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ABSTRACT

This document contains student progress checks designed for use with individualized modules 23 through 25 in the military-developed course on basic electricity and electronics. The course is one of a number of military-developed curriculum packages selected for adaptation to vocational instructional and curriculum development in a civilian setting. One experiment and one progress check is provided for each lesson in the modules. Answers are included at the conclusion of each module. (LRA)

CHIEF OF NAVAL EDUATION AND TRAINING

MARCH 1977

Military Curricula for Vocational & Technical Education

BASIC ELECTRONICS SCHOOL.

MODULES 23 - 25. MULTIVIBRATORS, WAVESHAPING CIRCUITS, SPECIAL DEVICES.

PROGRESS CHECKS.

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
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NORTHWEST
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The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL

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The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

THE NATIONAL CENTER
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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

MODULES

TWENTY THREE

MULTIVIBRATORS

TWENTY FOUR

WAVE SHAPING CIRCUITS

TWENTY FIVE

SPECIAL DEVICES

PROGRESS CHECK BOOKLET

MODULE TWENTY THREE

MULTIVIBRATORS

PROGRESS CHECK BOOKLET

EXPERIMENT
LESSON 1

Bistable Multivibrator

The operation of a bistable multivibrator will be demonstrated by performing the steps outlined in this Experiment.

Using an oscilloscope, you will observe the change in state of the "1" and "O" outputs of the multivibrator when the proper input is applied.

EQUIPMENT REQUIRED

Oscilloscope
Device 6F16 with template "G" bistable multivibrator
1X probe (three required)

PROCEDURE

I. Using all applicable safety precautions, energize the oscilloscope, obtain a line trace, and make the following settings:

a. CHANNEL SELECT to "Chopped".
b. SENSITIVITY CONTROL (both channels) 5 volts/centimeter.
c. SWEEP TIME to .5 millisec/centimeter.
d. A.C./D.C. to "D.C." (both channels).
e. Set channel "A" line trace 2 centimeters above center line. Set channel "B" line trace 1 centimeter below center line.
f. Connect 1X probes to channel "A" and "B" inputs.

II. Using all applicable safety precautions, set up Device 6F16 as follows:

a. Set up 6F16 using Template #G (Flip Flop multivibrator) and the parts called for by the template.
b. Connect one end of a jumper to + 4 volts (+ volt "battery" jack or the bottom of R3 or R6) leave the other end looze.
c. Connect channel "A" probe to the "1" output (Q1 collector).
d. Connect channel "B" probe to the "O" output (Q2 collector).
e. Energize the 6F16 using the line cord.

III. Now you are ready to observe the operation of the multivibrator.

1. What is the DC voltage level at the "1" output? ______________ VDC

2. What is the DC voltage level at the "O" output? ______________ VDC

3. Which transistor is conducting? ______________________________

4. The initial state of the multivibrator is determined by__________
____

5. Using the free end of the jumper (+4 volt source) momentarily touch the anode of CR 1. Did the flip-flop change state?
____

6. Momentarily apply +4 volts to the anode of CR 2. Did the flip-flop change state?______________________

7. What conduction state are the transistors in now? Q1__________ Q2______________

8. Touch the jumper to the anode of CR 2 again. Did the flip-flop change state?_______________

9. Touch the jumper to the anode of CR 1. Did the flip-flop change state?________________

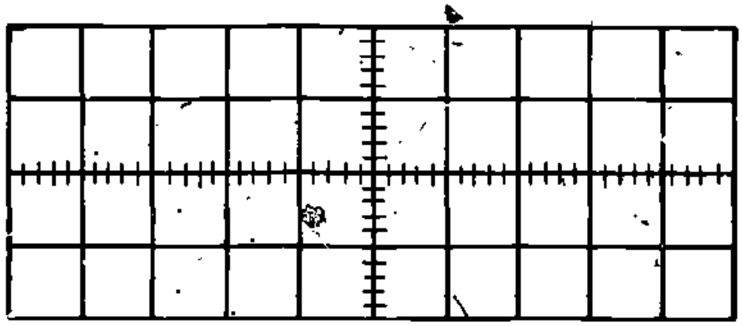
10. What conduction states are the transistors in now? Q1____________ Q2______________

IV. The following procedure will demonstrate the flip-flop action with a series of pulses applied to the circuit.

1. Remove the jumper from the +4 volt source.

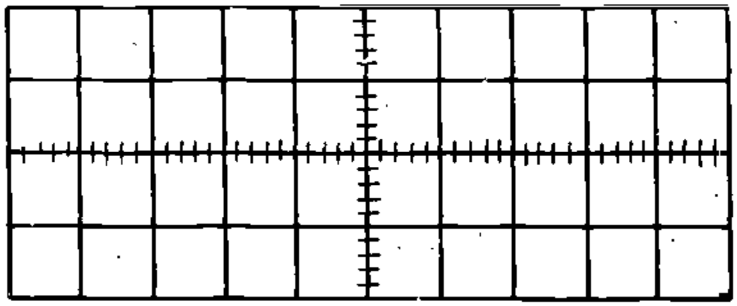
2. Connect a third 1X probe to J2 on the Test Output Box located on the top of the Carrel. Connect the other end of the 1X probe to the shorting strap that is connected between C1 and C2. You now have a 1KHz square wave input applied to C1 and C2. C1 - CR1 and C2 - CR2 are used in this circuit to shape the square wave input into positive triggers that are applied to the base of each of the transistors..

3. Observe the outputs at the collectors of the two transistors and draw the observed waveforms in the graticule below.



4. Disconnect the probe from the "O" output (oscilloscope channel "B") and reconnect it to the shorting strip between C1 and C2. Set "B" channel SENSITIVITY to 20 v/cm. The "B" channel of the oscilloscope will now display the input signal.

5. Draw the waveforms displayed on the oscilloscope in the space below.



6. What is the frequency relationship between the input (Channel "B") and the output (Channel "A")?____________________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II PROGRESS CHECK.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON I

Bistable Multivibrators

1. The bistable (flip-flop) multivibrator as __________stable states.

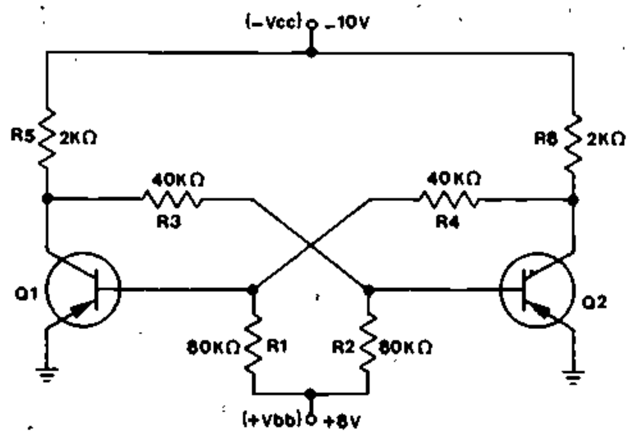
2. Bistable (flip-flops) multivibrators act like two-position electronic_________________________________.

3. The flip-flop (bistable) multivibrator will/will not change states when an external trigger of the correct amplitude is applied at the proper input.

4. The flip-flop (bistable) multivibrator has two inputs and________ output(s).

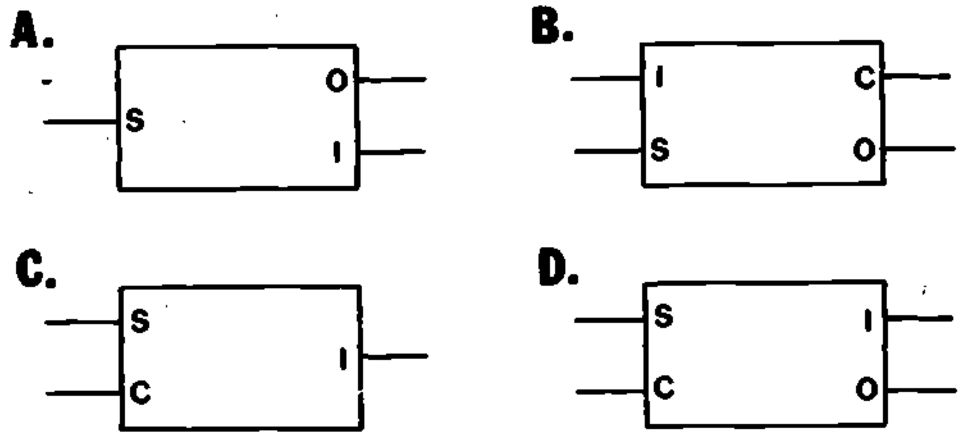
5. In a flip-flop multivibrator, when one transistor is saturated, the other transistor must be__________________________.

6. In the circuit illustrated, which voltage divider network supplies the bias potential to the base of Q1?__________________________

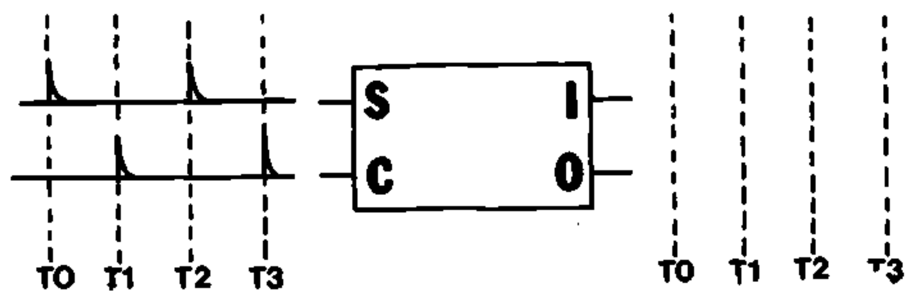


7. To change the state of a flip-flop multivibrator (illustrated in question #6), a positive/negative pulse may be applied to the base of the saturated transistor.

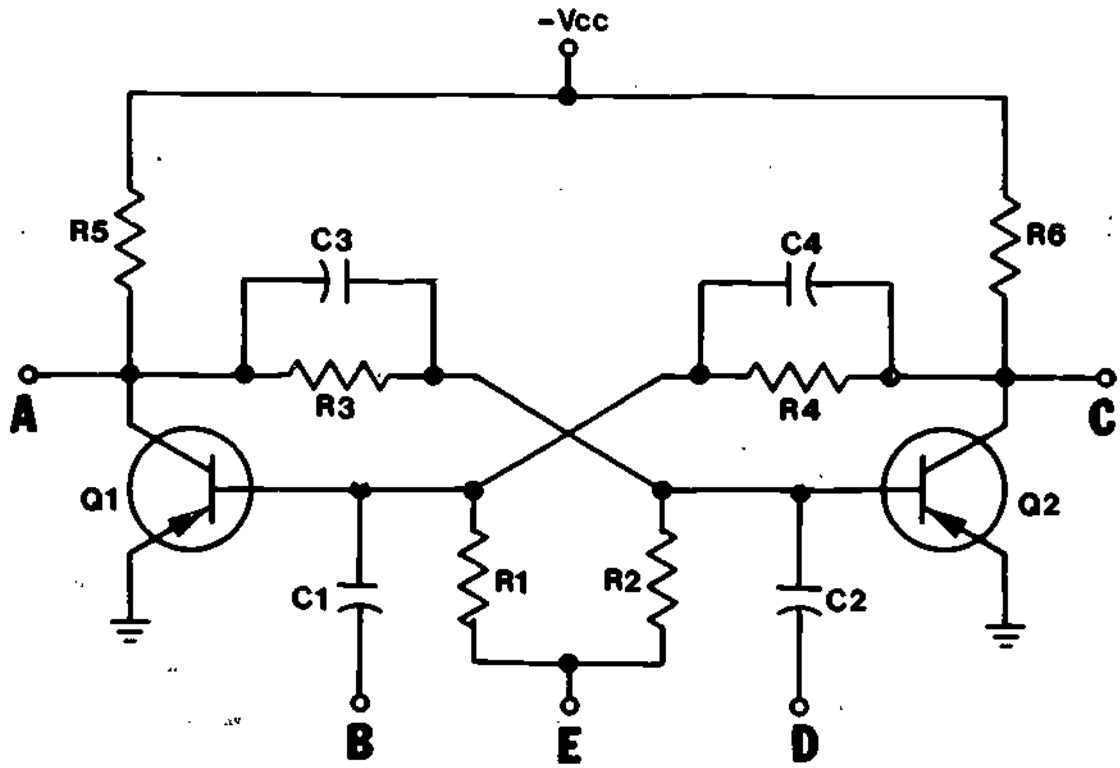
8. Which of the below illustrated symbols most correctly depicts a flip-flop (bistable) multivibrator?



9. Draw the "1" output waveform of the illustrated diagram. (The "1" output is zero prior to t_o. The "1" state is a positive voltage.)



10. Label the inputs and outputs of the flip-flop multivibrator illustrated below.



11. To change the state of a flip-flop, a pulse is normally applied to the ________________________ transistor.

12. An input pulse of the correct polarity which changes the state of a flip-flop is called a/an ________________________ pulse.

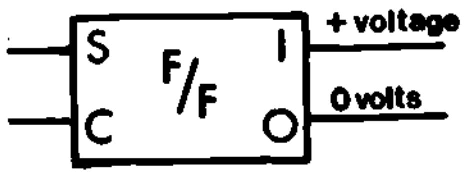
13. A trigger applied to the SET input which causes the "1" output to go positive or negative, will at the same time cause the "0" output to equal _______________ volts.

14. Define set state. ____

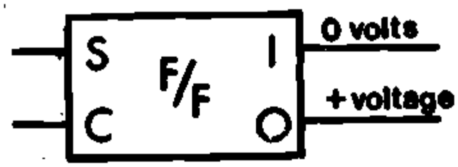
15. Define clear state. ____

16. Identify the state of the flip-flop in each illustrated block diagrams.

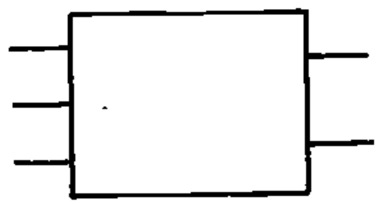
A.



B.

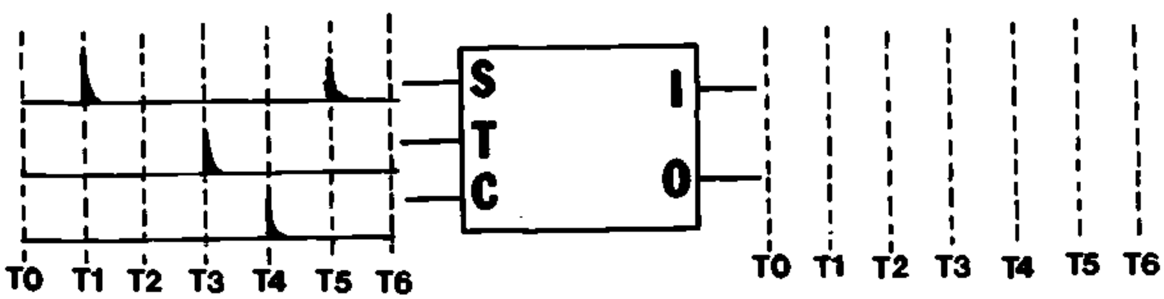


17. Identify each lead on the illustrated block diagram.

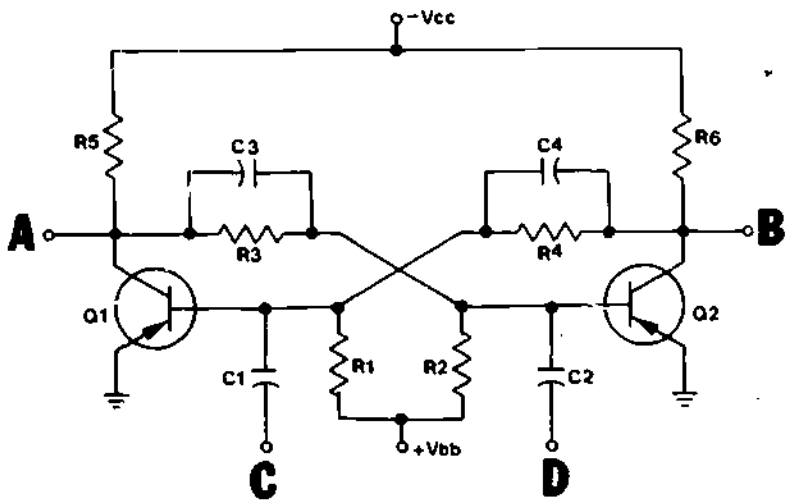


18. <u>EVERY</u> time a pulse is applied to the ______________ input, the flip-flop will change states.

19. Assuming that the flip-flop is in the set state at t_o, draw the "0" output waveform with the inputs as shown. (Assume the "1" state is a positive voltage.)



THE ILLUSTRATION BELOW WILL BE USED TO ANSWER QUESTIONS 20-22.



20. In the above illustration, if Q1 is saturated, Q2 is __________ and __________ will be the most negative output.

    a. saturated, B
    b. saturated, C
    c. cut off, A
    d. cut off, B

21. In the above illustration, with Q1 saturated, a __________ pulse applied to __________ will cause Q1 to cut off.

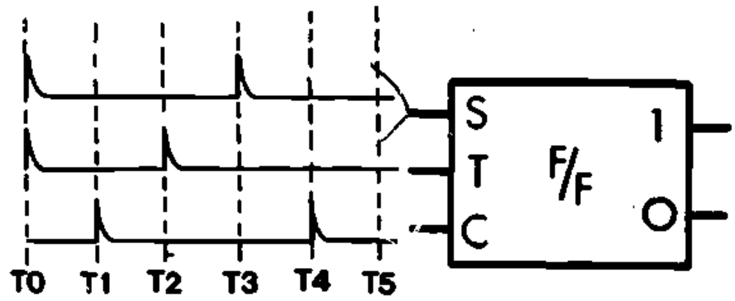
    a. positive, C
    b. negative, C
    c. positive, D
    d. negative, B

22. In the illustration above, Q1 is saturated. If a negative pulse is applied to C, what will happen?

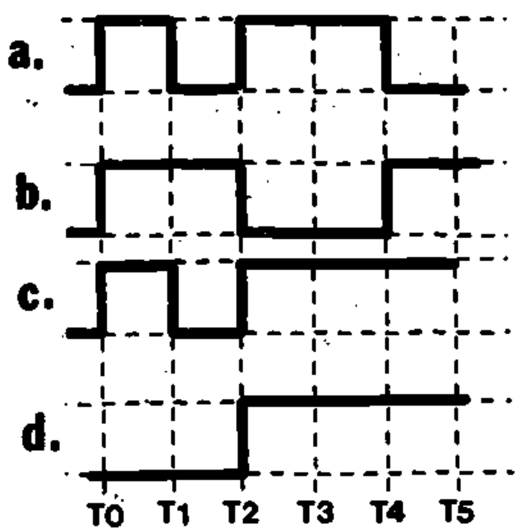
    a. Q2 will become saturated.
    b. Q2 will become cut off.
    c. Q1 will cut off.
    d. Nothing will happen.

23. A pulse that is used to cause a flip-flop to change states is called

    a. a flipping pulse.
    b. modulation.
    c. a trigger pulse.
    d. interference.



24. In the above illustration, what waveform would be seen on the "1" output with the inputs shown? (The flip-flop is in the clear state prior to t_o and the Vcc is positive)



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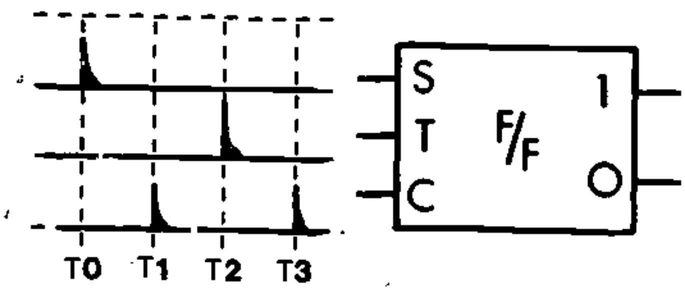
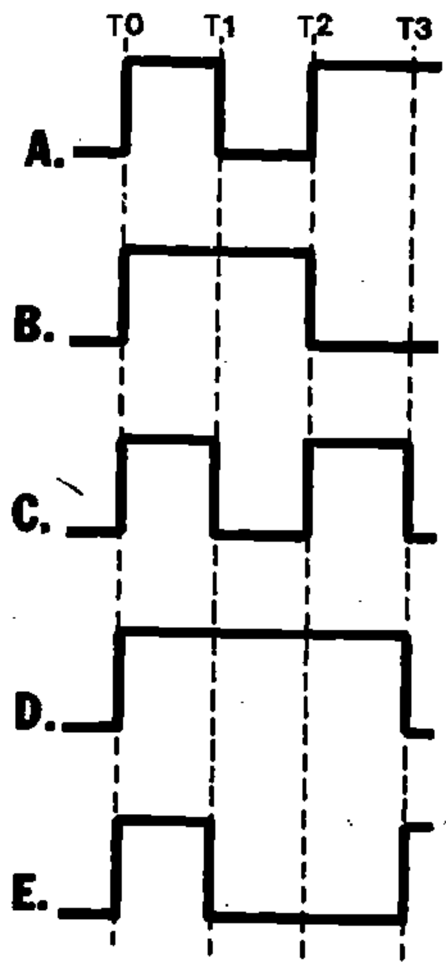
25. If a flip-flop is in the set state, a trigger on the __________ input will change it to the clear state. (Use the most complete correct answer.)

a. set, clear, or toggle
b. set or toggle
c. clear only
d. toggle or clear
e. toggle only

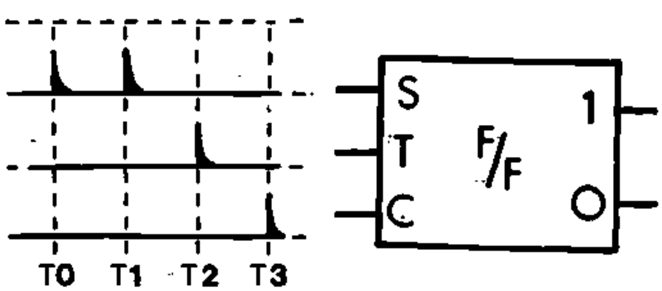
ON QUESTIONS 26 AND 27 MATCH THE INPUTS SHOWN WITH THE CORRECT "1" OUTPUT WAVEFORM. (The flip-flop is in the clear state prior to t_o and Vcc is positive.)

26.





27.



CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON 11 OF THIS MODULE.

EXPERIMENT
LESSON II

Astable Multivibrator (Free Running)

The operation of an astable multivibrator will be demonstrated by performing the steps outlined in this Experiment.

Using an oscilloscope, you will observe the output of an astable multivibrator.

EQUIPMENT REQUIRED

Oscilloscope
Device 6F16 with template "H" free running multivibrator
1X probe

PROCEDURE:

I. Using all applicable safety precautions, energize the oscilloscope, obtain a line trace, and make the following settings.

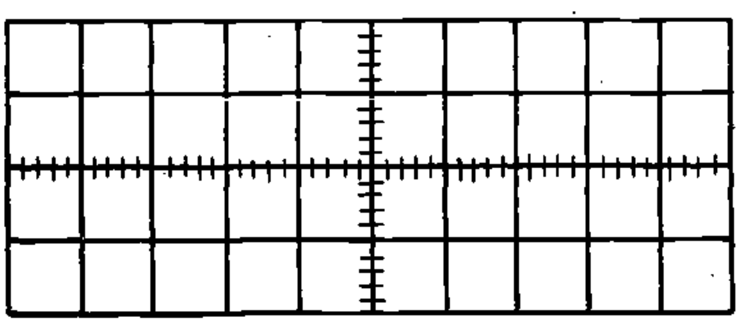
   a. SWEEP TIME to .5 milliseconds/cm.
   b. CHANNEL SELECT to "Channel A".
   c. SENSITIVITY to 5 volts/cm.
   d. Connect the 1X probe to Channel "A" input.

II. Using all applicable safety precautions, set up Device 6F16 as follows:

   a. Set up 6F16 using Template #H (Free Running Multivibrator) and the parts called for by the template.
      NOTE: DO NOT INSTALL RESISTOR R7.
   b. Connect Channel "A" probe to the output.
   c. Energize the 6F16 using the line cord.

III. You are now ready to observe the operation of an astable multivibrator.

1. Observe the output waveform and draw the observed waveform in the space below. NOTE: If there is no output, the circuit is probably balanced. To unbalance the circuit, momentarily insert R7 (390 ohm). Once the circuit is operating, R7 is not necessary; remove it.

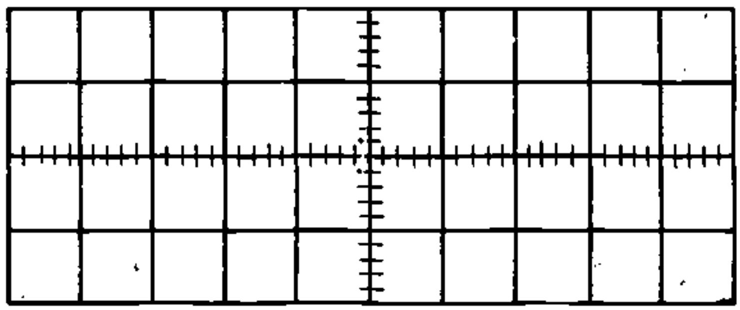


2. How long is Q2 in conduction? (Measure the time of the conducting half cycle.) ____________________

3. How long is Q2 cut off? ____________________

Now you will set up the multivibrator for an asymmetric output. "Asymmetric" means the output will not be symmetrical; that is, one transistor will conduct longer than the other. To accomplish this, remove C2 (.033 μfd capacitor) and replace it with a .010 μfd capacitor.

4. Set the SWEEP TIME on the oscilloscope to .2 millisec/cm and record the waveform displayed on the oscilloscope in the space below.



5. What is the time of the conducting half cycle of Q2? ____________

6. What is the time of the "cut off" half cycle of Q2? ____________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II PROGRESS CHECK.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON II

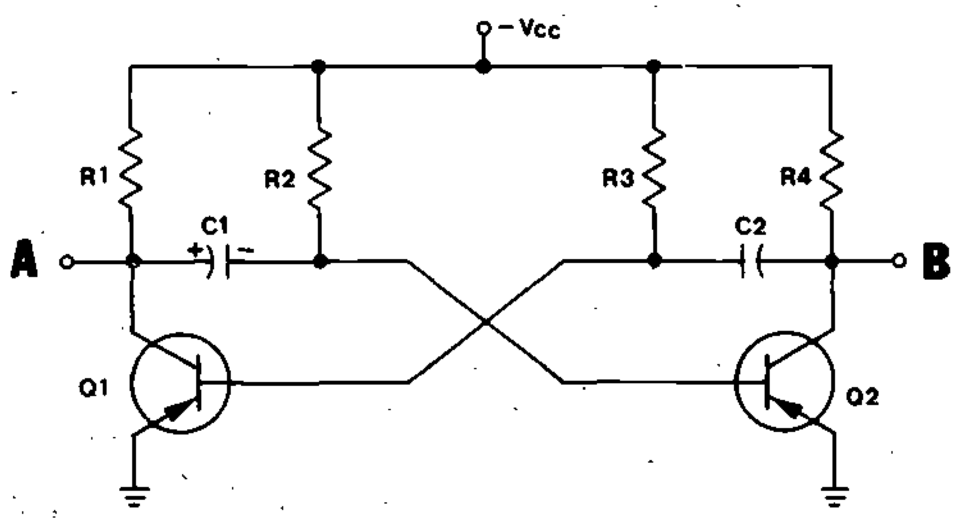
Astable Multivibrators

1. An astable multivibrator is also known as a/an ________________ ________________ multivibrator.

2. The astable multivibrator operates like a square-wave __________

3. The astable multivibrator has ________ input trigger(s) and __________ output(s).

USE THE BELOW ILLUSTRATION FOR QUESTIONS 4 THROUGH 9.



4. In the figure above, which component(s) determine the amount of time Q2 is in a cut-off state? ________________

5. If Q2 is cut-off, Q1 must be ________________.

6. The rate of charging of C1 depends on the time constant produced by which components?

7. The length of time that transistor Q1 remains cut off is determined by the charging rate of capacitor ________________.

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8. If Ql is saturated, which of the following will occur when Q2 begins to conduct? (In correct order of occurance.)

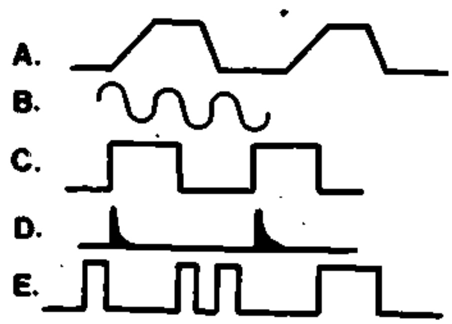
   a. E_{R1} drops to OV, E_{R4} rises to Vcc, C2 charges, and Ql cuts off.

   b. E_{Q2} drops to OV, E_{R4} rises to Vcc, Ql cuts off, and C2 charges.

   c. Ql cuts off, E_{R3} rises to Vcc, Cl charges, and Q2 saturates.

   d. E_{R1} rises to Vcc, Cl discharges and Ql breaks down.

9. The waveform at Point A will be most like ____________ shown below.



10. The astable multivibrator is used for
    a. amplification.
    b. timing.
    c. regulation.
    d. differentiation.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON III OF THIS MODULE.

EXPERIMENT
LESSON III

Monostable Multivibrator (One Shot)

The operation of the Monostable Multivibrator will be demonstrated by performing the steps outlined in this experiment.

Using an oscilloscope, you will observe the changes in state of the "0" output of the multivibrator when the proper input is applied. Since the "1" output is the inverse of the "0" output, it will not be necessary to look at the "1" output.

EQUIPMENT REQUIRED

Oscilloscope
Device 6F16 with template #1
1X probe (three required)

PROCEDURE:

I. Using all applicable safety precautions, energize the oscilloscope and obtain a line trace. Make the following additional settings:

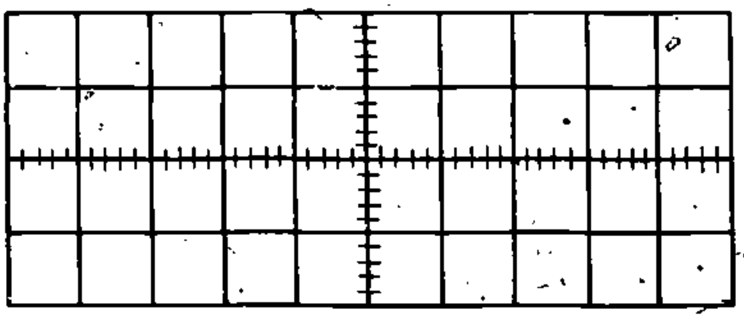
  a. SWEEP TIME to .2 millisec/cm.
  b. SENSITIVITY CONTROL to 20 volts (Channel "A") and 5 volts (Channel "B").
  c. CHANNEL SELECT to "Chopped" and obtain a line trace for Channel "B".
  d. Connect 1X probes to channel "A" and "B" inputs.
  e. Set the VERTICAL POSITIONS as follows; Channel "A", +1 cm; Channel "B", -1 cm.

II. Using all applicable safety precautions, set up Device 6F16 as follows:

  a. Set up 6F16 using Template #1 and the parts called for by the template. (Use a .01 μf capacitor for C1.)
  b. Connect the channel "A" probe to the base of Q1 (right side of C3).
  c. Connect the channel "B" probe to the "0" output (Q2 collector).
  d. Energize the 6F16 using the line cord.

III. Connect a 1X probe to J2 on the Test Signal Junction Box. Connect the other end of this probe to the 6F16 input.

1. Obtain a stable trace on the oscilloscope and draw the displayed waveforms in the space below.



2. The time that Q2 is in conduction is (greater than; less than; equal to) the time it is in cutoff.

3. Set Sweep Time to 50 microsec/cm.
   What is the time of the cut off state of Q2? ______________

4. Set Sweep Time to .1 millisec/cm.
   What is the time of the conducting state of Q2? ____________

5. The Pulse Width (time) of the positive going output pulse is determined by

   a. the RC time of C2 - R6.
   b. the input frequency.
   c. the RC time of R7 - C1.

6. What determines how long Q2's collector will remain negative?

   a. The RC time of C2 - R6.
   b. The input frequency.
   c. The RC time of R7 - C1.

7. What would happen to the output signal if capacitor C1 were changed from .01 µfd to a .03 µfd?

   a. The negative pulse width would increase.
   b. The positive pulse width would decrease.
   c. The positive pulse width would increase.
   d. There would be no change in the output.

8. Remove C1 (.01 μfd) and replace with a .03 μfd capacitor. What is the pulse width of the negative pulse? ______________

9. When you changed the capacitance of C1, the positive pulse width increased; decreased; remained the same)

THIS CONCLUDES THE JOB SHEET ON MULTIVIBRATORS. SECURE THE TEST EQUIPMENT AND PUT ALL COMPONENTS BACK IN THEIR PROPER PLACES. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON III PROGRESS CHECK,

INFORMATION SHEET
WAFER ROTARY SWITCHES

The wafer rotary switch is usually several separate switches linked (ganged) together. Figure 1 shows a typical wafer rotary switch. Notice the current path formed by the extended terminal, contact ring, wiper arm (part of the contact ring) and the short terminal touching the wiper arm.

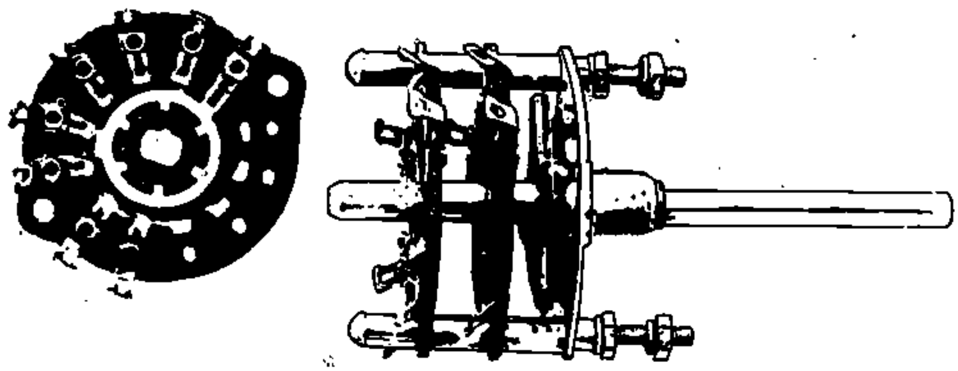


Figure 1

On most schematic diagrams the wafer rotary switch is shown in one position only. You must mentally determine the current path through the switch for any of the other positions. Figure 2 is a schematic representation of the wafer switch shown in Figure 1. The conduction path for the switch position shown is from terminal 1 through the contact ring to terminal 4. If this switch were turned two positions counterclockwise, the conduction path would now be from terminal 1 through the contact ring to terminal 2.

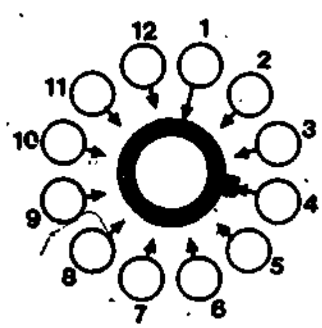


Figure 2

Figure 3 shows the schematic symbol for a slightly different type of wafer rotary switch. The basic construction of this switch is similar to the one in Figures 1 and 2. Note that the contact ring is split and there is a wiper and an extended terminal for each of the contact ring segments. There are actually two switches mounted on one wafer. Each switch operates the same as the switch in Figures 1 and 2, but there are fewer switch positions available. This switch in the position shown has a conduction path from terminal 12 through one half of the split conduction ring to terminal 11. There is also a conduction path from terminal 6 to terminal 5 through the other half of the conduction ring. If this switch were rotated two positions counterclockwise terminal 12 would be connected to terminal 9 and terminal 6 would be connected to terminal 3.

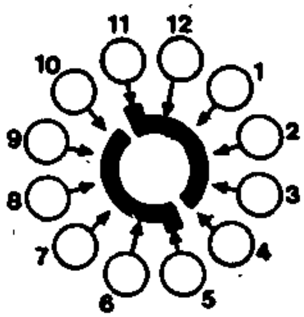


Figure 3

Figure 4 shows what a typical wafer rotary switch might look like on a schematic drawing. When these switches are shown on a schematic drawing, usually only those sections and/or positions used are shown. If there is more than one section shown for a switch, all the sections will be switched at the same time. The switch positions will be labeled on the schematic so you can tell where the wiper of the switch is actually positioned for a given switch position. For purposes of clarity on the schematic drawing, you may see an extra switch symbol with the switch positions indicated around it.

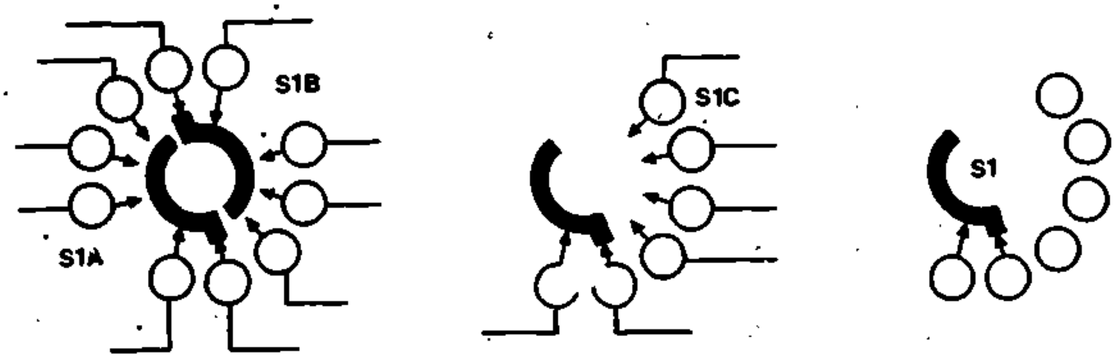


Figure 4

EXPERIMENT
LESSON III
PART 2

Multivibrator Systems

This experiment will demonstrate the operation of a system utilizing all three of the multivibrators that you have studied: astable, bistable and monostable. You will be using the NIDA 204 Function Generator for this demonstration. The NIDA 204 Function Generator is a complex looking piece of equipment, but don't let this frighten you; this experiment will cover only three of the PC boards and some of the front panel controls.

NOTE: Refer to information sheet Twenty Three-III that precedes this experiment for an explanation of wafer rotary switch operation.

SAFETY PRECAUTIONS: Observe all standard safety precautions. Do not energize the NIDA 204 until directed to do so.

EQUIPMENT REQUIRED:

NIDA 204 Function Generator
Oscilloscope
1X Probe (2)
BNC - BNC Coaxial Cable (2)
BNC "Tee" Connector (1)
PC 204-2 Printed Circuit Card
PC 204-3 Printed Circuit Card
PC 204-4 Printed Circuit Card
Instruction Manual, NIDA 204

PROCEDURE:

1. Energize and set up the oscilloscope for CHANNEL A operation and EXTERNAL TRIGGER mode.

   a. Using a BNC-BNC coaxial cable and the BNC "Tee" connector, connect the oscilloscope CHANNEL A INPUT to the EXTERNAL TRIGGER INPUT. Connect a 1X Probe to the BNC "Tee" connector.

2. Set the front panel controls of the NIDA 204 Function Generator as follows:

   a. TRIGGER switch to "EXT."
   b. FREQUENCY switch to "10 KHz."
   c. FREQUENCY dial to "1.5."
   d. INPUT controls - not used.
   e. PULSE WIDTH switch to "1 microsecond."
   f. PULSE WIDTH dial to "8".
   g. OUTPUT SYMMETRY - not used.
   h. OUTPUT LEVEL - fully clockwise.
   i. FUNCTION switch to "⊓⊔" (square wave).

3. Remove the top cover of the NIDA 204.

4. Connect the CHANNEL A probe to PC 204-2, pin 1D.

NOTE: DO NOT ENERGIZE THE NIDA 204.

5. Study Figure 1, page 29/30 of this experiment, and answer...

   (1) The CHANNEL A probe is connected to

   a. the input to the astable multivibrator.
   b. the output of the monostable multivibrator.
   c. the input to the monostable multivibrator.
   d. the output of the astable multivibrator.

   (2) FREQUENCY SWITCH S2 is shown in the 10 KHz position. Will the astable multivibrator operate with the switch in this position? (Yes/No).

   (3) The astable multivibrator will operate with switch S2 in

   a. any position.
   b. any position except "1 Hz."
   c. the "10 KHz" position only.
   d. any position except "10 KHz."

6. Plug in and energize the NIDA 204 Function Generator.

7. Check your answers to questions 5(2) and 5(3) by switching FREQUENCY SWITCH (S2) to its other positions and checking for a square wave output with the oscilloscope. If the results of this check agree with your answers, continue to step 8. If your answers do not agree, go back to Figure 1 and study the action of the FREQUENCY SWITCH.

8. Ensure the FREQUENCY SWITCH is in the "10 KHz" position. Determine the period and compute the output frequency of the astable multivibrator. Record your results. Period ________ Frequency ________.

9. Change the setting of the FREQUENCY DIAL (R21A and B) to "4" and answer the following questions:

   (1) The output frequency of the astable multivibrator

      a. increased.
      b. decreased.
      c. remains the same.

   (2) When you changed the setting of the FREQUENCY DIAL, you changed the

      a. capacitance of the RC circuit that determines the output frequency.
      b. resistance of the RC circuit that determines the output frequency.
      c. input frequency to the astable multivibrator.

10. The output of the astable multivibrator (PC204-2, pin 10) connects to the input of the bistable multivibrator (PC204-3, pin 3). The bistable multivibrator has two outputs: one at pin 8 and one at pin 11. Using Figure 1 answer the following questions:

   (1) The output frequency of the bistable multivibrator is determined by the

      a. RC time constants within the bistable multivibrator.
      b. setting of switch S3.
      c. input frequency to the bistable multivibrator.
      d. setting of R22 (PULSE WIDTH DIAL).

   (2) The output frequency of the bistable multivibrator is (twice/the same as/one half) the input frequency.

   Set up the oscilloscope for dual trace operation and connect the CHANNEL B INPUT to PC204-3, pin 8, with 1X probe. Check your answer to 10 (2) with the oscilloscope.

   (3) What is the relationship between the bistable multivibrator outputs (pins 8 and 11)?

      a. The two outputs are identical.
      b. Pin 8 output is twice the frequency of pin 11 output.
      c. The outputs at pins 8 and 11 are equal in frequency but 180 degrees phase displaced.

11. Disconnect the CHANNEL A probe from PC204-2, pin 10, and reconnect it to PC 204-3, pin 11. Check your answer to 10 (3) with the oscilloscope.

12. The third circuit used in this experiment is the monostable multivibrator (PC204-4). The components C1-4, CR1-4, CR2-4, R1-4 and R2-4 are not used. Pulse width switch (S3) and PULSE WIDTH DIAL (R22) are associated with the monostable multivibrator. Answer the following questions using Figure 1:

   (1) The monostable multivibrator will generate an output pulse each time the input

   a. changes polarity.
   b. goes positive.
   c. goes negative.
   d. goes either positive or negative.

   (2) The amount of time the monostable multivibrator will remain in its "unstable" state is determined by the

   a. RC time constant of the circuit.
   b. input to the circuit.

   (3) The amount of time the monostable multivibrator will remain in its stable state is determined by the

   a. RC time constant of the circuit.
   b. input to the circuit.

   (4) With the PULSE WIDTH SWITCH (S3) in the "10 μsec" position, capacitor ______ is in (series/parallel) with capacitor C3-4.

   a. C13
   b. C14
   c. C16
   d. C17

   (5) With the PULSE WIDTH SWITCH (S3) in the "1 μsec" position, what capacitor(s) determine the pulsewidth?

   a. C17 and C3-4
   b. C15 and C3-4
   c. C3-4 only
   d. C13 and C3-4

   (6) The PULSEWIDTH DIAL (R22) will control the (capacitance/resistance) of the RC time constant in the monostable multivibrator.

13. Disconnect the CHANNEL B probe from PC204-3, pin 8, and reconnect it to PC204-4, pin 9. Go ahead and verify the answers to questions in step 12 by checking the operation of the monostable multivibrator on your own.

NOTE: At the frequencies used in this experiment, the monostable multivibrator output will be unstable if the PULSE WIDTH SWITCH (S3) is set to any position other than "1 usec" or "10 usec." In the "10 usec" position, setting the PULSE WIDTH DIAL (R22), above "8" will probably result in unstable operation. This will not harm the equipment, but the output is unusable.

14. Before continuing with the experiment, let's review what you have learned so far. First you learned that the astable multivibrator in the NIDA 204 will operate with the FREQUENCY SWITCH (S2) in the "10 KHz" position only, and that the frequency can be varied with the FREQUENCY DIAL (R21A and B). The output of the astable multivibrator is the input signal to the bistable multivibrator.

    The bistable multivibrator has two outputs that are 180 degrees phase displaced from each other. The output frequency of the bistable multivibrator is one-half the input frequency. Only one of the outputs from the bistable multivibrator is used in this experiment. This output is taken from PC204-3, pin 11, and is applied to the input of the monostable multivibrator. The monostable multivibrator will put out a pulse at the frequency of the input. This output pulse will be of a duration determined by the setting of the PULSE WIDTH controls (S3 and R22).

15. Now, go to Figure 1 and look at the FUNCTION SWITCH (S4).

    (1) With this switch in the position shown (square wave), where is the signal at the OUTPUT jack coming from (disregard the amplifier)?

    a. PC 204-4, pin 12.
    b. PC 204-4, pin 9.
    c. PC 204-3, pin 11.
    d. PC 204-3, pin 8.

    (2) Where will the signal at the OUTPUT jack come from if the FUNCTION SWITCH (S4) is placed in the "⊓_" (pulse) position?

    a. PC204-4, pin 12.
    b. PC204-4, pin 9.
    c. PC204-3, pin 11.
    d. PC204-3, pin 8.

16. Remove the oscilloscope probes from the NIDA 204. Place the oscilloscope in CHANNEL A mode and disconnect the 1X probe or CHANNEL A from the BNC "Tee" connector. Connect the OUTPUT jack of the NIDA 204 to CHANNEL A of the oscilloscope using a BNC - BNC cable.

17. Switch the FUNCTION switch back and forth between "pulse" and "square wave" positions. Note that the output changes from a pulse to a square wave.

    (1) With the switch in the "pulse" position, the output signal is coming from

        a. PC 204-2.
        b. PC 204-3.
        c. PC 204-4.

    (2) With the switch in the "square wave" position, the output signal is coming

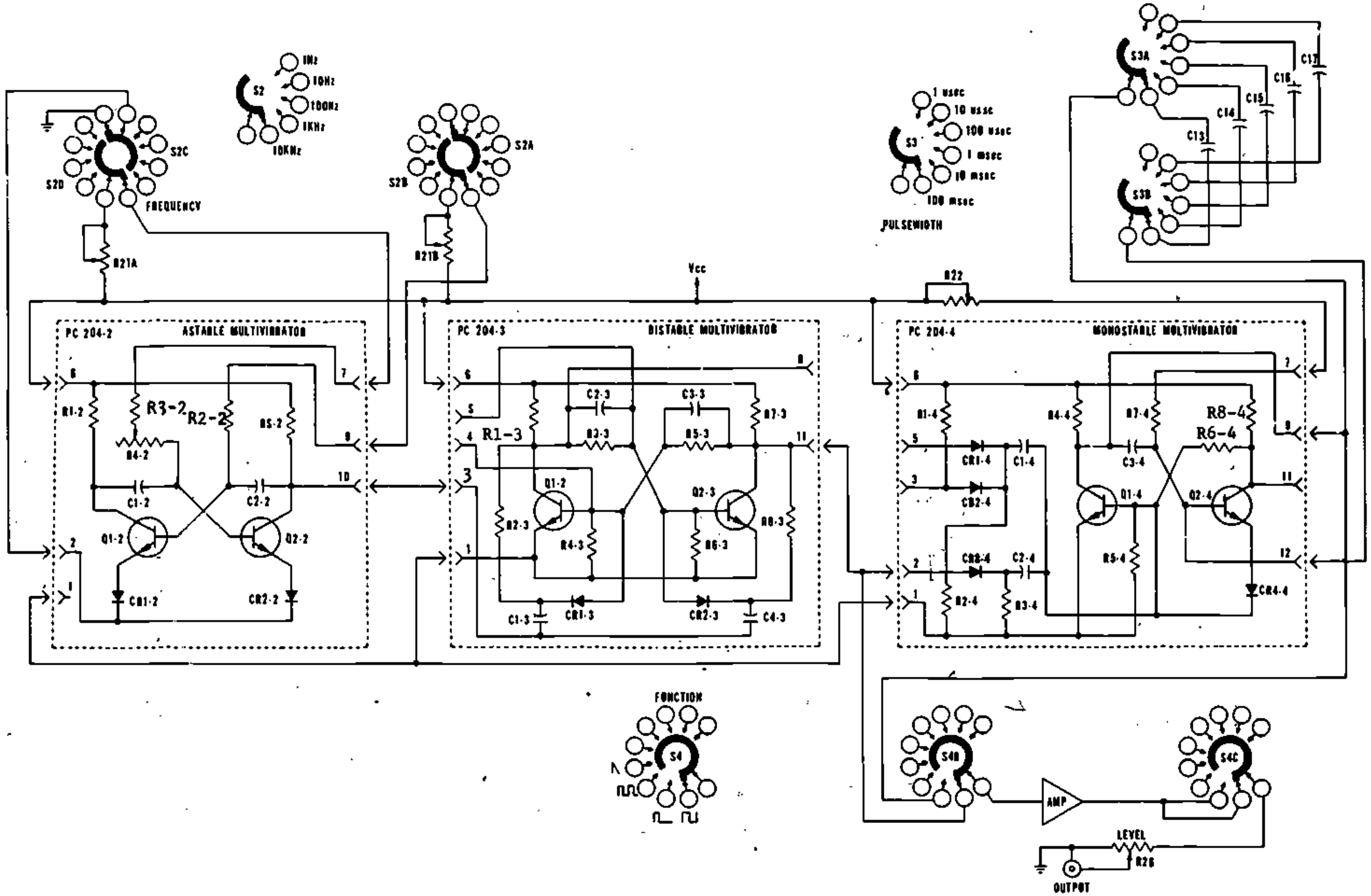
        a. PC 204-2.
        b. PC 204-3.
        c. PC 204-4.

    (3) If you had no output with the FUNCTION SWITCH (S4) in the "pulse" mode, but you had an output in the "square wave" mode, which of the following would be the most likely problem area?

        a. Switch S2.
        b. PC204-3.
        c. PC204-4.
        d. Power supply.

Question 17(3) shows a troubleshooting aid that is effective on many types of electronic equipment. Many times a casualty may be isolated to a specific area or even a circuit by using switches on the equipment to switch various sections in or out of operation. To use this aid requires a schematic drawing, block diagram, or other source of information to show what is happening when a certain switch is moved to a different position.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTERED THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS AND RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEED TO THE PROGRESS CHECK.



SQUARE WAVE & PULSE MODE

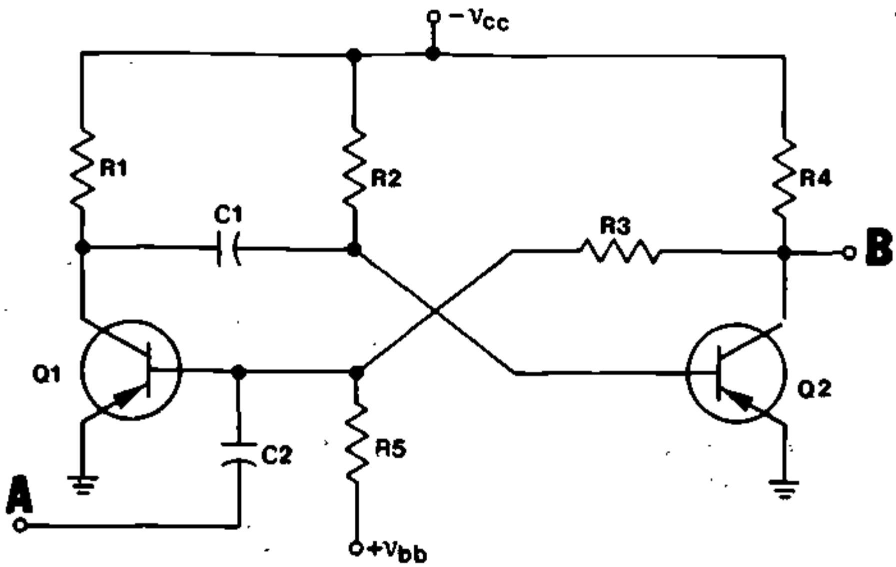
Figure #1

PROGRESS CHECK
LESSON III

Monostable Multivibrators

1. The monostable multivibrator has ________ input(s).

USE THE BELOW ILLUSTRATION FOR QUESTIONS AS INDICATED.



2. Before a trigger is applied to the circuit in figure 1, Q1 will be (cutoff/saturated) and Q2 will be (cutoff/saturated).

3. To change the state of the circuit in figure 1, a ____________ pulse would be applied at the input.

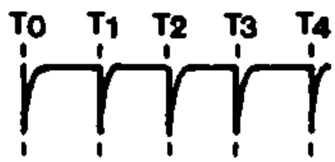
4. The monostable mulivibrator returns to its stable state after a (definite/indefinite) period of time.

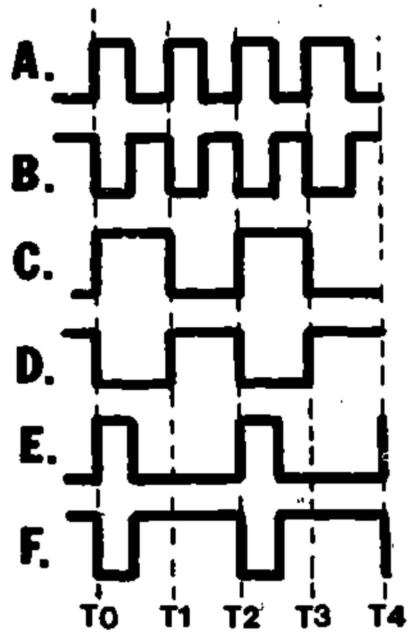
5. In figure 1, point A is the (input/output) and point B is the (input/output.)

6. In figure 1, when Q1 is saturated the output will ________.

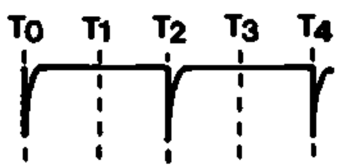
In questions 7 and 8 match the input triggers shown with the output wave forms. (Use the circuit represented in Fig. 1)

7.





8.



9. Refer to figure 1. The time duration of the negative output pulse is determined by

   a. C2 and R2.
   b. R1 and C1.
   c. C1 and R2.
   d. R1 and C2.

Match the circuits following question 15 with their correct titles for questions 10 through 15.

10. Flip-flop multivibrator

11. Monostable multivibrator

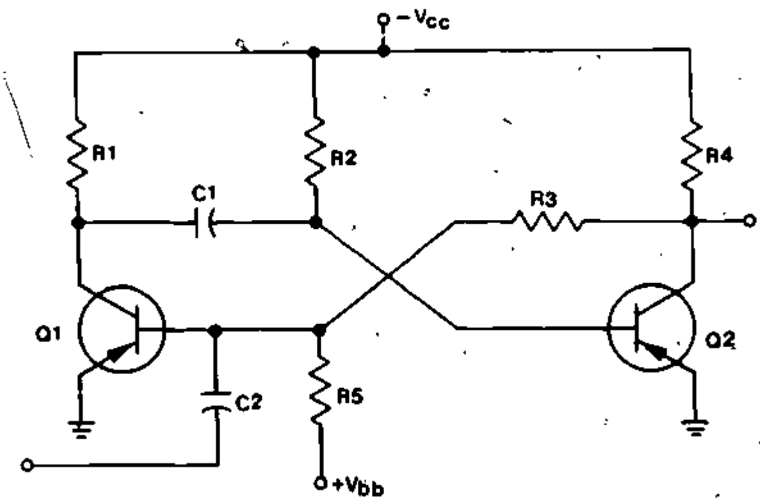
12. Astable multivibrator

13. Bistable multivibrator

14. One-shot multivibrator

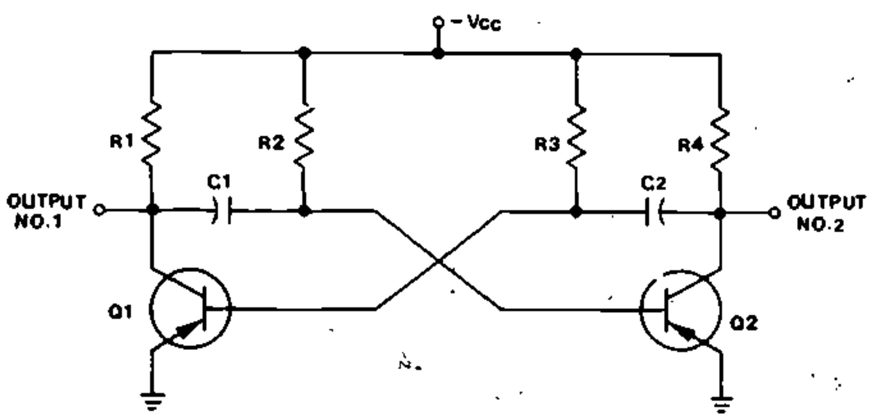
15. Free running multivibrator

a.



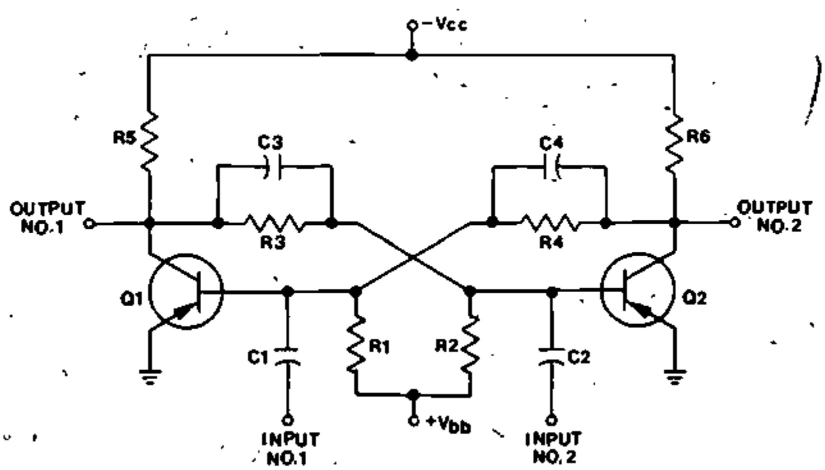
-Vcc
R1
R2
R4
C1
R3
Q1
Q2
C2
R5
+Vbb

b.



-Vcc
R1
R2
R3
R4
C1
C2
OUTPUT NO.1
OUTPUT NO.2
Q1
Q2

c.



-Vcc
R5
R6
C3
C4
OUTPUT NO.1
OUTPUT NO.2
R3
R4
Q1
Q2
C1
R1
R2
C2
+Vbb
INPUT NO.1
INPUT NO.2

16. When the circuit shown in figure C on the previous page is energized

    a. Q1 only will saturate.
    b. Q2 only will saturate.
    c. Q1 or Q2 will saturate.
    d. Q1 and Q2 will saturate.

17. When circuit B illustrated on the previous page is energized

    a. Q1 or Q2 will saturate and remain saturated.
    b. Q1 will cut off.
    c. Q1 and Q2 will alternately saturate and cut off.
    d. a sawtooth waveform will appear on output 2.

18. When circuit A illustrated on the previous page is energized

    a. Q1 will saturate and remain saturated until triggered.
    b. Q2 will saturate and remain saturated until triggered.
    c. it is impossible to tell which transistor will saturate first.
    d. neither Q1 or Q2 will saturate.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, SEE YOUR LEARNING SUPERVISOR FOR THE END OF MODULE TEST.

MODULE

TWENTY FOUR

WAVE SHAPING CIRCUITS

PROGRESS CHECK BOOKLET

EXPERIMENT
LESSON I
PART 1

Clippers

EQUIPMENT REQUIRED:

Device 6F16 with templates "D" and "E" - introduction to clippers
Oscilloscope
1X test probe (2)

SAFETY PRECAUTIONS: OBSERVE ALL APPLICABLE SAFETY PRECAUTIONS.

PROCEDURE:

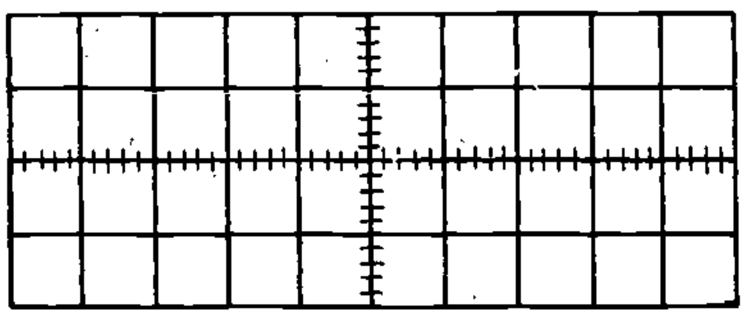
I. Set up the oscilloscope for dual trace operation.

a. CHANNEL SELECT to "Chopped" and obtain line traces for both channels.
b. Set the VERTICAL POSITION channel "A" to (+) 1 cm and Channel B to (-) 1 cm.
c. Set trigger source to line.
d. Set sweep time equal to 5 msec/cm.
e. Set Channel A and B sensitivity equal to 10v/cm.
f. Set Channel A and B AC/DC switches to "DC".

II. Set up device 6F16 as follows:

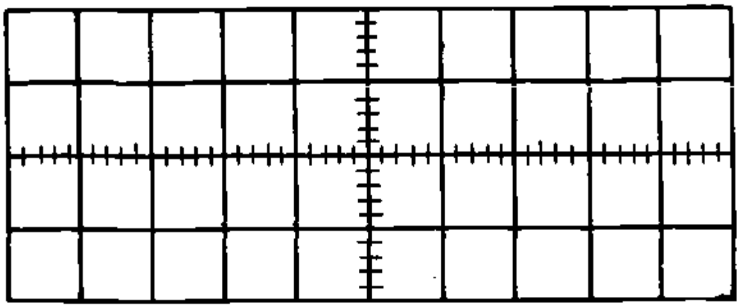
a. Use template D and the parts called for on this template.
b. Energize the 6F16 using the line cord.

III. 1. Connect one of the test probes to channel "A" and the other one to channel "B". Connect the channel "A" probe to the clipper circuit input. Observe and draw the input waveform.



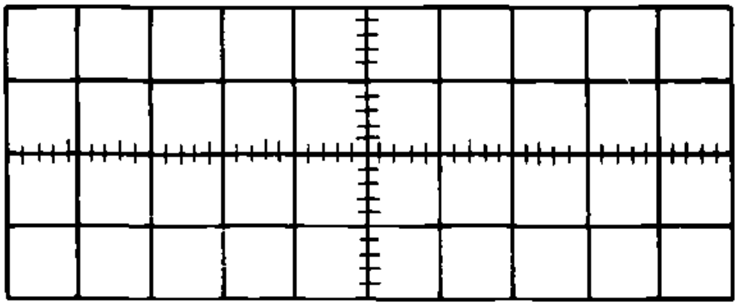
How much peak-to-peak voltage is applied to the clipper circuit?____________________

2. Now connect the channel "B" test probe to the clipper output. Observe and draw the output waveform.



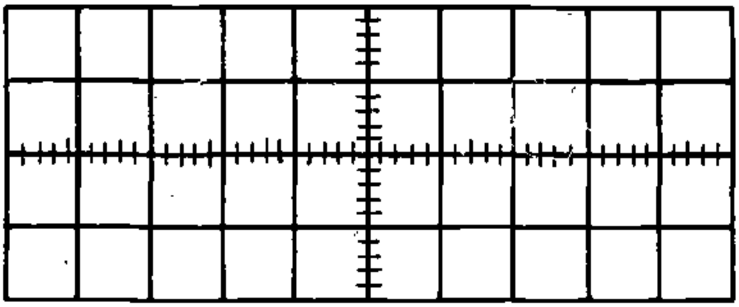
What kind of clipper is this? ____________________

3. Secure the power (unplug the power cord - FROM THE WALL SOCKET - and reverse the diode. Before you energize the device determine what kind of clipper this is. ____________________
Now, plug the line cord back in and draw the output waveform.



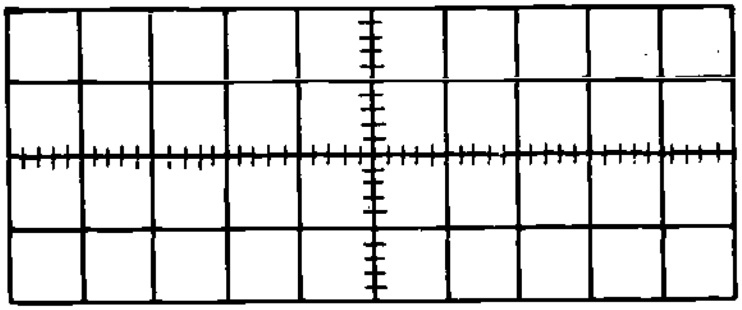
Were you right? ____________________

4. Okay, now let's add some bias. Secure the power again. Remove the shorting strip below the resistor. Plug one end of the red jumper patch cord into the hole right below the resistor and the other end into the negative side of the battery bias voltage. Re-energize the device and observe and draw the output waveform.



What kind of clipper is this? ____________________

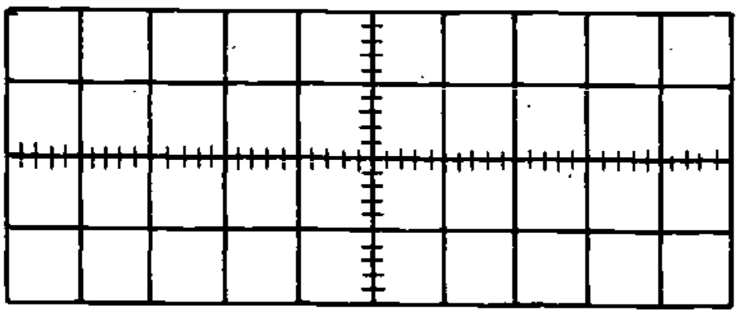
5. Plug the patch cord into the positive side of the battery bias voltage. Observe and draw the output waveform.



What kind of clipper is this? ______________________

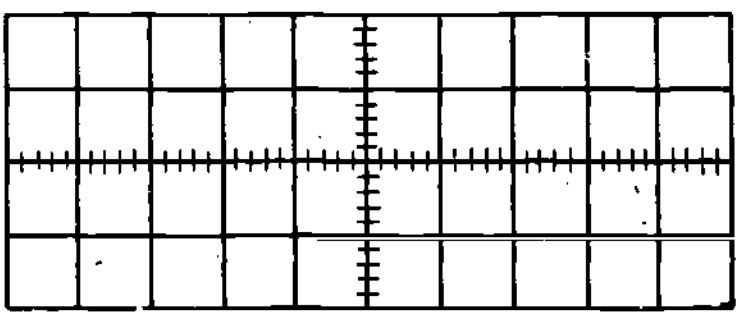
6. Now let's make some other kinds of clippers. All you have to do is reverse the diode again - SECURE THE POWER, FIRST!

Observe and draw the output waveform.



What kind of a clipper is this? ______________________

7. Go back to the negative side of the battery voltage. Observe and draw the output waveform.



What kind of clipper is this? ______________________

44

Part 2, PARALLEL CLIPPERS, is next. Secure the power to the 6F16, disconnect the test probes, remove the components and stow them where they belong, and return the template to its stowage.

If you wish, just for a few minutes, yawn, stretch, get a cup of coffee or take a short break.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO PART 2 OF THIS JOB SHEET.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

EXPERIMENT
LESSON I
PART 2

Clippers

PROCEDURE:

I. Time to search for templates again!
   a. Find template #E, Parallel Clippers, and put it on the 6F16 (the same way as before.)

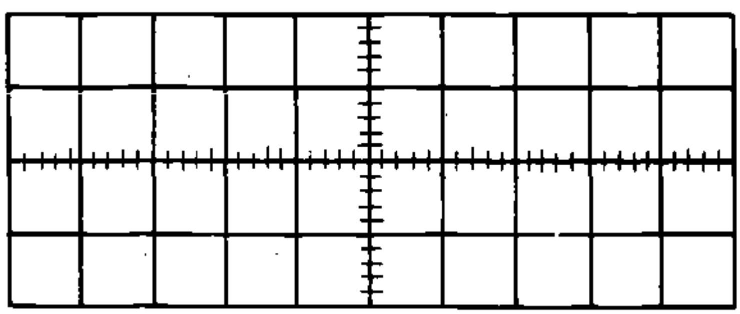
   b. Locate the components and "plug 'em in."

   Congratulations! You have built a parallel clipper.

   c. Use the oscilloscope set up as EXP. Twenty Four I-1.

   d. Energize the 6F16 and look at the input waveform. Is it still the same as before?_______________ If not, see your learning supervisor.

II. 1. Now look at the output. Here we go again - observe and draw the output waveform.

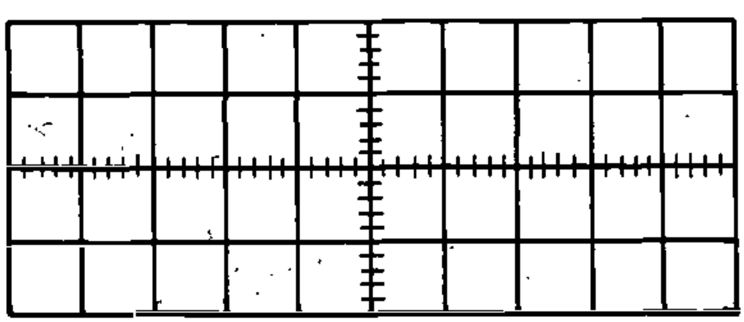


What kind of parallel clipper is this?_______________

2a. Deenergize the 6F16.
 b. Reverse the diode.
 c. Reenergize the 6F16.

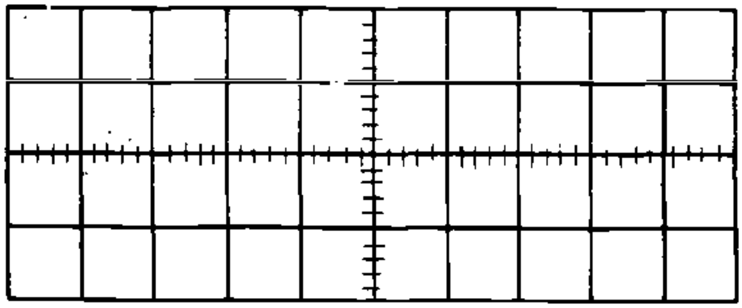
What kind of parallel clipper is this?_______________

Observe and draw the output waveform.



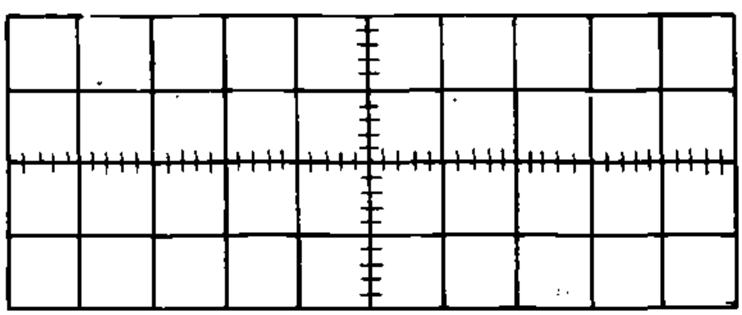
3. Time for bias again. Remove the shorting strip below the diode. (DON'T FORGET TO TURN OFF THE POWER FIRST.)

Plug in one end of the patch cord directly below the diode and then the other end into the negative side of the battery. Observe and draw the output waveform.



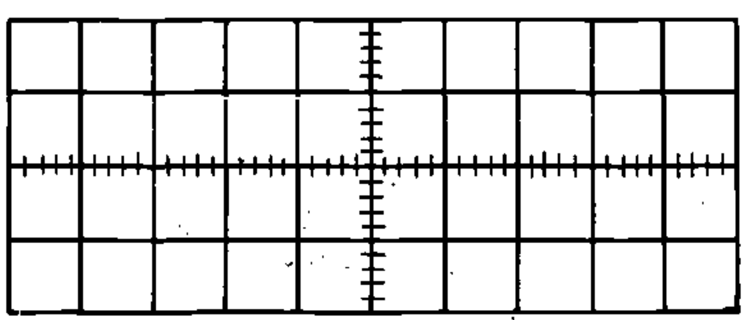
What kind of clipper is this one? ____________________

4. Now plug the patch cord into the positive side of the battery. Observe and draw the output waveform.



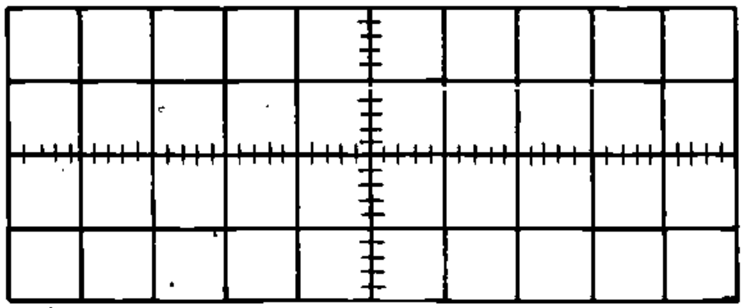
What kind of clipper is this one? ____________________

5a. Deenergize the 6F16
b. Reverse the diode.
c. Reenergize the 6F16 and - you guessed it - observe and draw the output waveform.



What kind of clipper is this? ____________________

6. Now bring the patch cord back to the negative side of the battery. What did you see? Draw it!



How about this one? What is it? ______________________________

This concludes the experiment on clippers.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON I PROGRESS CHECK.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

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PROGRESS CHECK
LESSON I

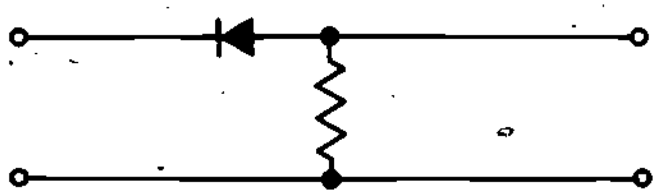
Clippers

1. A positive clipper removes the ____________ portion of the input waveform.

2. A negative clipper removes the ____________ portion of the input waveform.

3. In a series clipper, the diode is in series with the ___________.

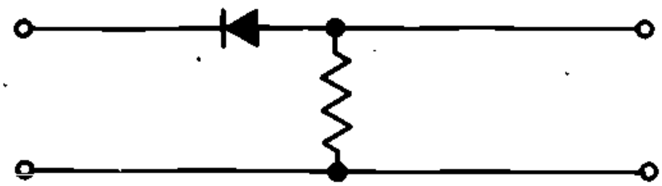
4. The below illustrated circuit is an example of a ______________ clipper.



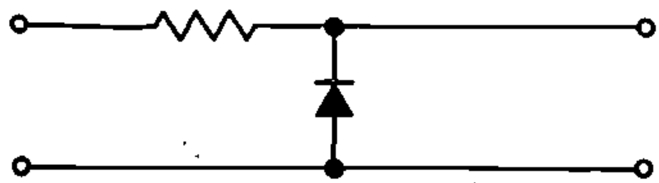
5. To clip only a portion of one alternation, a ______________ potential could be added to the circuit.

6. Which of the below circuits could represent a series negative clipper?

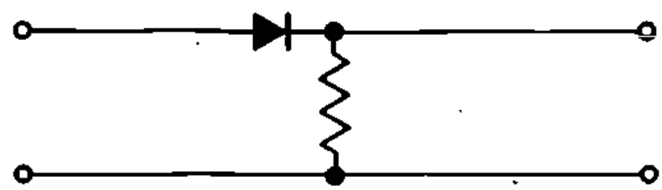
a.



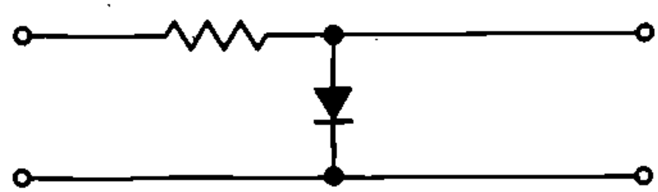
b.



c.

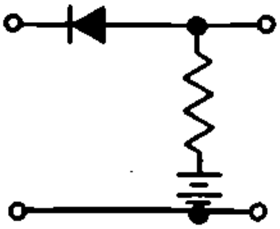


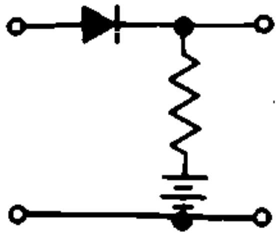
d.

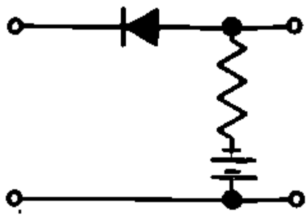


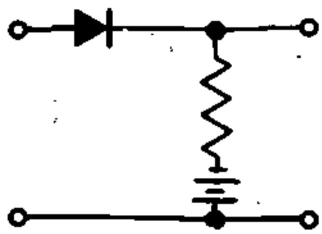
7. In a parallel clipper, the diode is in parallel with the ________

8. Match the below illustrated circuits with their correct titles.

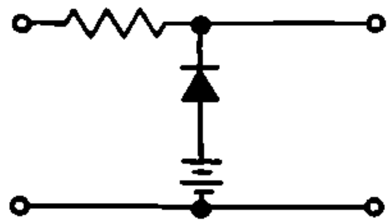
a.


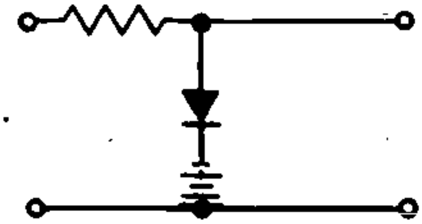
b


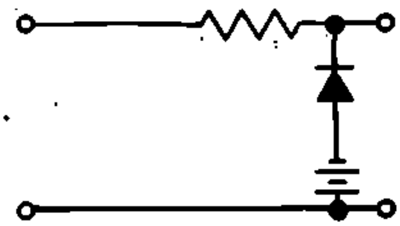
c.


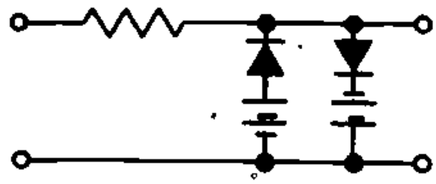
d.


e.


f.


g.


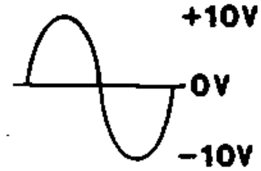
h.


i.


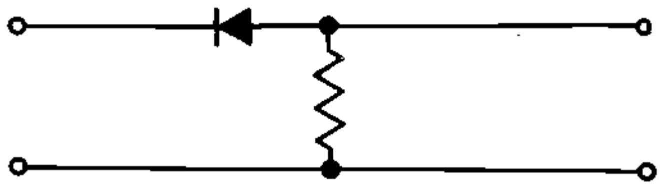
1. series negative clipper with positive bias.
2. parallel positive clipper with negative bias.
3. parallel positive and negative clipper with positive and negative bias.
4. series positive clipper with positive bias.
5. parallel negative clipper with positive bias.
6. series negative clipper with negative bias.
7. parallel positive clipper with positive bias.
8. series positive clipper with negative bias.
9. parallel negative clipper with negative bias.

9. Match the output waveforms below with their respective circuits.

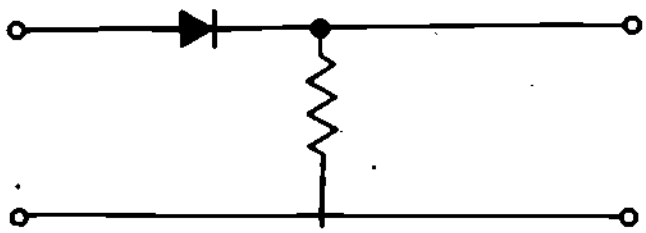
NOTE: All circuits have the input waveform of



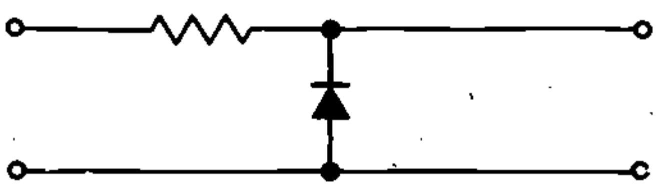
1.



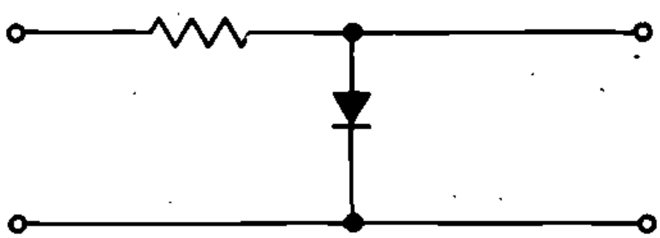
2.



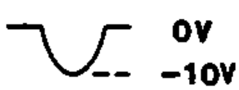
3.



4.

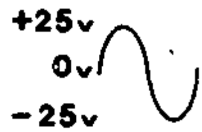


a.

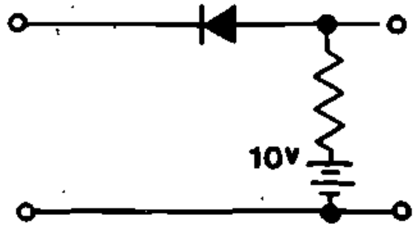


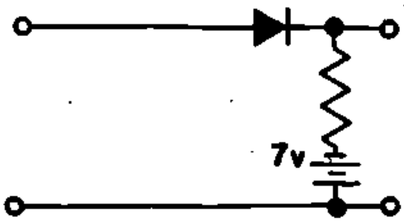
b.

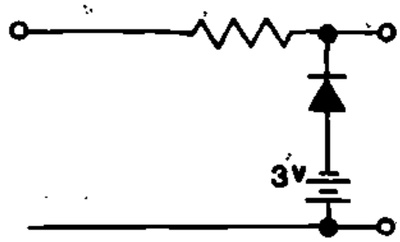
10. Draw the output waveforms for each clipper circuit illustrated.

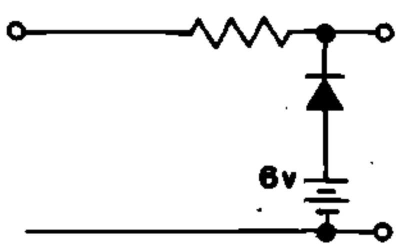
NOTE: All input waveforms are 

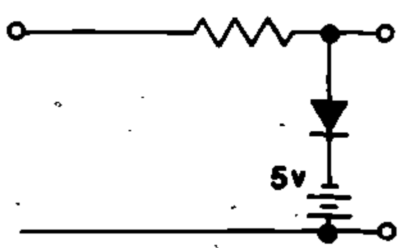
sinewave.

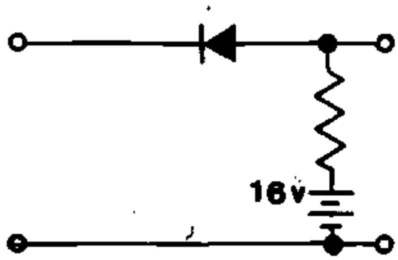
a.


b.


c.


d.


e.


f.


CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II OF THIS MODULE.

EXPERIMENT
LESSON II

Clampers

EQUIPMENT REQUIRED:

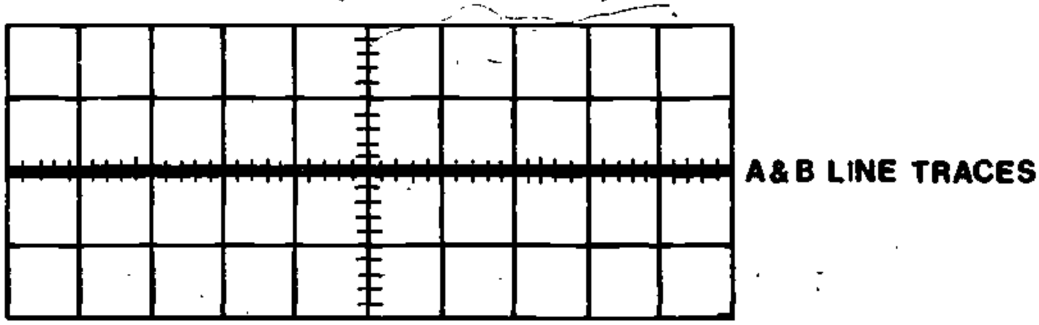
Device 6F16 with template "F" - introduction to clampers
Oscilloscope
1X test probe (2)
Patch Cord

SAFETY PRECAUTIONS: OBSERVE ALL APPLICABLE SAFETY PRECAUTIONS.

PROCEDURE :

I. Set up the oscilloscope for dual trace operation.

a. Obtain a line trace on both channels.
b. Place the VERTICAL PRESENTATION Switch in the chopped position.
c. Re-adjust both channel line traces so that they are exactly on top of each other. (see illustration).



d. Ensure that both VERTICAL POSITION POLARITIES are in the + up position and both vernier controls are "clicked" into their calibrated positions.
e. Place input switches to the "DC" position.
f. Set sweep time to 5 msec/cm.
g. Channel A and B sensitivity to 10 v/cm.

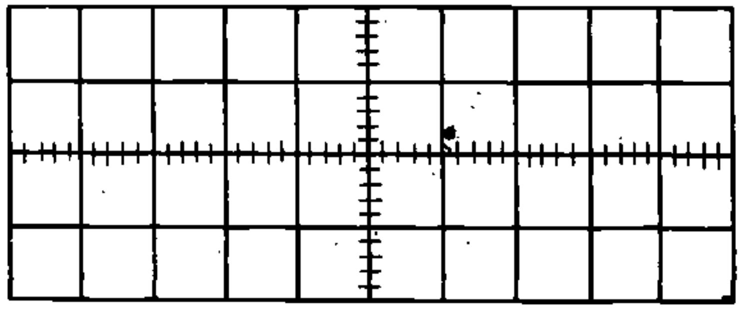
II. a. Place template #F labeled "Introduction to Clampers" on the 6F16.

b. Locate the components and place them in their proper positions.

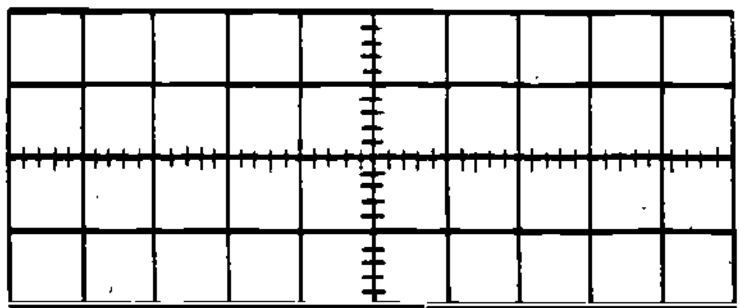
NOTE: Make sure the (+) end of the capacitor is to the right.

c. You now have a clamper circuit! Plug in and energize the 6F16 device.

III. 1. Connect channel A test probe on the input to the clamper circuit. Observe and draw the input waveform.



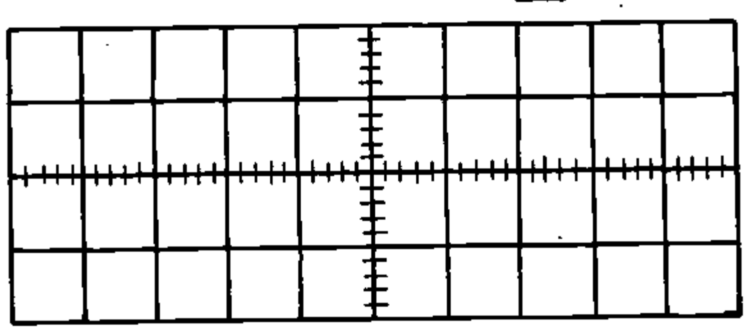
2. Place the channel B test probe on the output of the clamper circuit. (Hint: Either at the top of the diode or the top of the resistor, they're in parallel.) Observe and draw the output.



Is this a positive or a negative clamper?________________________

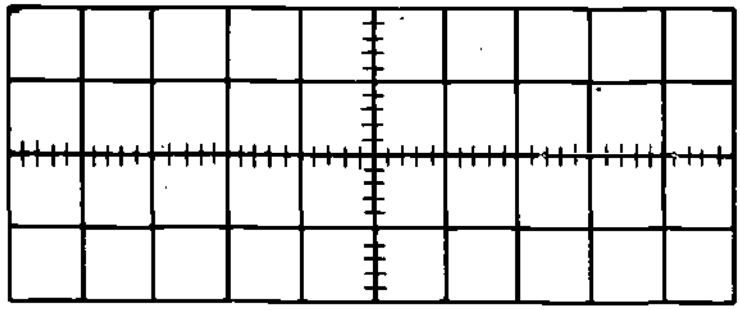
At what voltage level is the signal being clamped?________________

3. Now, secure the power and reverse the diode and capacitor. Reenergize the circuit and observe and draw the two waveforms.



What type of clamper is this?________________________________

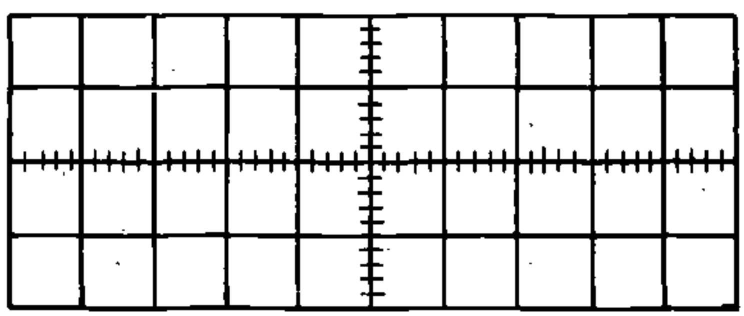
4. Secure the power and remove the bottom shorting strip (the lower one of the two that grounds the resistor and diode.) Using the patch cord, jumper from the top hole where the shorting strip was to the negative side of the battery. Draw the output waveform.

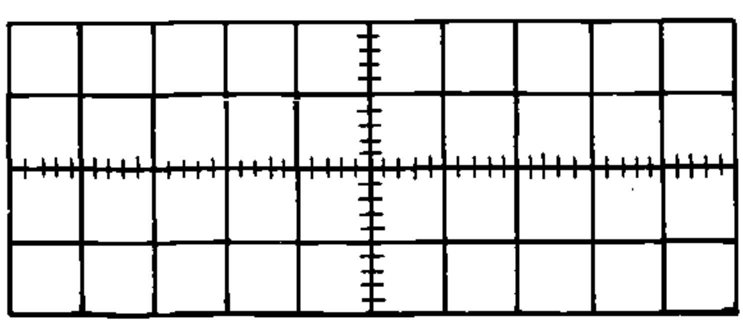


To what voltage level is the output waveform clamped?____________

5. Now place the patch cord at the positive side of the battery. Is the output clamped the same amount in the other direction?________

6. Reverse the diode and capacitor again. DON'T FORGET TO SECURE THE POWER! Observe and draw the waveforms using positive <u>and</u> negative bias.





You have just built and seen six different types of clampers in action.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II PROGRESS CHECK.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON II

Clampers

1. The function of a clamper circuit is to

   a. amplify the input waveform.
   b. attenuate the input waveform.
   c. raise or lower the reference level of the input waveform.
   d. make the input waveform oscillate.

2. A clamper is sometimes referred to as a_____________ ___________

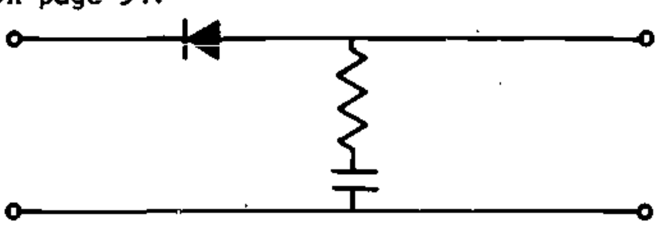
3. A positive clamper with no bias would clamp the input waveform above/below the original reference level.

4. The input waveform to a positive clamper could be a

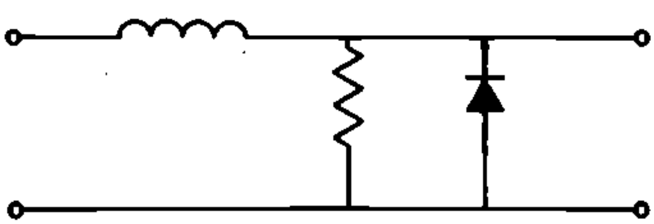
   a. square wave.
   b. sine wave.
   c. triangular wave.
   d. pulsed input.
   e. All of the above.

5. Which of the below illustrated circuits could be classified as a clamper circuit? NOTE: Choices a, b, & c are listed below. Choice d is on page 54.

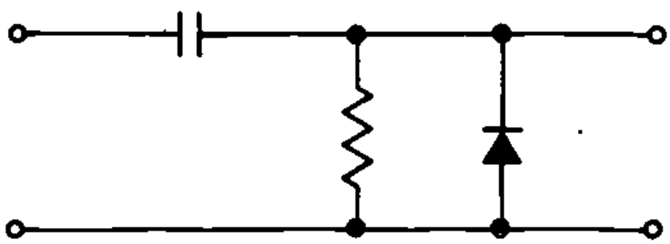
a.



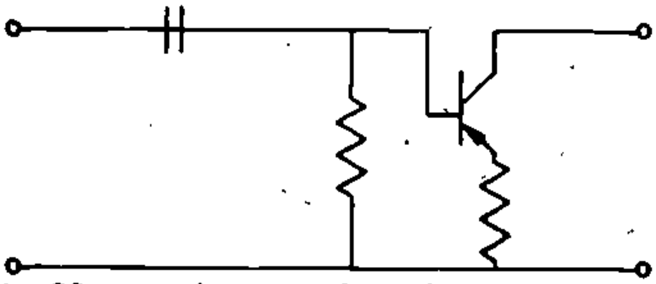
b.



c.



d.



6. In the RC network, the value of the __________ ________is very important.

7. The only physical difference in a positive and negative clamper is

   a. the way the diode is placed in the circuit.
   b. the amount of amplification in the circuit.
   c. the time constant of the circuit.
   d. the size of the resistor in the circuit.
   e. the size of the capacitor in the circuit.

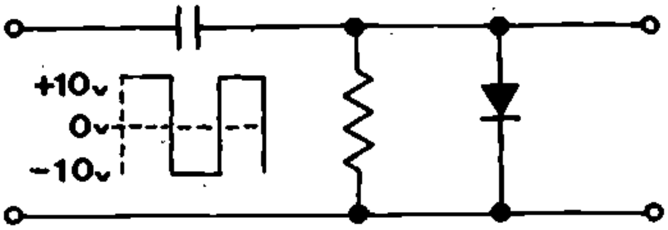
8. In a clamper circuit, the time constant should be <u>long/short</u> with respect to the input pulse.

9. In a biased clamper circuit the value of the ______________ will be the output reference level.

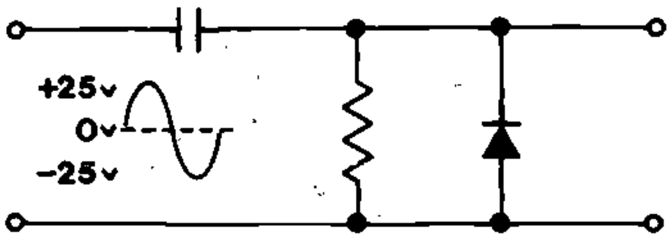
   a. time constant
   b. DC potential
   c. input reference level
   d. amplification factor of the diode

10. For the circuits below, draw the output waveform.

a.



b.



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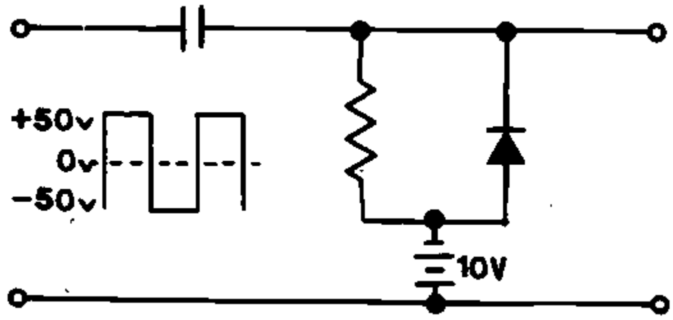
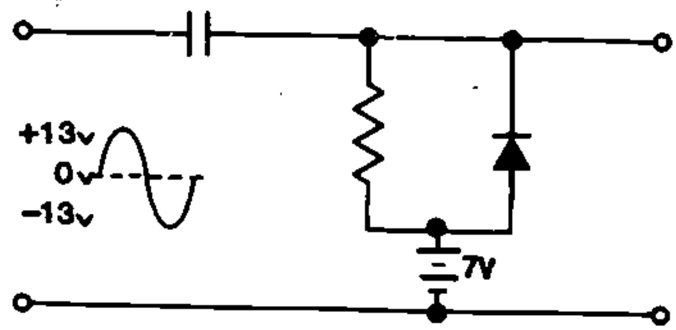
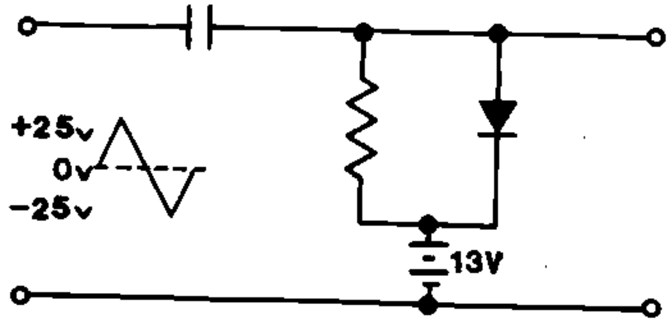
c.



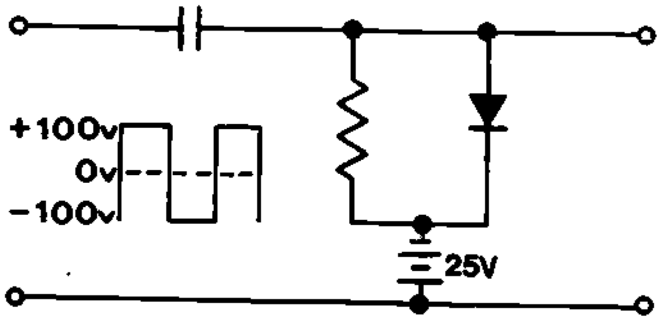
d.



e.



f.



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11. Using the circuits illustrated in the last question, identify each by its correct name.

Example: positive clamper with negative bias .

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON III.

EXPERIMENT
LESSON III
PART 1

Introduction to Integrators

EQUIPMENT REQUIRED:

Device 6F16 with template #1 and #2
Oscilloscope
1X test probe (3)
Signal input from test box

SAFETY PRECAUTIONS: OBSERVE ALL APPLICABLE SAFETY PRECAUTIONS,

PROCEDURE:

I. a. Set up the oscilloscope for dual trace operation.

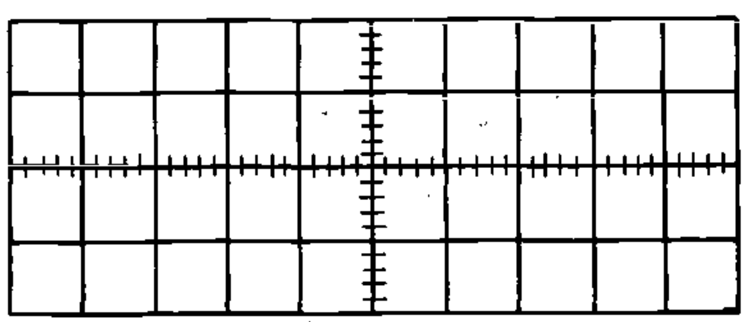
b. Place the oscilloscope's VERTICAL PRESENTATION switch in the channel A position.

c. Obtain a line trace and center it exactly on the horizontal axis.

II. a. Place template #1 on the 6F16 and plug in the indicated components.

b. Attach a 1X test probe to output #2 of the test signal box. This will be your input to the integrator. Attach the other end of the test probe to the input of your circuit. Attach a probe ground lead from this probe to the circuit ground.

III. 1. Using the channel A test probe, display the input waveform on the oscilloscope. Observe and draw the input waveform.

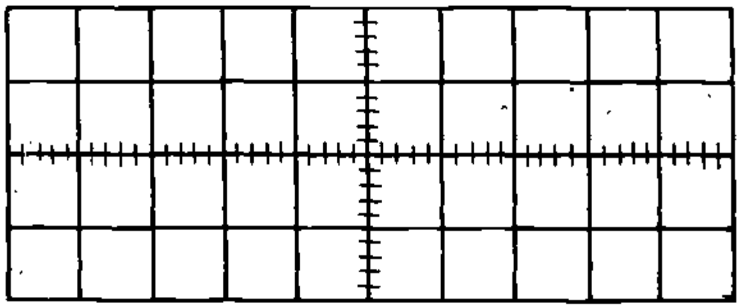


What is the peak-to-peak voltage?____________________

2. a. Place the oscilloscope's VERTICAL PRESENTATION switch in the channel B position and obtain a line trace.

   b. Center the line trace exactly on the horizontal axis.

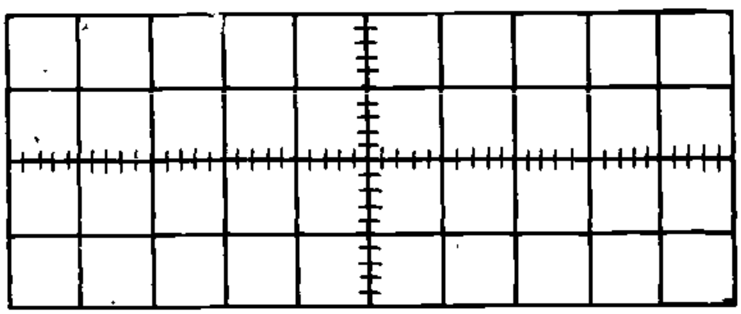
   c. Using the channel B test probe, observe and draw the output waveform.



What is the peak-to-peak voltage? ____________

3. Is this an integrator or a differentiator? ____________

4. Place the vertical position switch in the chopped position. Observe and draw the waveforms.



Notice how much the output is attenuated? This is because the capacitor is not being allowed to charge fully during each half cycle.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO PART 2 OF THIS JOB SHEET.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

EXPERIMENT
LESSON III
PART 2

Introduction to Differentiators

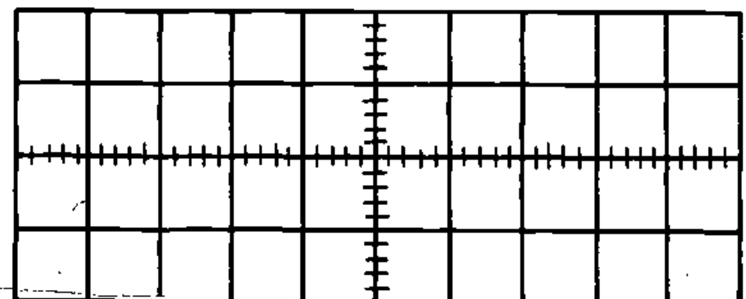
PROCEDURE:

I. a. Now you are going to assemble the opposite of an integrator - a differentiator. If an integrator has a long time constant, then a differentiator must have a ________________. That's right, a short time constant. Get template #2 and place it on the 6F16. Add the required components.

b. Readjust the oscilloscope, if necessary, for dual trace operation.

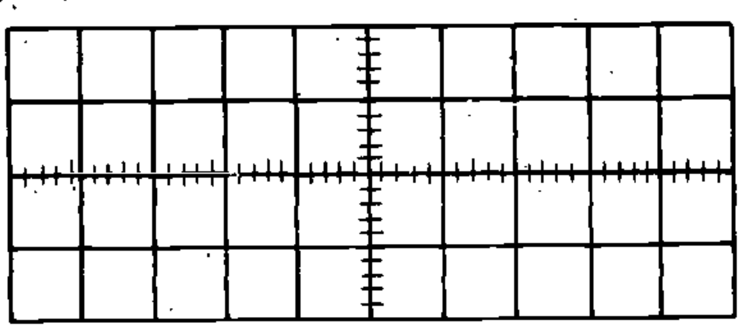
c. Connect a IX test probe to jack #2 of the test signal box and to the input, as you did in part #1 of this job sheet.

II. 1. Using channel A of the oscilloscope, observe and draw the input waveform.



It should look like the input used in Part 1.

2. Connect the channel "B" IX test probe to the output of the differentiator. Observe and draw the output waveform. (You didn't forget to turn the vertical presentation switch to channel "B", did you?)



NOTE: Don't be alarmed if you can't see the entire waveform. When the signal first starts to go positive or negative (leading edge), it happens so quickly (almost instantaneously) that the oscilloscope can't follow it.

3. What is the output peak-to-peak voltage? ______________

4. Now, locate a 33 K Ω resistor and put in place of the 4.7 K Ω resistor. What will happen to the output? It is now more/less differentiated? Did the output amplitude increase or decrease sharply? By how much? ______________

5. Now replace the 33 K Ω resistor with a 10 K Ω resistor. Which resistor (33 K Ω 10 K Ω, or 4.7 K Ω) produced the "best" differention?

6. You have now built RC integrators and differentiators and looked at the inputs and outputs of each. This leaves only the L/R type circuits (integrators and differentiators.) You will not be able to construct these as the 6F16 doesn't have these capabilities. Remember how they were covered in the written media? L/R circuits produce the same outputs as RC circuits. The only difference is where you take the outputs.

This concludes the Experiment on Integrators and Differentiators. Secure the test equipment and put all the components back in their proper places.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS YOU MAY TAKE LESSON III PROGRESS CHECK. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TESTS, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE. IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON III

Integrators and Differentiators

1. An RC integrator's output is taken across the ______________.

2. An L/R integrator's output is taken across the ______________.

3. An RC differentiator's output is taken across the ____________.

4. An L/R differentiator's output is taken across the ___________.

5. An integrator has a long/short time constant with respect to the input pulse.

6. A differentiator has a long/short time constant with respect to the input pulse.

7. Which of the illustrated output waveforms indicates the shortest time constant?

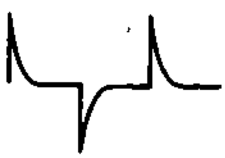
a. 

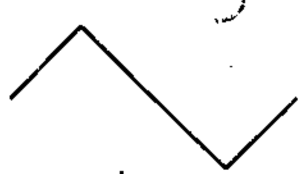
c. 

b. 

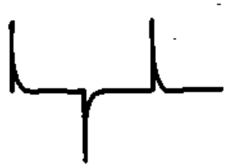
d. 

8. Which of the illustrated output waveforms indicates the longest time constant?

a. 

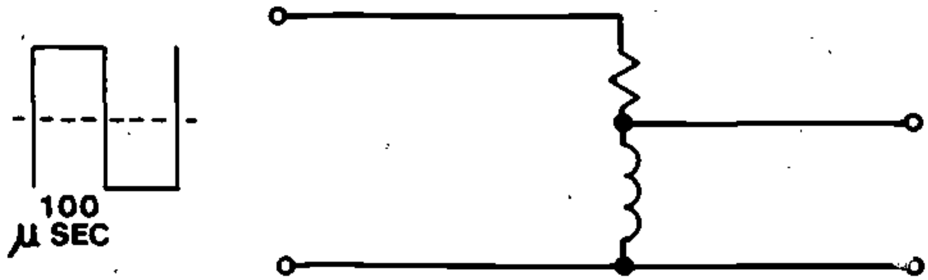
c. 

b. 

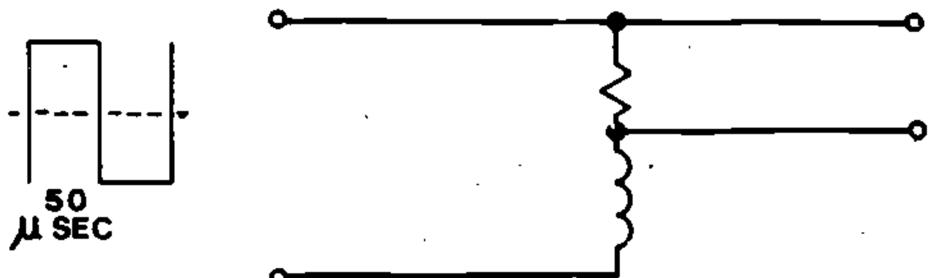
d. 

9. Match the illustrated circuits with their most correct names.

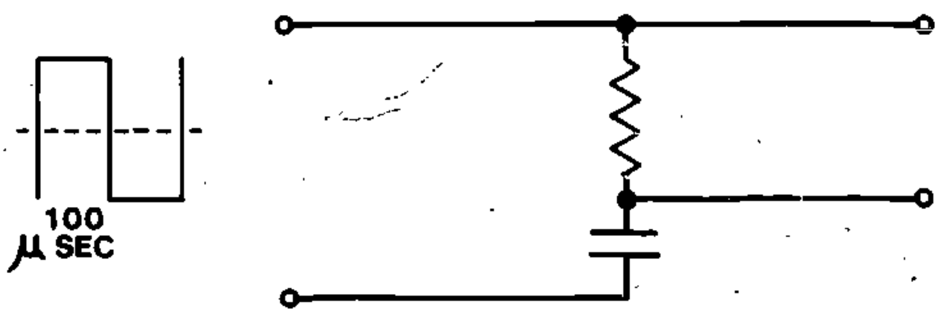
a. Tc=500 µ sec



b. TC=5 µsec



c. TC=5 m sec



d. TC=10 µsec

1. L/R differentiator
2. RC differentiator
3. L/R integrator
4. RC integrator

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO END OF MODULE TEST.

MODULE

TWENTY FIVE

SPECIAL DEVICES

EXPERIMENT
LESSON I
PART 1

Silicon Controlled Rectifier DC Control

This Experiment will demonstrate the operation of an SCR when forward bias is applied from a DC source.

EQUIPMENT REQUIRED:

Device 6F16 with template "J" - introduction to SCR's.

PROCEDURE:

1. Set up Device 6F16 using template #J and the parts called for by the template. Observe all applicable safety precautions.

   NOTE: Do not install jumper "F". Do not energize the device.

2. When this circuit is energized, will DS1 light?________________

3. Now energize the 6F16 using the line cord.

4. Why is the light out at this time?

   a. The SCR is forward biased.
   b. The SCR is reverse biased.
   c. There is no gate voltage applied.
   d. There is a positive gate voltage applied.

5. What will happen if jumper "F" is installed?

   a. The SCR will cut off.
   b. The SCR will conduct.
   c. The light will remain off.

6. Install Jumper "F".

7. What did jumper "F" do to the circuit?

   a. Forward biased the SCR.
   b. Reverse biased the SCR.
   c. Applied a negative voltage to the gate lead.
   d. Applied a positive voltage to the gate lead.

8. If jumper "F" is removed, will the light go out?

9. Remove jumper "F".

10. Now that the SCR is conducting, how can the circuit be restored to it's "off" condition?

    a. Apply a positive voltage to the gate.
    b. Remove the gate voltage.
    c. Remove jumper "C".
    d. Apply a ground to the gate lead.

11. Test your answer to #10 by momentarily performing the action you chose.

    NOTE: If you chose answer "A" obtain the voltage from the bottom of resistor R2. DO NOT apply full positive voltage to the gate lead. The SCR may be damaged if a high voltage is applied to the gate.

12. If the light goes off and remains off when the circuit is restored, your answer to #10 is correct. If the light is still lit, go back to #10 and try again.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO PART 2 OF THIS JOB SHEET.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

EXPERIMENT
LESSON I
PART 2

Silicon Controlled Rectifier AC Control

The AC control characteristics of an SCR will be demonstrated by this Experiment.

EQUIPMENT REQUIRED:

Oscilloscope
1X probe (two required)
Device 6F16 with template "K" - silicon control rectifier AC control characteristics

PROCEDURE:

I. Using all applicable safety precautions, energize the oscilloscope and obtain a line trace. Make the following settings:

a. SWEEP MODE to "LINE".
b. SWEEP TIME to 5 millisec/cm.
c. CHANNEL SELECT to "CHOPPED".
d. SENSITIVITY to 10 volts/cm (Channel "A") and 5 volts/cm (Channel "B").
e. SWEEP POSITION Channel "A" to +1 cm; Channel "B" to -1 cm.

II. Using all applicable safety precautions, set up Device 6F16 using Template #K and the parts called for on the template. Energize the 6F16 using the line cord.

III. 1. Using the 1X probes, connect channel "A" of the oscilloscope to the AC input to the circuit. (Left side of DS1.) Connect channel "B" to the top of R4.

2. Turn Potentiometer R2 fully clockwise (as viewed from the knob side).

NOTE: This gates the SCR on at the same time as the anode goes positive.

3. Channel "B" is displaying (full wave; half wave; no) rectification.

4. The SCR is operating like a (transistor; resistor; diode.)

5. Perform the following steps:

a. Remove the Channel "A" probe from the input and reconnect it to the anode of CR 1.
b. Turn R2 fully counter-clockwise.
c. Set CHANNEL SELECT to "B."
d. Set "B" SENSITIVITY to 2 volts/cm.
e. Slowly turn R2 clockwise until positive pulses just appear on the trace.

f. Set HORIZONTAL POSITION until the leading edge of the middle pulse coincides with the vertical center line of the graticule. The leading edge of the pulse is the "turn on" time of the SCR.

g. Set CHANNEL SELECT to "A".

h. Set "A" SENSITIVITY to 2 volts/cm.

i. Using Channel "A" POSITION set the positive peaks of the sine wave at the horizontal center line of the graticule. The horizontal center line of the graticle now represents the "turn on" voltage for the SCR. This is a representation of the voltage applied to the gate lead of the SCR.

j. Set the CHANNEL SELECT SWITCH to "CHOPPED." The sweeps will be superimposed, so remember which waveform is the input and which is the output.

6. What happens to the SCR when the voltage to the gate reaches the horizontal centerline of the graticule? The SCR (cuts off; conducts).

7. Turn R2 clockwise until the peak voltage displayed on Channel "A" reaches +.2 cm. (One small division above horizontal centerline.)

8. The gate voltage now reaches "turn on" voltage (earlier; later; at the same time) in the applied sinewave.

9. The SCR is now conducting (more; less; the same).

10. Turn R2 clockwise until the peak voltage to the gate is at +.6 cm (three small divisions above the centerline.) What happened to the conduction time of the SCR? The conduction time (increased; decreased; remained the same).

11. Which of the statements below best describes the action of the SCR in this circuit?

a. SCR conduction begins at the time the gate signal reaches the "Turn on" voltage level.
b. SCR conduction increases when the gate voltage increases.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON I PROGRESS CHECK.

IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

PROGRESS CHECK
LESSON I

Introduction to Silicon Controlled Rectifiers

1. SCR's are not affected by

    a. heat.
    b. vibration.
    c. cold.
    d. current.

2. The SCR is similar to a ___ ______________.

3. The three leads of an SCR are the______________, the__________, and the___________________________.

4. The bias conditions necessary to start an SCR into conduction are

    a. positive on the anode, negative on the cathode.
    b. negative on the anode, positive on the cathode.
    c. positive on the anode, negative on the cathode, and positive on the gate.
    d. negative on the anode, positive on the cathode, and negative on the gate.

5. The bias conditions necessary to maintain an SCR in conduction are

    a. positive on the anode, negative on the cathode.
    b. negative on the anode, positive on the cathode.
    c. negative on the anode, positive on the cathode, and positive on the gate.
    d. positive on the anode, positive on the cathode, and positive on the gate.

6. The direction of current flow through a conducting SCR is

    a. cathode to anode.
    b. anode to cathode.
    c. gate to anode.
    d. cathode to gate.

7. One way to stop conduction of an SCR is to

    a. remove the gate signal.
    b. reverse bias the SCR.
    c. increase forward bias.
    d. ground the cathode.

8. The output of an SCR with an "AC" input and a "DC" gate signal applied to the anode will look like

a. 

b. 

c. 

d. 

9. The shape of the output waveform of an SCR with an AC input and an AC gate signal depends upon

   a. gate timing.
   b. input amplitude.
   c. gate signal amplitude.
   d. the type of SCR.

10. The "turn on" voltage required on the gate lead of most SCR's ranges between

    a. +1 to +10 volts.
    b. +5 to +50 volts.
    c. -3 to +3 volts.
    d. +.1 to +1 volts.

11. Power output control of an SCR with an AC input signal is accomplished by

    a. applying and removing forward bias to the anode and cathode.
    b. applying and removing reverse bias to the anode and cathode.
    c. increasing and decreasing the AC amplitude applied to the gate below the triggering level.
    d. increasing and decreasing the AC amplitude applied to the gate

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO LESSON II.

EXPERIMENT
LESSON II
PART 1

Unijuction Transistor Sawtooth/Trigger Generator

EQUIPMENT REQUIRED:

Device 6F16 with template "L" - unijunction transistor sawtooth/trigger generator
6F16 Supplemental Parts Box (Small, grey box)
Oscilloscope
1X probe (2)

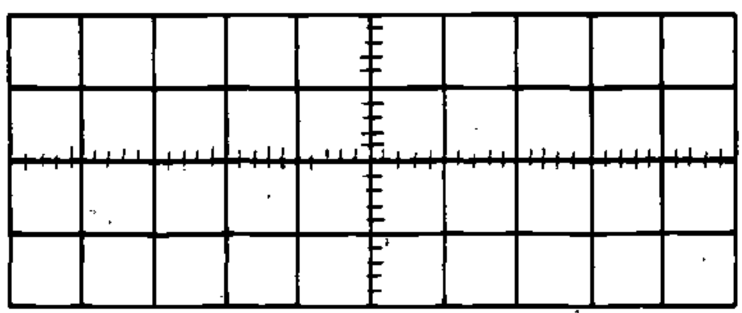
PROCEDURE:

I. Energize the oscilloscope and obtain a dual line trace. Make the following settings:

a. CHANNEL PRESENTATION switch "CHOPPED".
b. SWEEP POSITION: Channel "A" to +1 cm.
Channel "B" to -1 cm.

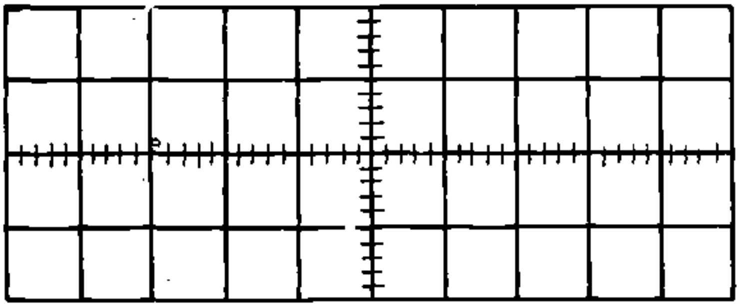
II. Using all applicable safety precautions, set up training device 6F16 using template #L and the required parts. Energize the 6F16 using AC line cord.

III. 1. Connect a 1X probe from Channel "A" input on the oscilloscope to the emitter of Q1 ("D"). Observe and draw the waveform on Channel "A".



2. a. Channel "A" is displaying a (sine wave, square wave, trigger, sawtooth) waveform.
b. How much peak to peak voltage do you read?
_______________ V p-p
c. Indicate on the waveform you drew in III. 1. the point where the U.J.T. starts to conduct.

3. Connect a 1X probe from channel "B" input on the oscilloscope to base 1 of Q1 ("C"). Observe and draw the waveforms.



4. a. Channel "B" is displaying a (sine wave, square wave, trigger, sawtooth) waveform.
b. How much peak to peak voltalge do you read?__________vp-p
c. The U.J.T. is at its highest conduction when the waveform at B1 is (not present, most positive, least positive).

5. a. From this job sheet you can see that you get two very different types of waveforms at different points on the U.J.T. By connecting the oscilloscope input to the emitter, you see a (sine wave, square wave, trigger, sawtooth) output.

b. By connecting the scope to base 1 a (sine wave, square wave, trigger, sawtooth) is viewed.

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EXPERIMENT
LESSON II
PART 2

Unijunction Transistor Multivibrator

EQUIPMENT REQUIRED:

Device 6F16 with template "M" - unijunction transistor multivibrator
6F16 Supplemental Parts Box (small, grey box)
Oscilloscope
1X Probe (2)

PROCEDURE:

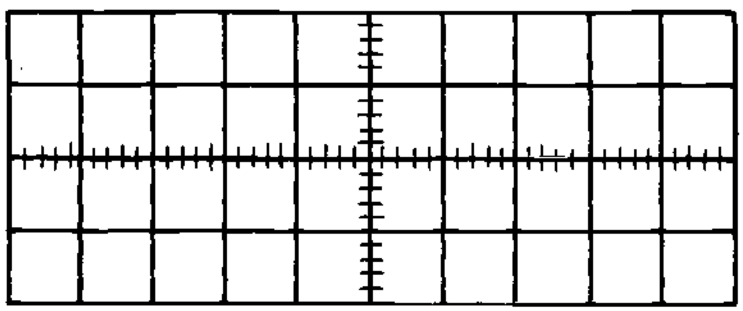
I. Energize the oscilloscope and obtain a dual line trace. Make the following settings.

a. CHANNEL PRESENTATION switch to "CHOPPED"
b. SWEEP POSITION: Channel "A" to + 1 cm.
Channel "B" to -1 cm.

II. Using all applicable safety precautions, set up training device 6F16 using template #M and the required parts. Energize the 6F16 using the AC line cord.

III. Connect a 1X probe from the oscilloscope Channel "A" input to base 2 ("F") of Q1.

1. a. Observe and draw the waveform appearing on channel "A".

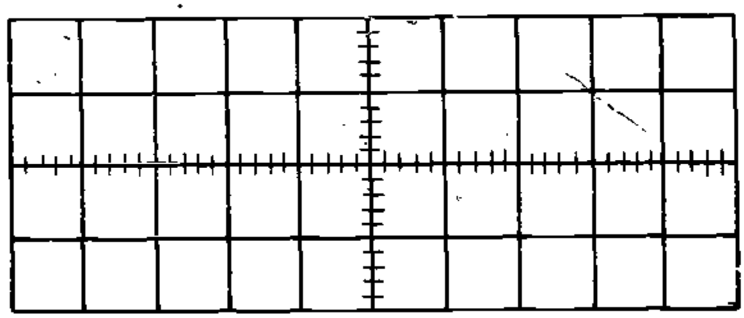


b. Channel "A" is displaying a (sine wave, square wave trigger, sawtooth) waveform.

c. How much peak to peak voltage do you read?________Vp-p

2. Connect a 1X probe from Channel "B" input on the oscilloscope to the cathode of CR1.

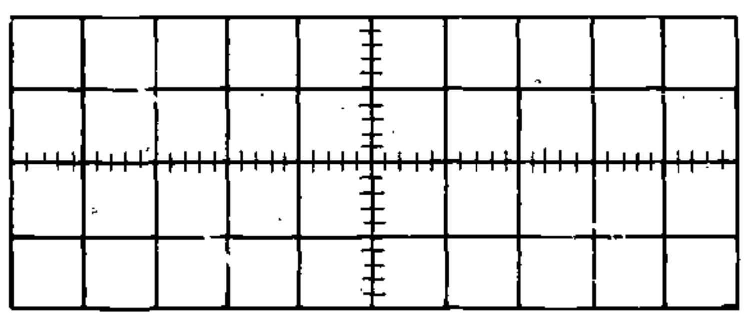
3. a. Observe and draw the waveform shown on channel "B".



   b. The waveform on channel "B" is displaying a (sine wave, square wave, trigger, sawtooth).
   c. How much peak to peak voltage do you read?__________Vp-p
   d. Q1 begins to conduct at ______________________volts.

4. Place the 1X probe from channel "B" input to the anode of CR 1.

5. a. Observe and draw the waveform on channel "B".



   b. Is the waveform different than the waveform on the cathode?____
   c. Why?____

6. What is the relationship of the conduction and cutoff times of Q1 and CR 1?
   a. Q1 not conducting, CR1 not conducting.
   b. Q1 conducting, CR1 not conducting.
   c. Q1 conducting, CR1 conducting.

7. Notice that once again the U.J.T. provides two very different types of outputs.

8. In the circuit on template #M, Base 2 provides a

   a. square wave.
   b. sine wave.
   c. trigger.
   d. sawtooth.

9. In the circuit on template #M, the emitter provides a

   a. square wave.
   b. sine wave.
   c. trigger.
   d. sawtooth.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS YOU HAVE COMPLETED THIS MODULE. IF YOU FEEL THAT YOUR PROGRESS CHECK RESULTS INDICATE THAT YOU ARE READY TO TAKE THE END OF MODULE TEST, SEE YOUR LEARNING SUPERVISOR. IF YOU FEEL YOU NEED FURTHER STUDY BEFORE TAKING THE END OF MODULE TESTS, YOU MAY REVIEW ANY PART OF THIS MODULE.
IF YOUR RESPONSES DIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS AND PROCEDURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR. IT IS SUGGESTED YOU TAKE THE PROGRESS CHECK FOR LESSON II PRIOR TO TAKING THE END OF MODULE TEST.

EXPERIMENT
LESSON 11
PART 3

UJT Ramp Generator and SCR Control Circuit

The experiment will demonstrate the operation of the NIDA 204 Function Generator's UJT Oscillator PC board and the SCR Control PC board. You will also be shown how these two circuits operate together in a system.

EQUIPMENT REQUIRED:

NIDA 204 Function Generator

PC 204 and 1 thru 8 Printed Circuit Cards

Oscilloscope

Signal Generator

BNC-BNC Cables (2)

1X Probe (2)

Jumper Cable with alligator clips (1)

REFERENCE MATERIAL:

Function Generator, NIDA Trainer, Model 204, Instruction Manual.

PROCEDURE:

1. Energize the oscilloscope and set it up for CHANNEL A and INTERNAL MODE operation. Using a BNC-BNC cable connect the NIDA Function Generator OUTPUT jack to CHANNEL "A" of the oscilloscope. Energize the signal generator to warm up for later use.

2. Set up the NIDA 204 Function Generator front panel controls as follows:

   a. TRIGGER to "Internal."
   b. FREQUENCY switch to "1000 Hz."
   c. FREQUENCY dial to "3."
   d. OUTPUT LEVEL fully clockwise.
   e. SYMMETRY full clockwise.
   f. FUNCTION switch to "⟋|" (Ramp)

3. Remove the top cover of the NIDA 204 and ensure all eight PC cards are in place.

4. Plug in and energize the Function Generator.

5. Observe the output waveform from the Function Generator. The output should be a ramp (sawtooth) voltage with a smooth (straight line) rise. The basic UJT oscillator in your study booklet had an "integrated" (curved line) output. The UJT oscillator in the NIDA 204 has some additional circuits that make the output linear.

   Refer to Figure 1 in this experiment and locate PC 204-6. This is a schematic of the UJT Oscillator - Ramp Generator.

NOTE: Transistor Q1-6 and its associated circuitry (R2-6, CR1-6, CR2-6, CR3-6, and R1-6) comprise a "Current Regulator." This current regulator will maintain current through the UJT Emitter Capacitors at a constant value resulting in a linear "Ramp" output.

6. Transistor Q3-6 is another device you are probably not familiar with. It is called a "Field Effect Transistor," or, to shorten the name a bit, FET. This FET and its associated components (R6-6 and R7-6) make up an amplifier circuit. An FET is used as an amplifier because it has a high input impedance and will not load the UJT circuit. If a regular transistor were used in place of the FET, the output would be distorted.

7. Refer to Figure 1 and answer the following questions:

   (1) The FREQUENCY SWITCH (S2) will change the (capacitance/resistance) of the UJT oscillator.

   (2) With the FREQUENCY SWITCH (S2) in the 1000 Hz position, capacitor (C9/C10/C11/C12) is in (series/parallel) with C1-6.

8. The FREQUENCY dial (R21A) sets the conduction level of the current regulator. If the regulated current increases, the capacitors in the emitter circuit of the UJT will charge more quickly and increase the output frequency.

   (1) The FREQUENCY potentiometer (R21A) is in (series/parallel) with R2-6.

Now that we have checked the operation of the UJT circuit, let's take a look at the SCR control circuit operation. (Refer to Figure 1 and locate PC 204-5 SCR control Circuit).

9. Deenergize and unplug the NIDA 204 Function Generator.

10. Remove the Unijunction Oscillator printed circuit card PC204-6.

11. Connect a 1X probe to the oscilloscope's CHANNEL B input and set up the oscilloscope for CHANNEL "B", INTERNAL TRIGGER mode.

12. Plug in and energize the NIDA 204 Function Generator.

13. Using the oscilloscope, measure and record the DC voltages at the anode and cathode of SCR2-5.

    (1) Anode: ____________ VDC
    (2) Cathode: ____________ VDC
    (3) Is SCR 2-5 conducting? (YES/NO)

HINT: Whenever the difference in potential between the anode and cathode of an SCR exceeds 0.6 volts, the SCR is not conducting.

    (4) Is SCR 2-5 forward biased?

    (5) What else is required to turn on SCR 2-5?

        a. Reverse bias SCR 2-5.
        b. Forward bias SCR 2-5.
        c. Apply a positive signal to SCR 2-5's gate lead.
        d. Apply a negative signal to SCR 2-5's gate lead.

14. Now we are going to turn SCR 2-5 on by applying a positive signal to the gate lead: De-energize NIDA 204 and connect one lead of a jumper to PC 204-7, pin 3, and leave the other end free. Energize and momentarily touch the free end to PC 204-5, pin 10.
    (1) Is SCR 2-5 conducting? (YES/NO)

15. Place the 1X probe at the SCR 1-5 gate lead. Carefully observe the oscilloscope trace for a "pulse" while rapidly pressing and releasing the TRIGGER SWITCH (S5).

    NOTE: The TRIGGER SWITCH will be in the "MAN" (manual) position when depressed and is spring loaded to return to the "EXT" (external) position when released. Use the .5v/cm. position on the Oscilloscope Channel B.

    (1) The signal applied to the gate lead of SCR1-5 when the TRIGGER SWITCH is depressed is a

        a. positive going trigger.
        b. negative-going trigger.

    NOTE: The trigger switch applies a negative signal to the base of transistor Q1. The signal is differentiated, inverted and applied to the gate lead of SCR 1-5. (Refer to Figure 1.)

16. Move the 1X probe to the anode of SCR 1-5. Carefully observe the oscilloscope trace while depressing and releasing the TRIGGER SWITCH (S5).

(1) When the TRIGGER SWITCH (S5) is placed in the "MAN" (manual) position SCR 1-5

a. "turns off" momentarily then "turns on" again.
b. "turns on" momentarily then "turns off" again.

NOTE: When SCR 1-5 conducts, capacitor C2-5 will discharge through CR1-5 and SCR1-5. Resistor R6-5 in the anode circuit of SCR1-5 is a high value resistor. There is insufficient current through R6-5 (holding current) to maintain SCR1-5 in conduction. SCR1-5 will "shut off" when capacitor C2-5 is discharged. The discharge path for C2-5 is through the forward biased CR1-5 and SCR1-5.

17. Move the 1X probe to the anode of SCR 2-5.

(1) Is SCR 2-5 conducting? (YES/NO)

18. Turn on SCR 2-5. (Momentarily connect a jumper between PC204-7, pin 3, and PC204-5, pin 10.)

19. While observing the oscilloscope trace, place the TRIGGER SWITCH (S5) to "MAN". This action causes SCR1-5 to conduct, discharges C2-5 and drives the anode of SCR2-5 negative; thereby shutting SCR2-5 "off."

We will now see how the SCR Control Circuit and the UJT Oscillator-Ramp Generator work together.

20. Deenergize the NIDA 204 Function Generator and insert the UJT Oscillator-Ramp Generator printed circuit card, PC204-6.

21. Ensure the NIDA 204 Function Generator is set up as follows:

a. FREQUENCY SWITCH (S2) to "1000 Hz."
b. FREQUENCY DIAL (R21A) to "3."
c. TRIGGER SWITCH (S5) to "INT."
d. INPUT SENSITIVE CONTROL fully clockwise.
e. TRIGGER LEVEL fully counter clockwise.
f. OUTPUT LEVEL fully clockwise.
g. FUNCTION SWITCH to "⟋|"

22. Using a BNC-BNC cable, connect the Audio Output from the Signal Generator to the input of the NIDA 204. Set up the Signal Generator as follows:

a. METER READS switch to "400 Hz."
b. AUDIO OUTPUT to read 5 on the microvolt scale.

23. Energize the NIOA 204. Set up the oscilloscope for CHANNEL A - Observe the waveform on the oscilloscope, then replace the TRIGGER switch (S5) on the NIOA 204 to "EXT."

(1) The number of ramps displayed on the oscilloscope (increased/ decreased/remained the same).

NOTE: The number of ramps displayed decreased because placing the TRIGGER SWITCH (S5) to "EXT." allowed the SCR control circuit to control the UJT Oscillator - Ramp Generator. (Figure 1 shows the interconnection between the UJT and SCR circuits you have just studied.)

24. Place the oscilloscope's CHANNEL "B" probe on Base 1 of the UJT (Q2-6). Look closely for a positive trigger.

NOTE: Set up the osc. loscope as follows to better observe the trigger:

a. CHANNEL MOOE SWITCH to "chopped."
b. SWEEP MOOE to "Internal."
c. SWEEP TIME to ".5 millisecond/CM."
d. CHANNEL "A" SENSITIVITY to "5 volts/CM."
e. CHANNEL "B" SENSITIVITY to "1 volt/CM."

(1) The positive trigger from Q2-6 base 1 will cause SCR 2-5 to (conduct/turn off).

NOTE: When the TRIGGER SWITCH (S5) is in the "External" position and SCR2-5 conducts, the UJT circuit cannot generate another ramp.

25. Place the CHANNEL "B" 1X probe on the gate lead of SCR 1-5.

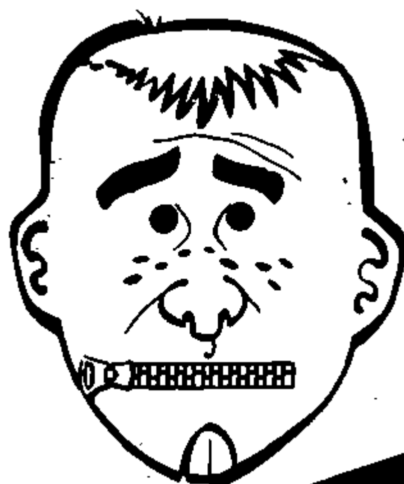
This signal originating from the signal generator (external input) will turn SCR1-5 (on/off).

NOTE: When SCR1-5 turns "on," SCR2-5 turns "off" and another ramp will be generated by the UJT circuit. Therefore, using an SCR control circuit allows us to determine when a ramp will be generated.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIOEO IN THE BACK OF THIS BOOKLET. IF YOUR RESPONSES OIFFER FROM THOSE GIVEN, RECHECK YOUR SETTINGS ANO PROCEOURES. IF YOU STILL HAVE A PROBLEM, SEE YOUR LEARNING SUPERVISOR.

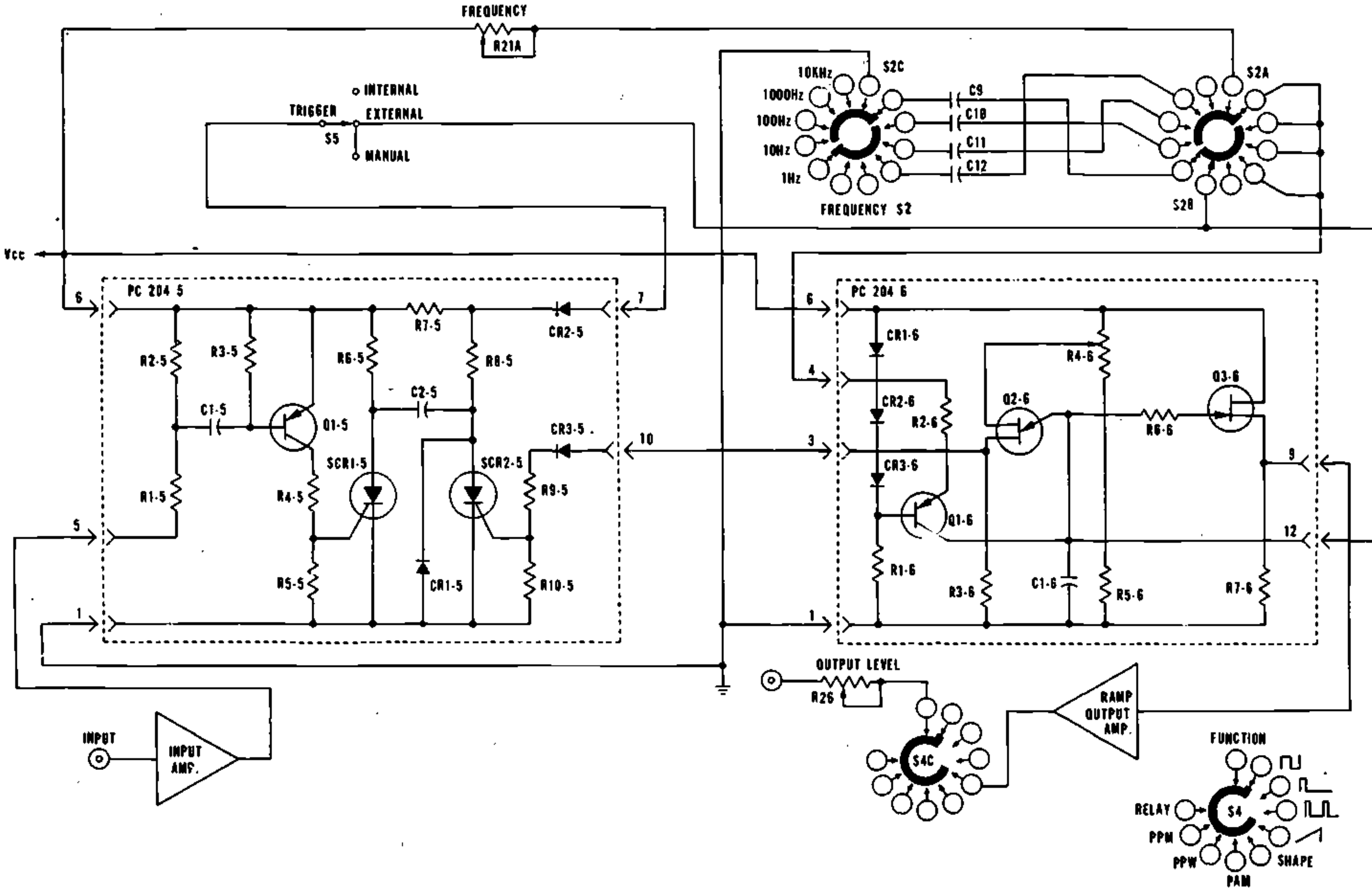
WHEN YOUR RESPONSES AGREE WITH THE ANSWERS GIVEN AND YOU FEEL THAT YOU HAVE MASTEREO THE MATERIAL IN THIS EXPERIMENT, REPLACE ALL THE COVERS ANO RETURN YOUR EQUIPMENT TO ITS STOWAGE, THEN PROCEEO TO THE PROGRESS CHECK.

GOT A SAFETY SUGGESTION?



Don't keep it to yourself!

U.S. Naval Safety Center,
NAS, Norfolk, Virginia 23511



RAMP MODE

Figure #1

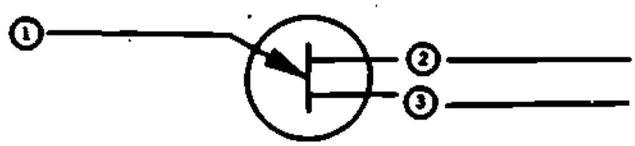
87

81/82

PROGRESS CHECK
LESSON II

Introduction to U.J.T.

1. Label the leads on the schematic symbol of the U.J.T.



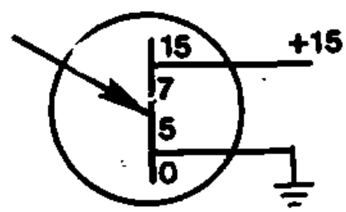
2. The material between the bases of the U.J.T. acts as a _________.

3. The emitter of the U.J.T. must be _________________ in respect to the _____________________ in order for the U.J.T. to conduct.

4. The sequential rise in potential between Base 1 and Base 2 is called a/an ____________________________.

5. The small amount of current flow in a reverse biased U.J.T. is called _________________.

6. What is the conduction point of the U.J.T. shown below? ___________



7. What does the waveform at TP "B" look like in the circuit shown below?

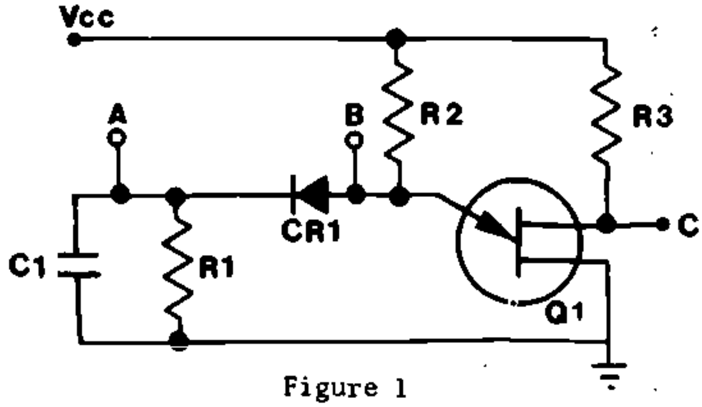


Figure 1

a.

c.

b.

d.

8. The shape of the waveform at TP "C" in figure 1 is determined by the

a. on/off state of Q1.
b. on/off state of CR1.
c. time constant of C1, R2.
d. time constant of CR1, R1.

9. The waveform at TP "A" in the circuit shown in figure 2 looks like:

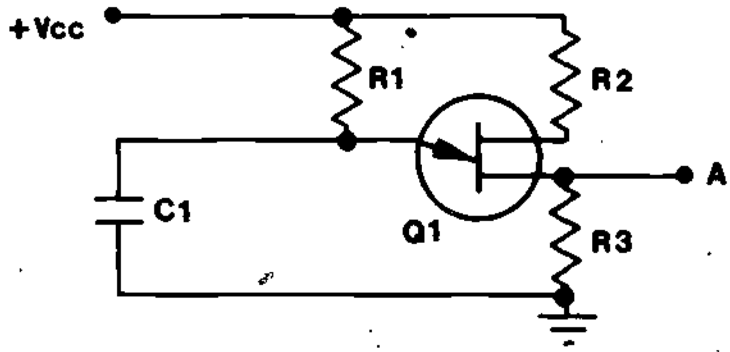
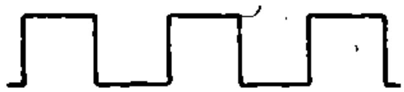


Figure 2

a. 

b. 

c. 

d. 

10. The frequency of the waveform at TP "A" in figure [illegible] s determined by

a. Q1.
b. R1.
c. R2.
d. R3.

11. In the circuit shown in figure 3 C1 charges through

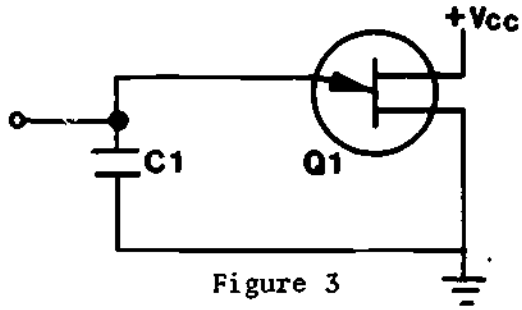


Figure 3

a. Q1's B1 - B2 junction.
b. Q1's E - B2 junction.
c. Q1's E - B1 junction.
d. ground.

12. The current that charges C1 is called____________________.

CHECK YOUR RESPONSES WITH THE ANSWERS PROVIDED IN THE BACK OF THIS BOOKLET. WHEN YOUR RESPONSES AGREE WITH THE ANSWERS, PROCEED TO END OF MODULE TEST.

ANSWER SHEETS

FOR

MODULES

TWENTY THREE

TWENTY FOUR

TWENTY FIVE

ANSWER SHEET FOR EXPERIMENT LESSON I

Bistable Multivibrator

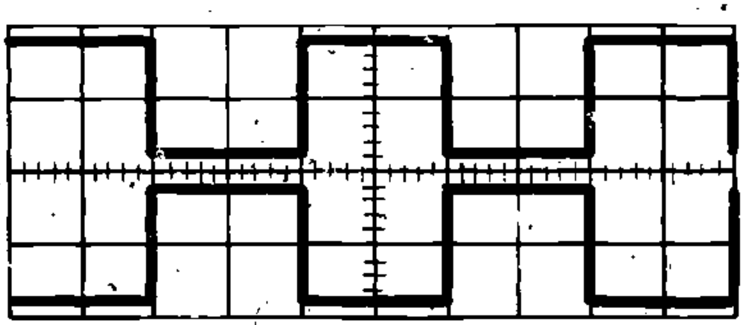
III.

NOTE: There are two possible answers to questions 1, 2, 3 and 5. If your answer to #1 is - 4 volts, use the first answer for 2, 3, and 5. If your answer is 0 volts, use the second answer for 2, 3 and 5.

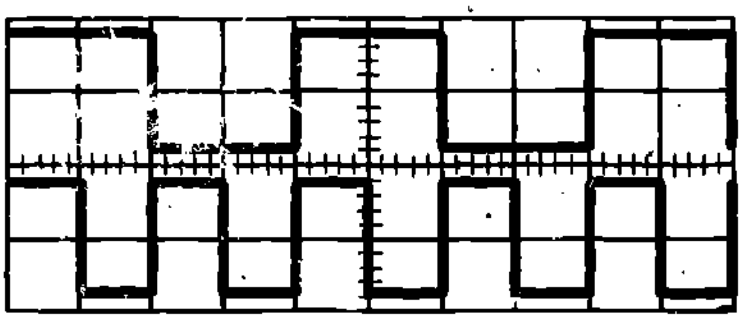
1. -4 volts   0 volts
2. 0 volts   -4 volts
3. Q2   QI
4. slight variations in component values. (or words to that effect)
5. NO   YES
6. yes
7. Q1 conducting, Q2 cut off
8. NO
9. YES
10. Q1 cut off, Q2 conducting

IV.

3.



5.

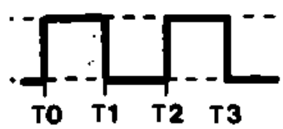


6. The input frequency is twice the output frequency. (or words to that effect.)

ANSWER SHEET FOR PROGRESS CHECK LESSON I

Bistable Multivibrators

1. Two
2. switches
3. will
4. two
5. cut-off
6. R6, R4, and R1
7. positive
8. D
9.



10. a. output
    b. input
    c. output
    d. input
    e. +Vbb

11. saturated

12. trigger

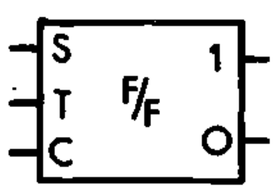
13. zero

14. A flip-flop is in the set state when there is a voltage at the "1" output and no voltage at the "O" output. (Or words to this effect).

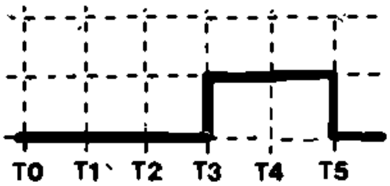
15. The clear state of a flip-flop is the state in which the "1" output is at zero volts and the "O" output has voltage. (Or words to this effect).

16. a. set
    b. clear

17.



18. toggle

19. 

20. d. cutoff, B

21. a

22. d

23. c

24. a

25. d

26. c

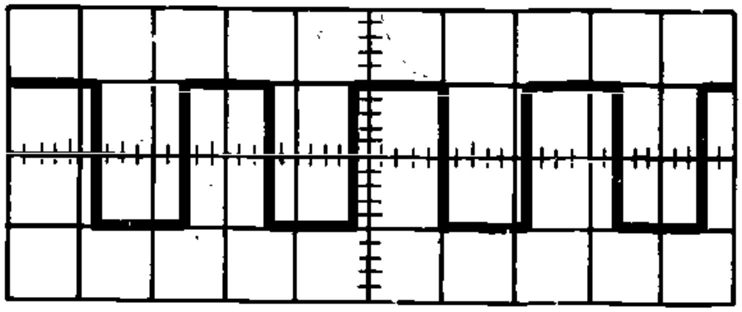
27. b

ANSWER SHEET
FOR
EXPERIMENT
LESSON II

Astable Multivibrator (Free Running)

III.

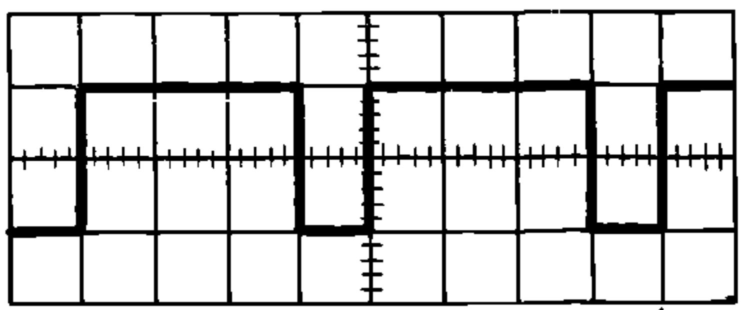
1.



2. .64 millisec.

3. .6 millisec.

4.



5. .2 millisec

6. .6 millisec

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON II

Astable Multivibrators (Free Running)

1. free running

2. oscillator or generator

3. zero (No), two (in that order.)

4. R2 and C1

5. saturated

6. C1 and R2

7. C2

8. b

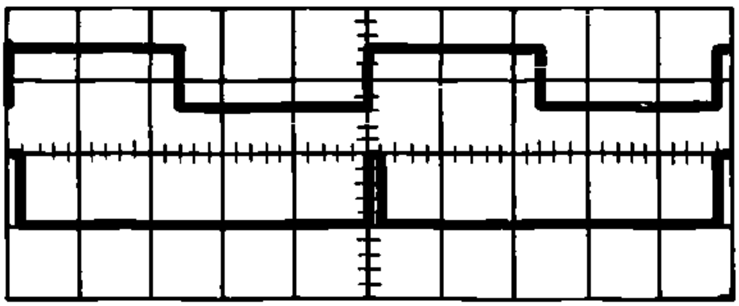
9. c

10. b

ANSWER SHEET
FOR
EXPERIMENT
LESSON III

Monostable Multivibrator (One Shot)

1.



2. greater than

3. 65 microsec

4. .92 millisec.

5. c

6. b

7. c

8. .25 millisec

9. increased

EXPERIMENT
ANSWER SHEET
LESSON III
PART 2

5.
   (1) d.

   (2) YES

   (3) c.

8. Period 37 usec, Frequency 27 KHz (± 10%).

9.
   (1) a.

   (2) b.

10.
   (1) c.

   (2) one-half.

   (3) c.

12.
   (1) b.

   (2) a.

   (3) b.

   (4) d. parallel

   (5) c.

   (6) Resistance.

15.
   (1) c.

   (2) b.

17.
   (1) c.

   (2) b.

   (3) c.

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON III

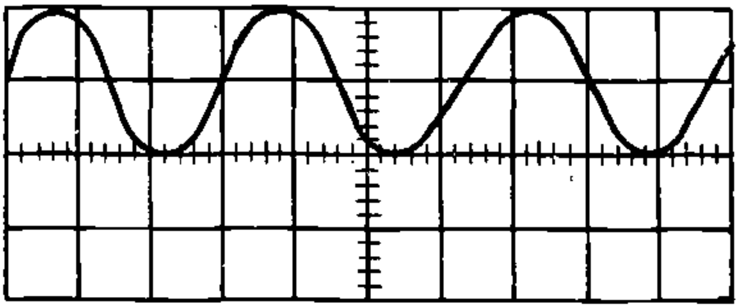
Monostable Multivibrators (One Shot)

1. one
2. cut off, saturated (in that order)
3. negative
4. definite
5. input, output (in that order)
6. -Vcc
7. b
8. f
9. c
10. c
11. a
12. b
13. c
14. a
15. b
16. c
17. c
18. b

ANSWER SHEET
FOR
EXPERIMENT
LESSON I
PART 1

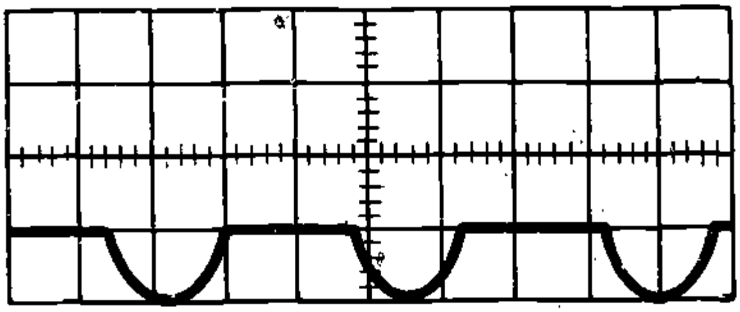
Clippers

1.



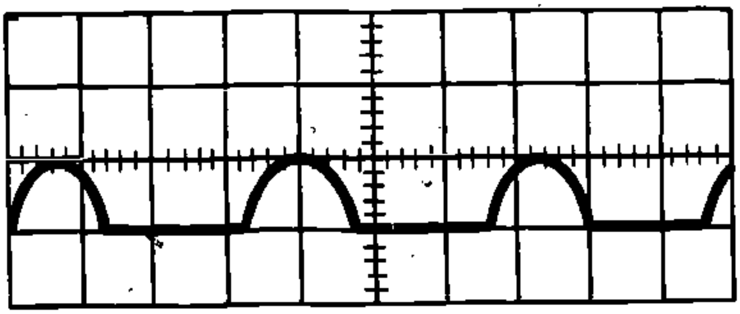
20 volts p-p

2.



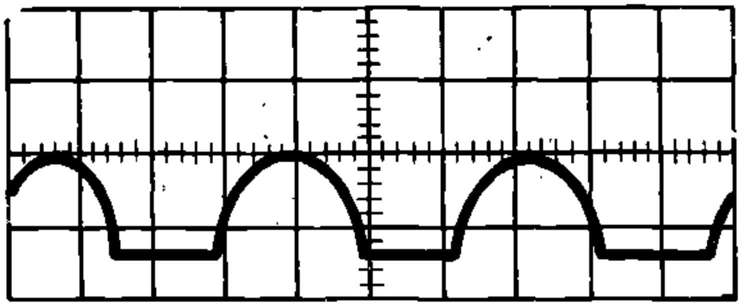
POSITIVE CLIPPER

3.



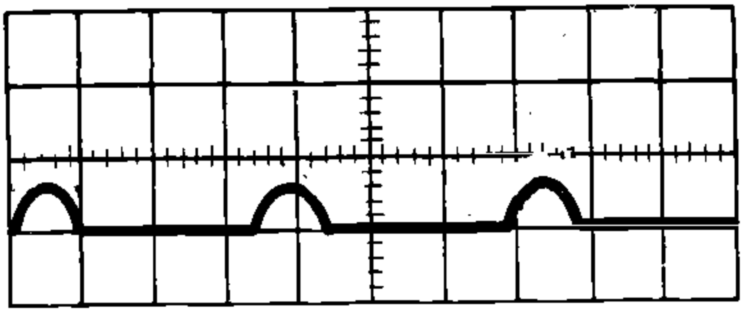
NEGATIVE CLIPPER

4.



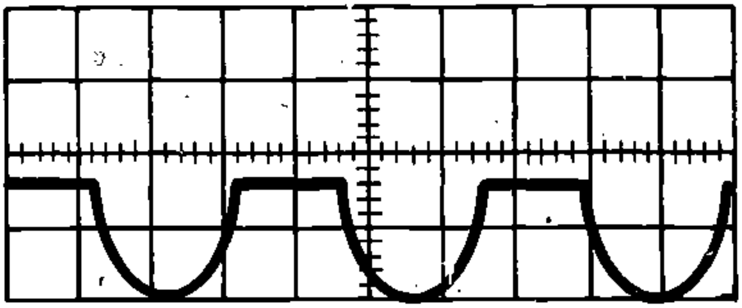
NEGATIVE CLIPPER with DC aiding forward bias

5.



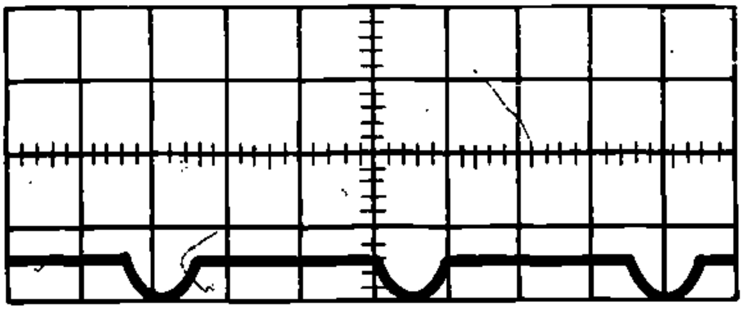
NEGATIVE CLIPPER with DC aiding reverse bias

6.



POSITIVE CLIPPER with DC aiding forward bias

7.

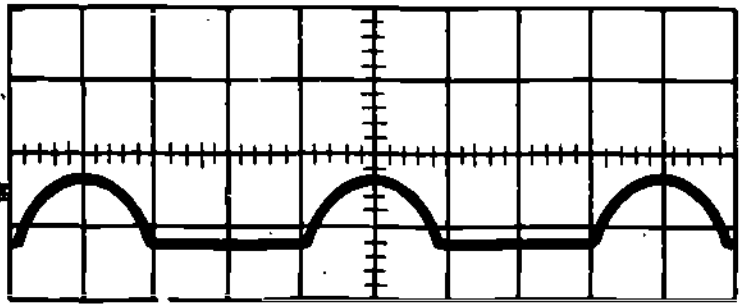


POSITIVE CLIPPER with DC aiding reverse bias

ANSWER SHEET
FOR
EXPERIMENT
LESSON I
PART 2

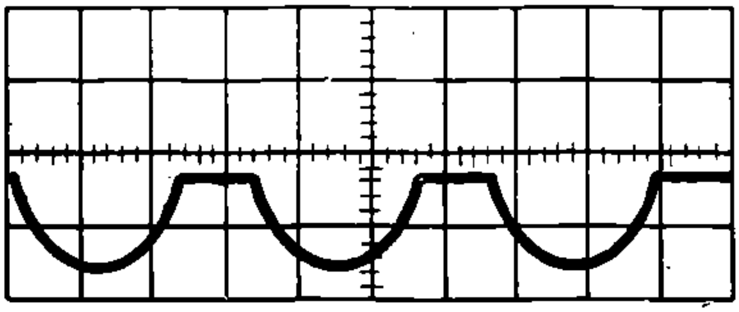
Clippers

1.



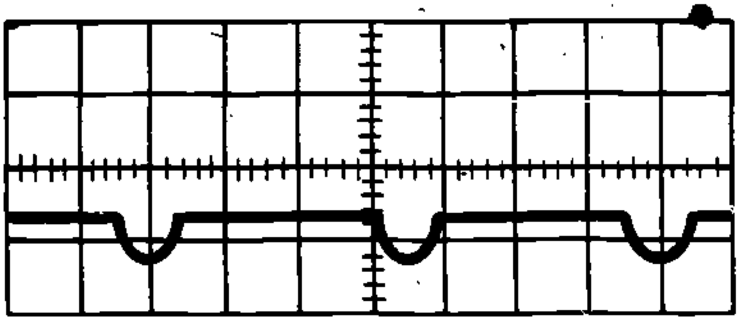
NEGATIVE

2.



POSITIVE

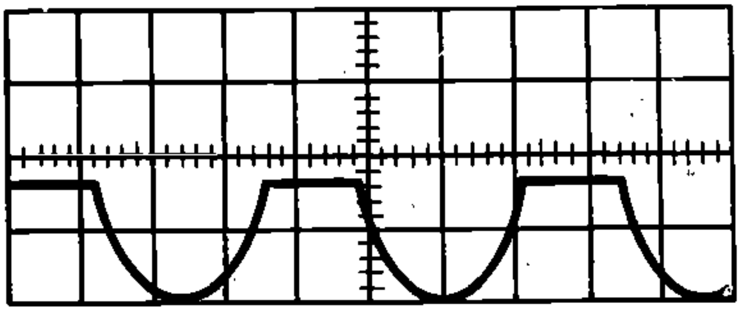
3.



POSITIVE CLIPPER with DC aiding forward bias

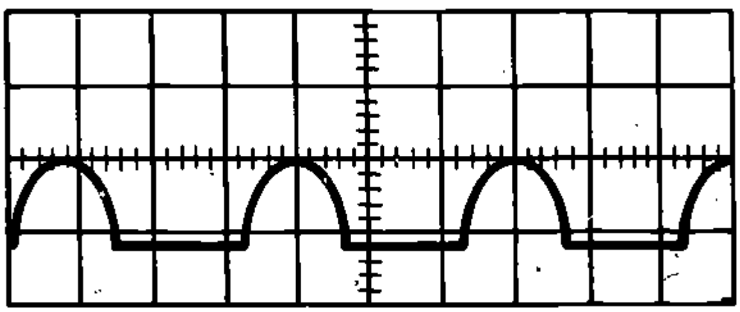
104

4.



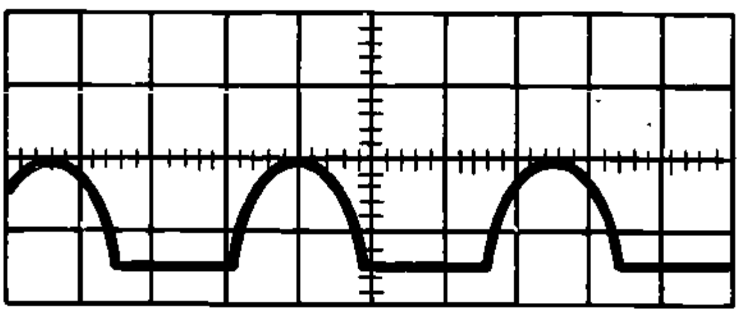
POSITIVE CLIPPER with DC aiding reverse bias

5.



NEGATIVE CLIPPER with DC aiding forward bias

6.



NEGATIVE CLIPPER with DC aiding reverse bias

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON I

Clippers

1. Positive

2. Negative

3. Input

4. Series positive

5. DC

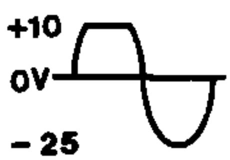
6. C

7. Load or output

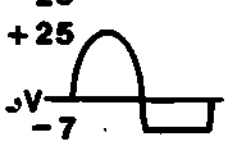
8. a-4 series positive clipper with positive bias
b-1 series negative clipper with positive bias
c-8 series positive clipper with negative bias
d-6 series negative clipper with negative bias
e-7 parallel positive clipper with positive bias
f-5 parallel negative clipper with positive bias
g-2 parallel positive clipper with negative bias
h-9 parallel negative clipper with negative bias
i-3 parallel positive and negative clipper with positive and negative bias

9. 1-a, 2-b, 3-b, 4-a

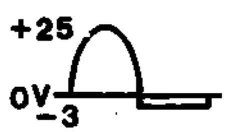
10. a



b.

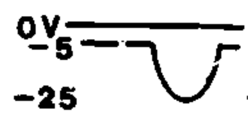


c.

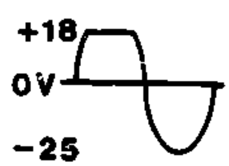


d.

e.



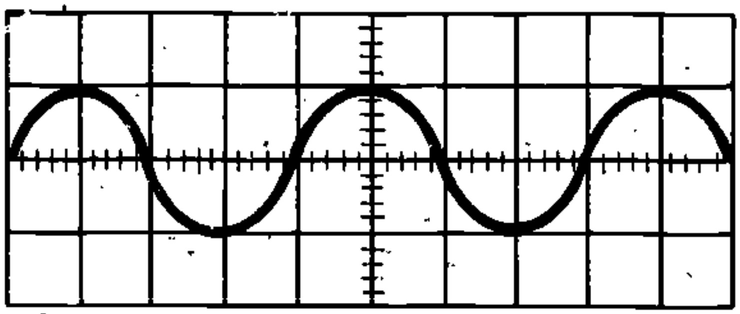
f.



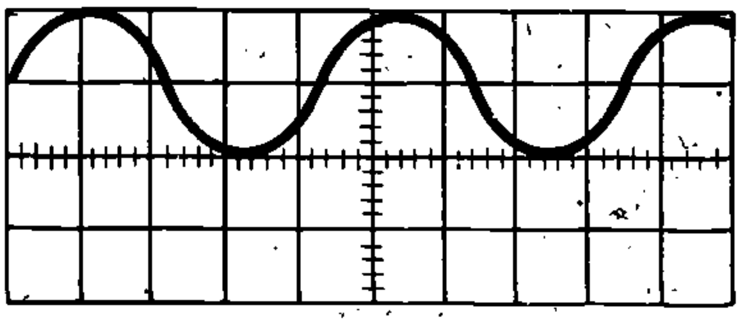
ANSWER SHEET
FOR
EXPERIMENT
LESSON II

Clampers

1.

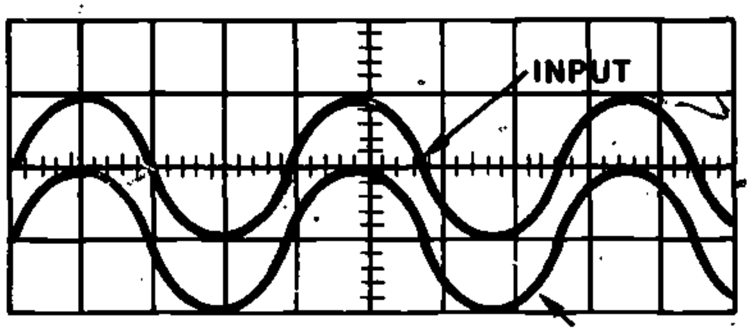


2.



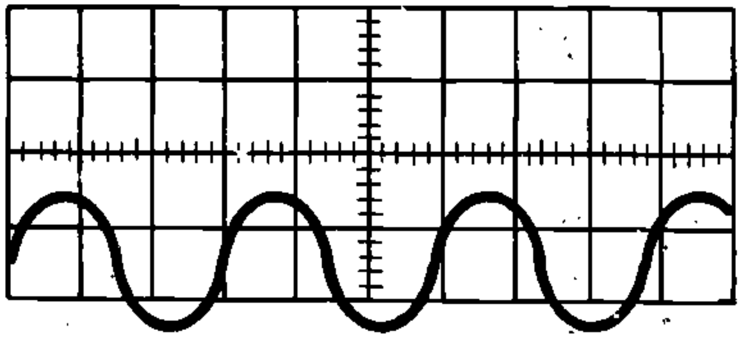
POSITIVE clamper
0 volts

3.



NEGATIVE clamper

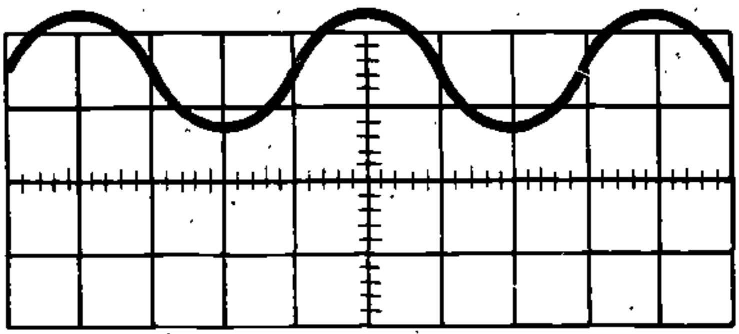
4.

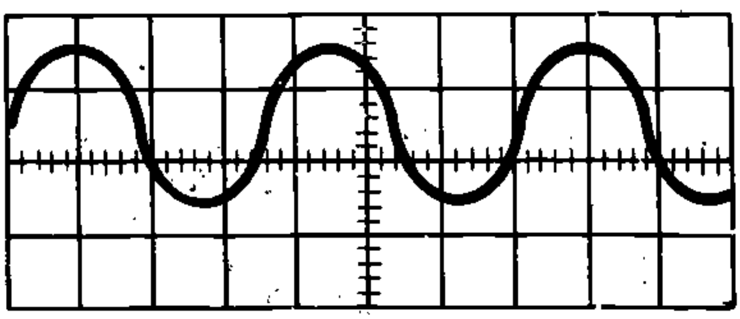


-5 volts

5. YES

6.





ANSWER SHEET
FOR
PROGRESS CHECK
LESSON II

Clampers

1. c

2. DC restorer

3. above

4. e

5. c

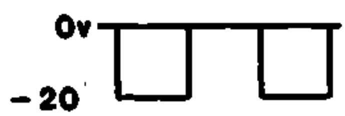
6. time constant

7. a

8. long

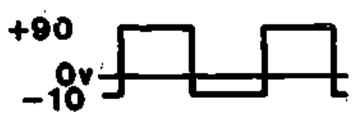
9. b.

10. a.



b.

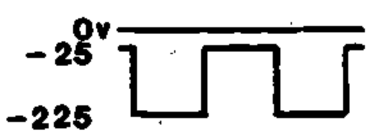
c.



d.

e.

f.

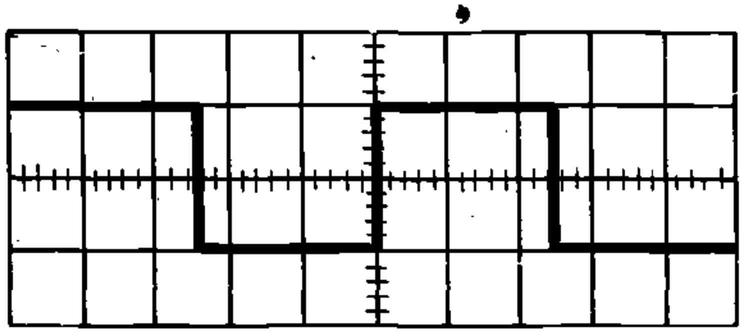


11. a. negative clamper
    b. positive clamper
    c. positive clamper with negative bias
    d. positive clamper with positive bias
    e. negative clamper with positive bias
    f. negative clamper with negative bias

ANSWER SHEET
FOR
EXPERIMENT
LESSON III
PART 1

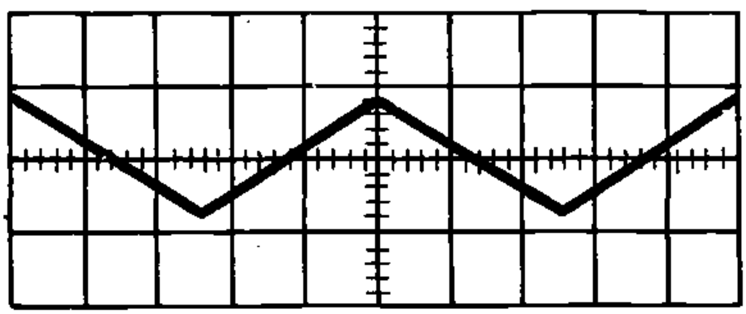
Integrators

1.



20 volts p-p

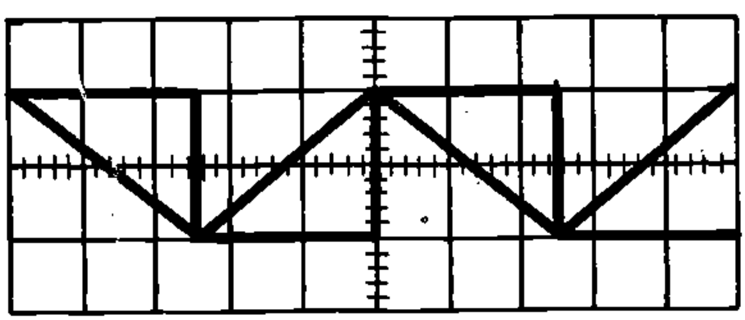
2.



.7 volt p-p

3. integrator

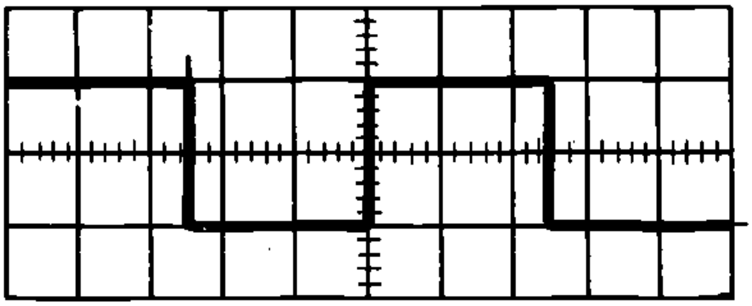
4.



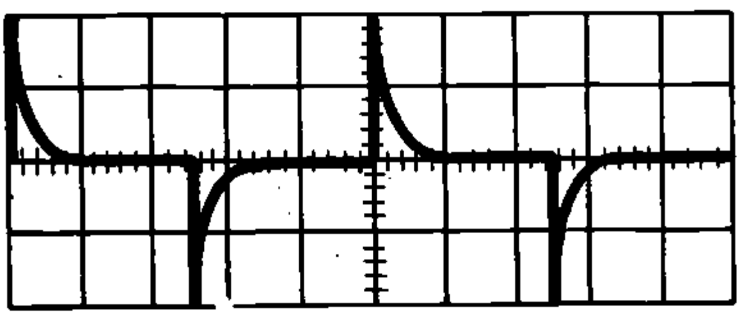
ANSWER SHEET
FOR
EXPERIMENT
LESSON III
PART 2

Differentiators

1.



2.



3. 40 volts p-p

4. less; decrease; 6 volts

5. 4.7 K ohm

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON III

Integrators and Differentiators

1. capacitor
2. resistor
3. resistor
4. coil
5. long
6. short
7. b
8. c
9. a. (4) RC integrator
   b. (1) L/R differentiator
   c. (3) L/R integrator
   d. (2) RC differentiator

ANSWER SHEET
FOR
EXPERIMENT
LESSON I
PART 1

Silicon Controlled Re tifier DC Control

2. no

4. c. There is no gate voltage applied

5. b. The SCR will conduct.

7. d. Applied a positive voltage to the gate lead.

8. no

10. c. Remove jumper "C".

ANSWER SHEET
FOR
EXPERIMENT
LESSON I
PART 2

Silicon Controlled Rectifier AC Control

3. half wave

4. diode

6. conducts

8. earlier

9. more

10. increased

11. a. SCR conduction begins at the time the gate signal reaches the "Turn on" voltage level.

ANSWER SHEET FOR PROGRESS CHECK

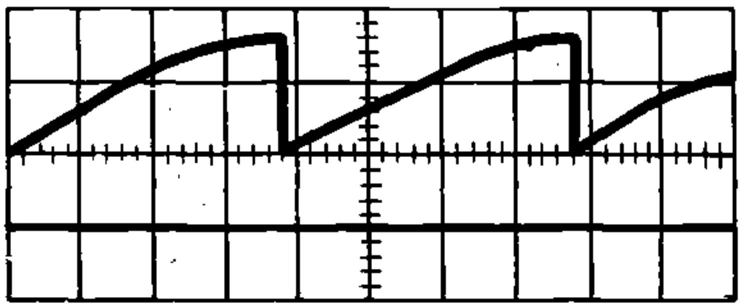
Silicon Controlled Rectifier Theory

1. b
2. diode
3. gate, anode, cathode (any order)
4. c
5. a
6. a
7. b
8. d
9. a
10. d
11. d

ANSWER SHEET
FOR
EXPERIMENT
LESSON II
PART 1

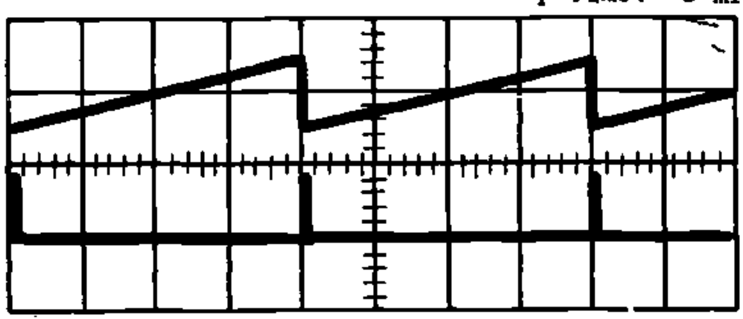
U.J.T. Sawtooth Trigger Generator

1. waveform taken with oscilloscope: "A" sensitivity .5 volts/cm
   Sweep time: 1 milliseconds/ cm



2. a. sawtooth
   b. +.75 volts peak to peak
   c. (The arrows on the above waveform indicate the U.J.T. conduction points)

3. waveform taken with Oscilloscope: "A" sensitivity: .5 volts/cm
   "B" sensitivity: 2 volts/cm
   Sweep Time: 2 miliseconds/cm



4. a. trigger
   b. +2 volts p-p

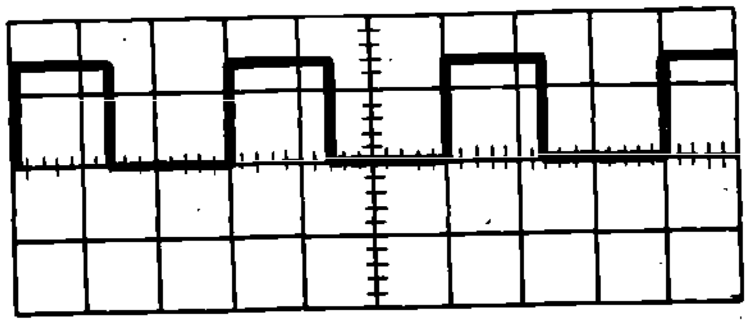
   c. most positive

5. a. sawtooth
   b. trigger

ANSWER SHEET
FOR
EXPERIMENT
LESSON II
PART 2

U.J.T. Multivibrator

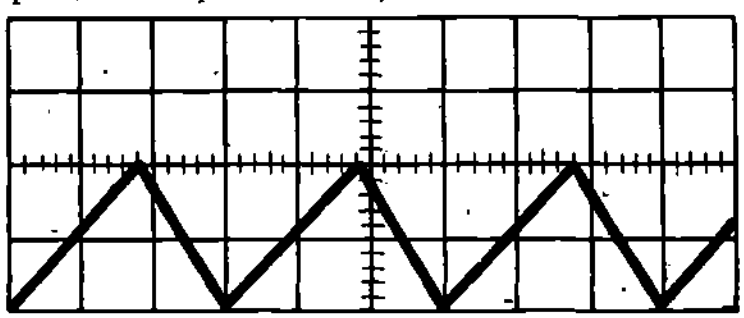
1. a. waveform taken with oscilloscope: "A" sensitivity .5 volts/cm
Sweep Time: 2 milliseconds/cm



b. square wave

c. .7 volts peak to peak

3. a. Waveform taken with oscilloscope: "B" sensitivity .5 volts/cm
Sweep Time: 2 milliseconds/cm

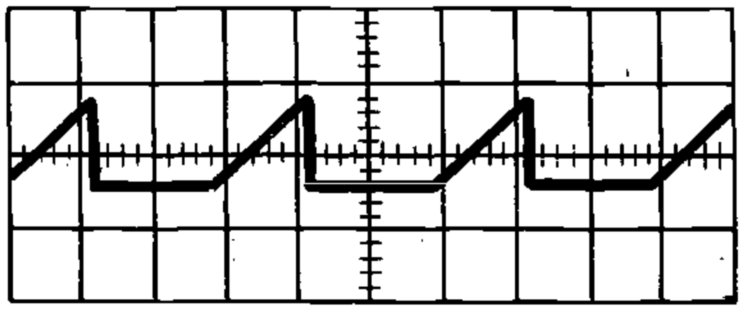


b. sawtooth

c. .8 volts peak to peak

d. +.8 volts

5. a. Waveform taken with oscilloscope: "B" sensitivity .5 volts/cm
   Sweep Time: 2 milliseconds/cm.



   b. yes

   c. Because of the halfwave rectification of diode CR1 (or words to that effect.)

6. b.

8. a.

9. d.

EXPERIMENT
ANSWER SHEET
LESSON II
PART 3

7. (1) capacitance
   (2) C12; parallel

8. (1) series

13. (1) 22 VDC (± 10%)
    (2) 0 VDC
    (3) No
    (4) Yes
    (5) c

14. (1) yes

15. (1) a

16. (1) b

17. (1) No

23. (1) decreased

24. (1) conduct

25. (1) on

120

PROGRESS CHECK
ANSWER SHEET
LESSON II

U.J.T. Theory

1. a. emitter, b. base 2, c. base 1

2. resistor

3. positive, Base 1 (in that order)

4. voltage gradient

5. reverse current

6. +5 to + 5 1/2 V

7. d

8. a.

9. d.

10. b.
11. b.
12. reverse current

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