Chapter 1

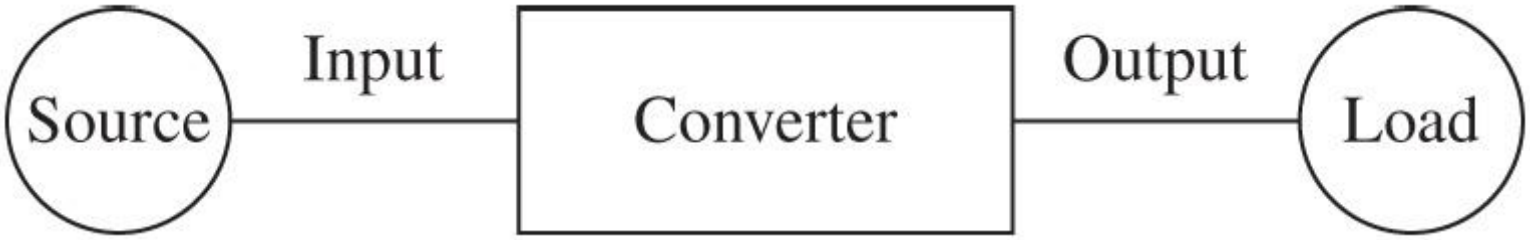
INTRODUCTION

INTRODUCTION

- CONVERTER CLASSIFICATION
- POWER ELECTRONICS CONCEPTS
- ELECTRONIC SWITCHES
- SWITCH SELECTION
- SWITCHES IN LTSpice

Figure 1.1

CONVERTER CLASSIFICATION



ac input/ dc output
(*rectifier*)

dc input/ac output
(*inverter*)

dc input/dc output (“Converter”)

ac input/ac output

Figure 1.2

THE DIRECTION OF POWER FLOW DETERMINES CONVERTER CLASSIFICATION

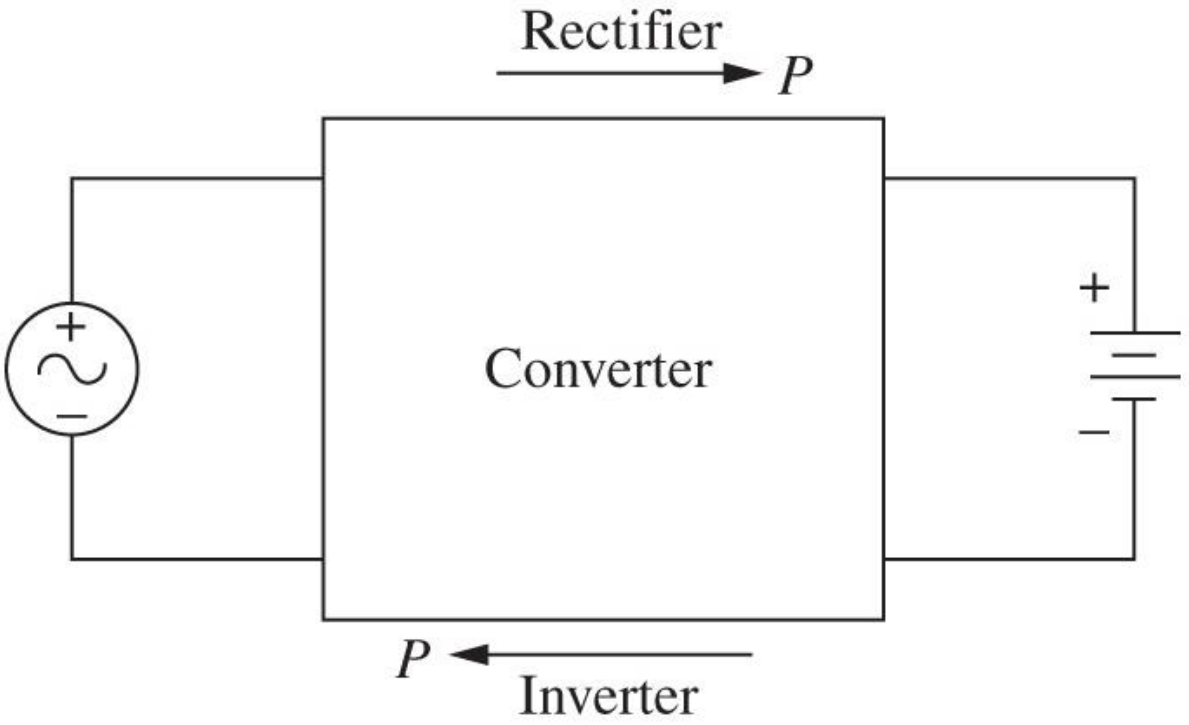
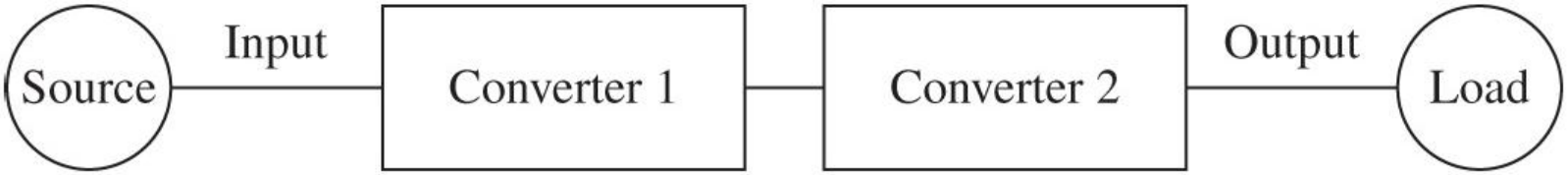


Figure 1.3

TWO OR MORE CONVERTERS CAN BE USED IN A MULTISTEP PROCESS

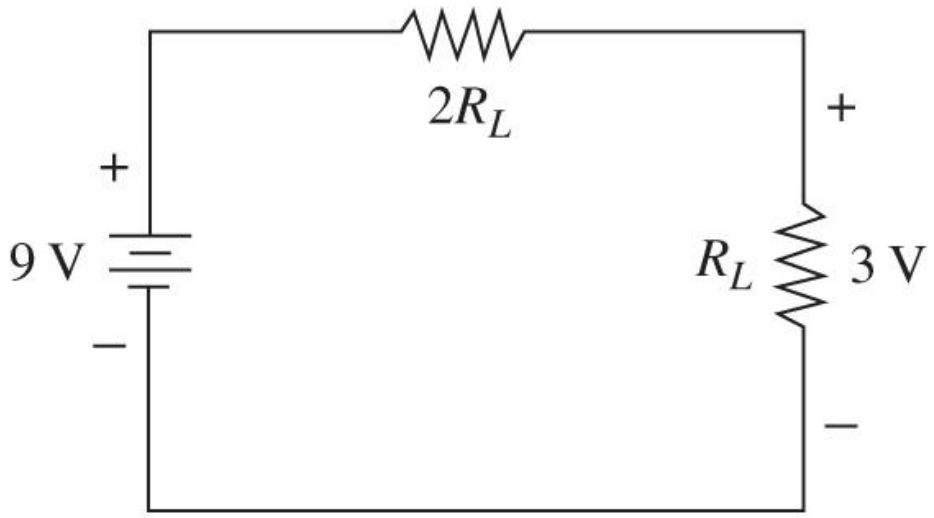


Example of Wind Turbine

Wind Turbine → AC-DC → DC-AC → Power Grid

Figure 1.4

A BASIC (AND INEFFICIENT) DC-DC CONVERTER: A VOLTAGE DIVIDER

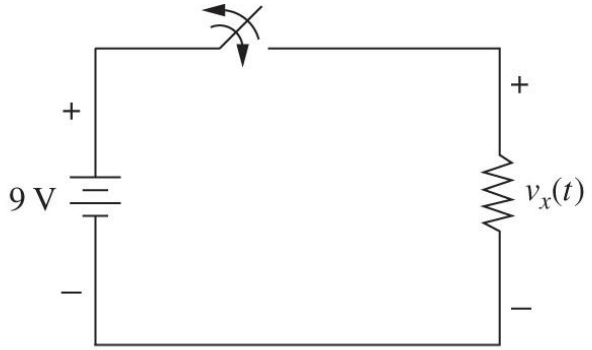


Energy Loss in $2R_L$?

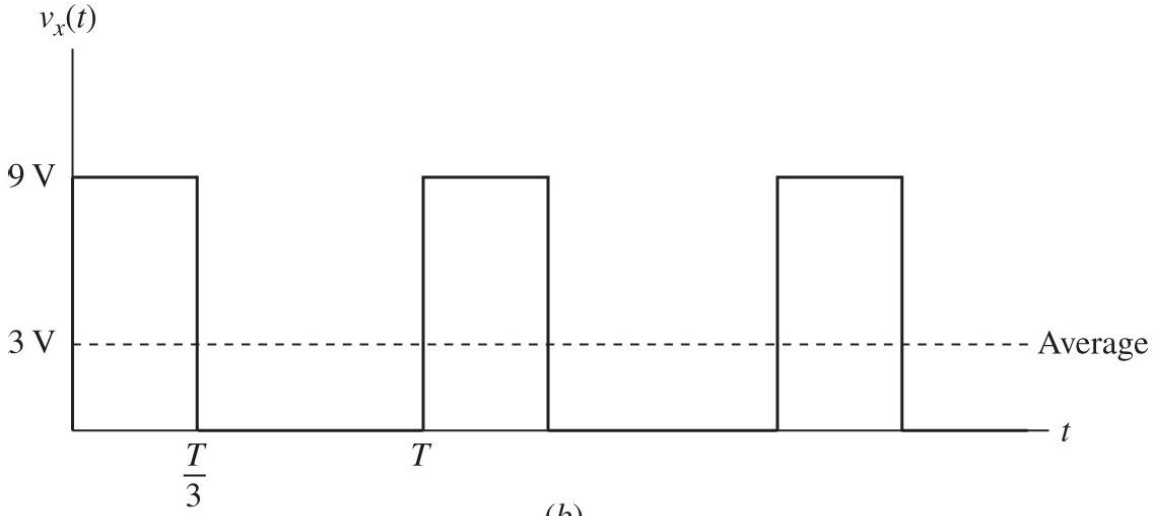
Energy Efficiency ?

Figure 1.5

A DC-DC SWITCHED CONVERTER



(*a*)



(*b*)

$$\text{avg}(v_x) = V_x = \frac{1}{T}\int_0^T v_x(t)dt = \frac{1}{T}\int_0^{T/3} 9dt + \frac{1}{T}\int_{T/3}^{T} 0dt = 3\ \text{V}.$$

Figure 1.6

Insert a low-pass filter to remove all but the dc (average) voltage. The output is then purely dc for an ideal filter.

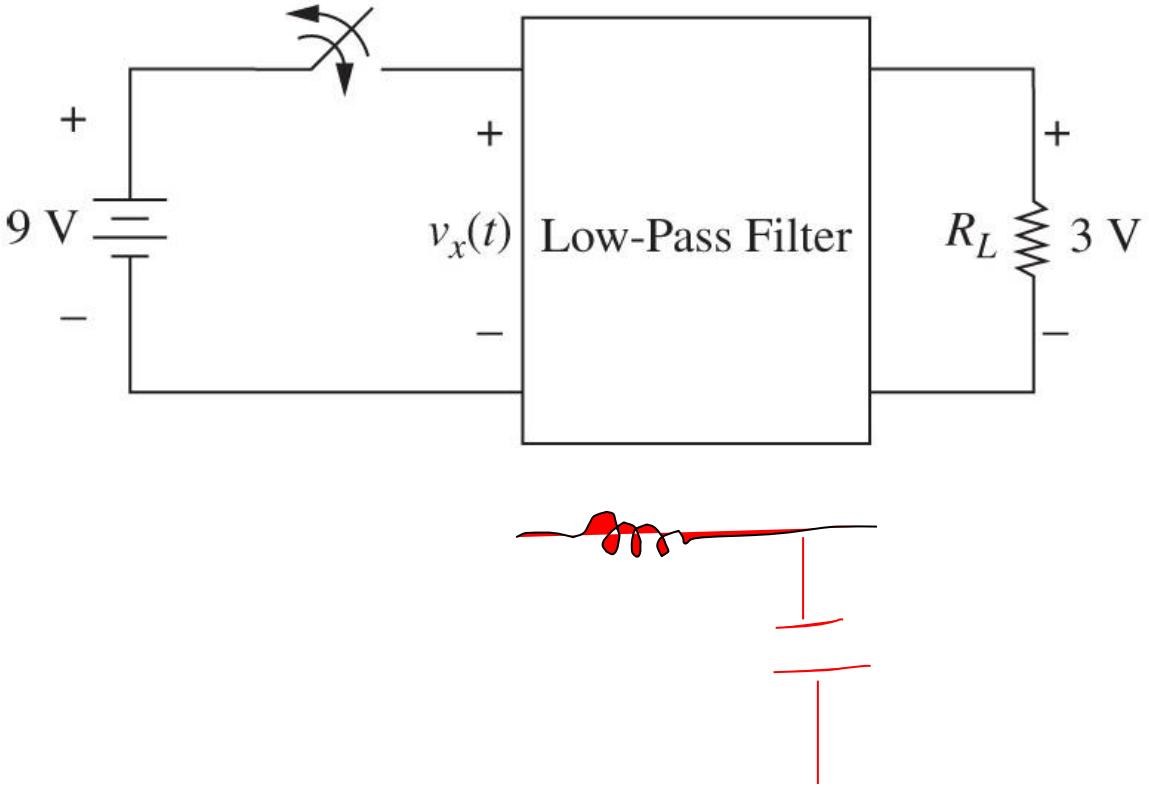


Figure 1.7

Switch control can compensate for variations in V_s and regulate the output.

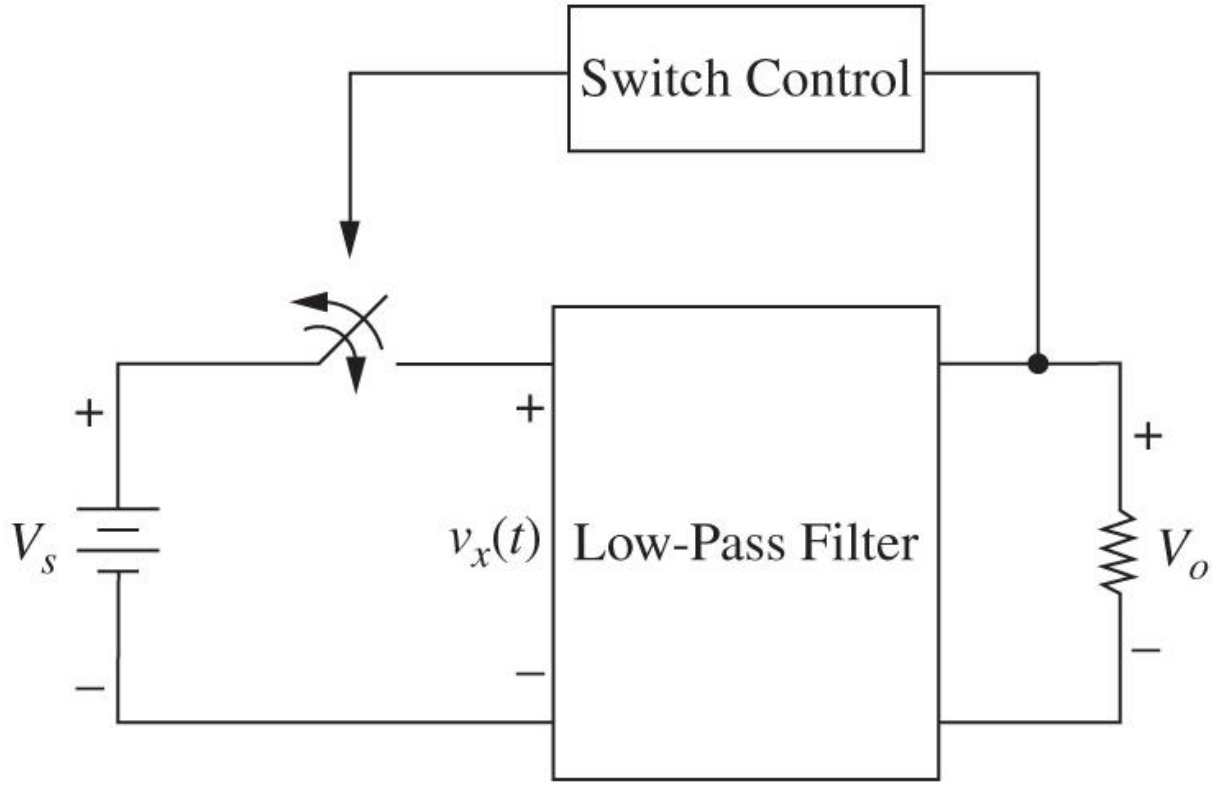
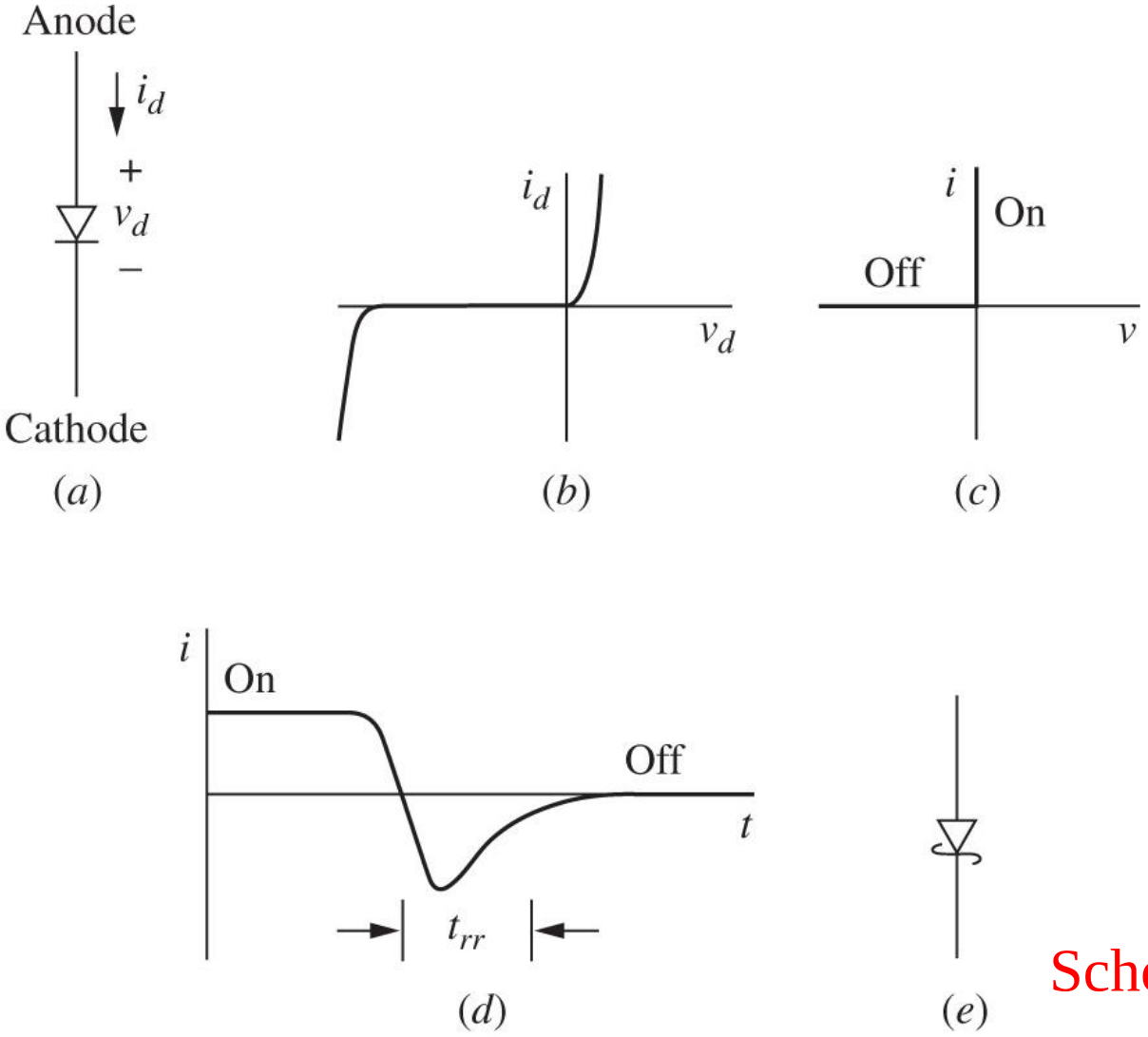


Figure 1.8

Diodes



Schottky diode

Figure 1.9

Thyristors

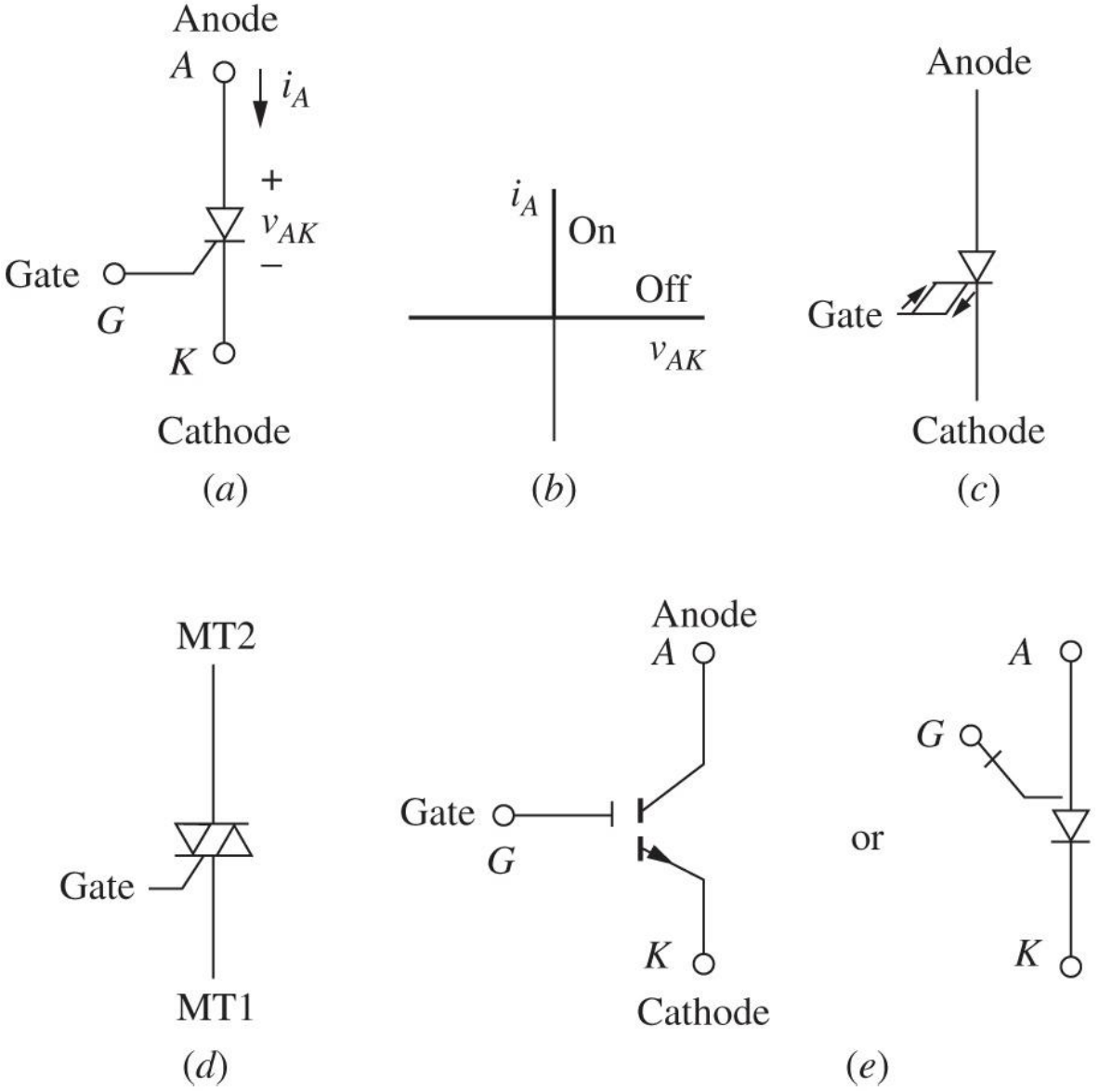


Figure 1.10

THE MOSFET

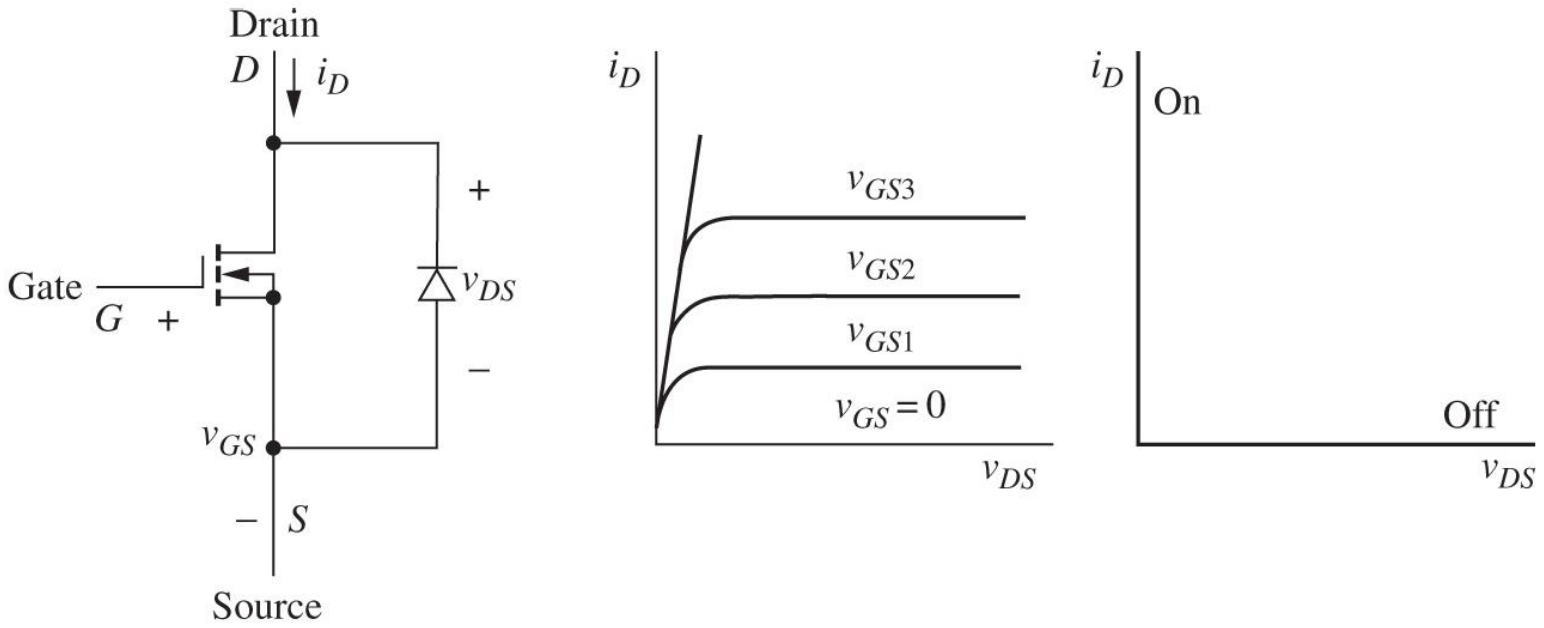


Figure 1.11

Bipolar Junction Transistor (BJT)

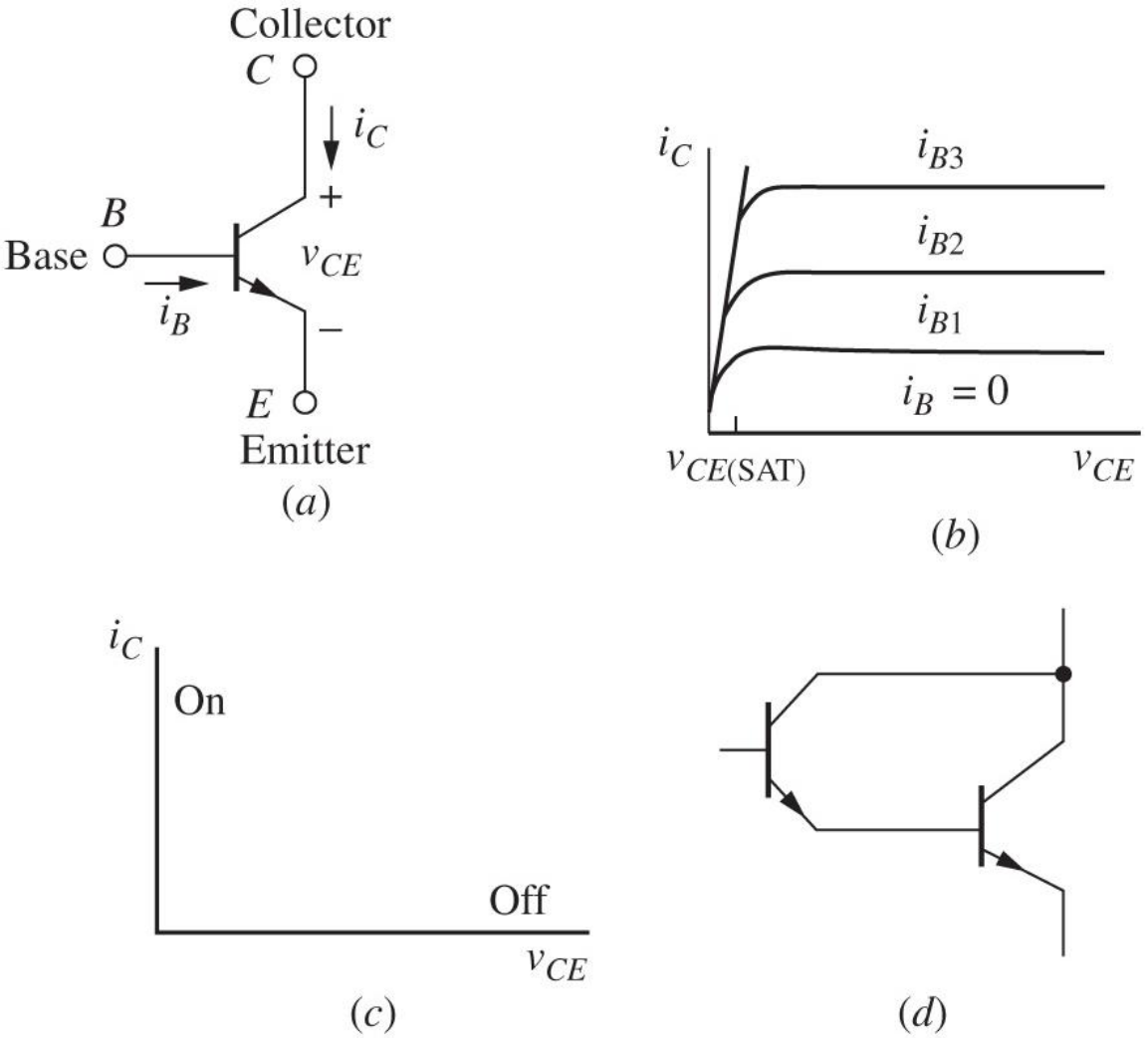
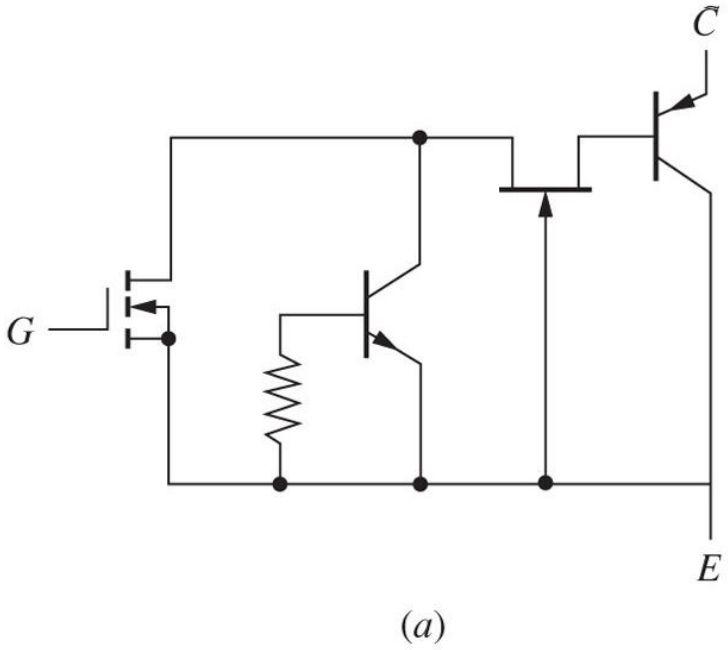
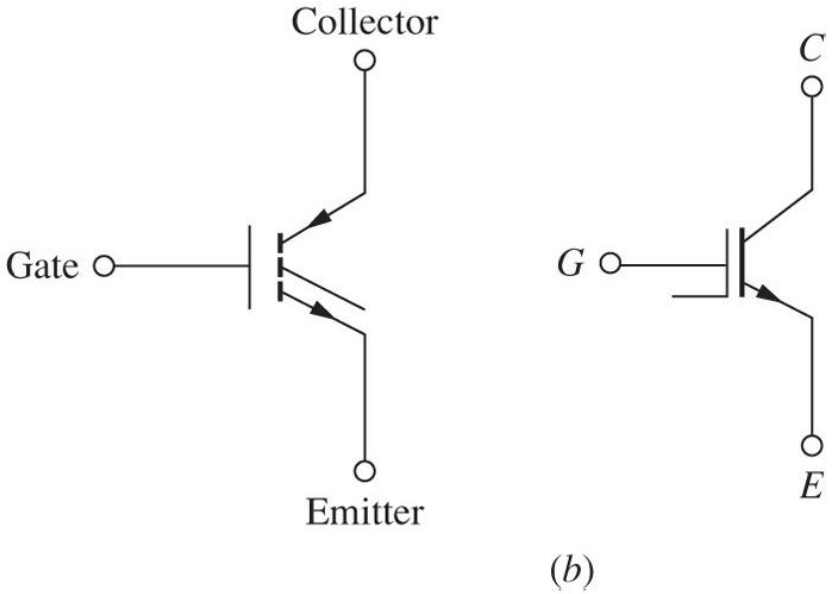


Figure 1.12

Insulated-Gate Bipolar Transistor (IGBT)



(a)



(b)

Figure 1.13

Switch Selection (Example 1)

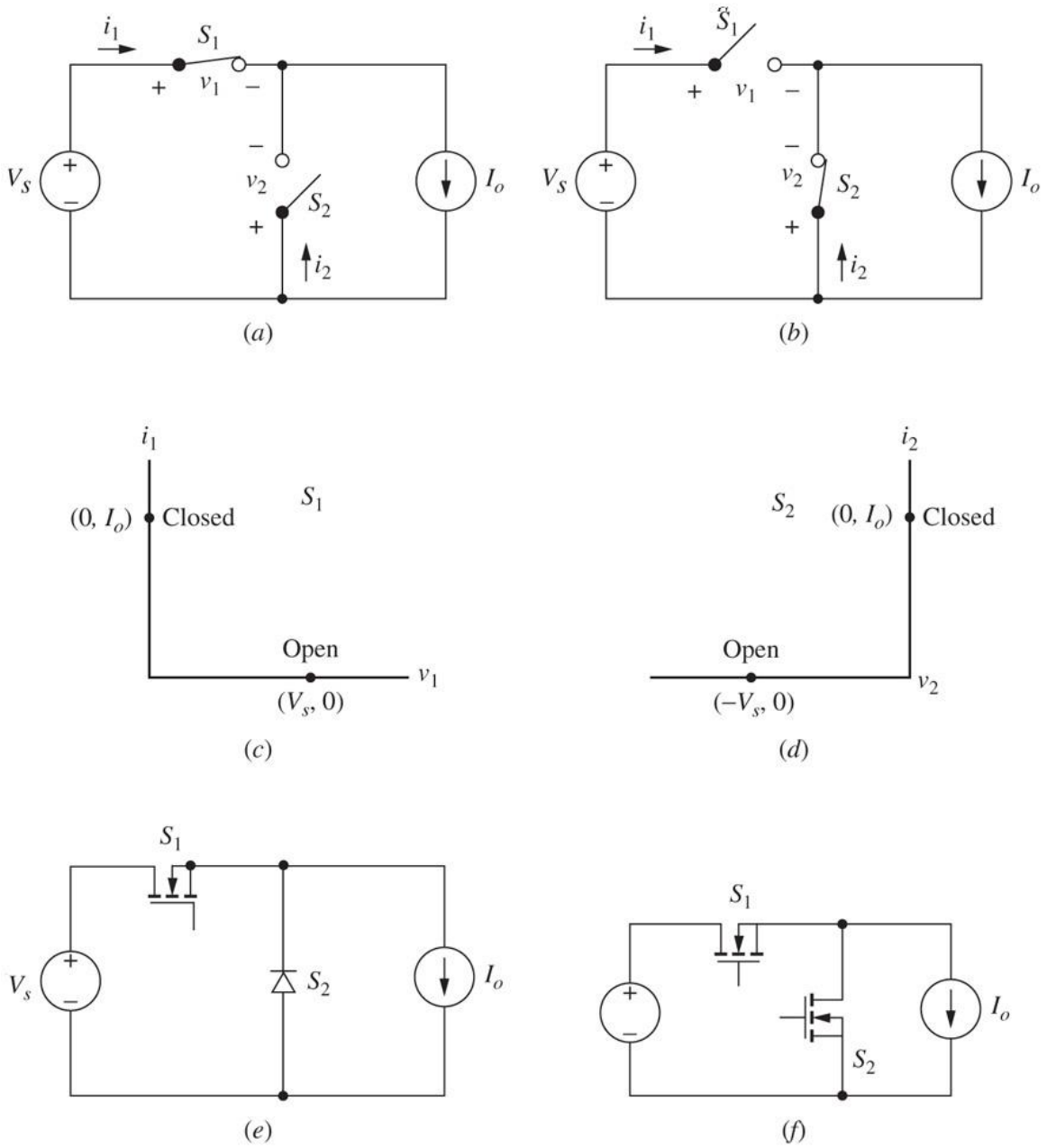


Figure 1.14

LTSpice: A voltage-controlled switch (Example 2)

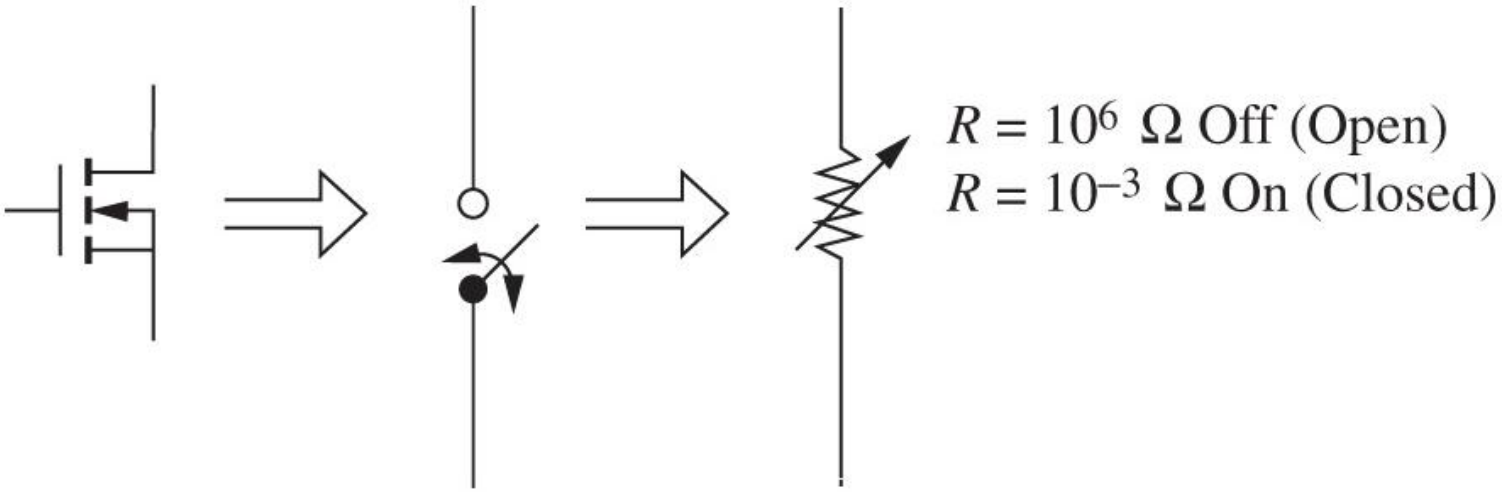


Figure 1.15a

A circuit using the voltage-controlled switch in LTSpice

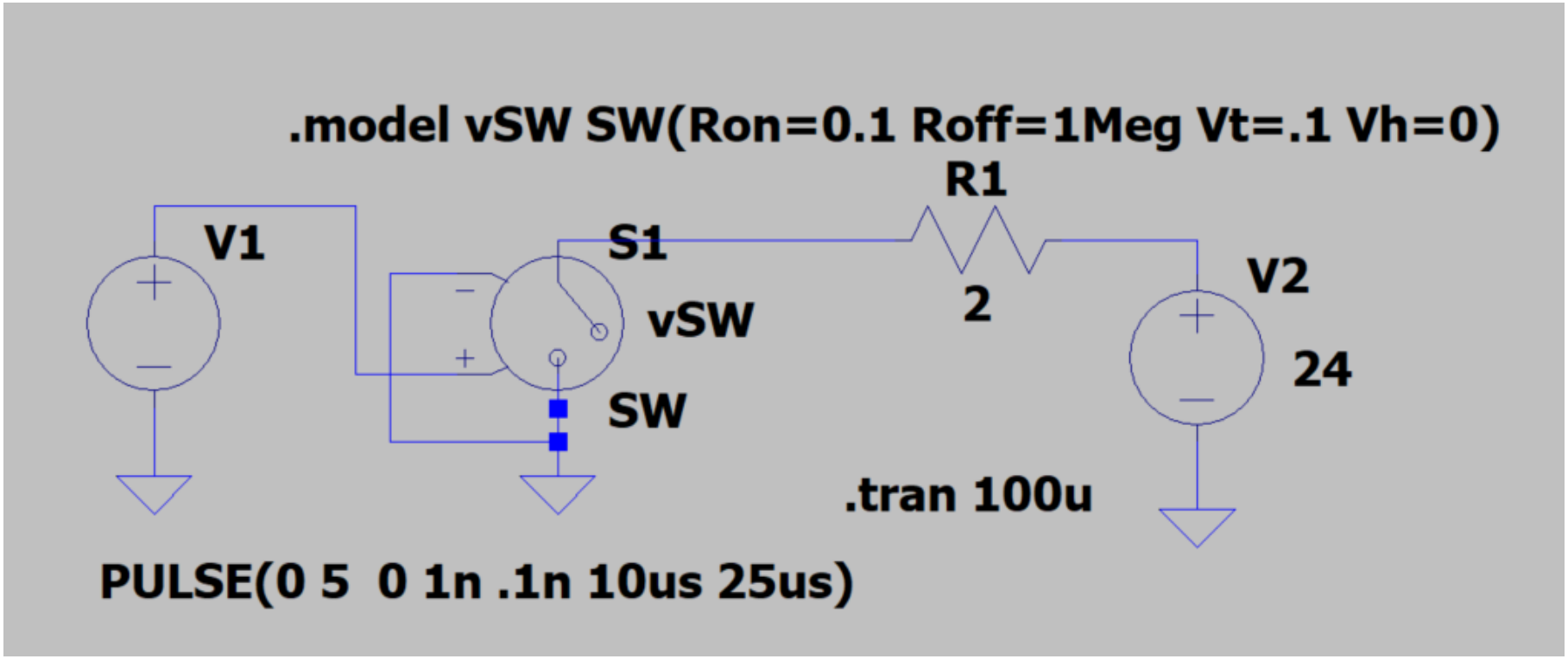


Figure 1.15d

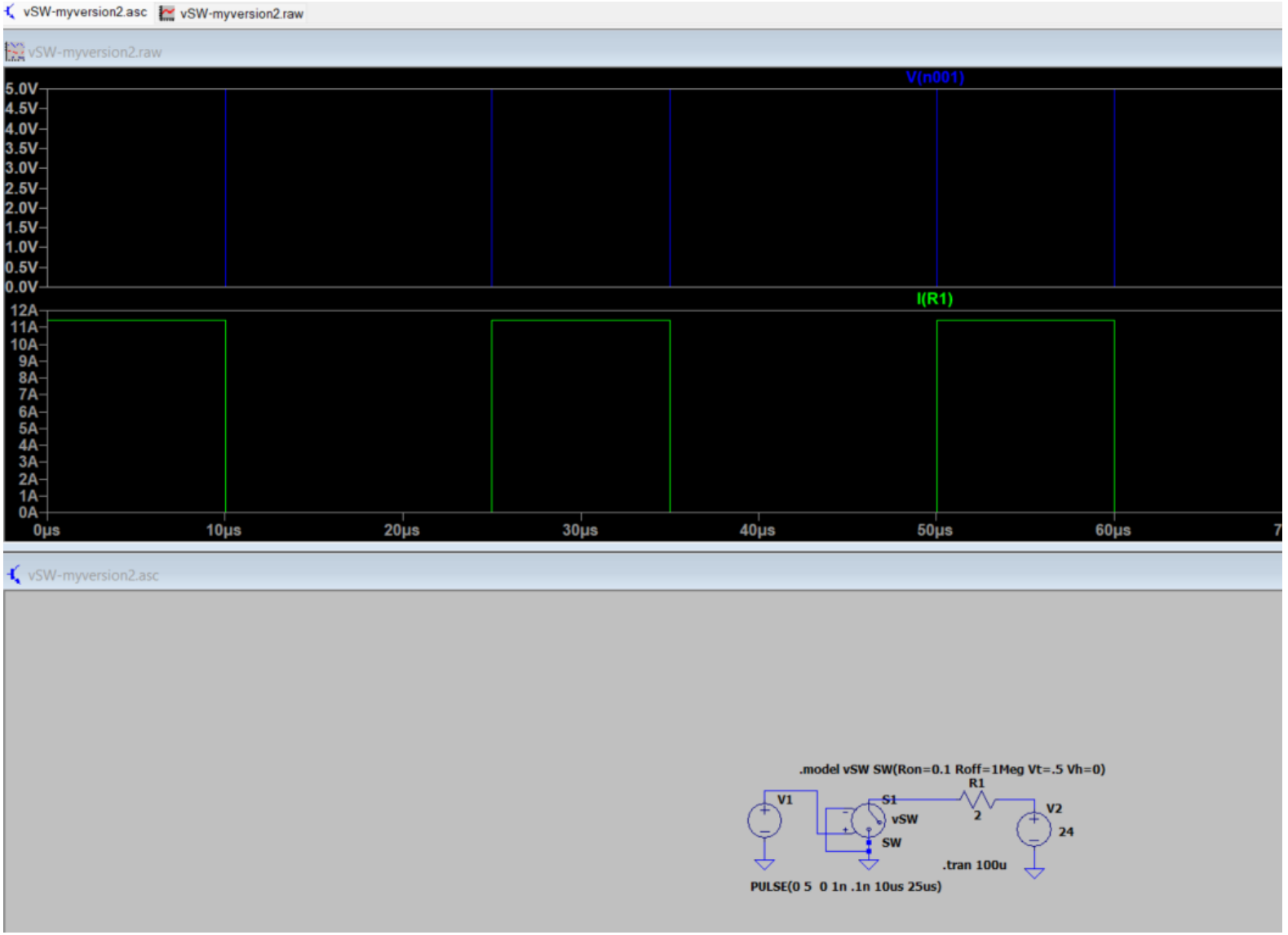


Figure 1.15a

A circuit using the voltage-controlled switch in LTSpice

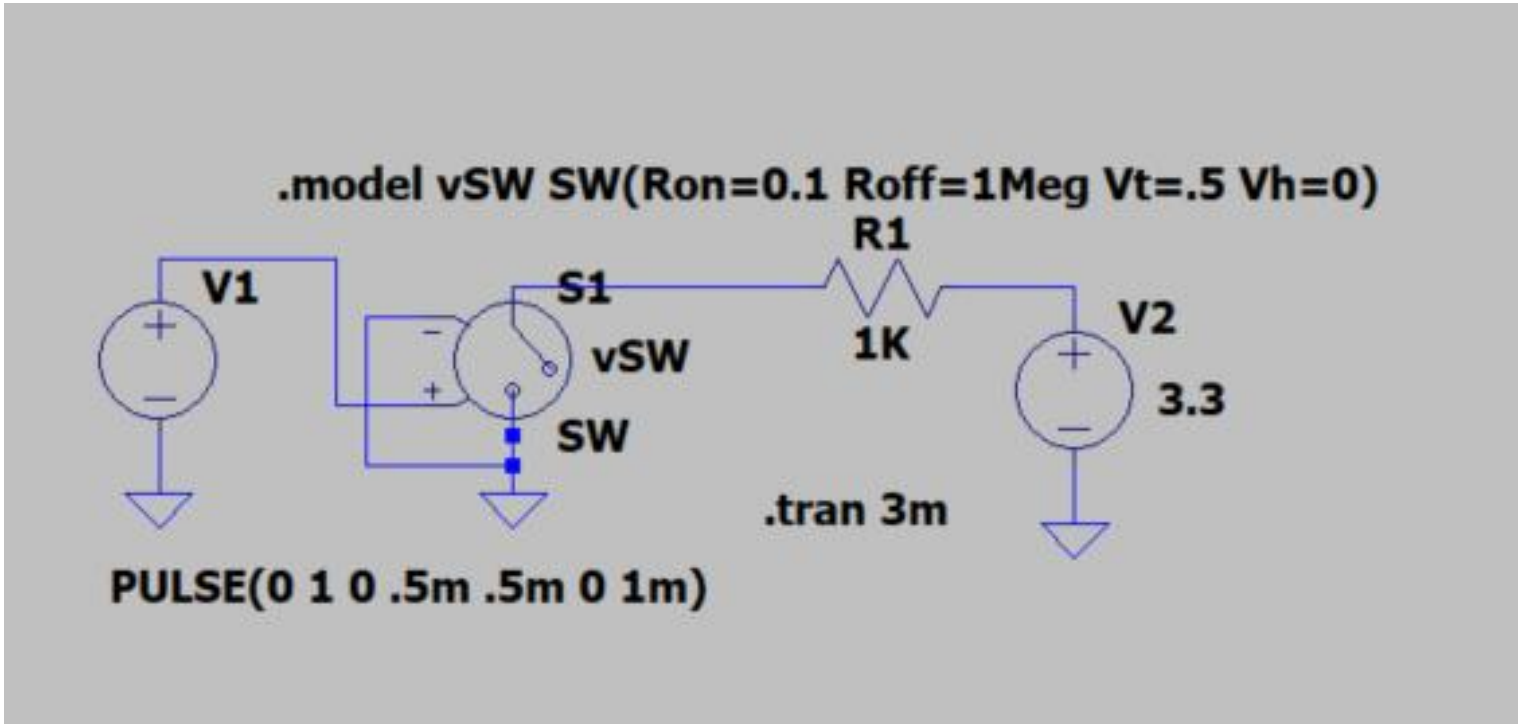


Figure 1.15d

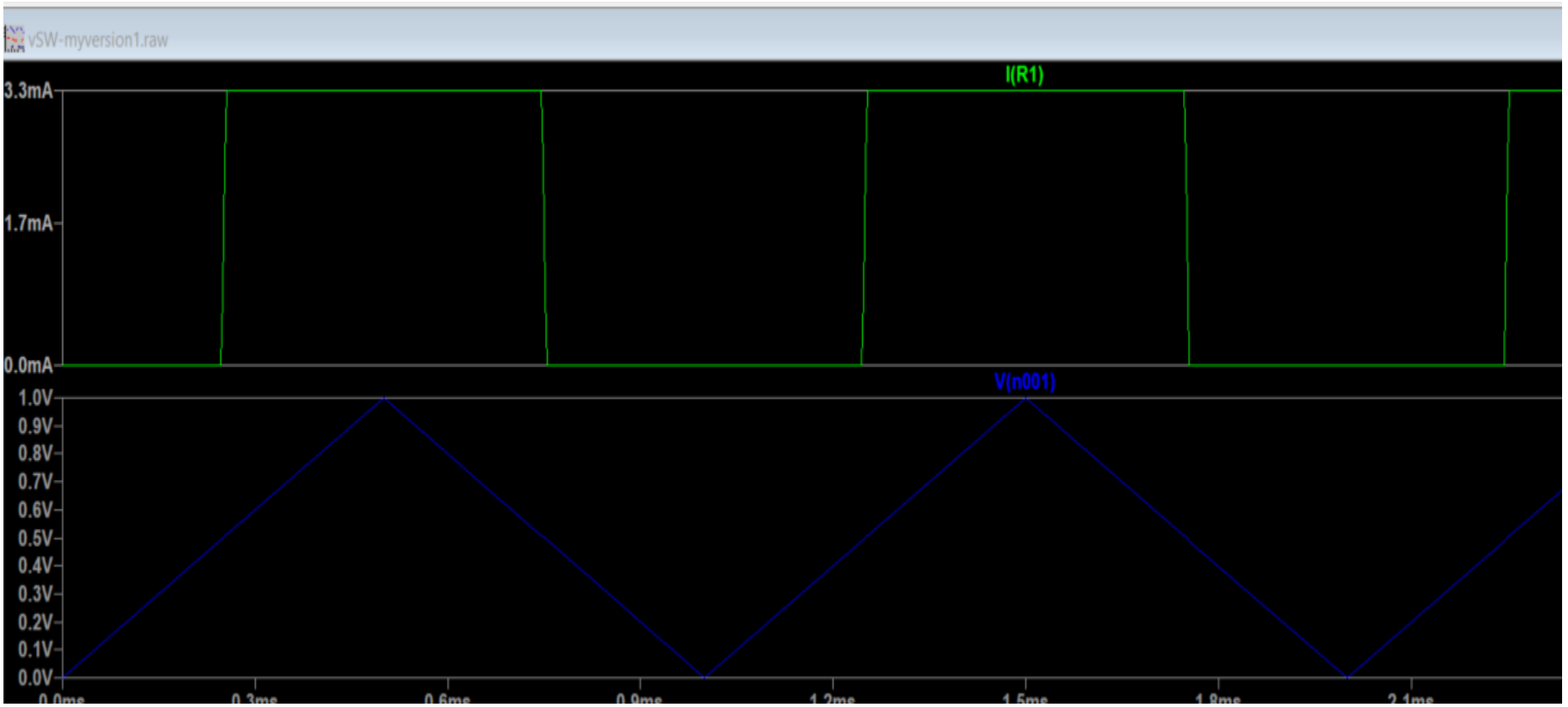
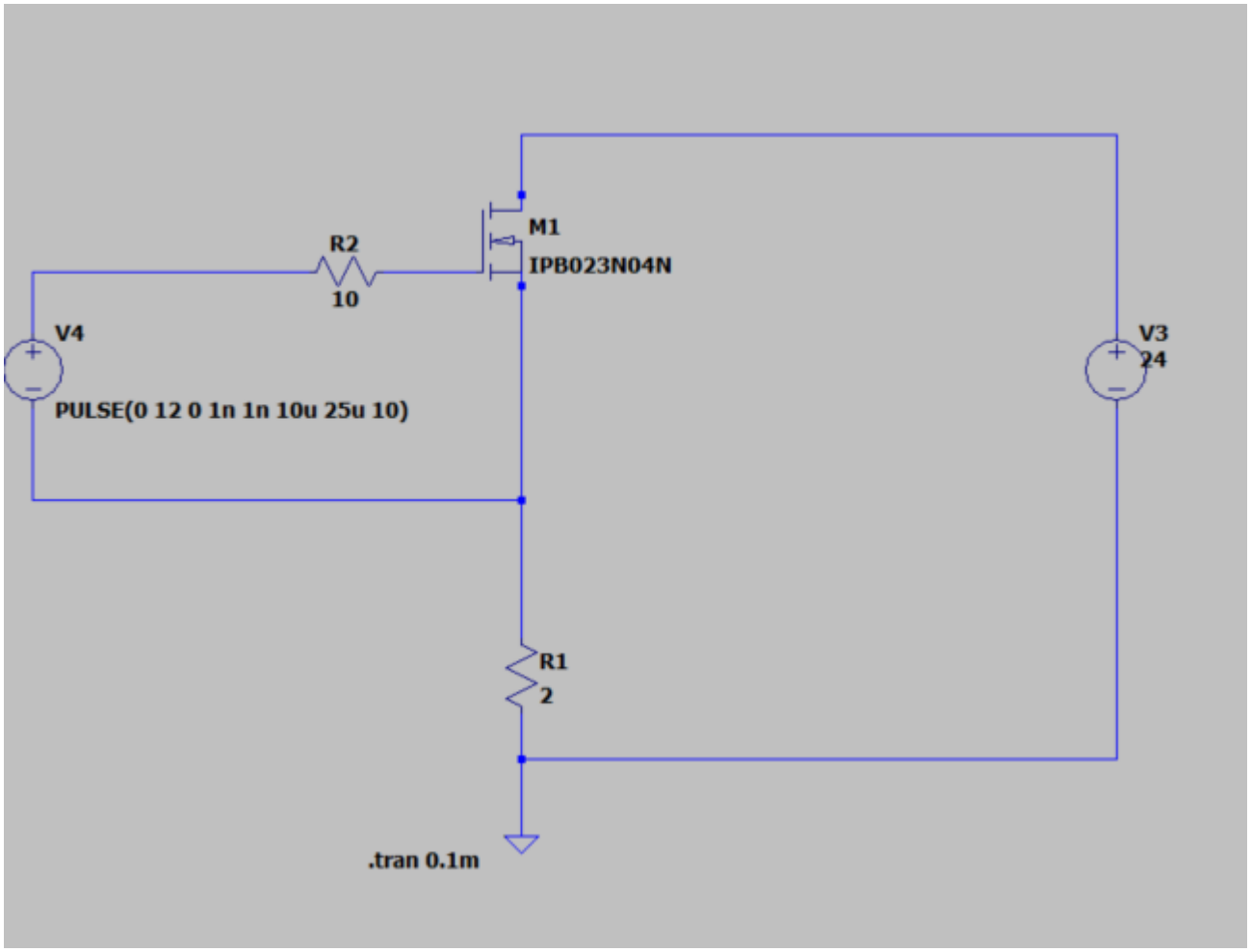


Figure 1.16

An idealized drive circuit for a MOSFET in LTSpice



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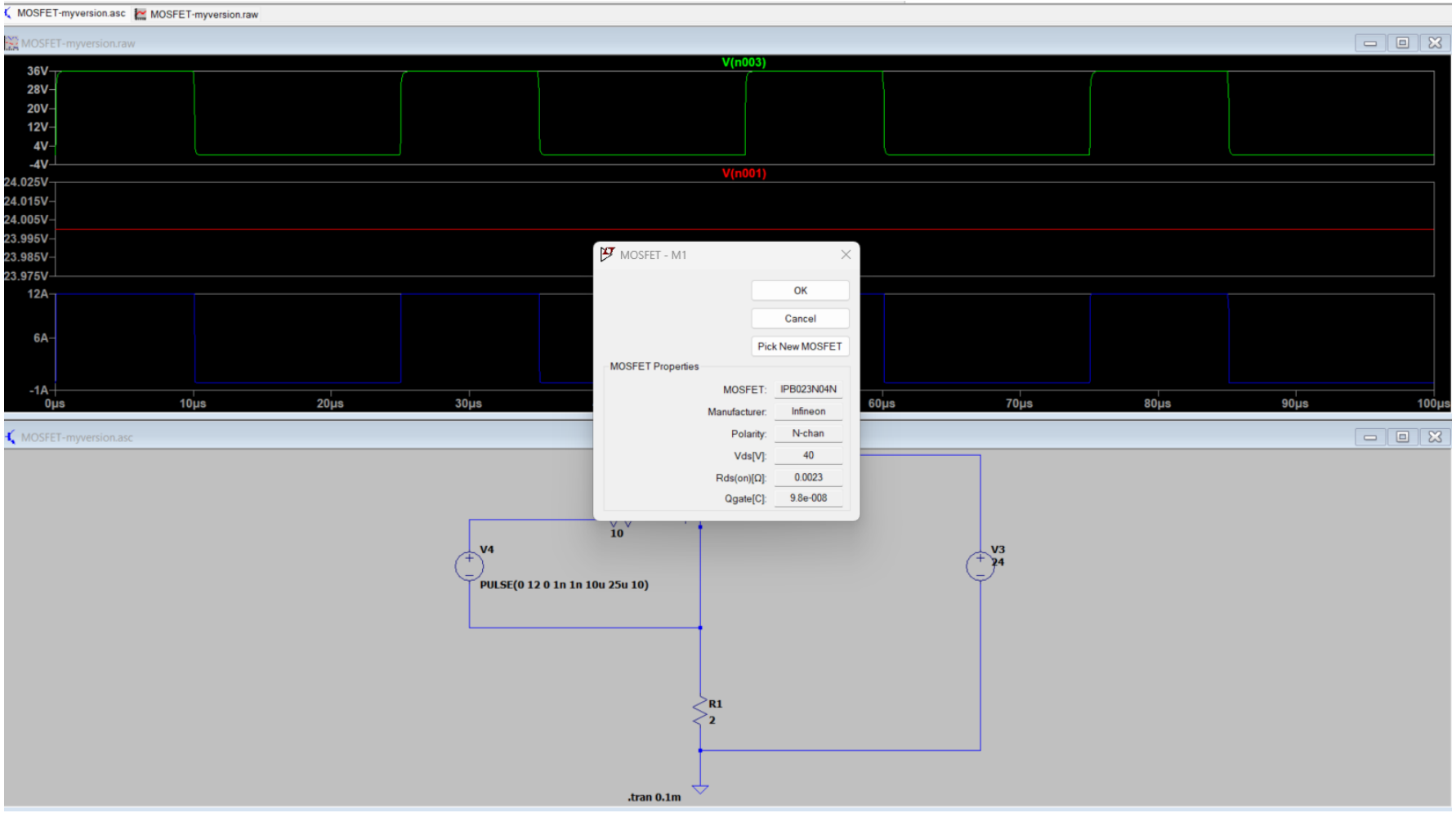

Figure 1.16

A Thyristor (SCR) in LTSpice

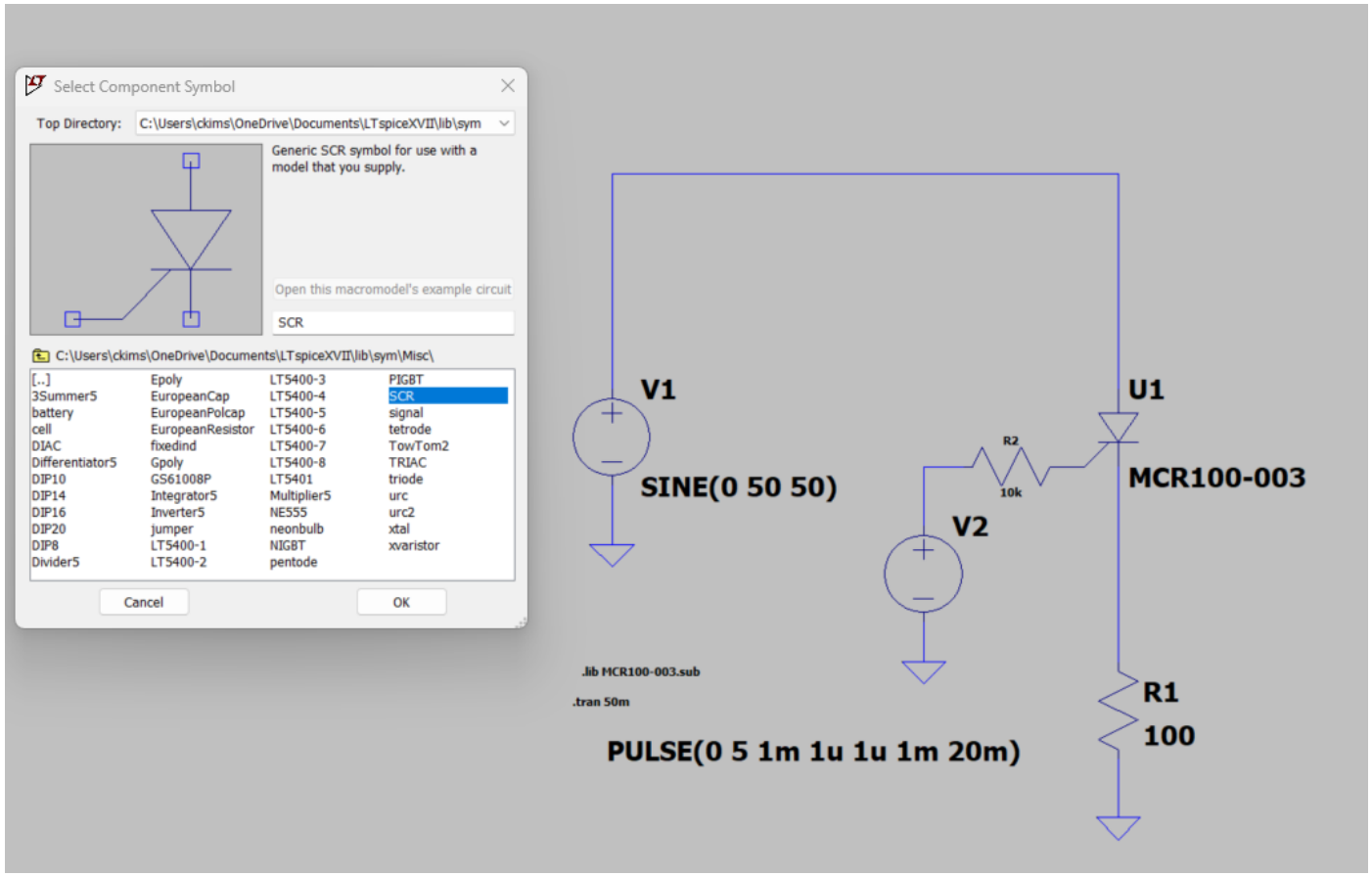

Figure 1.16

A Thyristor (SCR) in LTSpice

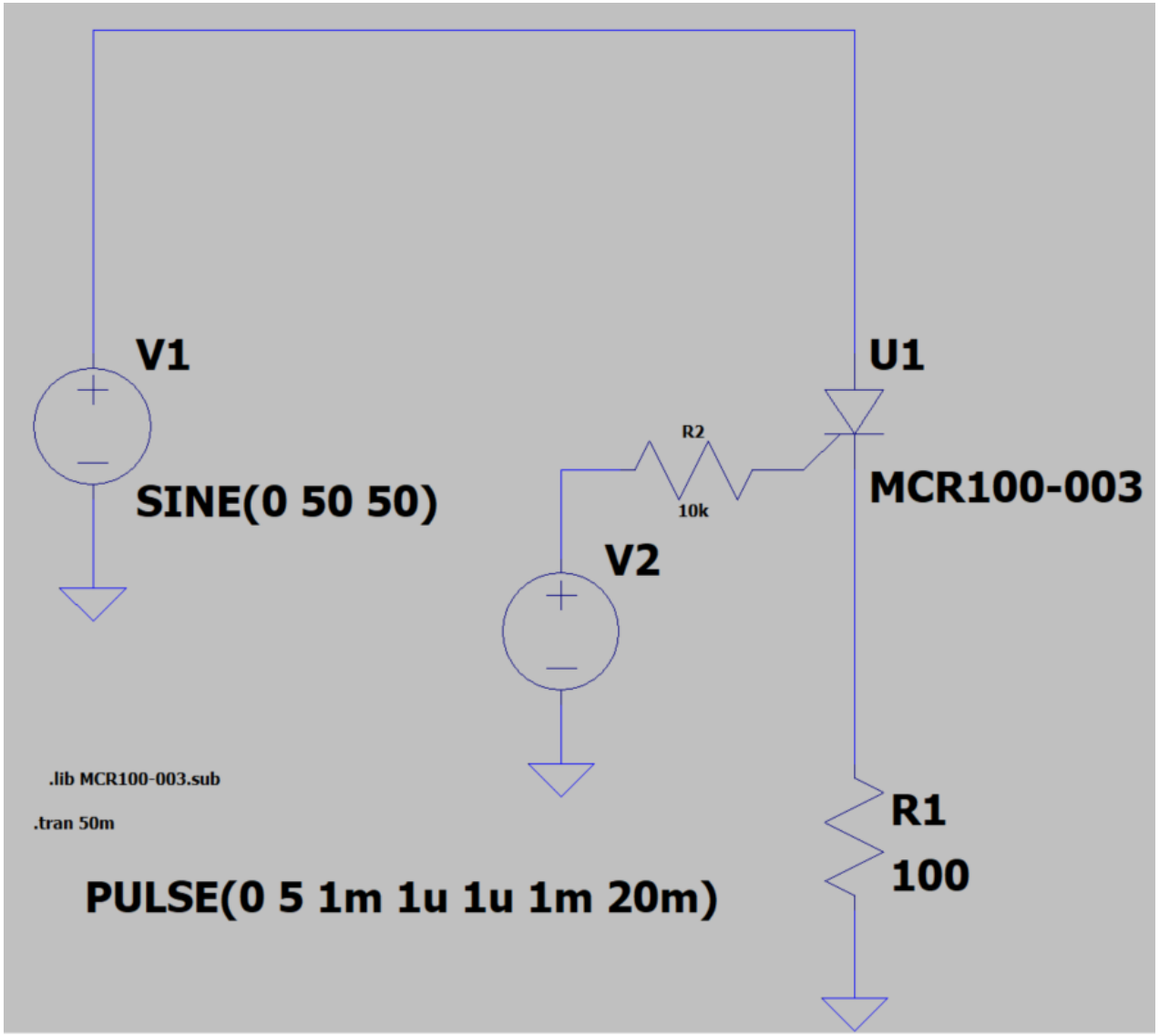

Figure 1.16

A Thyristor (SCR) in LTSpice