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| **Course Name:** | **Linear Integrated Circuits and Design** | **Semester:** | **V** |
| **Date of Performance:** | **07/08/2020** | **Batch No:** | **B1** |
| **Faculty Name:** | **Prof. Milind Marathe** | **Roll No:** | **1912052** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **/25** |

**Experiment No: 4**

**Title: Design a Schmitt Trigger (Inverting) with UTP & LTP values.**

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| **Aim and Objective of the Experiment:** |
| To Design and study the working of Schmitt Trigger using op-amp IC 741.   * To analyze the Schmitt Trigger * To verify UTP and LTP values practically |

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| **COs to be achieved:** |
| **CO3:** Design circuits using op-amps as nonlinear applications. |

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| **Theory:** |
| The class of Comparators which use the positive (regenerative) feedback is called as Schmitt Trigger or Regenerative comparators. The Schmitt trigger circuit is as shown below. The resistance divider formed by R1 & R2, connected between the output and the non-inverting terminal of the op amp, introduces positive feedback. This Schmitt trigger circuit is basically an inverting comparator with positive or regenerative feedback introduced. Thus it is called as regenerative comparator. Note that the sine wave has been applied as the input voltage to the inverting input. |

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| **Circuit Diagram/ Block Diagram:** |
| 1. **For UTP=4V and LTP = -4 V.** |
| 1. **For UTP =4V and LTP = -2 V** |
| 1. **For UTP =4V and LTP = 0V** |

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| **Stepwise-Procedure:** |
| 1. Connect the circuit as shown in the fig 1) and 2) with proper resistances used.  2. Observe the waveforms at the input and output terminal.  3. Verify observed and theoretical values.  4. Change the peak value of Vin from 10V to 12V and to 3V and observe Vout.  5. Also observe the hysteresis of the circuit keeping CRO in X-Y mode.  6. Observe Vout waveform If we reduce the value of R2 = 0.  7. Draw input and output waveforms as observed on CRO for both the circuits with scale.  8. Comment and draw if necessary for points 4, 5and 6 in procedure. |

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| **Observation Table:** |
| 1. **For UTP=4V and LTP = -4 V.**  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Sr. No.** | **Vin(peak)** | **Theoretical values** | **Practical Values** | **Vout(p-p)** | | 1. | 10V | UTP=4V, LTP = -4 V | UTP=4V, LTP = -4 V | 20V(p-p)(Square wave) | | 2. | 12V | UTP=4V, LTP = -4 V | UTP=4.5V, LTP = -4.5 V | 20V(p-p)(Square wave) | | 3. | 3V | -- | -- | Vout=10V(DC) |  1. **For UTP =4V and LTP = -2 V.**  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Sr. No.** | **Vin(peak)** | **Theoretical values** | **Practical Values** | **Vout(p-p)** | | 1. | 10V | UTP=4V, LTP = -2V | UTP=4V, LTP = -1V | 20V(p-p) (Square wave) | | 2. | 12V | UTP=4V, LTP = -2V | UTP=4.5V, LTP = -2V | 20V(p-p) (Square wave) | | 3. | 3V | -- | -- | Vout=10V(DC |  1. **For UTP =4V and LTP = 0V.**  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Sr. No.** | **Vin(peak)** | **Theoretical values** | **Practical Values** | **Vout(p-p)** | | 1. | 10V | UTP=4V, LTP = 0 V | UTP=4V, LTP = 0 V | 20V(p-p) (Square wave) | | 2. | 12V | UTP=4V, LTP = 0V | UTP=4.5V, LTP = 0V | 20V(p-p) (Square wave) | | 3. | 3V | -- | -- | Vout=10V(DC | |

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| **Calculation:** |
| **Design:-**  1) For UTP=4Vand LTP=4V.(Assume VCC=12V,VEE=-12V) & (Assume +Vsat=10V,-Vsat=-10V)  *Assume R1=10KΩ*  *R2=15 KΩ*  *Assume R1=10KΩ*  *R2=15 KΩ*  2) For UTP=4V and LTP=2V.(Assume VCC=12V,VEE= -12V)&(Assume +Vsat=10V,-Vsat=10V)  *Assume R1=10KΩ*  *R2=15 KΩ*  *Assume R1=10KΩ*  *R2’=40KΩ*  *R3=47KΩ(pr actical value)*  3)For UTP =4Vand LTP=0V(Assume VCC=12V,VEE=-12V)&(Assume +Vsat=10V,-Vsat=-10V)  *Assume R1=10KΩ*  *R2=15 KΩ*  *Assume R1=10KΩ*  *R3=infinite* |

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| **Waveforms:** |
| **1. For UTP=4V and LTP = -4 V**      **2.** **For UTP =4V and LTP = -2 V**      3. **For UTP =4V and LTP = 0V** |

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| **Post Lab Subjective/Objective type Questions:** |
| 1. How can you obtain triangular wave using schmitt trigger?   Ans:- The arrangement consists of a non-inverting Schmitt trigger and an integrator. The output of a  Schmitt trigger is a rectangular wave that drives an integrator. The output of the integrator is a  triangular wave, which is fed back and used to drive the Schmitt trigger. Thus first stage drives  the second, and the second drives the first.  When the Schmitt trigger is connected to power supplies for the first time, the output of the  Schmitt trigger must be either low or high. When the Schmitt trigger output is low, the output of  the integrator will be a rising ramp while for Schmitt trigger high output, the integrator will  produce falling ramp. Either way, the triangular waveform has started, and the positive feedback  will keep it going.  The transfer characteristic of the Schmitt trigger is shown in figure. When the output is low, the  input must increase to the UTP to switch the output to high. Likewise, when the output is high,  the input must fall to the LTP to switch the output to low. The triangular-wave produced by the  integrator is capable of driving the Schmitt trigger. When the output of Schmitt trigger is low, the  integrator develops a rising ramp which increases till it reaches UTP, as illustrated in figure. At  this point the output of the Schmitt Trigger switches to the high state and forces the triangular  wave to reverse in direction. The negative or falling ramp produced by the integrator now falls till  it reaches LTP, where another Schmitt output change occurs.   1. Why Schmitt trigger is called regenerative comparator?   Ans:- A Schmitt trigger circuit is also called a regenerative comparator circuit. The circuit is designed  with a positive feedback and hence will have a regenerative action which will make the output  switch levels. Also, the use of positive voltage feedback instead of a negative feedback, aids the  feedback voltage to the input voltage, instead of opposing it. The use of a regenerative circuit is  to remove the difficulties in a zero-crossing detector circuit due to low frequency signals and  input noise voltages.It is basically an inverting comparator circuit with a positive feedback. The purpose of the Schmitt trigger is to convert any regular or irregular shaped input waveform into a square wave .   1. What is hysteresis voltage in Schmitt trigger?   Ans:- The hysteresis voltage is the difference between the upper and lower threshold voltages.  V hysteresis = VUTP – VLTP |

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| **Conclusion:** |
| We have successfully implemented and observed the working of Schmitt Trigger for different UTP and LTP values |

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| **Signature of faculty in-charge with Date:** |