

**Electronics Laboratory
And
Students' kits
For
Self-Study
And
Distant Learning**

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LAB REPORT OUTLINE FOR ELECTRONIC EXPERIMENTS

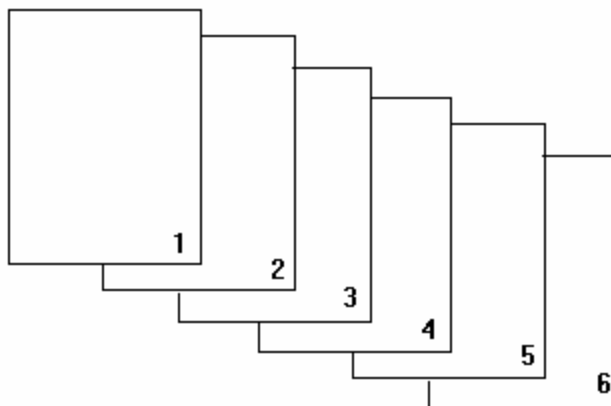
1. Explain objective of experiment.
2. What are you going to measure?
3. What do you expect the results to be?
4. Divide experiment into parts.
 - a) Show measurements and results for each part.
 - b) Make sure that each step clearly shows what circuit was used plus the corresponding waveforms, amplitude, frequency, etc...
5. Conclusions
 - a) Did the experiment verify what you expected?
 - b) Were there any unexpected or surprising results?

Grading Will Be Based On:

1. Neatness
2. Organization of Material
3. Explanation
4. Correctness
5. Grammar and Spelling
6. Style

LAB REPORT FORMAT
APPROPRIATE CONTENT SEQUENCE FOR EACH REPORT

All sheets 8 ½" x 11" Stapled together at upper left hand corner



1. Proper cover sheet
2. The completed experiment handout (if a textbook is used: copies of data tables)
3. Graphs and Waveform sheets if required
4. Calculations as required
5. Questions and Answers

The paper for 3, 4, 5 (and 2 if a lab text book is used) is quadrille ruled paper with five squares per inch.

The grade earned on each report is base on:

Completeness

Accuracy

Quality of rendering

Rendering

1. Report must be neat and clean.
2. Proper grammar and spellings must prevail. Must use black ink.
3. Each graph and Waveform sheet must have a title.
4. Each graph curve and wave form sketch must be labeled if there is more than one on a sheet.
5. Each graph axis must be titled with unit included.
6. Data points on graphs must be apparent.
7. Graph curves and waveforms must be rendered as solid, thin, single, black ink, freehand line.

EXPERIMENT #1

JUNCTION—DIODE CHARACTERISTICS

Parts Required:

- 1- 1N914 DIODE
- 1- 470 / ½W RESISTOR
- 1- 250 Ω / 2W RESISTOR
- 1- 10k Ω POTENTIOMETER

Procedure:

1. Connect the circuit shown and complete table 1.

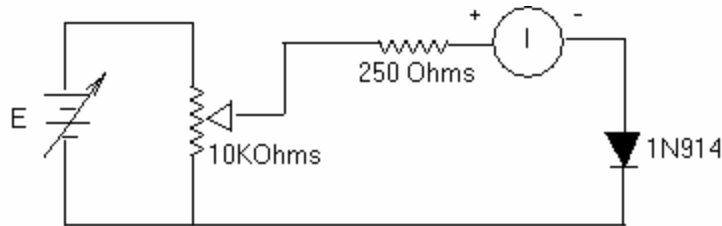


FIG 1

$V_D(V)$	$I_D(mA)$	$V_D(V)$	$I_D(mA)$
.10		.55	
.20		.60	
.30		.65	
.40		.70	
.45		.75	
.50		.80	

TABLE 1

2. Observe the blocking action of the diode when reverse biased.

$$V_D = -20V$$

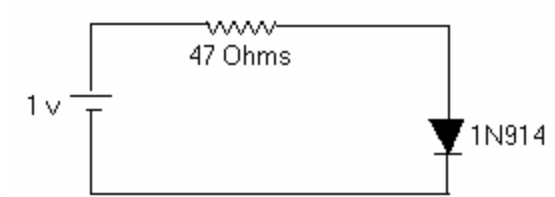
$$I_D = \underline{\hspace{2cm}}$$

3. Plot the volt-ampere characteristics of the diode using the data in table 1.

4. Determine the operating point for the diode in the circuit shown in fig 2. by plotting the load line on the graph

$$V_D = \underline{\hspace{2cm}}$$

$$I_D = \underline{\hspace{2cm}}$$



5. Measure the operating point for the circuit in fig.2 and compare your results to step 4.

$$V_D = \underline{\hspace{2cm}}$$

$$I_D = \underline{\hspace{2cm}}$$

* use $I_D = V_R/R$

EXPERIMENT #2

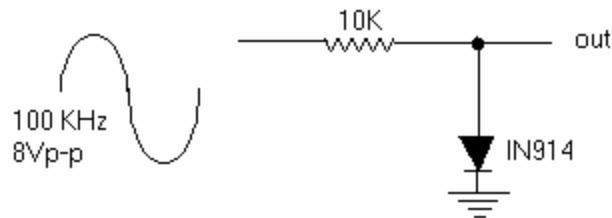
CLIPPER/CLAMPER

Parts Required:

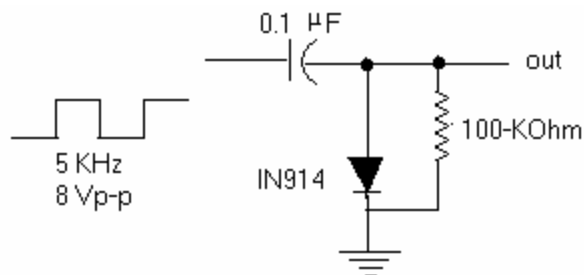
- 1- 1N914 Diode;
- 1- 1N2070 Diode
- 1- 100 k Ω Resistor
- 1- 10k Ω Resistor
- 1- 0.1 μ F Capacitor

Procedure:

1. Connect the positive peak shunt clipper circuit shown and superimpose the output waveform on the input waveform and study the result.



2. Replace the IN914 switching diode with the 1N2070 rectifier diode and study the result.
3. Change the input to a square-wave and repeat steps 1 and 2
4. Lower the frequency to 1 KHz and repeat steps 1, 2, and 3.
5. Change the circuit to a positive peak series clipper and repeat step 1-4.
6. Connect the negative damper shown and superimpose the output waveform on the input waveform and study the result



7. Change the frequency of the input and study the result.
8. Replace the 100 K Ω -resistor with the 10 K Ω -resistor and repeat steps 6 and 7.

Questions:

1. What conclusions can be drawn from your observations in step 1- 4?
2. As in question #1 but for step 5?
3. As in question #1 but for step 6-8?

EXPERIMENT #3

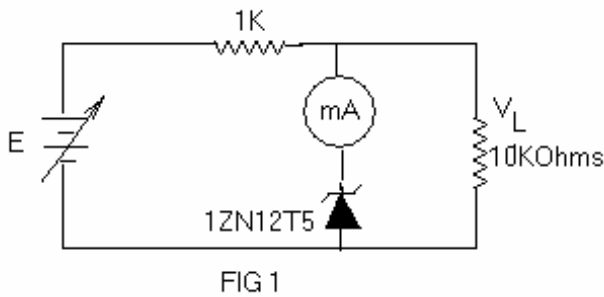
ZENER DIODE REGULATOR

Materials Required:

- 1- 1ZM12T5 Zener Diode
- 1- 1KΩ/ 2W; 10KΩ/ 2W; 100Ω/.5W Resistors
- 1- 10KΩ Potentiometer;
- 1- SPST Switch

Procedure:

1. Connect the circuit shown in Fig.1 (Connect Zener diode properly)



V ₁ (V)	V _L (V)	I _z (ma)
11		
13		
15		
17		
19		
21		
23		

TABLE 1

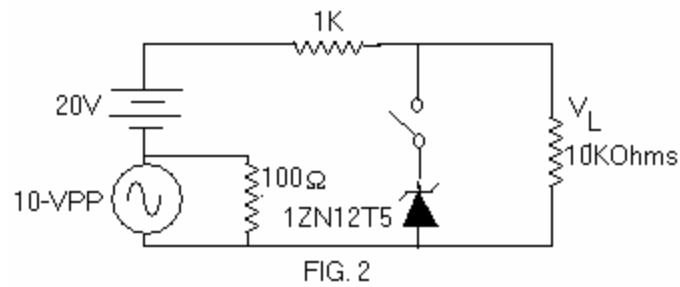
2. To observe the “line regulation “of the regulator, adjust V₁ and complete table 1.
3. To observe the “load regulation “of the regulator, replace R_L with a 10KΩ Pot, and set V₁ = 20V and complete table 2.

R _L	V _L (V)	I _z (mA)
9.5K		
9K		
8.5K		
8K		
7.5K		
7K		
6.5K		
6K		
5.5K		

TABLE 2

R _L	V _L (V)	I _z (mA)
5K		
4.5K		
4K		
3.5K		
3K		
2K		
2.K		
1.5K		
0.5K		

4. Connect the circuit shown in Fig.2. Frequency set at 1KHZ



5. Measure ripple voltage across RL.

Ripple Voltage = _____

6. Close the switch and measure ripple voltage across RL

Ripple Voltage = _____

7. Make a graph of information contained in table 1, and table 2

Questions:

1. Explain in detail why V_L acted as it did in table 2.
2. Why did the Zener diode act to reduce the ripple in step 6?
3. Why exactly did the presence of the milliammeter in the Zener branch reduce the effectiveness of the diode?
4. If the 10-KO load resistor opened in the circuit of Fig.2. How much Zener dissipation would be developed?

EXPERIMENT #4

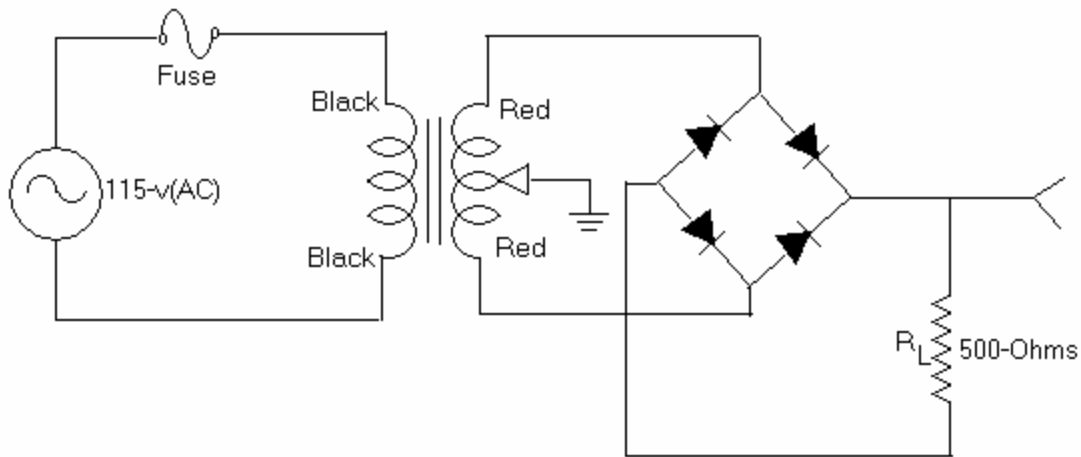
BRIDGE POWER SUPPLY

Parts Required:

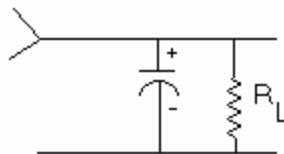
- 1- 26.8VCT Transformer
- 4- 1N5625 Rectifier Diodes
- 1- 500Ω/5W Resistor
- 2- 100μF/50V Filter Capacitors
- 1- Fused Line Cord
- 1- SPST Switch
- 1- 1000Ω/1W Resistor

Procedure:

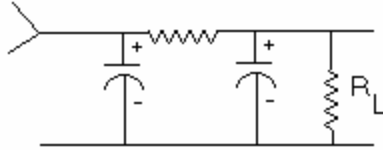
1. Check each diode with the DMM to see if it's good.
2. Connect the circuit shown, but before applying power, very carefully check your wiring.



3. Plug in the fused line cord.
4. Turn on the power switch (* Caution: R_L gets hot). Measure the DC voltage across R_L with the DMM and measure the peak to peak ripple voltage across R_L with the scope (input = AC). Record these values in table 1. Notice the shape of the ripple voltage also.
5. Open the power switch. Add a 100μF filter capacitor across $P1$ (see figure for correct polarity). Repeat step 4.



6. Open the power switch. Add an additional $100\mu\text{F}$ filter capacitor across R_L . Repeat step 4.
7. Open the power switch. Connect a 1000Ω resistor between the filter capacitors to make a Pi filter (see figure). Repeat step 4.



8. Open power switch. Remove any one of the diodes from the bridge (leave an open circuit in its place).
9. Repeat step 4.
10. Open the power switch. Remove the 1000Ω resistor from the circuit and put a short circuit in its place. Repeat step 4.
11. Open the power switch. Remove one of the filter capacitor from the circuit. Repeat step 4.
12. Open the power switch. Remove the remaining filter capacitor from the circuit. Repeat step 4.

Step	Vdc	P-P	Step	Vdc	P-P
	4	12			
	5	11			
	6	10			
	7	9			

TABLE 1. Voltage across R_L .

EXPERIMENT #5

TRANSISTOR FAMILIARIZATION

While working in electronics you'll encounter many transistors. Transistors are composed primarily of either silicon (Si) or germanium (Ge).

As is the case with solid, state diodes, the transistors that are germanium will indicate lower measured resistance values than those that are silicon.

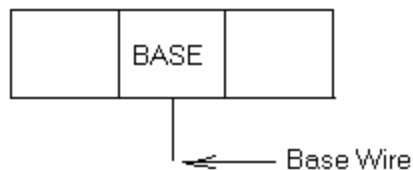
Each transistor is composed of three sections, either PNP or NPN as shown in FIG. 1.



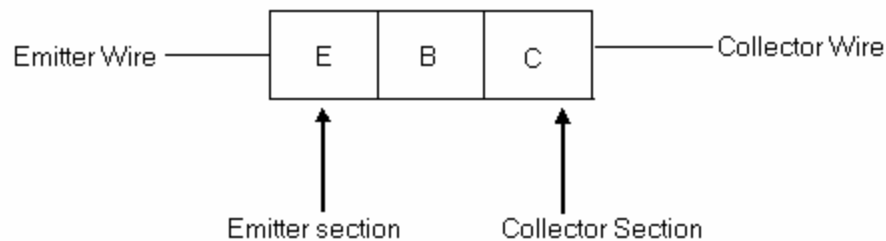
FIG. 1

Notice that each end section is doped similarly while the center section is doped opposite to the ends. As with diodes the letters P and N indicate the types of dopants that are used in each section (P = acceptors, N = donors). Also, like diodes, transistors are monocrystalline. That is, each section is a continuation of the growth of the preceding section.

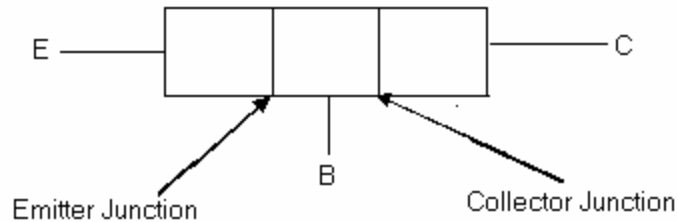
Each section has a wire attached; the middle section is called the base.



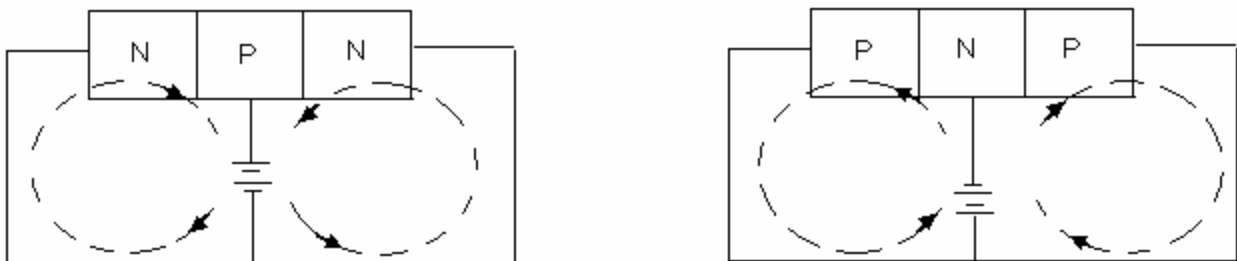
Even though the end sections are doped with the same kind of dopant, the emitter section is doped heavier than the other end section, which is called the collector section.



Notice that the transistor has two PN junctions. They are referred to as the emitter junction and collector, junction respectively.



For the PNP type transistor: if a battery is connected with the negative lead touching the base wire and the positive lead touching the emitter and collector wires both junctions become forward biased. The reverse polarity would be needed to forward bias both junctions of the NPN transistor.



Equipment

- | | |
|-----------------------------|----------------------|
| 1- L_V power supply | 1- 2N1011 transistor |
| 1- VOM | 1- 2N1086 transistor |
| 1- 10mA milliammeter | 1- 2N1413 transistor |
| 1- 200 μ A microammeter | 1- 2N3569 transistor |
| 1- 470K Ω resistor | 1- 2N4000 transistor |
| 1- 2N404 transistor | 1- 2N6541 transistor |

Determining the Polarity of Ohmmeter Leads

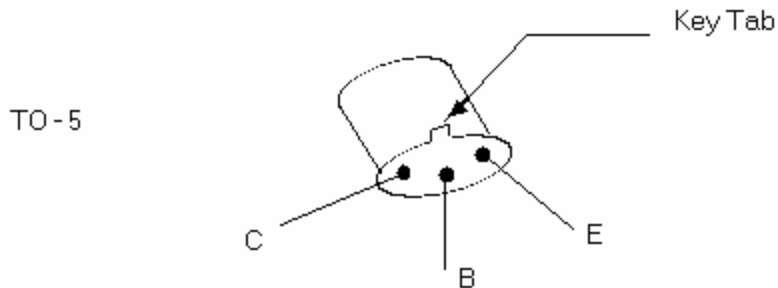
Adjust the VOM to the Rx1K ohmmeter range and set the milliammeter to the 10 mA range.

Connect the ohmmeter leads across the milliammeter so that the milliammeter pointer moves up scale (moves to the right).

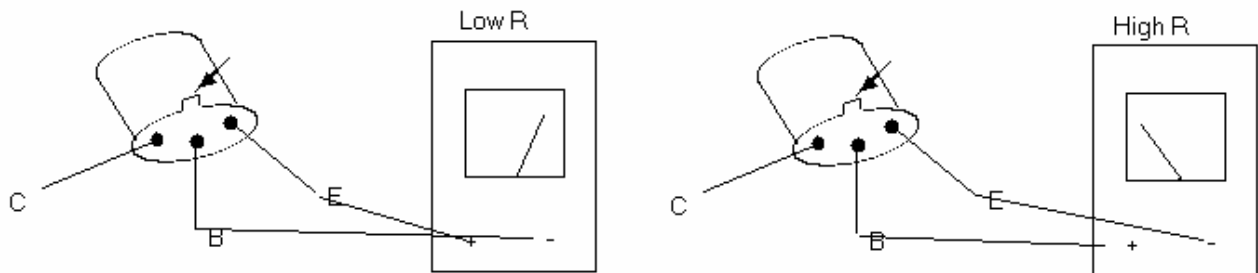
With this connection, the ohmmeter lead connected to the negative (black) post on the milliammeter is the negative ohmmeter lead and the other is the positive ohmmeter lead.

NPN? or PNP?

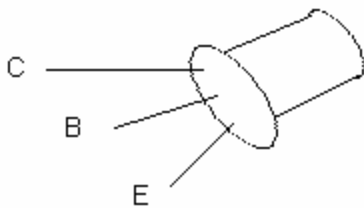
The 2N404 transistor is packaged in the TO – 5 style metal case.



The 2N404 is a PNP transistor. You can easily verify this if you connect the negative ohmmeter lead (always use the Rx1K range) to the base wire of the transistor and the positive ohmmeter lead to the emitter wire, a low (approximately 1KO - 2KO) resistance should be indicated. Reverse the ohmmeter leads and note the very high resistance indicated.



Now verify that the 2N1086 is a NPN transistor.



Both the 2N404 and the 2N1086 are germanium transistors.

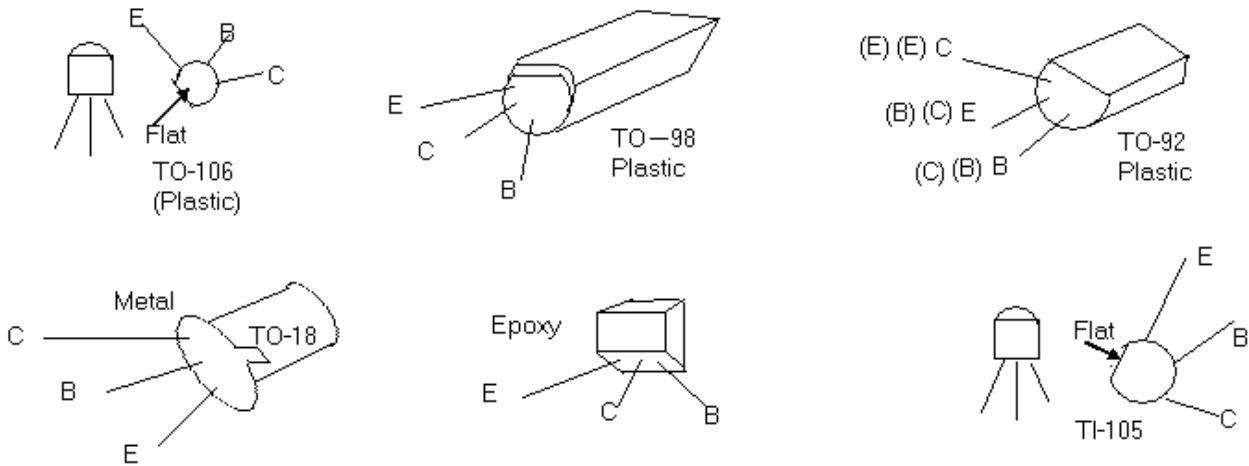
Verify that the 2N6541 transistor is a NPN transistor.

Notice that the resistance values indicated are higher than before. This is so because the 2N6541 transistor is a silicon transistor.

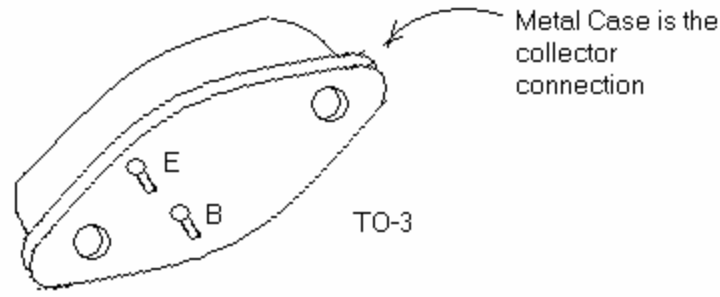
Determine if the 2N1413 transistor is NPN or not, and silicon or not. The 2N1413 is a (NPN) (PNP) (Si) (Ge) transistor.

The 2N3569 transistor is packaged in the TO - 98 case.
 The 2N3569 transistor is a (NPN) (PNP) (Si) (Ge) transistor.

The 2N4400 transistor is packaged in the TO - 106 case.
 The 2N4400 transistor is a (NPN) (PNP) (Si) (Ge) transistor.

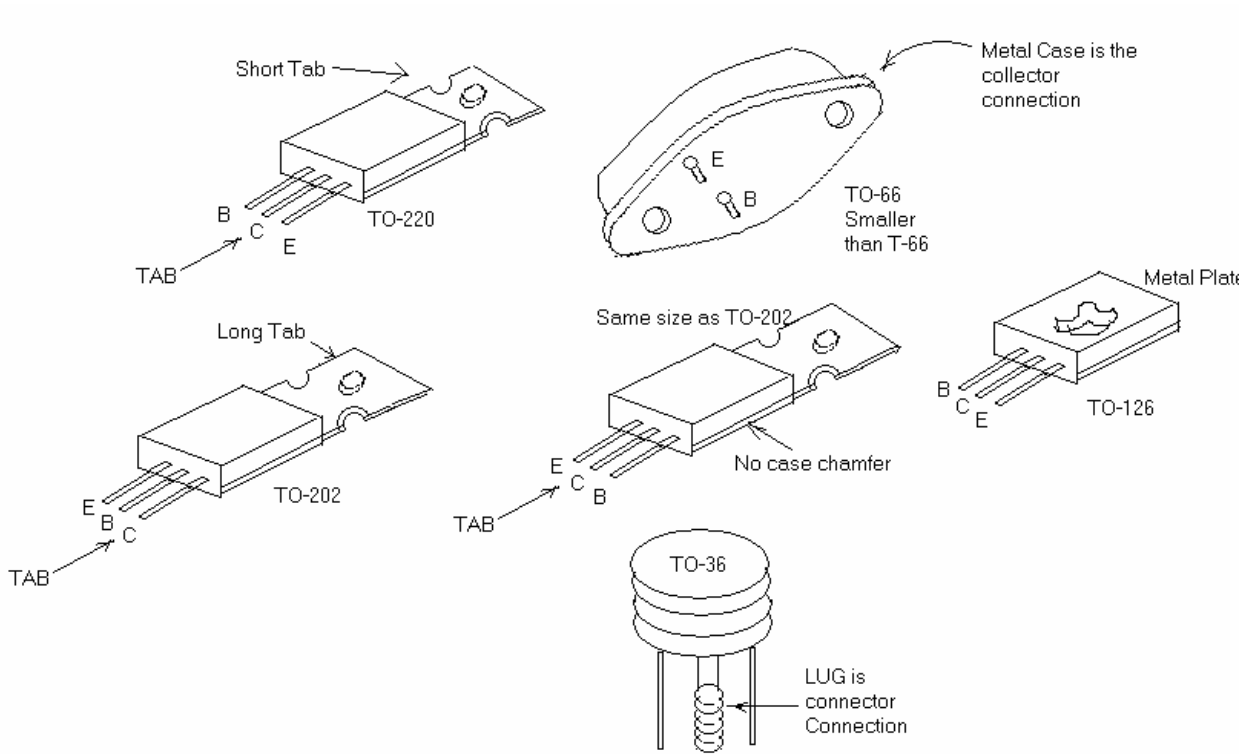


The transistors that you have been checking have been some of the physically small “milliwatt” types. The 2N1011 transistor is classified as a “power” transistor because of its ability to safely pass higher currents and dissipate more power than the milliwatt type transistor. The diamond shaped case of the 2N1011 transistor is the TO - 3 style. The black finned, aluminum structure that the case is bolted to is called a “heat sink”, “heat exchanger”, or just “cooler”.



Verify that the 2N1011 transistor is a PNP transistor. The 2N1011 is germanium, but notice that the measured resistances are lower than those encountered with the milliwatt germanium transistors. Silicon power transistors also indicate lower resistances than the silicon milliwatt types. This is so because power transistors have much larger junction areas and employ higher doping.

Shown below are some additional case styles used with power transistors.



Transistor Symbols

The symbols used for power transistors on circuit diagrams are the same as those used for the milliwatt types, but a distinction is made between NPN and PNP.

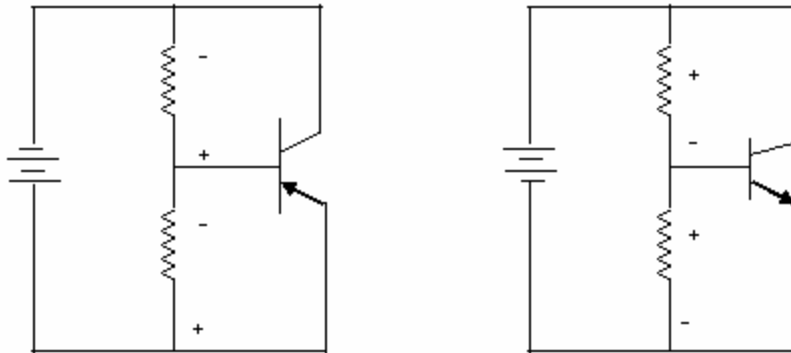


Notice that the emitter always has the arrow head and it points out for the NPN transistor but points in for the PNP transistor. The B, C, E letters are not part of the transistor symbols and as such are seldom included on circuit diagrams.

Transistors Biasing

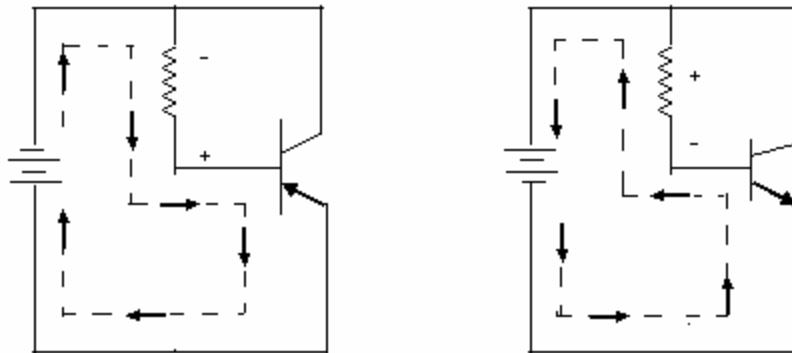
One of the most common biasing arrangements employs a single battery or power supply.

Transistors are normally biased so that the emitter junction is forward biased and the collector junction is reverse biased. In order to achieve this, a resistor voltage divider is used with the power supply or battery.



Notice that the voltage drop polarities across the upper resistors are for proper reverse biasing the collector junctions, while the lower resistor produce forward bias polarities for the emitter junctions.

Sometimes the lower resistors are not used and the forward biased emitter junctions act as the lower elements in the voltage divider.

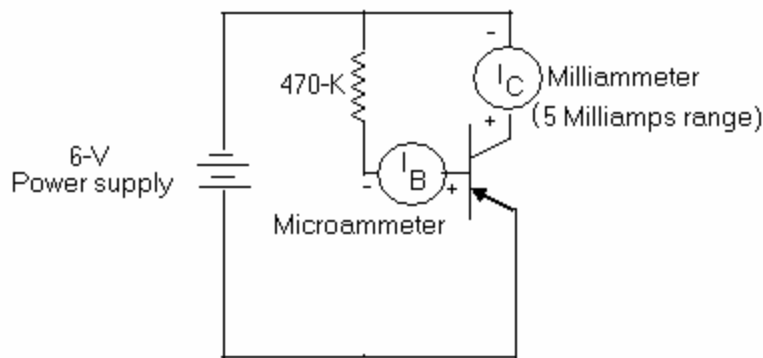


One would expect because the collector junction is reversed biased that the collector current would be very small, “transistor action”, the collector flow is usually quite large compared to the base current.

The transistor acts like a valve for electrons flowing between the collector and the emitter. A small base current, which acts like a control current, produces a much larger (sometimes hundreds of times larger) collector flow. The flow in the emitter is the sum of the base and collector flows.



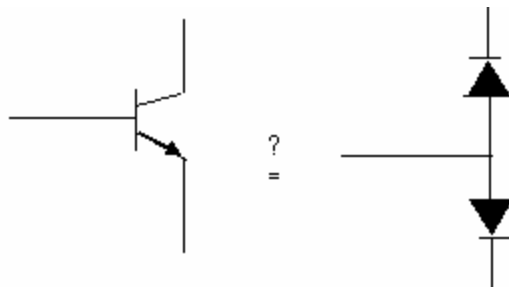
Using the 2N404 transistor connect the circuit shown below.



Notice that the collector current (I_C) is far from zero and is in fact much larger than the current flowing in the 'case lead'.

Questions

1. Operationally, what would be the consequence of making the base section of a transistor much too wide?
2. Why do you suppose the maximum reverse voltage rating for the emitter junction of a transistor is much lower than that of the collector junction?
3. Why do you suppose the collector junction gets hotter than the emitter junction in a properly biased transistor?
4. Do you think that two diodes could be wired together as shown below to make a transistor? Explain.



EXPERIMENT #6

DC CHARACTERISTICS OF A TRANSISTOR

Objectives:

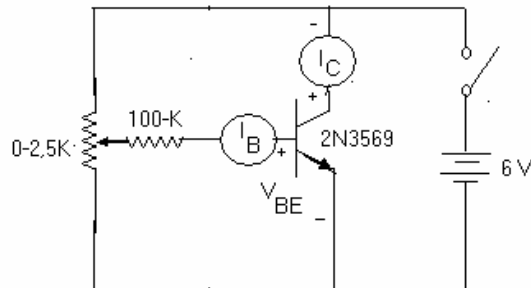
To investigate relationships between base to emitter voltage, base current, collector to emitter voltage, and collector current for a milliwatt style silicon transistor

Parts Required:

- 1- DC Power supply
- 1- DMM
- 1- DC Milliammeter
- 1- DC Microammeter
- 1- 2N3569 Transistor
- 1- SPST switch
- Resistors: 100K Ω ; 5000 Ω Pot; 2.5K Ω Pot

Procedure:

1. Connect the circuit shown in FIG 1.



2. Close the switch and adjust the base current to the values shown in Table 1.

V_{BE} (V)									
I_B (μ A)	0	5	10	15	20	25	30	35	40
I_C (mA)									

TABLE 1

3. Modify the circuit to that shown in Fig.2.

4. Close the switch and adjust the base current to 10 microamps. Adjust the collector to emitter voltage to the values shown in table 2 and record the collector currents. Repeat for the other base currents shown in Table 2.

	Vce (Volts)					
IB (μ A)	0	1	2	3	4	5
10						
20						
30						
40						

TABLE 2
Collector Currents (mA)

5. Make three graphs of the data in table 1.
Examples:

6. Make a family type graph of the data in table 2. Title the graph "Step 4".
Example:

7. On your graph of step 4 draw the collector DC load lines for resistors of 470 Ω , 1K Ω , and 2.2K Ω . Use $V_{cc} = 5V$.

8. Indicate the operating points on your load lines when $I_B = 30\mu A$.

Question:

1. Which has the greater effect on I_c , changing the I_B values or changing the V_{ce} Values?

