Name ____________________

Date ____________________

Instructor ____________________

EXPERIMENT

30

Comparator Circuits Operation

OBJECTIVE

To measure DC and AC operation using comparator IC circuits.

EQUIPMENT REQUIRED

Instruments

Oscilloscope
DMM
Function generator
DC power supply

Components

Resistors

(1) 1-kΩ
(1) 3.3-kΩ
(3) 10-kΩ
(1) 20-kΩ
(3) 100-kΩ
(1) 50-kΩ potentiometer

Capacitors

(2) 15-µF
(1) 100-µF

Transistors and ICs

(1) 2N3904
(1) 741 Op-amp IC (or equivalent)
(1) 339 Comparator IC (or equivalent)
(1) LED (20 mA)

EQUIPMENT ISSUED

Item	Laboratory serial no.
DC power supply	
Function generator	
Oscilloscope	
DMM	

RÉSUMÉ OF THEORY

A comparator circuit is essentially a very high gain op-amp having a plus (+) and a minus (–) input. The output of the comparator is a logic level that provides an indication of when the plus input voltage is greater than the minus input or when the plus input is less than the minus input. Although an op-amp can be used for this purpose, special comparator ICs are available which are better suited for this operation.

Figure 30.1 shows a 741 op-amp used as a level detector. The reference level voltage V_{ref} is set at +5 V. The indicator LED goes *on* whenever the input V_i goes *below* V_{ref} and goes *off* whenever V_i goes *above* V_{ref}. Figure 30.2 shows a similar operation using a 339 comparator IC.

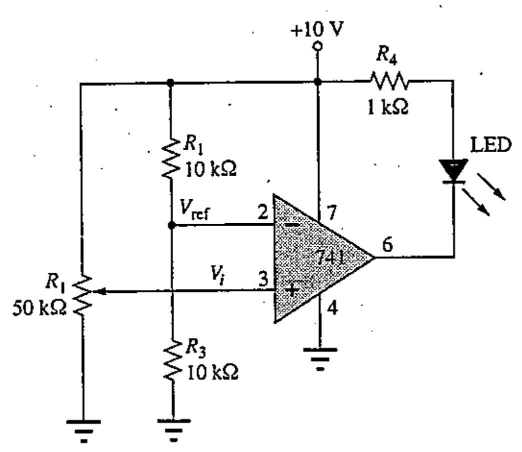

Figure 30-1

Figure 30.3 shows two comparator stages connected as a window detector—a circuit which provides indication of whenever the input voltage is *within* a specified range of voltage.

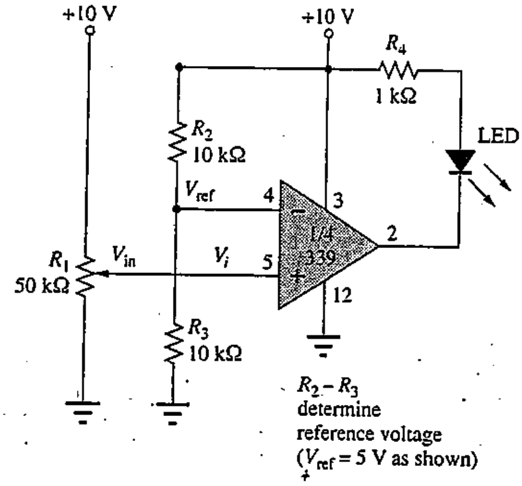

Figure 30-2

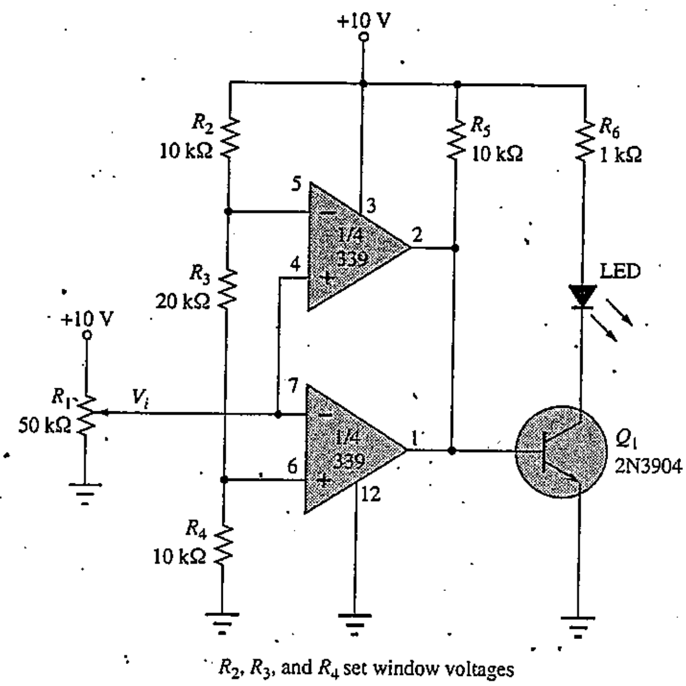

Figure 30-3

PROCEDURE

Part 1. Comparator with 741IC Used as a Level Detector

a. For the circuit of Fig. 30.1 verify that V_{ref} = 5 volts.

V_{ref} (verified) = ________ (R_3 = 10 kΩ)

b. Construct the circuit of Fig. 30.1. (Measure and record resistor values in Fig. 30.1.)

c. Using a DMM measure the reference voltage, V_{ref}.

V_{ref} (measured) = ____________

d. Adjust potentiometer R_1 so that the LED just goes *on**, and then just goes *off*. Record the voltage V_i for each condition.

V_i (measured) (LED goes *on*) = ____________
V_i (measured) (LED goes *off*) = ____________

e. Replace R_3 with a 20-kΩ resistor and repeat steps 1(**b**) and 1(**c**).

V_{ref} (measured) = ____________
V_i (measured) (LED goes *on*) = ____________
V_i (measured) (LED goes *off*) = ____________

Compare the values of V_{ref} calculated in step 1(**a**) with those measured in steps 1(**c**) and 1(**e**).

*The potentiometer could be replaced by a rectified triangular wave at 100 Hz to provide the V_i input. The V_i signal and comparator V_o can then be observed simultaneously on the oscilloscope.

Part 2. Comparator with 1/4 339IC Used as Level Detector

a. For the circuit of Fig. 30.2 calculate V_{ref}.

V_{ref} (calculated) = __________ ($R_3 = 10\ k\Omega$)

Repeat the calculation for $R_3 = 20\ k\Omega$.

V_{ref} (calculated) = __________ ($R_3 = 20\ k\Omega$)

b. Construct the circuit of Fig. 30.2. (Measure and record resistor values in Fig. 30.2.)

c. Using a DMM measure the reference voltage.

V_{ref} (measured) = __________ ($R_3 = 10\ k\Omega$)

d. Adjust potentiometer R_1 so that the LED just goes *on** and also just goes *off*. Measure the input voltage for each condition.

V_i (measured) = __________ (LED goes *on*)

V_i (measured) = __________ (LED goes *off*)

e. Replace R_1 with a 20-kΩ resistor. Repeat steps **c** and **d**.

V_{ref} (measured) = __________ ($R_3 = 20\ k\Omega$)

V_i (measured) = __________ (LED goes *on*)

V_i (measured) = __________ (LED goes *off*)

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*see footnote on page 322.

f. Interchange connections at pins 4 and 5 so that V_i goes to the *minus* input and V_{ref} goes to the *plus* input. Repeat step 2(**d**).

V_i (measured) = ________ (LED goes *on*)

V_i (measured) = ________ (LED goes *off*)

Compare the calculated and measured voltages in steps 2(**c**) through 2(**f**) with that calculated in step 2(**a**).

Part 3. Window Comparator

a. For the circuit of Fig. 30.3 calculate V^+ (pin 5) and V^- (pin 6).

V^+ (calculated) (pin 5) = ____________

V^- (calculated) (pin 6) = ____________

b. Construct the circuit of Fig. 30.3. (Measure and record resistor values in Fig. 30.3.)

c. Using a DMM measure the voltages at pins 1, 5, and 6.

V_i (measured) (pin 1) = ____________

V^+ (measured) (pin 5) = ____________

V^- (measured) (pin 6) = ____________

d. Adjust V_i from 0 V to +10 V*. Measure the voltage levels at which the LED goes *on* and then goes *off*.

V_i (measured) = ________ (LED goes *on*)

V_i (measured) = ________ (LED goes *off*)

e. Adjust V_i from +10 V to 0 V. Measure the voltage levels at which the LED goes *on* and then goes *off*.

V_i (measured) = ________ (LED goes *on*)

V_i (measured) = ________ (LED goes *off*)

f. Interchange resistors R_3 and R_4 and repeat step 3(**d**).

V_i (measured) = ________ (LED goes *on*)

V_i (measured) = ________ (LED goes *off*)

Compare the calculated values in step 3(**a**) with those measured in step 3(**c**).

*see footnote on page 322.