The Science of Measurements

Radio Building Blocks

An Improved Power Supply

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Power Supply Improvements

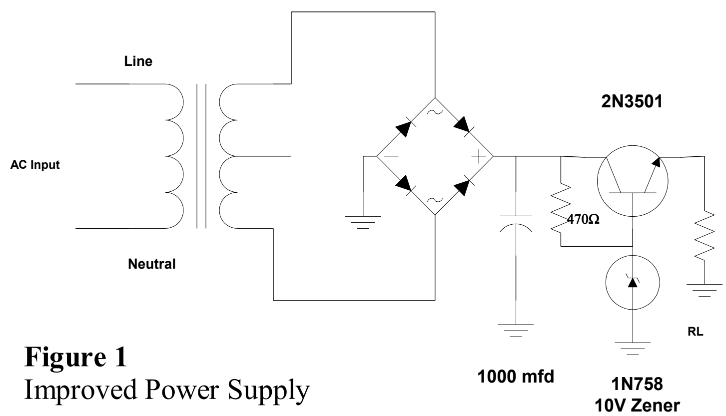


Figure 1
Improved Power Supply

In the last two articles I discussed the use of two instruments, and in the recently held measurements seminar those instruments were put to use evaluating a simple power supply. From the results observed using both the oscilloscope and the digital multimeter, we saw the limitations of that design.

The original power supply design lacked any sort of load regulation, so I added a few simple components to improve the regulation. In this improved circuit, I added a 2N3501 transistor and a 1N758 zener diode in the base leg of the transistor. The 470 Ω resistor acts to provide a biasing source for both the transistor and the zener diode. The zener diode is a voltage regulator diode and is inserted in the circuit in the reverse bias position (i.e. with the cathode connected to the positive supply). The voltage at the cathode end of the diode will remain 10V over a large change in the load resistor. The voltage across RL was measured at 9.3Vdc. Remember that there is a .7V drop from base to emitter of the transistor. That base to emitter drop could have been compensated by placing a standard diode (in the forward bias position) in series with the zener diode if an output of 10 volts was required.

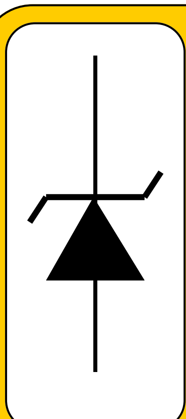
R_L	V_{OUT}	V_{RIPPLE}
3 kΩ	18.65 V	40 mV_{P-P}
1 kΩ	17.85 V	80 mV_{P-P}

Table 1 Original Power supply

Table 2
Improved Power Supply

Change in output voltage and ripple as the load is varied.

R_L	V_{OUT}	V_{RIPPLE}
1 kΩ	9.42 V	2 mV_{P-P}
750 Ω	9.31 V	2 mV_{P-P}
470 Ω	9.28 V	2 mV_{P-P}



The Zener Diode.

If we apply sufficient reverse voltage to a silicon diode, it will break down and the rush of current will most likely destroy it. However, if we limit the current (we can put a suitably high valued resistor in series with the voltage source), we will see that the breakdown voltage will be relatively constant over a wide range of current. This breakdown voltage can be precisely controlled during the fabrication of the diode. Thus, the diode can be used as a shunt type of voltage regulator. The series resistor is chosen to allow as much current as is required by the load plus some for the zener, but not so much as to over heat the zener if the load is removed. This is not an efficient regulator as it works by keeping the current through the series resistor constant, whether it is used by the circuit or by the zener. Diodes made for this type of operation are available in voltages ranging from 1.8 volts to 200 volts and power ratings of 0.05 watts to 50 watts.

For the regulator circuit I used components that I had on hand. There are other devices that are "off the shelf" regulator integrated circuits. In figure 2, I substituted for the zener diode and transistor, a 3 terminal regulator. These devices are available in a variety of package styles depending on the current and power rating. The current that they can handle will range from about 100mA to several amperes.

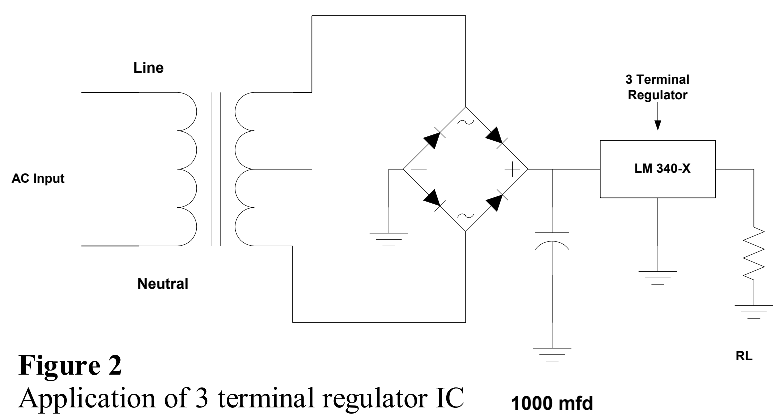


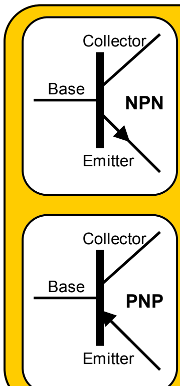
Figure 2
Application of 3 terminal regulator IC

Three terminal regulators are easy to use: they require no external components; they have internal thermal overload protection (they shut down if they get too hot); and they have internal short circuit current limiting. These devices perform quite well over a wide temperature range. The higher current devices may need a heat sink to keep the temperature in acceptable range.

The reason for this discussion will become clear in other articles. Sometimes if you need a stable signal source for your radio such as a 100 KHz calibrator signal or a separate DC voltage for a VFO (Variable Frequency Oscillator) circuit, a design like this will usually do the trick. (More on oscillators in a later article!). In the coming articles I will describe radio building blocks to arrive at a QRP solid state radio. We will use instruments such as a frequency counter, laboratory power supplies, and signal generators in the analysis and design.

Next month, we will look at different amplifier designs.

If there are any questions, please contact me at WB6WXO@soara.org



The Transistor.
The useful characteristic of the bipolar transistor is that there is a constant ratio of emitter current to base current under usual operating conditions. This ratio of currents is known as the Beta (β) of the transistor. A typical value for beta is 50. Thus the transistor can be used as a current amplifier. The base and emitter connections of a transistor have the characteristics of a diode. When the base is drawing current there is a forward diode voltage drop (~0.7 V) between the base and the emitter . Taking advantage of these two characteristics we use the transistor as a pass (control) element in a voltage regulator with the base regulated by a zener diode (shunt) regulator and the transistor passing the (larger) operating current to the regulated load. In a sense the transistor behaves as a variable resistor in this application and is fairly efficient.