Experiment 2:   Diode Voltage Limiters

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Purpose:
To observe the ability of diodes of different types to limit, or regulate the output voltage of a circuit.

Method:
A periodic input voltage v_{IN} will be applied to series resistor-diode circuits, and the relationship between the diode voltage v_D and v_{IN} will be observed simultaneously in two ways: a plot of the two waveforms as a function of time, and a plot of the voltage transfer function v_D vs. v_{IN}.

Hardware Setup:
Build this circuit, using the pn-junction diode that you saved from Experiment 1.
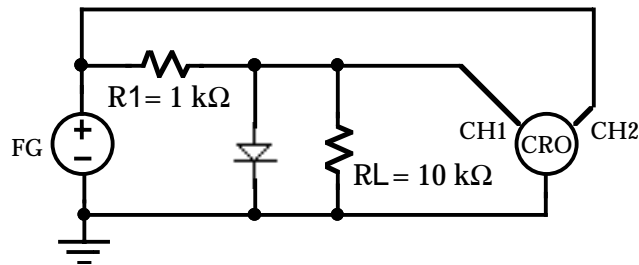
Use 10x probes for both oscilloscope channels. Have available a 100 Ω and a 1 kΩ resistor to substitute for R_L.

Software Setup:
Configure a function generator instrument panel for a triangular waveform with zero offset. As always, set load = infinity. Add an **AMPLITUDE** input terminal (*Object Menu --> Add Terminal --> Amplitude*).

Connect a Real Knob or Real Slider (*Data --> Continuous -->*) to the function generator input terminal, and set its range for zero to 20. Configure the knob so that the program will run whenever a new value is selected (*Object Menu --> Set Properties --> Execution --> Auto Exec*).

Create an oscilloscope instrument panel and *reset* it, then configure it for a timebase of 0.2 ms/div. Set the Channel 1 sensitivity to 2 v/div, and set the probe factor to 10 for both channels. Add a SENS-CH1 input terminal, and **WF-CH1** and **WF-CH2** output terminals (the latter produce the two waveforms as sequences of amplitudes at fixed time intervals). Connect a second knob or slider to the input terminal and set its range for zero to 20 also. The selected value will determine the vertical scale of channel 1. **The actual vertical sensitivity that you choose is not critical, as long as the waveform amplitude does not exceed the height of the screen. If this happens, overflow occurs and the output values are meaningless.**

When you run the program, you will observe the input and output waveforms on the actual oscilloscope. To obtain a simultaneous display of v_D vs v_{IN}, create an X vs Y Plot object, and

provide for markers with *Object Menu --> Set Properties --> Markers --> Delta*. Connect the WF-CH1 output of the oscilloscope driver to the Y input and the WF-CH2 output to the X input.

Procedure:

Run the program with the input amplitude set to 20 V and the XY plot object open. Always click Auto Scale to view the voltage transfer curve. Estimate V_f, the "turn-on" voltage for the 1N4007 diode and compare it with your value from experiment 1.

What slope do you expect for the linear portion of the voltage-transfer curve (below V_f)? Use the movable markers on the XY display to calculate the slope. If it is different from your expected value, explain it. Use the markers to estimate the slope above V_f, and record the result.

What change, if any, do you expect in the v_D vs v_{IN} plot if you change the function generator output from a triangular wave to a sinusoid? After writing your prediction in your notebook, make the necessary changes in your software and test your prediction.

Replace the diode with the 1N4733 zener diode that you used earlier, and rerun the experiment using an input amplitude of 20 V. Record and explain what you see in the two displays.

Keep the zener diode in the circuit and change R_L to 100 ohms. Rerun the experiment with a 20 V input amplitude. and explain your observations. Repeat for R_L = 100 ohms.
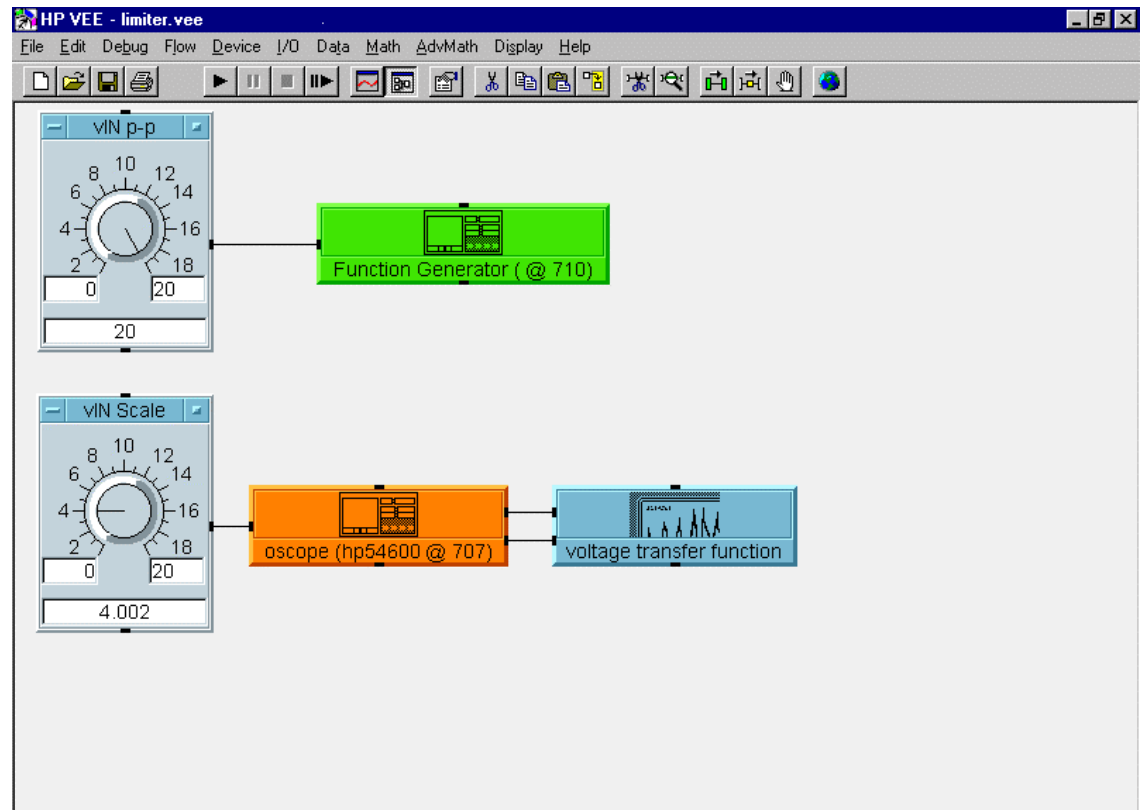Now reduce the input amplitude to 2 V and explain what you see.

Fig. 2-1 Agilent VEE Setup