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213 Solutions Manual Laboratory Exercises for Electronic Devices Ninth Edition David M. Buchla Steven Wetterling 214Instructor note: The B experiments include useful notes regarding the Anadigm Signal Processor (ASP) and the Programmable Analog Module (PAM). These are presented on an as needed basis with the heading Instructor note:. Experiment 1: The Diode Characteristic Part 1: The Diode Characteristic Curve Step 1: Answers depend on the meter. A meter with a diode test will typically show about 0.6 V in one direction and an open in the other direction. Table 1-1 Component Listed Value Measured Value R1 330 331 R2 1.0 M 1.05 M Table 1-2 VF VR1 (measured) IF (computed) 0.45 V 3.8 mV 11 A 0.50 V 16.3 mV 49 A 0.55 V 83 mV 250 A 0.60 V 230 mV 695 A 0.65 V 690 mV 2.08 mA 0.70 V 1.85 V 5.59 mA 0.75 V 4.58 V 13.8 mA Table 1-3 VS (measured) VR2 (measured) IR (computed) 5.0 V 454 mV 0.43 A 10.0 V 890 mV 0.85 A 15.0 V 1.3 V 1.24 A 215Step 8: Plot of the diode curve: 0.1-150.2-100.3-5.00.4 0.5 0.6 0.7 0.8Note Scale changeVoltage (V)Current (mA)2.04.06.08.01012142.00 VI Curve for a 1N4001 Diode Plot 1-1 Step 9: The semilog plot shows that logarithm of forward current is proportional to the diode drop. Plot 1-2 Questions: Part 1 1. The input impedance is equal to the series 1 M resistor, which can be seen from the voltage: divider rule. 2. The larger resistor is needed to develop enough voltage to be easily measured. 0.010.11101000.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8I F (mA)VF (V) 216Part 2: Plotting Diode Curves with an Oscilloscope Step 3: The barrier potential is reduced by the addition of heat, causing current to increase for a given voltage. Step 4: The threshold is about 1.5 V for a red LED. Step 5: The threshold is about 1.8 V for a green LED. Step 6: The zener forward voltage is about 0.7 V; the breakdown is at 5.0 V. Questions: Part 2 1. The dynamic resistance is measured by observing a small voltage change in the characteristic curve at the point it is being measured and dividing by a corresponding current change. 2. The setup can be used to measure any two-terminal device because it enables a plot of current versus voltage. Experiment 2 Diode Applications Part 1: Diode Rectifiers Step 1: Waveforms: Vout Vsec2.0 ms/div 2.0 ms/div20 V 20 V-20 V -20 V Plot 2-1 Table 2-1 Half-wave rectifier. Without Filter Capacitor With Filter Capacitor Computed Measured Compute Measured Measured Vsec(rms) Vsec(rms) Vout(p) Vout(p)) VOUT(DC) Vr(pp) Ripple Frequency 12.6 V ac 14.4 V rms 20.3 Vp 20.0 Vp 19.1 V dc 1.4 Vpp 60 Hz Step 4: Waveforms: Vout Vsec2.0 ms/div 2.0 ms/div10 V 10 V-10 V -10 V Plot 2-2 217 Table 2-2 Full-wave rectifier circuit. Without Filter Capacitor With Filter Capacitor Computed Measured Compute Measured Measured Vsec(rms) Vsec(rms) Vout(p) Vout(p)) VOUT(DC) Vr(pp) Ripple Frequency 6.3 V ac 7.3 Vrms 10.2 Vp 9.8 Vp 9.5 V dc 0.35 Vpp 120 Hz Step 7: A second parallel load resistor increases the load current and the ripple voltage. Table 2-3 Bridge rectifier circuit. Without Filter Capacitor With Filter Capacitor Computed Measured Computed Measured Measured Vsec(rms) Vsec(rms) Vout(p) Vout(p)) VOUT(DC) Vr(pp) Ripple Frequency 12.6 V ac 14.5 Vrms 20.5 Vp 19.5 Vp 19.0 V dc 0.65 Vpp 120 Hz Step 10: The output voltage drops; ripple voltage is doubled; ripple frequency is 60 Hz. Questions: Part 1 1. The scope ground connection, if common with the circuit, will short the secondary if it is connected to one side, so two channels are necessary. 2. An open diode will cause the ripple frequency to drop to 60 Hz (instead of 120 Hz). Part 2: Diode Clipping Circuits Step 1: R2 and RL form a voltage divider; the voltage across RL is only slightly less than VS. Step 2: Waveforms: VoutVR2Vs+3.0 V+0.7 V+2.3 V3.0 V2.5 V0.5 VVertical 2 V/div Horiz = 0.2 ms/div0 V0 V0 V Plot 2-3 218Step 3: The load has a waveform with a minimum of -2.72 V and a maximum of 0.68 V similar to the second waveform in Plot 2-3. The change in the lower part of the waveform is due to loading effects. Step 4: The positive clipping level follows changes in the power supply voltage. As the supply is increased, the positive clipping level moves up from about 0.7 V to the peak of the input waveform. Step 5: The negative portion of the waveform is clipped. The power supply controls the level, which varies from 0.7 V to the positive peak. Step 6: Reversing the power supply voltage moves the clipping level to negative voltages. Questions: Part 2 1. The clipping level stays the same when the load is reduced but the lower level of the waveform changes due to loading effects. 2. At all times, the algebraic sum of the voltages around a closed path is zero. The voltage across R2 can be found directly by subtracting the load voltage from the source voltage. Part 3: Diode Clamping Circuits Step 1: The output is an ac waveform that varies from approximately 0.6 V to +5.4 V. The output tracks changes in the input amplitude but the lower peak remains at 0.6 V (after a short delay for settling to the new level). Step 2: The power supply voltage adds to the output. See Plot 2-4 for output waveform. Vo ut+7.26 V+1.26 V0 V 2 V/div Plot 2-4 Step 3: The circuit is now a negative clamping circuit. The peak is at approximately 0.6 V when the dc supply is zero and the clamping point moves more negative as the dc voltage increases. Questions: Part 3 1. The capacitor is polarized, so how it charges needs to be considered in placing it in the circuit. 2. The output will settle faster due to the decreased time constant. There is also a small additional distortion on the bottom of the waveform when the diode conducts. 219Experiment 3 Special-Purpose Diodes Part 1: The Zener Diode and Regulator Table 3-1 Resistor Listed Value Measured Value R1 220 219 R2 1.0 k 1.00 k RL 2.2 k 2.22 k 0 mA+10 mA10 mA10 V +10 V0 V Plot 3-1 Table 3-2 Vs Vout (measured) IL (computed) VR1 (computed) Is (computed) IZ (computed) 2.0 V 1.82 V 0.82 mA 0.18 V 0.82 mA 0.0 mA 4.0 V 3.60 V 1.62 mA 0.40 V 1.81 mA 0.19 mA 6.0 V 4.70 V 2.12 mA 1.30 V 5.90 mA 3.78 mA 8.0 V 5.07 V 2.28 mA 2.93 V 13.3 mA 11.0 mA 10.0 V 5.24 V 2.26 mA 4.76 V 21.6 mA 19.3 mA Step 4: As shown in Table 3-2, zener current increases for increasing source voltage. Table 3-3 RL Vout (measured) IL (computed) VR1 (computed) Is (computed) IZ (computed) 1.0 k 5.32 V 5.32 mA 6.68 V 30.4 mA 28.0 mA 750 5.31 V 7.08 mA 6.69 V 30.4 mA 28.0 mA 500 5.26 V 10.5 mA 6.72 V 30.5 mA 28.1 mA 250 5.08 V 20.3 mA 6.92 V 31.5 mA 29.2 mA 100 3.75 V 37.5 mA 8.25 V 37.5 mA 0.0 mA* * out of regulation with this load. 220Voltage (V)0246810Resistance ( )0 200 400 600 800 1000 Plot 3-2 Step 9: From the data taken, the zener was able to regulate as long as the load was at least 250 . Step 11: The regulated output had approximately 1 mV of ripple. The ripple waveform showed only the tip of the positive waveform. Noise level was less than 1 mV. Although this circuit had the advantage of a larger filter capacitor, the ripple is hundreds of times smaller than the unregulated supply in step 9 of Experiment 2 (see Table 2-3 for a comparison.) Questions: Part 1 1. (a) The region between zener breakdown and 0.7 V is approximated by an open circuit. (b) Both the forward-bias region and the reverse-bias region are approximated by a short. 2. Percent line regulation = outin5.24 V 5.07 V100% 100% 8.5%10 V 8.0 VVV = = 3. For the worst case (1 k and 100 loads) the percentage load regulation was poor since the zener carried no current for the 100 load. Percent load regulation = VNL VFLVFL=5.32 V 3.75 V3.75 V 100% = 42%Part 2: The Varactor Diode Step 1. Note: Measured resonant frequencies are shown in Table 3-4. Three varactor diodes were tested, all from the same manufacturer, with consistently lower than calculated resonant frequencies. The lower measured frequencies may be due to stray capacitance acting to reduce the measured frequency. With no stray capacitance, the calculated fr should be approximately 226 kHz with 4 V of bias. 221 Table 3-4 VBIAS Resonant

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