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ABSTRACT

This learning module for a postsecondary electronics course in solid state circuits is designed to help teachers lead students through electronics troubleshooting. The module is intended to be used for a second-semester technical college course for electromechanical technology majors. The module introduces students to semiconductor devices and circuits. It contains a module objective and five specific objectives, a content outline, suggested instructor methodology, a list of student activities, evaluation criteria and procedures, a list of seven resources, an outline of the troubleshooting process, troubleshooting tips and assumptions, worksheets, and a posttest. (KC)

High-Technology Training Module

Module Title: ELECTRONICS TROUBLESHOOTING

Unit: DIODE APPLICATIONS

Course: SEMICONDUCTOR FUNDAMENTALS

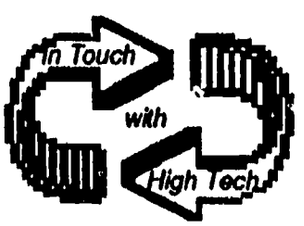
Grade Level (s): POSTSECONDARY

Developed by: DAN LODAHL

Date: SEPTEMBER 29, 1989

School: NORTHCENTRAL TECHNICAL COLLEGE

1000 CAMPUS DRIVE, WAUSAU, WI 54401



Developed as a part of the High-Technology Training Model for Rural Based Business and Industry, Technical Colleges and Local and State Educational Agencies under Grant No. V199A90151.

TITLE: "ELECTRONICS TROUBLESHOOTING"

SCHOOL: NORTHCENTRAL TECHNICAL COLLEGE, DAN LODAHL

DESCRIPTION:

The module of instruction fits into a course called Solid State Circuits. This is a second semester Technical College course for Electromechanical Technology majors. The students are introduced to semiconductor devices and circuits. The module is a response to industry's request for a technician that can troubleshoot and be able to use sound reasoning to solve problems.

Before the module is attempted, the student must have demonstrated a fundamental knowledge of circuit operation and familiarity with the use of test equipment.

MODULE OBJECTIVE:

Given an Oscilloscope, multimeter and a defective DC power supply, the student will locate the defect within a specified time period according to the provided troubleshooting guide.

SPECIFIC OBJECTIVES:

- Attend an informational demonstration on troubleshooting
- Complete worksheet on troubleshooting DC power supplied
- Complete lab experiment on troubleshooting a DC power supply
- All lab work will be done following the safety guidelines of the lab
- Complete follow-up report

CONTENT OUTLINE

TROUBLESHOOTING A DC POWER SUPPLY

I. Lecture/Demo on troubleshooting

A. System operation review

B. Troubleshooting procedure
   a. Flow diagrams
   b. Parts and purposes analysis
   c. Troubleshooting process, assumptions and tips
   d. Failure probabilities

II. Worksheet on troubleshooting DC power supplies

A. Students individually complete worksheet

B. Worksheet is reviewed and evaluated

III. Lab experiment

A. Determine system flow
   a. Use schematic diagram of power supply
   b. Draw block diagram of system
   c. Complete supplied "Parts of Purposes Sheet"
   d. Calculate and predict voltages and waveforms
   e. Instructor check

B. Take measurements at specified test points
   a. Voltages
   b. Waveforms
   c. Record results
   d. Instructor check

C. Analyze Data
   a. Compare measured results with expected results
   b. Describe problem
   c. List possible causes
   d. Determine most likely cause
   e. Instructor check

D. Repair circuit
   a. Corrective action taken
   b. Repeat measurements and analysis, steps B and C

E. Troubleshooting report
   a. Block diagram
   b. Parts and purposes sheet
   c. Data
   d. Analysis
   e. Corrective action
   f. Final instructor check

F. Follow safety guidelines of lab

METHODOLOGY

1. Prepare for presentation a lecture on troubleshooting
2. Write a troubleshooting procedures handout
3. Write a troubleshooting assumptions and tips handout
4. Write a troubleshooting worksheet
5. Design and draw a schematic of DC power supply to be used
6. Construct several DC power supplies with concealed switches which will be used to insert faults
7. Write a system "Parts and Purposes" form
8. Write a troubleshooting experiment procedure form
9. Write a future probability handout

STUDENT ACTIVITIES

1. Attend a lecture/demonstration on troubleshooting
2. Complete the worksheet on troubleshooting
3. Draw a system flow diagram of the DC power supply
4. Complete the "~Parts and Purposes" worksheet
5. Predict voltage levels and waveforms indicated on the systematic
6. Measure voltages and waveforms at test points with the oscilloscope or multimeter
7. Record results from step 6
8. Compare measured results with expected results
9. Describe problem
10. Determine the most likely cause
11. Take corrective action
12. Repeat measurements, and if necessary, analyze. (If circuit still not functioning.)
13. Complete a troubleshooting report
14. Follow the safety guidelines of the lab

EVALUATION CRITERIA AND PROCEDURE

1. PRETEST: Student will troubleshoot a DC power supply circuit without troubleshooting background knowledge. They will be allowed 45 minutes to determine the fault. I will tally how many faults were discovered during the time allotted. ex. 10 students determined 8 faults in 45 minutes.

2. TROUBLESHOOTING BACKGROUND: The next 45 minutes will be devoted to troubleshooting presentation. Included will be information on procedures, flow diagrams, parts and purposes analysis, basic assumptions, tips, and failure probabilities.

3. POST TEST: Students will again troubleshoot DC power supply circuit with new faults inserted. Once again they will be allowed 45 minutes to determine the fault. I will tally how many faults were determined during the time allotted.

4. Upon completion of the post test, the student will fill out an evaluation form on the unit. (Enclosure (4))

NOTE: I will be doing this module on October 16th at 1:30 p.m.

RESOURCES

Author: Metzger, Daniel

Title: Electronic Component Instruments, and Troubleshooting

Source: Prentice Hall Publishing Company, 1981

Author: Ahlers, R. H. and others

Title: Special Issue on Special Systems for Department of Defense Training

Source: Journal of Computer Based Instruction; v13 n2 p2-61, Spring 86

Author: Morrow, Rick and Humler, John

Title: Applied Industrial Electronics: Power Control and Electronic Troubleshooting

Source: Oklahoma State Board of Vocational and Technical Education, Stillwater. Curriculum and Instructional Materials Center, 1985

Author: Knerr, Bruce and others

Title: Computer-based Simulations for Maintenance Training: Current ARI Research. Technical Report 544

Source: Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA 1979

Author: Swanson, Richard A. and Sisson, Gary R.

Title: Analysis of Process and Troubleshooting Work Behavior

Source: Performance and Instructional Journal, 1983, Vol. 22, #2, Pg. 19-22

Author: Long, William E.

Title: Getting Started in Electronic Troubleshooting

Source: Reston Publishing Co., Inc., 1979

Author: Woods, Donald R.

Title: Novice Versus Expert Research

Source: Journal of College Science Teaching, December, 1988/ January, 1989

TROUBLESHOOTING PROCESS

1. Gain understanding of normal circuit operation
   a. System flow diagram (block diagram)
   b. Parts and purposes analysis
   c. Expectations at test points

2. Gather data: Visual, measurements, etc.

3. Determine problem
   (Is there a match between expectations and measurements? Be specific

4. List possible causes and most likely causes (Why isn't there a match?)

TROUBLESHOOTING TIPS AND ASSUMPTIONS

1. Get a schematic

2. Gain at least basic understanding of how circuit is supposed to work

3. Break circuit into functional blocks. ie. rectified, filter, zener regulator, etc.

4. Know what you're "suppose" to find before making a measurement.

5. If your measurement does not match your expectations, there are 3 possible reasons:
   1. circuit is defective
   2. your expectation was wrong
   3. your measurement was wrong

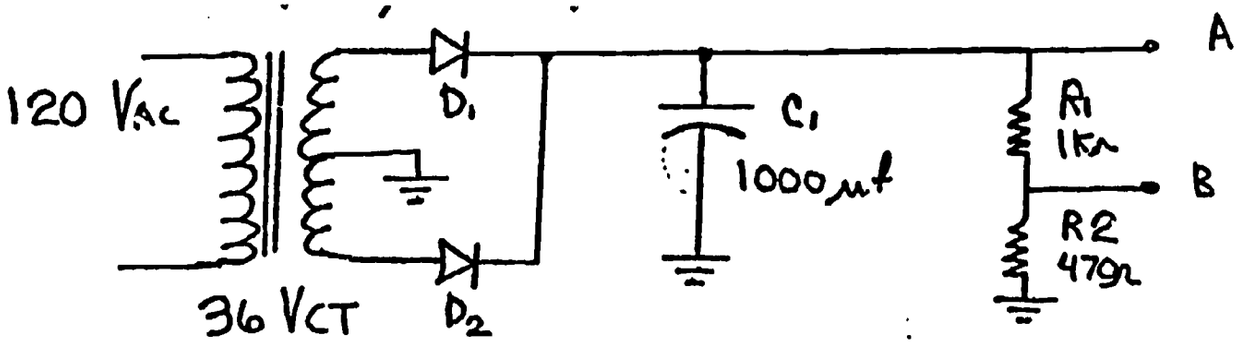
6. Assume equipment once worked properly

7. Assume only 1 problem exists

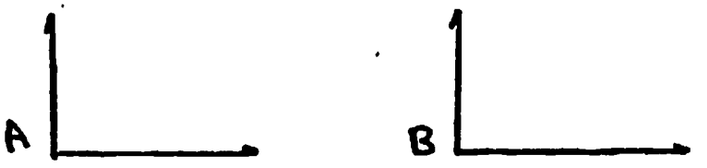
8. Keep a record of problems, causes, and solutions

TROUBLESHOOTING WORKSHEET

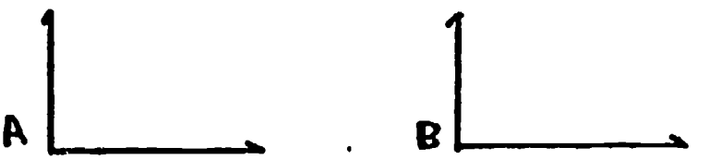
Sketch the expected output at each test point for the conditions given. Include voltage levels and frequency if applicable. (Test points referenced to gnd.)



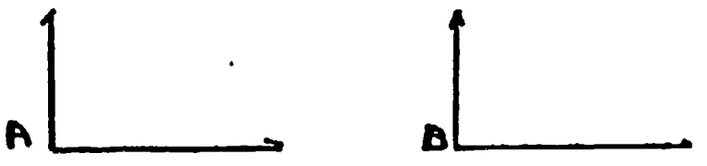
1. Normal operation



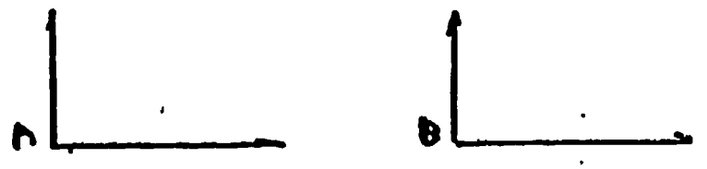
2. D_2 open



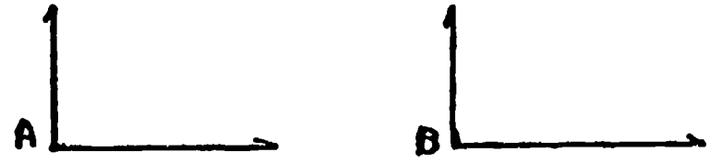
3. C_1 Leaky



4. C_1 open



5. R_1 open



FAILURE PROBABILITIES

(WHAT'S MOST LIKELY TO CAUSE A PROBLEM?)

MOST LIKELY

LEAST LIKELY

Operator error

Connectors, cables outside instrument

Switches, relays

Power semiconductors

Connectors, cables inside instrument

Soldering connections, bad circuit boards

Small signal semiconductors

Electrolytic capacitors

Power transformers and inductors

Power resistors

Variable resistors

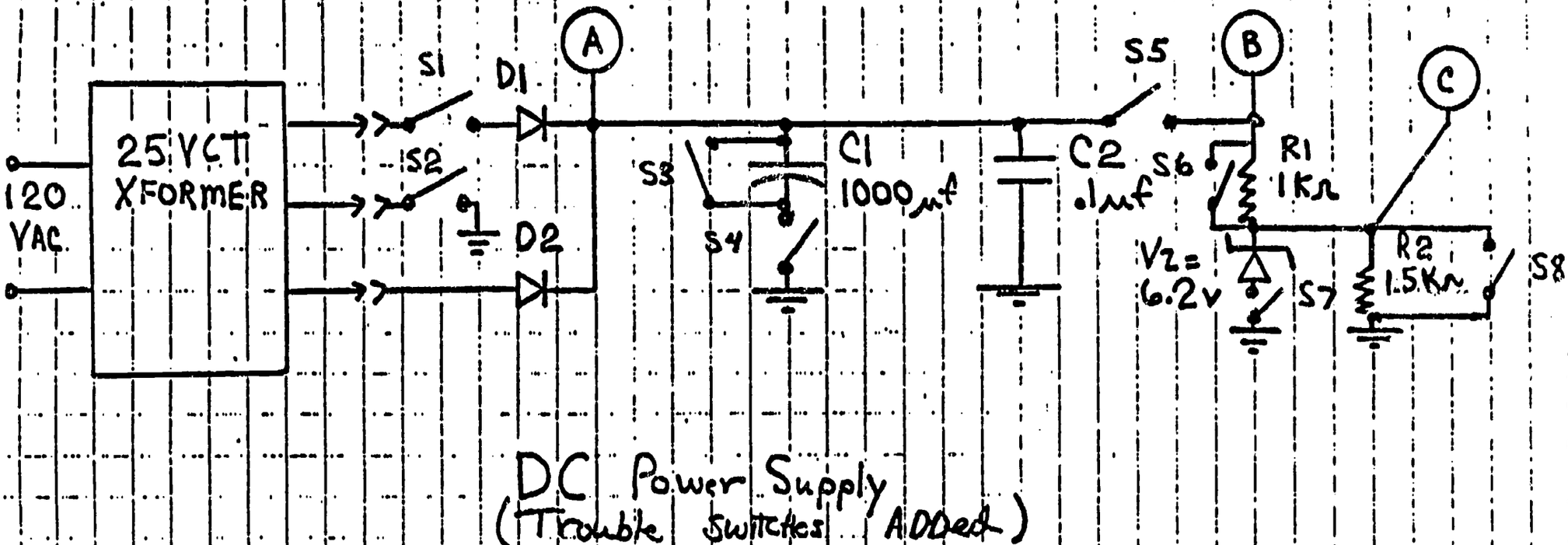
Ceramic capacitors

Mylar and paper capacitors

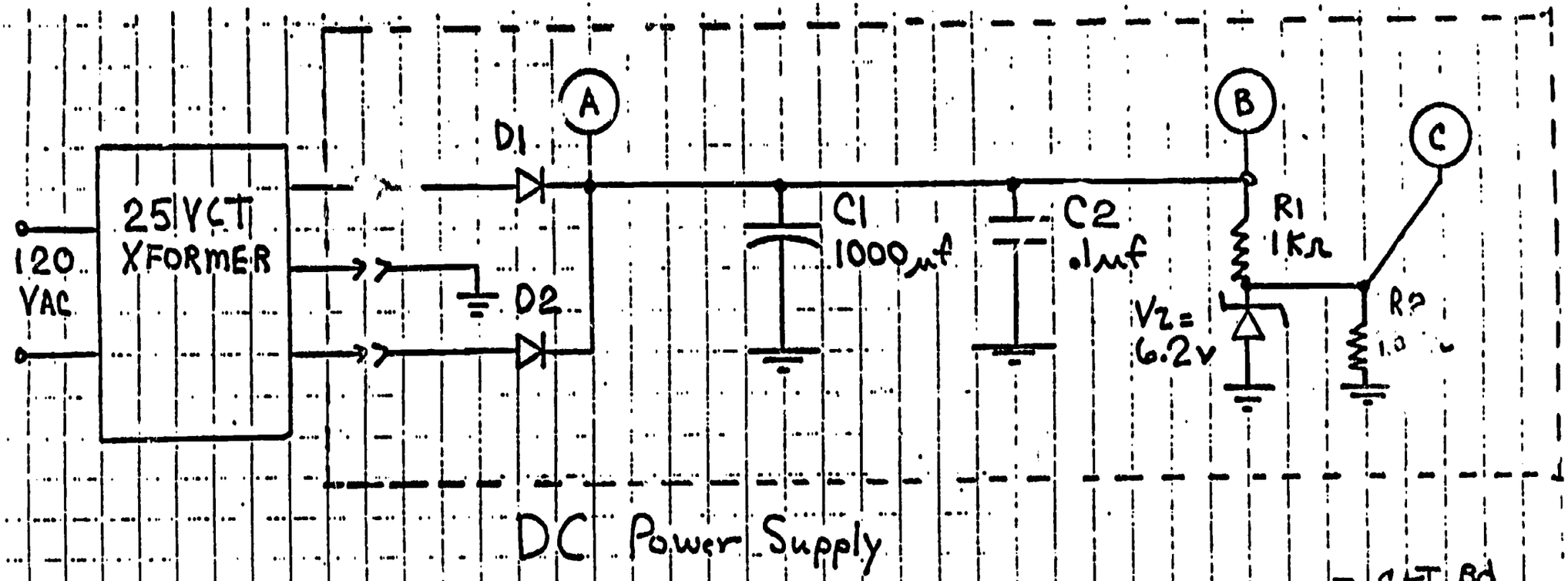
Low-power resistors

Mica capacitors

Low-power inductors



DC Power Supply
(Trouble Switches Added)


A
B
C
D1
D2
25 VCT
XFORMER
120
VAC
C1
1000 μf
C2
.1 μf
R1
1 KΩ
R2
1.0
V2 =
6.2 V
DC Power Supply
= CKT Bd

NAME _____

Parts and Purposes Analysis

PART	Purpose (What it Does and How it Work

TROUBLESHOOTING A DC POWER SUPPLY
(Part 1)

1. Measure and record the waveforms at the three test points specified on the schematic.

2. Is there as problem indicated by your measurements?

3. What is wrong about your measured values?

4. List some possible causes and most likely cause.

5. Instructor check.

EXPERIMENT: Troubleshooting a DC Power Supply (Part 2)

OBJECTIVE: Given an oscilloscope, multimeter, and a defective DC power supply trainer, the student will locate the defect according to the procedure guide lines within the time available.

PROCEDURE:

1. Draw system flow diagram

2. Complete parts and purposes form

3. Calculate and record expected waveforms at test points.

4. Measure and record waveforms at test points.

5. Compare measured values with expected values and indicate the problem. (What is wrong with waveforms).

6. List possible causes and most likely cause.

7. Instructor check.

8. Report write up:
   a. flow diagram
   b. parts and purposes form
   c. Calculated and measured data
   d. Indicated problem, cause, and corrective action necessary

9* Additional faults will be inserted if time permits