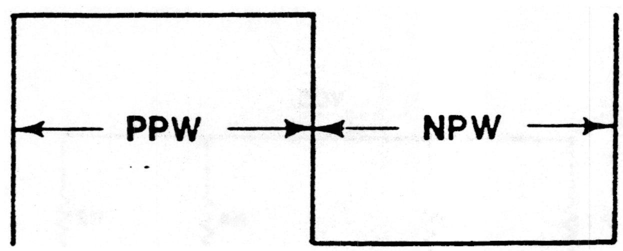
MULTIVIBRATORS

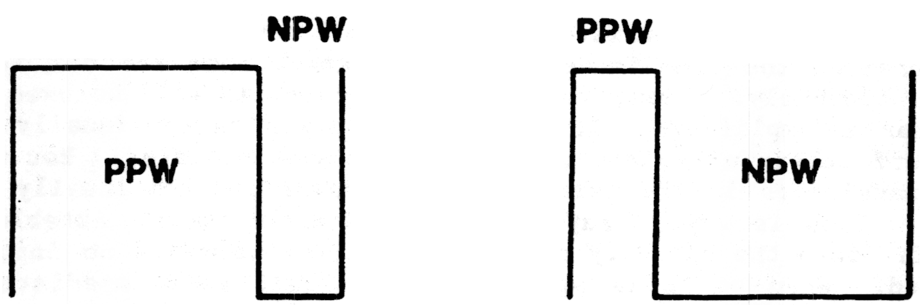
Multivibrators are widely used in radar systems to generate square waves that can be used to control other circuits. Multivibrators are often used in radar systems to determine the Pulse Repetition Frequency of the radar, which in turn controls the sweep, unblanking and rangemark circuits. These circuits will be covered in Pulse Circuits.

A multivibrator is an electronic circuit that is designed to produce square waves. Fig. 1 is a square wave.



1.

The square wave has a positive alternation called a positive pulse width (PPW) and a negative pulse width, (NPW). Fig. 1 is a symmetrical square wave (PPW=NPW). However, it is not necessary for both pulse widths to be equal. Fig. 2 is two asymmetrical square waves.



2.

The sizes of the various components making up the multivibrator will determine what the output looks like.

All multivibrators are divided into two broad categories according to how they generate a square wave. The two categories are free-running and triggered. Free-running multivibrators will generate outputs as soon as power is applied. Triggered multivibrators require an input "trigger" pulse of some type before they will generate an output.

Multivibrators are divided into three types: astable, monostable, and bistable. Astable never has an input trigger while monostable and bistable must have input triggers to operate.

Fig. 3 is a very basic astable multivibrator and will be used for familarization.

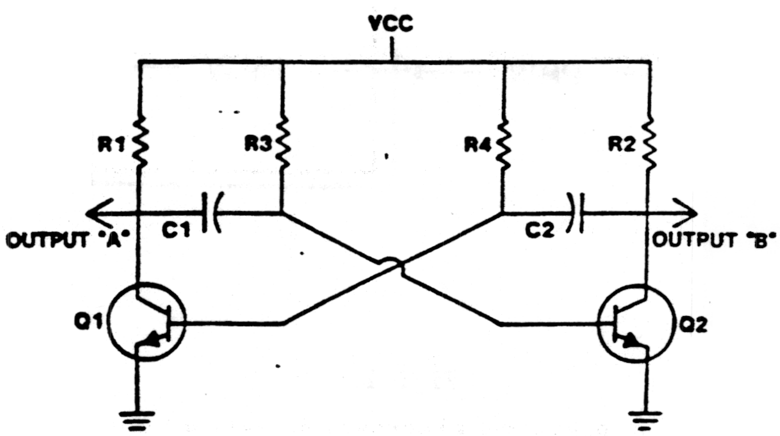
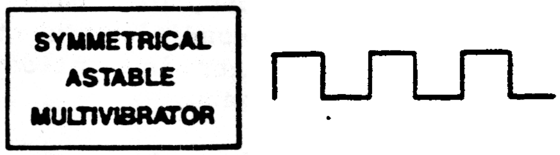
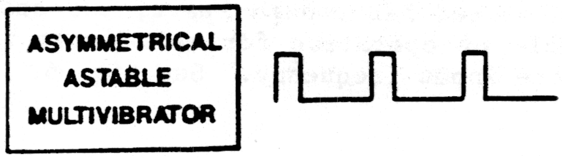


Fig. 3.

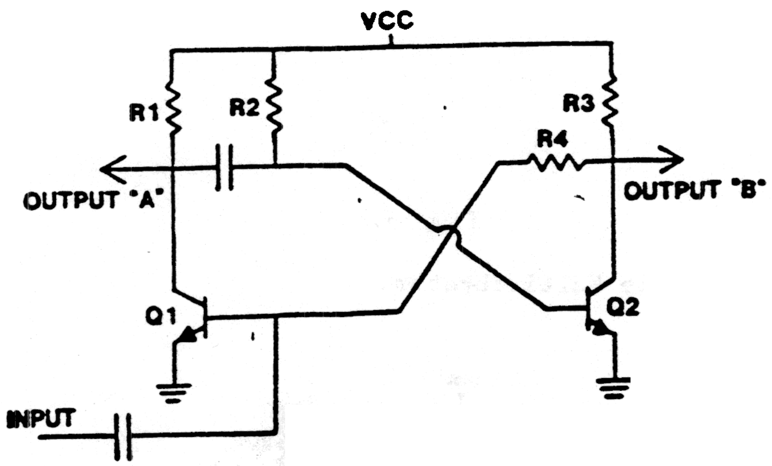
The word astable means there is no stable state. All of the circuits in this lesson use two transistors. When power is first applied there is no way to determine which transistor Q1 or Q2 will conduct first. During the circuit operation the transistors turn on (conducting) and off (non-conducting) continuously. Transistors in these circuits will be used more as switches than as amplifiers. If one transistor was on continually and the other was off continually this would be their stable states. You will see that the transistors in the Astable Multivibrator are continually turning on and off. This is why we say there is no stable state. Astable Multivibrators fit into the category of free-running so there is no input trigger required. When power is applied, the circuit goes immediately into operation and the only way to stop the circuit is to remove power. When power is removed, the circuit is not in a stable state, it is off. Under normal conditions, once power is applied the astable multivibrator will turn on and produce an output that is a continuous train of square waves. These square waves will be either symmetrical or asymmetrical depending on the individual circuit components. See fig. 4.





4.

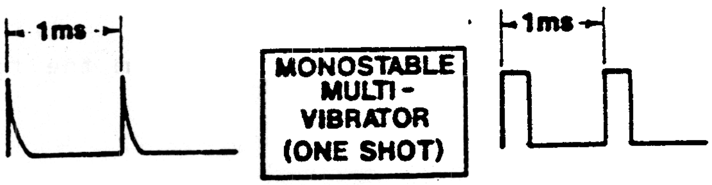
The Monostable Multivibrator, fig. 5, gets its name from the fact that it has one stable state.



5.

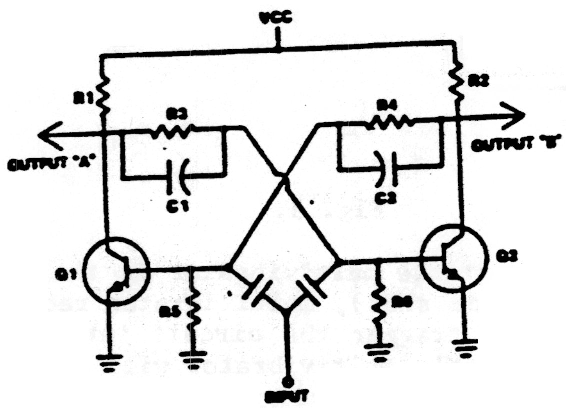
Another name given to a monostable multivibrator is the "one shot multivibrator". The monostable, (one shot), multivibrator requires an input signal. This input signal will trigger the circuit into action. When power is first applied, the monostable multivibrator will go to its stable state and remain in this condition until a trigger is applied. When referring to a monostable multivibrators stable state, one transistor is conducting and the other is off. In the circuit in Fig. 5 assume R2 is smaller than R3 and R4 combined when power is applied, both Q1 and Q2 will attempt to conduct. Q2 will be driven into saturation resulting in its collector going low. This low voltage is then felt by Q1 base turning Q2 off. This will be the stable state of the circuit, Q1 cutoff and Q2 conducting. These transistors will remain in this condition due to the biasing arrangement of the circuit. When a trigger is applied at the input, the circuit switches to its unstable condition.

Both transistors reverse their levels of conduction. This is called the unstable condition because the circuit will remain in this condition for only a short period of time. It then reverts back to its stable condition and will remain there until another input trigger is applied. Providing the input triggers are spaced far enough apart, the one-shot multivibrator will complete one cycle of operation for each input trigger. The output frequency will equal the input frequency. See fig. 6.



6.

Fig. 7 is a basic Bistable Multivibrator



. 7.

A bistable multivibrator is one that will remain in one of two stable states, (conditions). Bistable multivibrators fit into the category of triggered multivibrators. In the case of a bistable multivibrator, if the input trigger is removed, the circuit action will come to a stop in either of two possible stable states. The bistable multivibrator uses two transistors. One stable state would be Q1 on and Q2 off. The other stable state would be Q1 off and Q2 on. Once the bistable is in a stable state, it will remain there until an input trigger causes it to switch to the other state, where it will remain until the next input trigger again makes it change states. Since the bistable multivibrator requires a trigger to make it change from one stable state to another, two input triggers are required to obtain one complete cycle out. See fig. 8.

Fig. 8

The output frequency is then one-half the input frequency. The bistable multivibrator can be called a divider circuit.

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Fig. 9 is a schematic of the astable multivibrator whose operation will be covered.

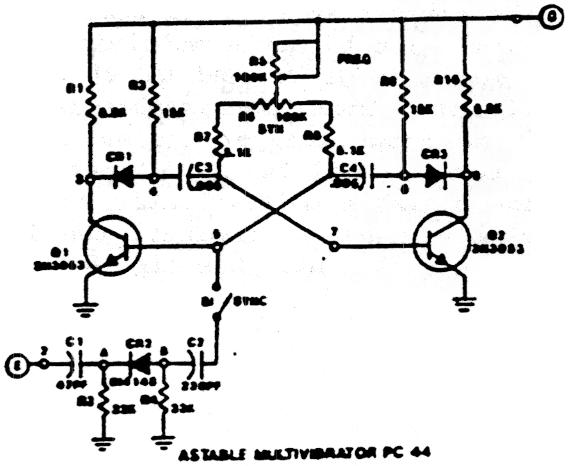


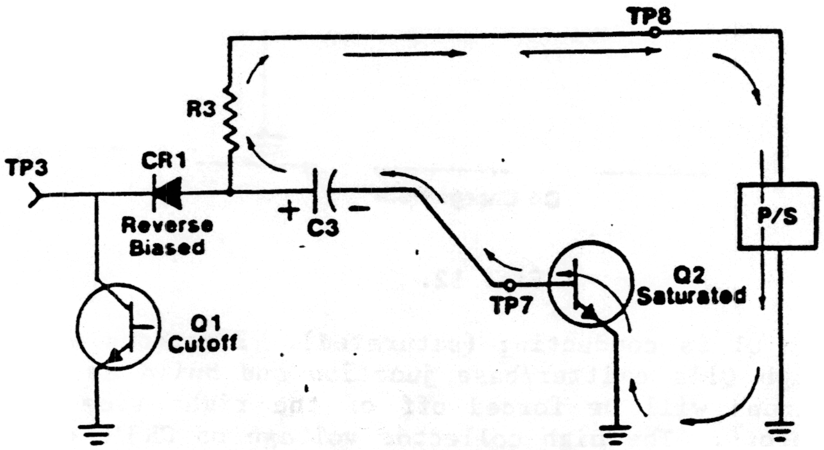
Fig. 9.

C1 and R2 form a differentiator circuit. CR2 will be forward biased by the negative pulse and pass this pulse to R4 and C2 where it is coupled into the circuit through S1. This circuit would be used if the astable multivibrator was going to be synchronized to an external pulse. During this lesson we are interested only in the free-running mode so S1 will always be left open. R8, R6, and R5 form the dc bias network for Q1. R7, R6, and R5 form the dc bias network for Q2. In addition to providing bias, R6 and R5 will determine how long it takes C3 or C4 to discharge. R1 and R10 are the load resistors for Q1 and Q2 respectively. CR1 and CR3 will act as switches. Their purpose is to isolate C3 from TP3 and C4 from TP9 when each is reverse biased. This will result in an improvement of the output waveshape, giving it a sharp leading edge. See fig. 10.

Fig. 10.

CR1 or CR3 will be forward biased when Q1 or Q2 are saturated. C3 and C4 will be used to couple the change in the collector voltage of Q1 and Q2 to the base of the other transistor. The time it takes capacitors to discharge will determine how long the transistors are turned off. Q1 and Q2 are general purpose transistors that will be used as switches. The output of the circuit will be taken directly from their collectors. R3 and R9 will provide a charge path for C3 and C4.

Before covering the actual circuit operation it is important to understand the charge and discharge paths for C3 and C4. See fig. 11.

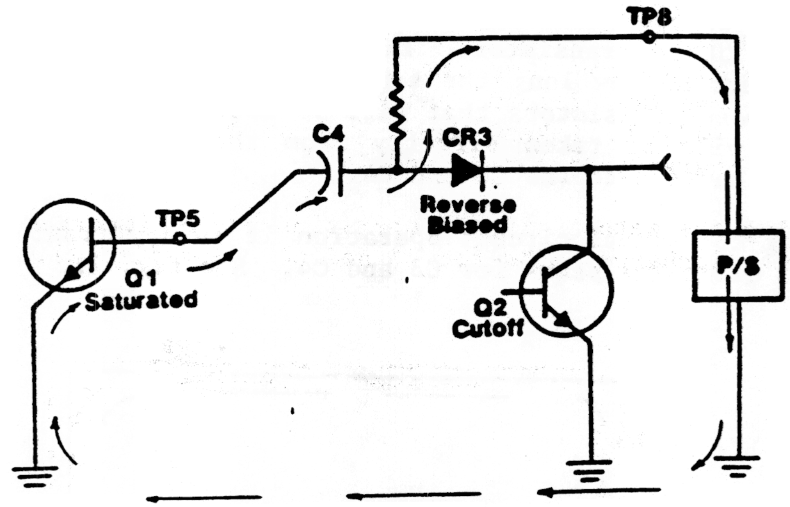


C3 Charge Path

Fig. 11

C3 will charge when Q2 is conducting (saturated). Electrons will flow up from ground, thru Q2's emitter/base junction and build up on the right side of C3. Electrons will be forced off of the left plate of C3. At this time Q1 is cutoff. The high collector voltage on CR1's cathode will reverse bias it and at this time it acts as an open switch. Electrons being forced off of C3 will then flow up through R3 over to TP8, through the power supply to ground, completing the charge path.

C4's charge path will be the opposite of C3. See fig. 12.

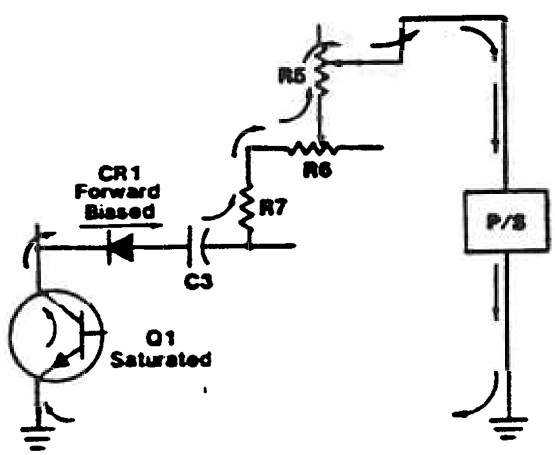


C4 Charge Path

Fig. 12.

C4 will charge when Q1 is conducting (saturated). Electrons will flow up from ground, through Q1's emitter/base junction and build up on the left side of C4. Electrons will be forced off of the right side of C4. At this time Q2 is cutoff. The high collector voltage on CR3's cathode will reverse bias it and at this time it acts as an open switch. Electrons being forced off of C4 will then flow up through R9 and over to TP8, through the power supply to ground completing the charge path.

We will now cover the discharge paths of C3 and C4. The time that it takes these capacitors to discharge is very important. It is the discharge time that will determine how long each transistor is held off. C3 will discharge when Q1 is conducting (saturated). See fig. 13.

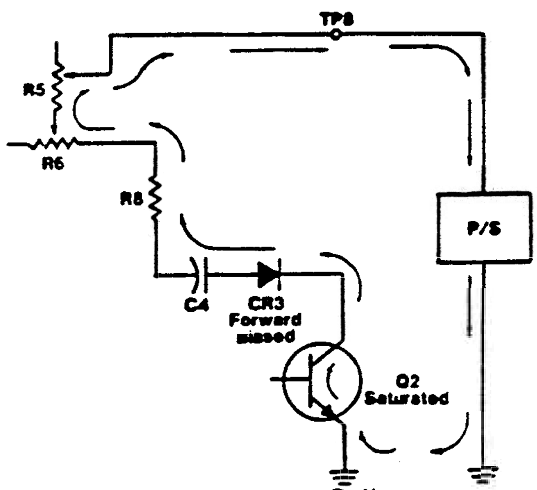


C3 Discharge Path

Fig. 13.

Electrons will leave the right side of C3, move up through R7, the left half of R6, the bottom portion of R5 to TP8, to the power supply to ground, up from ground through the conducting transistor, (Q1), through the forward biased CR1 to the other side of C3. Moving the wiper arm of R6 to the right or the wiper arm of R5 up will increase the resistance in the discharge path. An increase in this resistance will result in C3 taking longer to discharge. Moving either wiper the other direction will result in decreasing the discharge time of C3.

C4's discharge path is shown in fig. 14.



C4 Discharge Path

Fig. 14.

C4 will discharge when Q2 is conducting. Electrons will leave the left side of C4, move upward through R8, R6, and R5 to the power supply, from the power supply ground to Q2's emitter, up through the conducting Q2, through the forward biased CR3 to the right side of C4. As with C3, the discharge time of C4 can be controlled by adjusting R6 and R5.

It should be understood that during normal operation both Q1 and Q2 will be switching on and off alternately. During the time that Q1 is conducting, Q2 is cutoff. At this time C3 will discharge and C4 will charge. During the time that Q2 is conducting C3 will charge and C4 will discharge.

The charge time of C3 and C4 is very short and has little to do with controlling the operation of the multivibrator. It is the discharge of these two capacitors that will determine the symmetry and the frequency of the output. Notice that the multivibrator can be divided into two stages. The Q1 stage consists of R1 as the load resistor and R8, R6, and R5 as the base biasing resistors. Q2 stage consists of its load resistor, R10, and the base biasing resistors R7, R6, and R5. C3 will be the input capacitor for Q2 and C4 the input capacitor for Q1. Any change felt at Q1's collector will be coupled to the base of Q2 and any change in Q2's collector will be coupled to Q1's base.

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We will now look at one cycle of operation of the Astable Multivibrator. See fig. 9. The instant that power is applied, both transistors will feel a positive potential on both bases. Both transistors will start to conduct. As each transistor starts to head toward saturation both C3 and C4 will charge. Since it is impossible to manufacture all components to exact tolerances the two stages will not be perfectly balanced. This being the case, one transistor will conduct harder that the other. Assume that Q1 conducts harder. It's collector will drop to a very low voltage, (saturation). This low voltage will forward bias CR1 and be felt at the left plate of C3. This low voltage will now start to repel electrons off of the right plate of C3. C3 will now be discharging. Electrons will leave the right plate of C3 and flow through the discharge path, fig. 13. As electrons flow upward through R7, they will develop a negative voltage at the bottom of R7. This negative voltage will be felt at the base of Q2 and shut Q2 off. Originally, the voltage at TP7 was 600mv. As the collector of Q1 decreased from 12V, (cutoff), to 120mv, (saturation), TP7 also dropped by a like amount. See fig. 15.

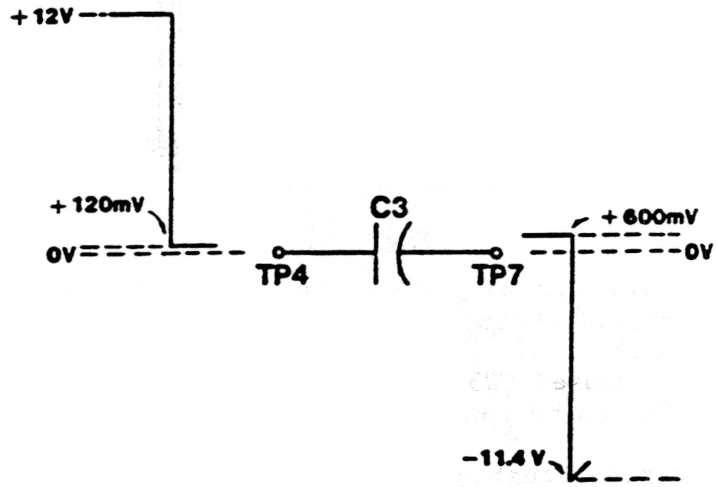


Fig. 15.

If 600mv decreases in the negative direction by 12V, it must drop to -11.4V. C3 will now start to discharge. Due to the high resistance in the discharge path it will take some time to discharge. See fig. 16.

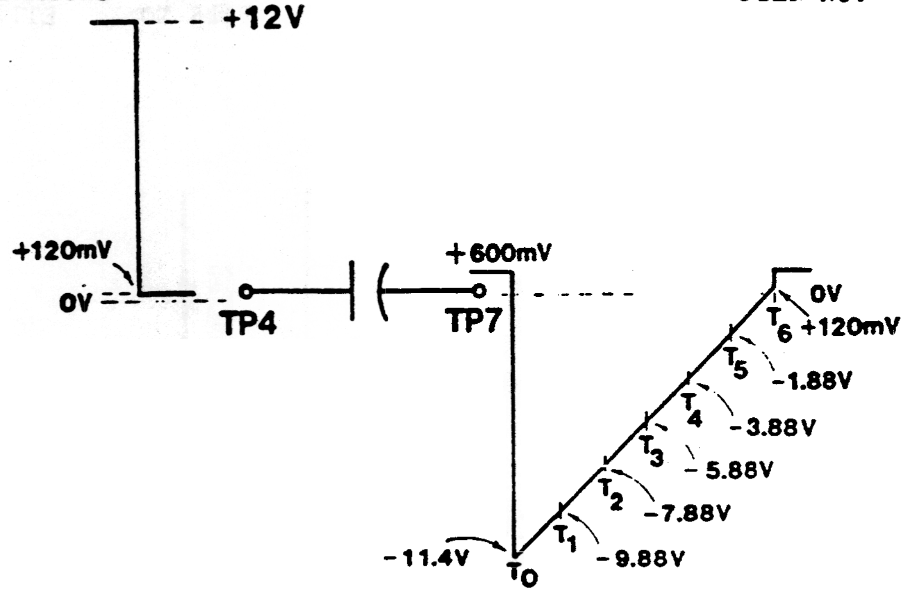


Fig. 16.

At T1 C3 has discharged to -9.88V.

At T2 C3 has discharged to -7.88V.

At T3 C3 has discharged to -5.88V.

At T4 C3 has discharged to -3.88V.

At T5 C3 has discharged to -1.88V.

At T6 C3 has discharged to + 120mv.

AT T6, C3 has discharged to a point that it can no longer hold Q2 cutoff. At this time, Q2 turns on and current flow in Q2's base circuit returns TP7 to 600mv. When Q2 started to conduct (saturate) its collector dropped to 120mv. With Q2 conducting it now provides a charge path for C3 and a discharge path for C4. The low positive felt by CR3's cathode forward biases it and causes C4 to start discharging. The flow of electrons leaving the left plate of C4 develop a negative voltage at the bottom of R8. This negative is felt on the base of Q1 and cuts Q1 off. Q1's collector now goes to 12V, (cutoff), and reverse biases CR1.

C4 will now discharge up through R8. As when TP7 went negative, fig. 12 and 13, TP5 now goes negative and C4 starts to discharge through it's normal path, fig. 11. Eventually C4 will discharge to the point that it can no longer hold Q2 cutoff. At this time, Q1 will turn on and go into saturation. Q1's collector now drops to 120mv and one cycle of operation has been completed. The action will now repeat itself.

Notice that for one complete cycle, both transistors will vary once between cutoff and saturation. See fig. 17.

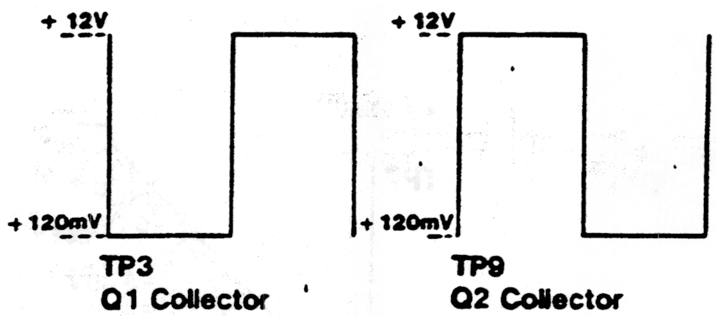


Fig. 17.

TP3 and TP9 will be the output of the circuit and will always be 180 degrees out of phase with each other. Since the two transistors are continually switching between cutoff and saturation they will produce a continual train of square waves. See fig. 18.

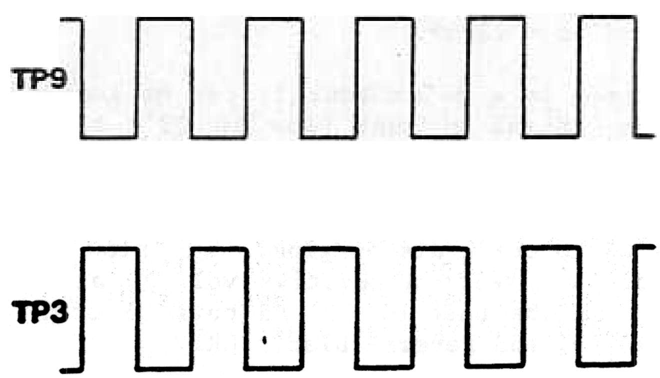
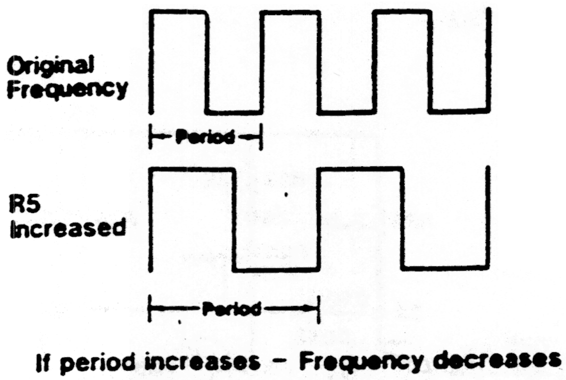


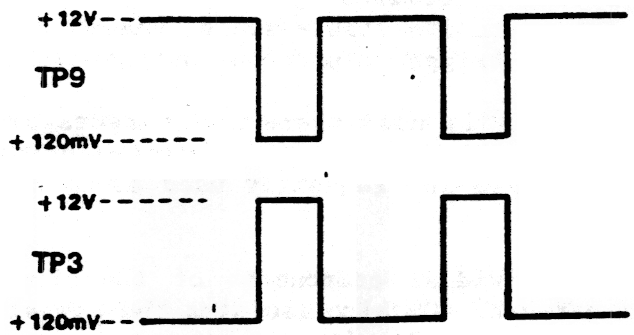
Fig. 18.

Since both C3 and C4 discharge through R5, if the resistance of R5 is increased it will take longer for both capacitors to discharge. If it takes longer for them to discharge both transistors will be held off longer. The result would be that both pulse widths will increase and the output frequency will decrease. See fig. 19.



19.

R6 controls the symmetry of the output waveform. If the wiper arm of R6 is in the middle, the resistance of the two discharge paths is equal. If the wiper arm of R6 is moved to the right, the resistance of C4's discharge path decreases and the resistance of C3's discharge path increases. Q1 will be cutoff a shorter amount of time and Q2 will be held off a longer amount of time. See fig. 20.



20.

Moving R6 wiper arm past the middle and to the left will reverse the situation.

MONOSTABLE MULTIVIBRATOR PC46

Fig. 21 is a schematic of PC46

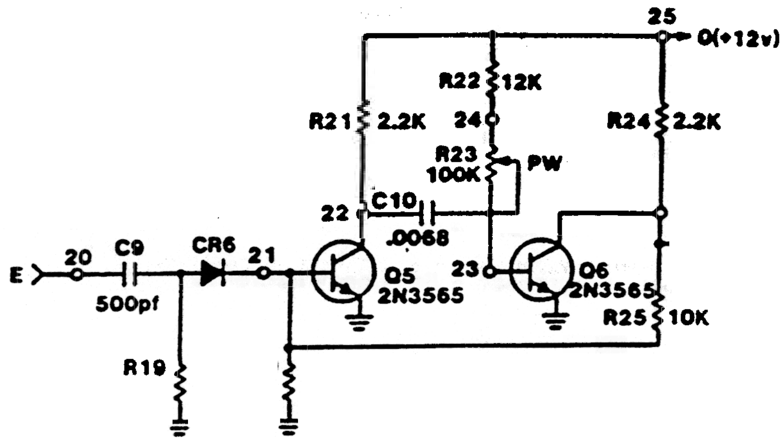


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Fig. 21.

The monostable multivibrator is a multivibrator with one stable condition. With no input trigger signal, one transistor conducts and the other is cutoff. When an input trigger is applied, the multivibrator will change state for a period of time determined by an RC time constant of the circuit. It will then return to its stable state, where it will remain until triggered again. One input trigger causes one output cycle.

The monostable multivibrator is used where it is necessary to maintain a constant frequency, (PRF), yet have a variable gate output, (variable on and off times). This circuit is frequently used as a VARIABLE GATE GENERATOR.

We will now cover the individual components of the circuit. C9 and R19 form a differentiator network. C9 also isolates the monostable dc voltages from the astable multivibrator. See fig. 22.

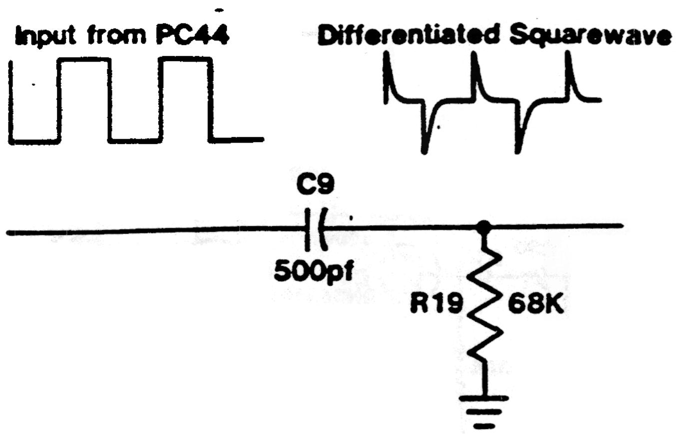


Fig. 22.

CR6 will become forward biased when the signal on its anode goes positive and pass this positive pulse to the base of Q5. See fig. 23.

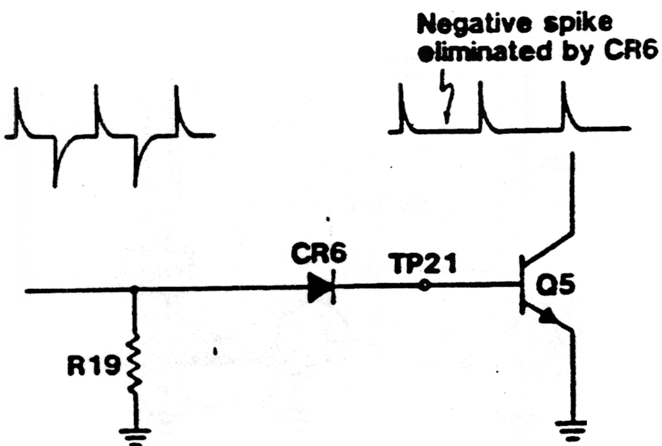
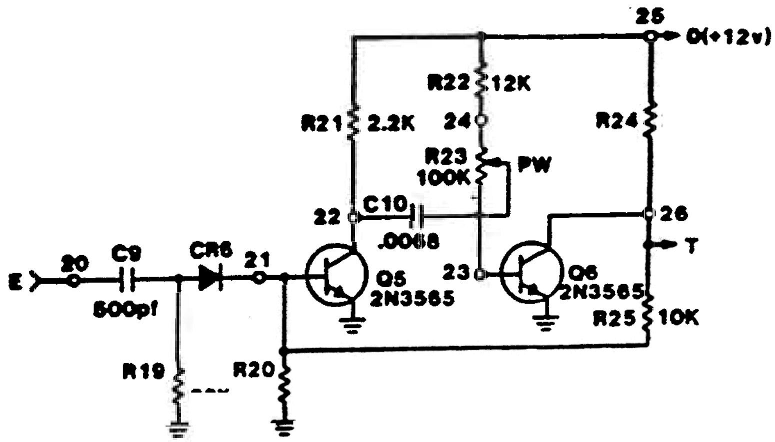


Fig. 23.

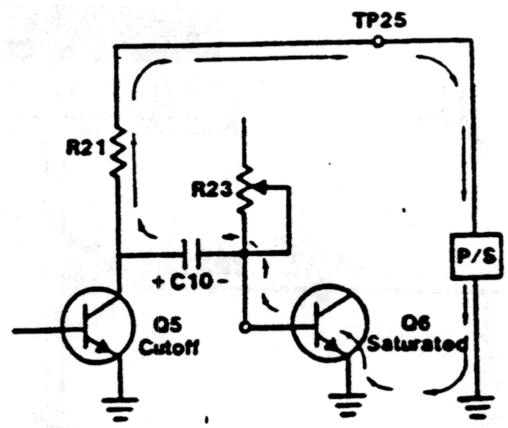
Refer to Fig 24. Q5 and Q6 are both NPN transistors connected in the common emitter configuration. R21 is Q5's collector load resistor and R24 is Q6's collector load resistor. R22 and R23 provide the base bias for Q6. R24, R20, and R25 provide base bias for Q5. C10 will couple the output of Q5 to Q6. As in the astable multivibrator, the discharge time of C10 will determine the amount of time that Q6 will remain cutoff. We will see that the positive pulse width can be varied by adjusting R23.



MONOSTABLE MULTIVIBRATOR PC 46

Fig. 24.

Before covering the operation of the circuit we will develop the charge and discharge path of C10. C10 will charge when Q5 is cutoff and Q6 is conducting. The charge path of C10 is shown in fig. 25.



C10 Charge Path

Fig. 25.

When Q5 is cutoff 12V will be felt at TP22. Electrons flowing through Q6's emitter/base junction will be attracted to the right plate of C10. Electrons leaving the left plate of C10 will move up through R21, over to TP25, through the power supply to ground and return to Q6's emitter.

The discharge path for C10 is shown in fig. 26.

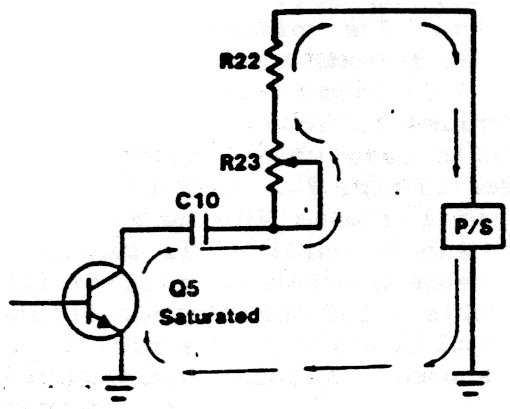


Fig. 26.

When Q5 becomes forward biased it conducts and completes the discharge path for C10. Electrons move up through R23 and R22, to the power supply and return to Q5's emitter through ground. Notice that moving the wiper arm of R23 up will decrease the resistance of R23. Moving the wiper arm down will increase the resistance. By increasing the resistance of R23, the discharge time of C10 will be increased. Discharge time will be decreased if the resistance of R23 is decreased.

We will now go through one complete cycle of operation. During the explanation refer to fig. 27 for the waveforms developed in respect to time.

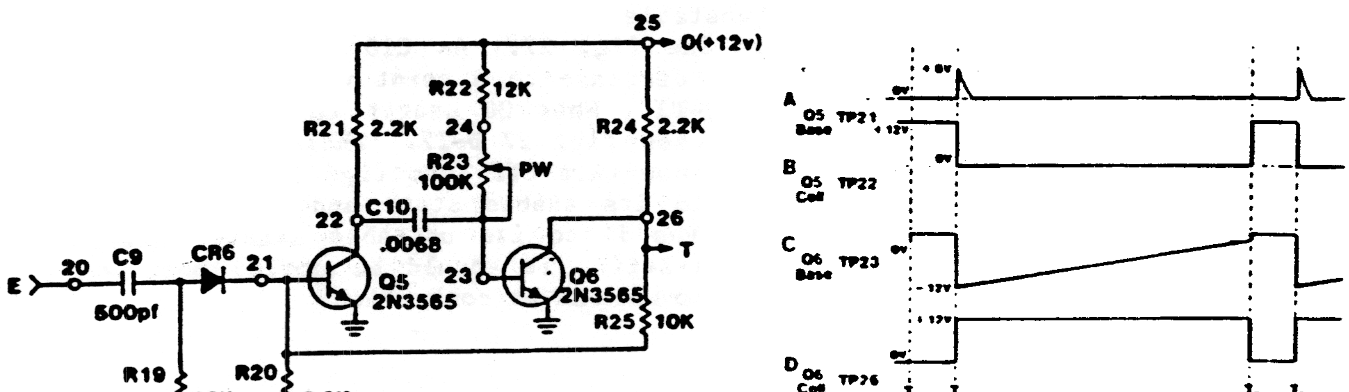


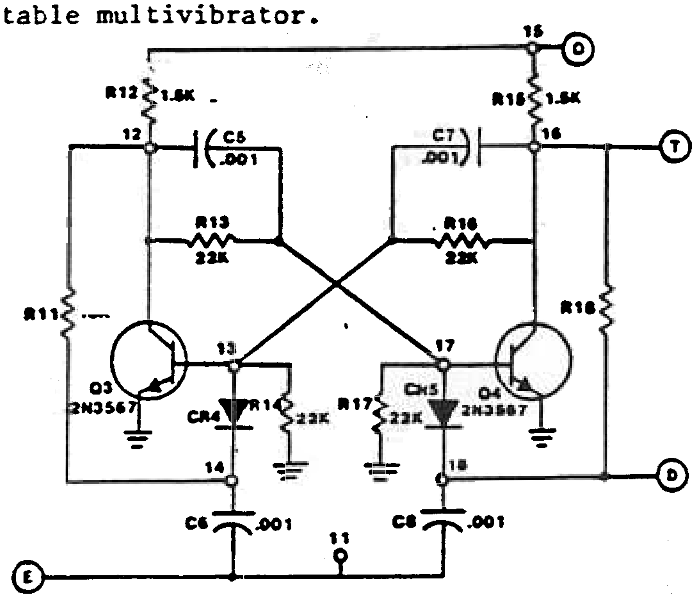
Fig. 27.

When power is first applied, both transistors will attempt to conduct. Q5's bias is applied through R24, R25, and R20. Q6's bias is applied through R22 and R23. As Q6 conducts, its internal resistance becomes very low, and as a result, a very low voltage drop is felt across it. This low voltage would be read at TP26. As current flows through R25 it drops Q6's collector voltage even lower. The voltage at TP26 is applied to voltage divider R25 and R20 producing an extremely low voltage at Q5's base. The result is that the bias on Q5's base is extremely low and Q5 will now cutoff. Q5's collector now rises to Vcc, (12V). This rise in voltage is felt through C10 and on Q6's base which drives Q6 into saturation. C10 charges at this time. Refer to fig. 24. Once Q5 is cutoff and Q6 is saturated, both transistors will remain in these conditions indefinitely. C10 is charged and will remain so until Q5 is turned on. With Q5 cutoff and Q6 saturated the Monostable Multivibrator is in its one stable condition. To drive the Monostable Multivibrator out of its stable condition an input trigger must be applied to the base of Q5. The trigger will be applied from an external source. A squarewave applied to TP20 will be differentiated, and CR6 will pass only the positive portion of this signal to the base of Q5. The negative portion must be eliminated because if the input frequency was high enough and CR6 was not there, the negative trigger could come in before C10 had a chance to discharge. If the negative trigger came in to soon it would turn Q5 off instead of the normal time constant of the multivibrator.

The positive trigger applied to Q5's base will cause it to be forward biased and Q5 will start to conduct. See fig. 27 A-T1. Q5's collector voltage will start to decrease, see fig. 27 B-T1. As the voltage on the left side of C10 decreases, electrons are forced off of the right plate. As these electrons flow up through R23, they develop a negative voltage at TP23, see fig. 27 C-T1. This negative voltage will be felt at Q6's base and turn it off. Q6's collector will now rise to a high positive voltage, (cutoff), see fig. 27 D-T1. This high positive will now be felt through R25 and applied to Q5's base which will drive Q5 into saturation. The circuit has now switched to its unstable state. With Q6 cutoff and Q5 saturated C10 will now discharge. See fig. 27. As C10 discharges the negative voltage at TP23 will slowly decrease to a point where it can no longer hold Q6 cutoff, see fig. 27 C-T2. When Q6 starts to conduct its collector will decrease, (saturate), see fig. 27 D-T2. This low voltage will be felt by Q5's base which will now turn off, see fig. 27 B-T2. At this time the circuit has returned to its stable state and will remain there until another input trigger drives it to its unstable state. When this occurs, the cycle will repeat itself. It should be noted that by adjusting R23 that the positive pulse width can be controlled.

BISTABLE MULTIVIBRATOR PC45

Fig. 28 is a bistable multivibrator.



BISTABLE MULTIVIBRATOR PC45

Fig. 28.

R12 and R15 are the collector load resistors for Q3 and Q4. R13 and R17 function as the base voltage divider for Q4 while R16 and R14 perform the same function of Q3. C5 and C7 form quick coupling networks with R13 and R16. There purpose is to help decrease the time it takes the transistors to switch their conduction levels. By decreasing the time the transistors take to switch on or off, the shape of the square wave is improved. See fig. 29.

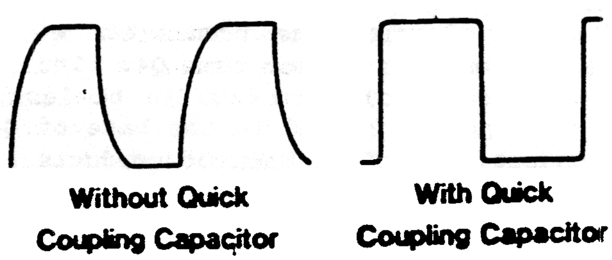


Fig. 29

R11 and R18 provide a means of biasing CR4 and CR5. R11 and C6, R18 and C8, form differentiator circuits when their respective diodes, CR4 and CR5 are forward biased. CR4 and CR5 function as STEERING DIODES. Only one at a time will be forward biased. When an input is applied to the bistable multivibrator it will be present at the cathode of both diodes but will pass through only the forward biased steering diode and be felt by the base of the respective transistor as a differentiated square wave. See fig. 30.

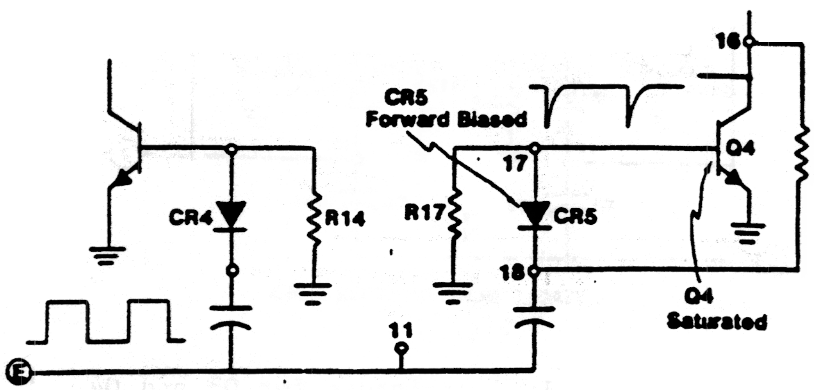


Fig. 30.

CIRCUIT OPERATION

Notice that the circuit is symmetrical, since each transistor amplifier has the same component values. When power is first applied, the voltage divider networks place a positive voltage at the bases of Q3 and Q4. Both transistors have forward bias and both start to conduct. Due to the slight difference between the two circuits one transistor will conduct harder than the other. Assume Q3 conducts harder than Q4. The increased conduction of Q3 causes the collector voltage of Q3 to be less positive. This change, (decrease), in voltage is coupled to the base of Q4 decreasing the forward bias and the conduction of Q4. When Q4 conducts less, its collector voltage goes more positive, (cutoff). The positive going change at the collector of Q4 is coupled to the base of Q3 and causes Q3 to conduct even harder. This regenerative action continues until Q4 is cutoff and Q3 is saturated. The circuit is then in a stable state and will remain there until a trigger is applied. With Q3 saturated, its collector voltage is very low. This low voltage will be felt through R11 and at the cathode of CR4. The voltage at CR4's cathode, (TP14), will be less positive than the voltage at Q3's base, (TP13). This being the case, CR4 is now forward biased. With Q4 cutoff, its collector voltage, (TP16), will be very high, (11.3V). This high positive is felt at CR5's cathode, (TP18). A very low positive voltage is present at TP17 due to the fact that TP12 is so low. CR5 is then reverse biased. When the next input trigger is applied to PC45 it will be felt by Q3 through the forward biased CR4. The negative trigger applied to Q3's base will decrease its forward bias. Q3's collector will start to rise heading toward cutoff. This increase in positive voltage will be felt at Q4's base and Q4 will begin to conduct. At the same time the positive going collector voltage of Q3 will also be felt at TP14, (CR4's cathode), and reverse bias CR4. As Q4 starts to conduct harder, its collector voltage now drops, (saturation). This decrease in collector voltage, (TP16), is coupled to the base of Q3, turning Q3 off. The decrease in collector voltage of Q4 is also felt at the cathode of CR5, (TP18), which will now be forward biased.

The circuit has now gone from one stable state, Q3 saturated, Q4 cutoff, to the other stable state Q3 cutoff, Q4 saturated. The circuit will remain in this condition until another trigger is applied to the circuit. When the next trigger is applied it will be felt at the cathode of both steering diodes but will pass through only CR5. The negative trigger will then be applied to Q4's base where it will reduce the forward bias. As Q4 reduces its conduction level, its collector voltage will start to increase. This increase in positive voltage is coupled to the base of Q3. Q3 will then start to conduct. Q3's collector voltage will decrease and this decrease, coupled to Q4's base will drive Q4 into cutoff. As Q4's collector voltage reaches the applied voltage, it drives Q3's base high enough to place Q3 into saturation. The rise in Q4's collector voltage is also felt at TP18, (CR5's cathode). The drop in Q3's collector voltage is felt at TP17. CR5 is now reverse biased. The drop in Q3's collector voltage is also felt at TP14. This low voltage will now forward bias CR4. The next trigger will now be applied to Q3's base. At this time one complete cycle has been completed. Notice that it took two input triggers to complete one cycle of operation. The output frequency is then one half the input frequency. For this reason the bistable multivibrator is called a divider circuit. The input frequency has been divided in half.

TROUBLESHOOTING

To troubleshoot the multivibrator circuits, you will use procedures already established in previous lessons. The oscilloscope can be used to sectionalize to a card. Once the defective card is located, the oscilloscope can also provide additional information as to help locate the actual problem.

Use the oscilloscope to monitor the outputs of each individual card. Using procedures already learned, check the output of PC45, (TP16), the output of PC44, (TP9), and if needed the output of PC46, (TP26). Once the faulty card is located you are ready to localize to the proper stage. If the faulty card has absolutely no output, chances are one of the amplifiers is malfunctioning. If the output is distorted or just incorrect, (wrong frequency), the problem will be in an area that is either common to both amplifiers or that is not critical to their operation. The easiest problems to locate are those which display no output. When this condition is encountered, use the DMM to determine the conduction level of each transistor. If you find one transistor conducting and the other cutoff, force the conducting transistor to cutoff. The reason for doing this is to see if the transistor can actually be made to change conduction levels. This can be done by GROUNDING THE BASE of the conducting transistor. Since the emitter of each transistor is connected to ground, if the base is grounded there will be no difference in potential between the emitter and base, (no bias). The conducting transistor should now be cutoff. Check the collector to see if it went from saturation to cutoff when the base was grounded. If it did, the transistor and its biasing network is good. With the base still grounded, check the collector of the other transistor. It should have gone from cutoff to saturation. If it didn't switch, that is the defective stage. At this point, use the normal procedures to analyze the circuit, (voltage and resistance checks). Another possibility is both transistors might be saturated. Ground both bases to see if the transistors can be cutoff. Again, if both transistors switch, the problem will have to be in a common area. If one transistor can be forced off and the other can't, the likely problem is a load resistor. The transistor that won't switch wasn't actually saturated, it just appeared to be. The low voltage reading wasn't saturation voltage, it was due to leakage. If both transistors are cutoff, grounding the base will have no effect, and you will have to use voltage and resistance readings alone to isolate the problem.

If there is an output of some type, it will either be distorted or of the incorrect frequency. It is important to know what the output frequency should be. Since the Astable MV is freerunning, its frequency can be set. If the frequency is not what it should be or if the output is unbalanced, the problem will be in the area of the frequency and symmetry controls.

Keep in mind that the output frequency of the Monostable MV is the same as the input, and the output of the Bistable Multivibrator is one half the input.

On the triggered circuits, (PC45 and PC46), it is possible for one stage not to operate while the other continues to operate as an amplifier. If you observe a trigger on the base of a transistor and an inverted trigger on the collector, the stage is still capable of turning on and off but is not doing so at the proper rate. Never lose track of the fact that if the transistor is forward biased it should conduct.

SUMMARY: The astable multivibrator has no stable state and is known as a free running multivibrator. It requires no input and produces a square wave or rectangular output. The output frequency and the pulsewidth is determine by the RC time constant. The monostable multivibrator has one stable state. The output frequency is determined by the input frequency. The bistable multivibrator has two stable states and is known as a flip-flop or frequency divider. It REQUIRES two triggers to get one complete waveform out. The output frequency and pulse width is determined by the frequency of the input triggers.

(The material covered in this presentation is UNCLASSIFIED)