MULTISIM DEMO 7.5: MODELING AN AC-TO-DC POWER SUPPLY

In the textbook, basic AC-to-DC power supplies are presented, as well as the basic theory behind them. Multisim along with its extensive real-world parts catalog allows for a nice way to test these power supplies.

Let's build the basic power supply shown in Figure 7.5.1 below.



The Transformer component can be found under:

Group: Basic Family: TRANSFORMER Component: TS_POWER_10_TO_1

How accurate is it to assume a transformer is ideal? In the real world, electrical transformers are among the most efficient machines made by humanity, so an ideal transformer isn't too inaccurate. Of course, There is some loss. Next time you're standing near a high voltage power station, and you hear a hum of about 60 Hz, that's inefficiency you're hearing. The laminated core of the transformer is vibrating causing the noise. Also there is some heat lost, but we are still nowhere near the inefficiency of a gas engine or something like that.

The Bridge Rectifier can be found under:

Group: Diodes Family: FWB Component: 3N247

The Select a Component Window for the Bridge Rectifier can be seen in Fig. 7.5.2 on the next page.

The capacitor is an electrolytic device, although you can use a normal capacitor if you'd like.

Connect all of the components together as shown in Fig. 7.5.3. You'll notice that we are using the center-tap of the transformer. This is simply to get the proper voltage turns ratio (10:1) that we want.

Select a Component				
Database:	Component:	Symbol (ANSI)	ок	
Master Database 💌	3N247	,		
Group:	184842		Close	
→ Diodes	1G4B42		Search	
Family:	1J4B42		Detail Report	
	3N246	· · · · · · · · · · · · · · · · · · ·	Model	
All Select all families	3N247			
	3N248 3N249	Function:	Help	
	3N250			
R ZENER	3N251			
H LED	3N252			
FWB	3N253			
* SCHOTTKY_DIODE	3N254	Model manuf./ID:		
SCR	3N255	IIT/D3N247		
DIAC	3N256			
TRIAC	3N257 3N258	, Footprint manuf./Type:		
H VARACTOR	3N259	Generic / CASE312-02		
	BAT15 099R			
	MDA2500	Hyperlink:		
	MDA2501			
]	MDA2502	1		
Components: 58	Searching:			
Figure 7 5 2	Select a Component	window for Bridge Rectifier 3	N247	

Place a Multimeter (in DC Voltmeter mode) across the output terminals of the power supply as shown below. Run the Interactive Simulation to see the output voltage. It should be about 14.652 V.



The Multimeter only gives us so much information. Let's run a transient simulation on the output to see what the signal looks like. Run the Transient Analysis using the parameters specified in Fig. 7.5.4 shown on the next page.

🛷 Transient Analysis
Analysis Parameters Output Analysis Options Summary
Initial Conditions Reset to default
Parameters Start time (TSTART) 1 Sec
End time (TSTOP) 1.05 Sec
✓ Maximum time step settings (TMAX)
C Minimum number of time points 99
Maximum time step (TMAX) Ie-005 Sec
C Generate time steps automatically
More options
Sec initial time step (TSTEP) 1e-005 Sec Estimate maximum time step based on net list (TMAX)
Simulate OK Cancel Help
Figure 7.5.4 Transient Analysis Specifications.

The simulation may take a little bit of time if your computer is slow. This can of course be amended by changing the maximum time step to something less, but be careful, for if the time steps are too course, good measurements of the output signal can become impossible. Also, one can run the Transient Analysis over an earlier time span such as 0.1 seconds to 0.2 seconds. This way the computer won't have to simulate all of the time before 1 second as it does in the simulation presented. The author's computer is fast, however, so it makes no difference.



The output shown in Fig. 7.5.5 reveals a ripple voltage of about 23.3 mV.

Now what if we want a power supply that provides a different output voltage? As the book suggests, this can be done using a Zener diode. Let's pretend that we need to supply some TTL digital logic. TTL logic requires about 5.0 V for a power supply, so let's go and find a Zener Diode in Multisim's vast libraries in order to get the value we want.

To get to the Zener diodes set: Group: Diodes Family: ZENER

In looking through the different diodes, you can click on the Detail Report button on the right side of the Select a Component window. Find the Zener diode IN4733A (as shown in Fig. 7.5.6), and bring up its Detail Report.



When the report is brought up you can see the critical characteristics of the Zener diode. Most of these are of no importance to us for this project, however we are looking for the Zener voltage, V_Z . As shown in Fig. 7.5.7, the Zener voltage for this diode is 5.10 V, which is pretty close to 5.0 V. We'll use it!

Insert the diode into the circuit as shown in Fig. 7.5.8 and run the Interactive Simulation. The voltage measured by the Voltmeter should be about 5.134 VDC as shown.





Now let's run a Transient Analysis similar to before. The result is shown in Fig. 7.5.9 on the next page.



As we can see, the ripple voltage is 800 μ V, a nice, small value.