

Part	Value	Unit
LM2901 Quad Voltage Comparator Chip	N/A	N/A
Pull-up Resistor	3000	Ω
Potentiometer	50,000	Ω
LED	N/A	N/A
Voltage Box	5	V
Breadboard	N/A	N/A
Red Wire	N/A	N/A
Black Wire	N/A	N/A
Yellow Wire	N/A	N/A
Voltmeter	N/A	N/A

Picture 1: Comparator module construction



References

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