Knowledge Domain: Power Supply
Unit: Regulator
Skill: Diagnosing Regulator Problems

Tools and Parts Required:

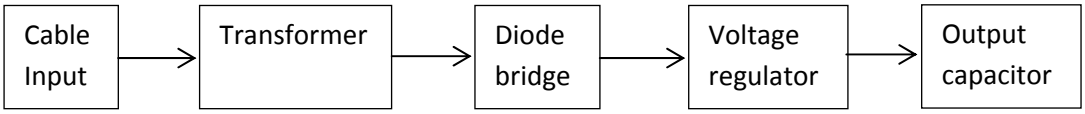
1) **Digital multimeter (DMM)**
2) **Screwdriver set**
3) **Calculator**

Introduction

A voltage regulator maintains a constant voltage level in a device. Two common DC voltage regulators are linear regulators and switching regulators. Linear regulators continuously adjust as the input voltage changes to maintain a constant output voltage level. This skill will discuss linear DC voltage regulators.

Example

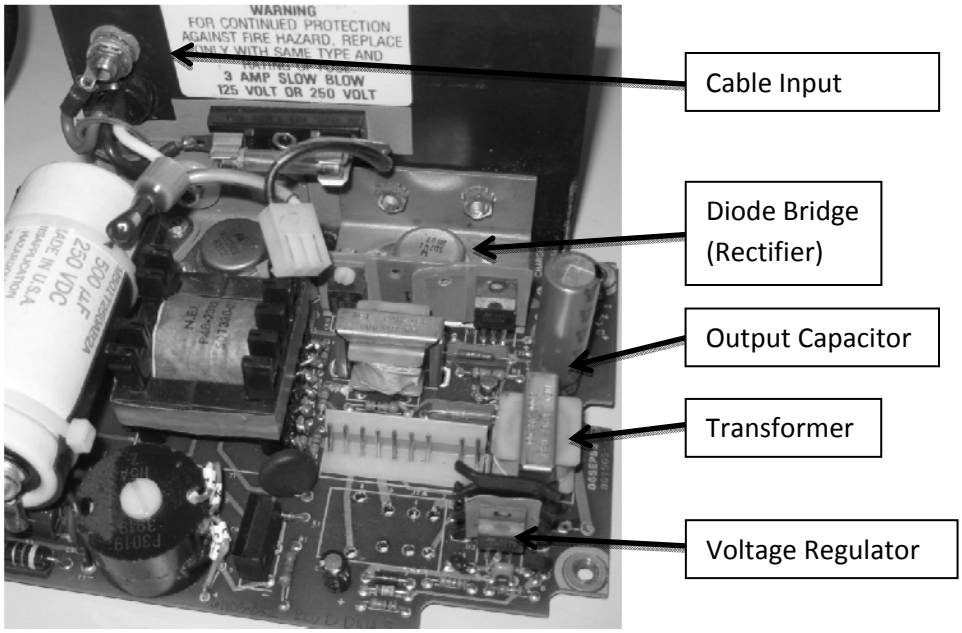
Linear voltage regulators are packaged as integrated circuits. Linear voltage regulators may be small. To find the voltage regulator, begin at the power input to the device. Follow the chart below to find the voltage regulator. There may be extra components along the path due to varying power supply designs.



This is only one example of a device layout. Your device will probably differ. Linear voltage regulators are usually found near the power input.

It is important to insure that the part you are investigating is a linear voltage regulator. There are other components that may look similar to a linear voltage regulator.

- To insure you are looking at a linear voltage regulator, find the part number. The part number will be written on the side of the part.
- Search for the part number online using an internet search engine. If the results indicate that the part you have found is a linear voltage regulator, proceed according to the instructions below.



Identification and Diagnosis

If a device does not turn on, there may be a problem with the voltage regulator. Verify that the medical device is receiving AC power. Next measure the output voltage of the power supply with a digital multimeter (DMM). If the specified voltage output does not match the expected voltage output, the voltage regulator or surrounding circuitry may have a problem.

Procedure

The following procedure is used to diagnose a faulty voltage regulator. A poorly regulated voltage output is often caused by one or more of these four components:

1. Diode bridge
2. AC transformer
3. Voltage regulator
4. Output capacitor

Open the device to expose the power supply and regulator. You will use a DMM to make four measurements.

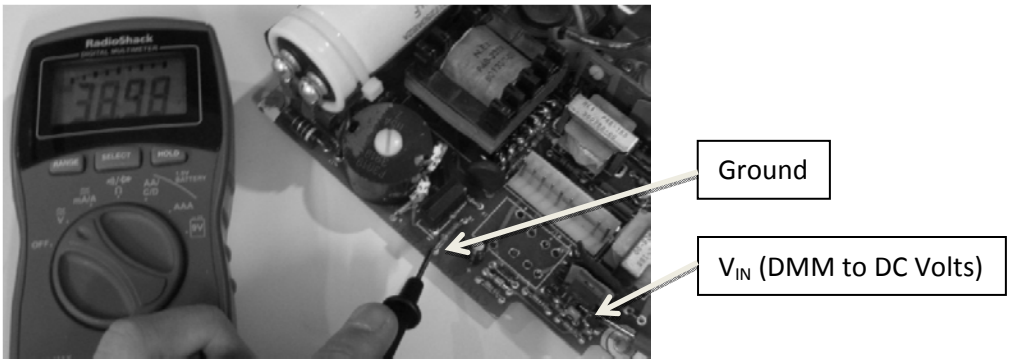
Note: It may be necessary to look up the configuration of the pins on the data sheet for your particular voltage regulator. You can find these data sheets by doing an internet search for the part number of your voltage regulator. The data sheets will tell you which pins are the output and input.

1. Plug in and turn on the device. Using information from the data sheet, place the positive DMM probe (usually red) on the input pin of the linear voltage regulator.

Place the negative DMM probe (usually black) on the electrical ground. Insure that the probe is placed as close to the regulator as possible. Use the DC setting of the DMM to take the first reading.

DC input to regulator, DC_{IN} = _____V

- This voltage must be greater than the specified power supply output voltage by at least 2V. If it is not, check the diode bridge for failure. Resolder failed connections. Replace failed diodes.

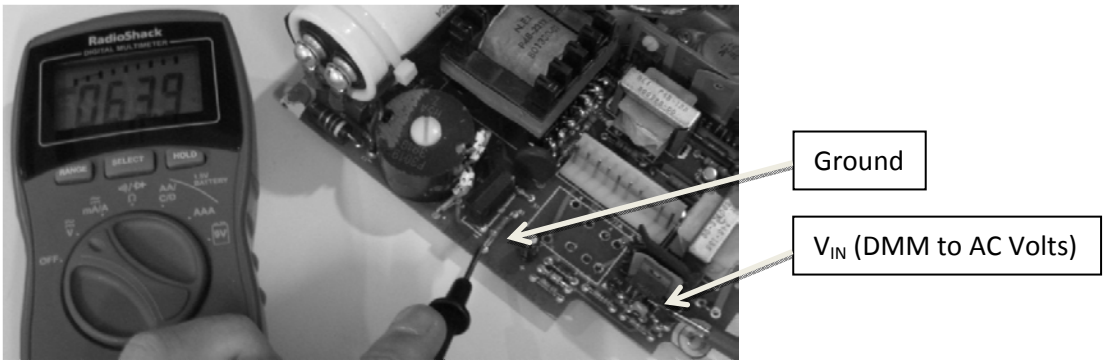


2. With the probes in the same positions as in step 1, set the DMM to read AC and take the following reading.

   AC input to regulator, $AC_{IN\text{-}RMS}$ = _____V

   - Your DMM measures AC voltage in root-mean-square (RMS). However, it may not be a true RMS meter, and the AC may not be sinusoidal. This means that the reading you just took may not be very accurate. So, to calculate the peak AC voltage, multiply your DMM reading by 2.

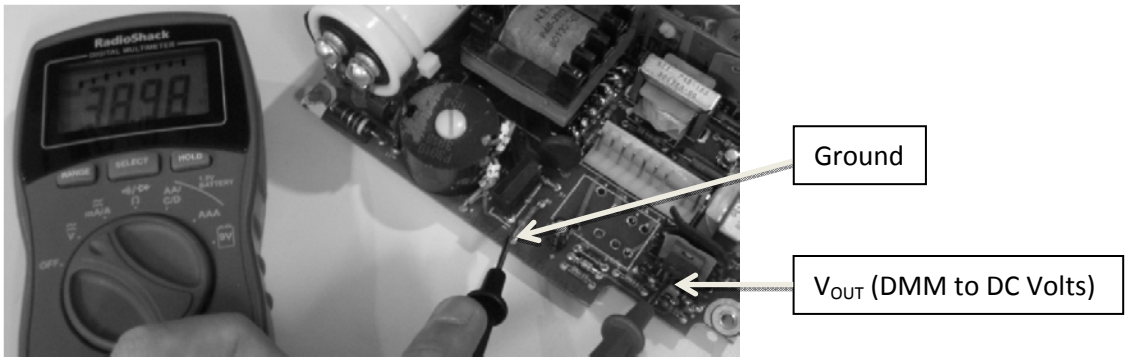
     $AC_{IN\text{-}P\text{-}APPROX} = AC_{IN\text{-}RMS} * 2$ = _____V
   - Calculate $DC_{IN} – AC_{IN\text{-}P}$ = _____V. This value must be greater than the specified power supply output voltage by at least 2V. If it is not, check the input transformer for failure. Refer to the BTA skill *PowerSupply-Transformer-VoltageConversionTransformer* for more information on repairing failed transformers.



3. Now place one probe from the DMM on the output pin of the linear voltage regulator. You may need to consult the data sheet to determine the output pin. The other probe should remain on the electrical ground.

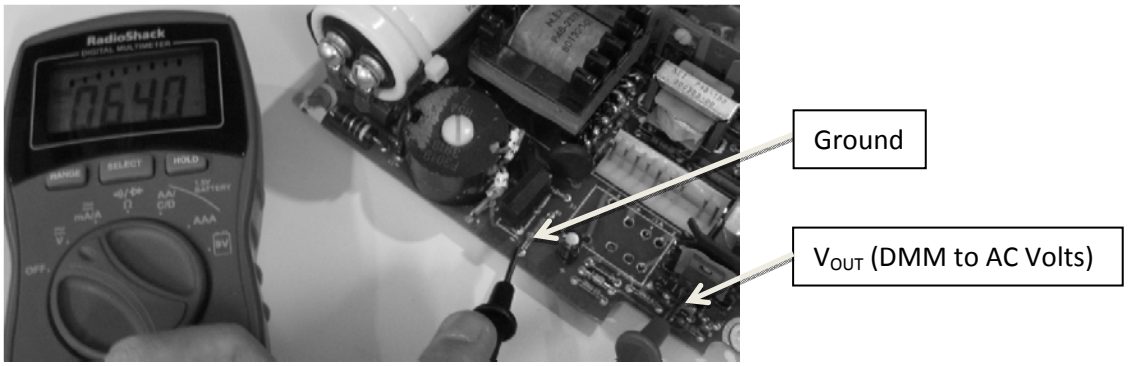
   DC output from regulator, DC_{OUT} = _____V

   - This value should equal the expected power supply output. If it is not, the voltage regulator must be replaced.



4. With the probes in the same positions as in step 3, set the DMM to read AC and take the following reading.
   AC output from regulator, $AC_{OUT\text{-}RMS}$ = _____V
   - Use a calculator to calculate the peak-to-peak AC voltage by multiplying $AC_{IN\text{-}RMS}$ by $2\sqrt{2}$.

     $AC_{IN\text{-}PP} = AC_{IN\text{-}RMS} * 2\sqrt{2}$ = _____V
   - $AC_{IN\text{-}PP}$ should be no greater than 1% of the expected power supply output. If it is, check the output capacitor for failure. Resolder failed connections. Replace failed capacitors.



Exercise

Obtain a device with power supply and a linear regulator. Perform the four measurements listed. Determine whether there is any source of failure in the regulator or surrounding parts. Your instructor must verify your work before you continue.

Preventative Maintenance and Calibration

Always calibrate every medical device before returning it to use.