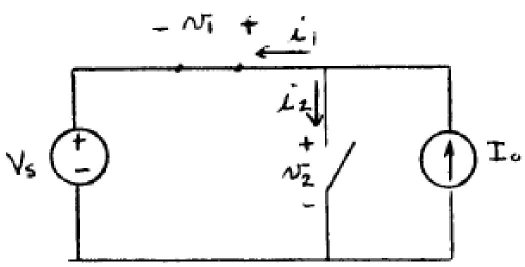
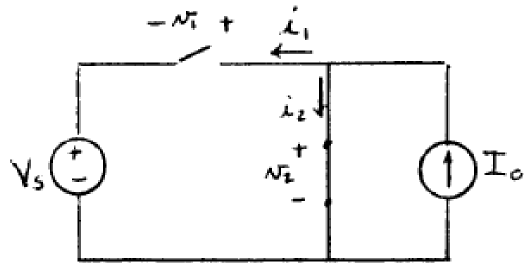
CHAPTER 1 SOLUTIONS

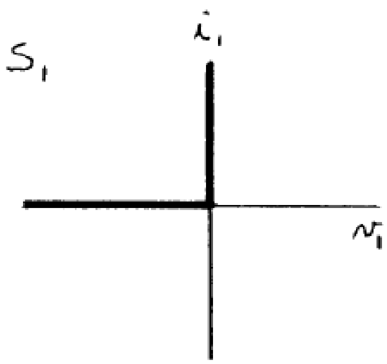
(1-1)



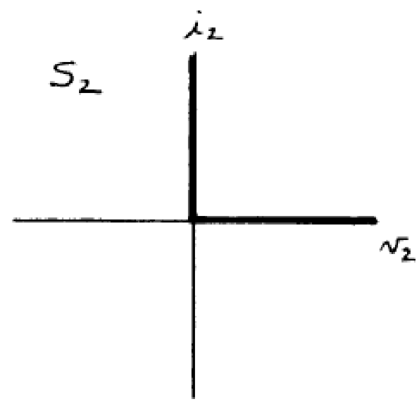
S_1: $i_1 = I_0 > 0$, $v_1 = 0$
S_2: $i_2 = 0$, $v_2 = V_s > 0$



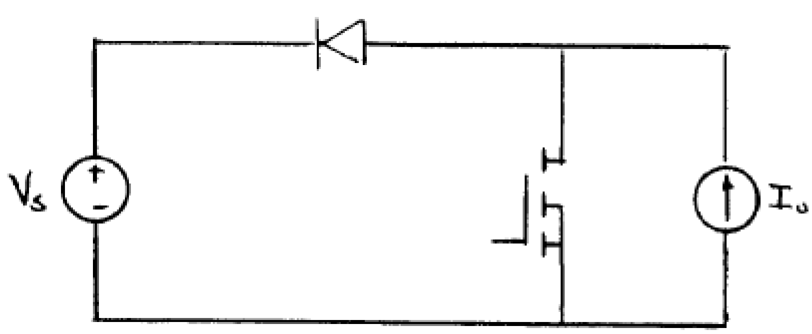
S_1: $i_1 = 0$, $v_1 = -V_s < 0$
S_2: $i_2 = I_0 > 0$, $v_2 = 0$



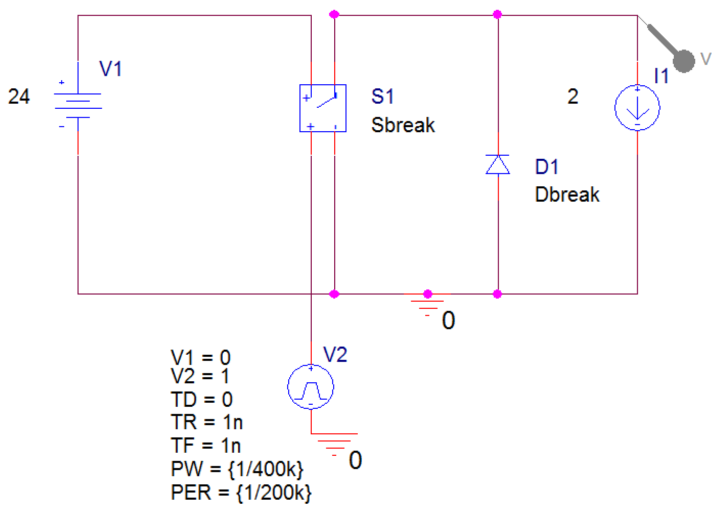
S1: Diode is sufficient

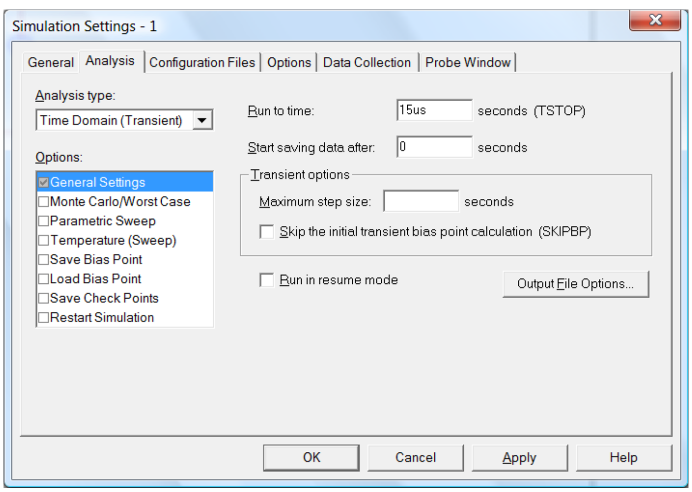


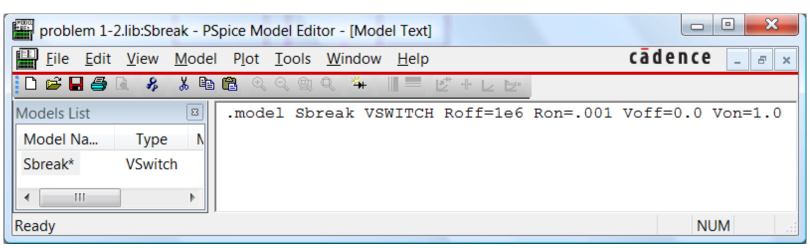
S2: Controlled device,
e.g., MOSFET

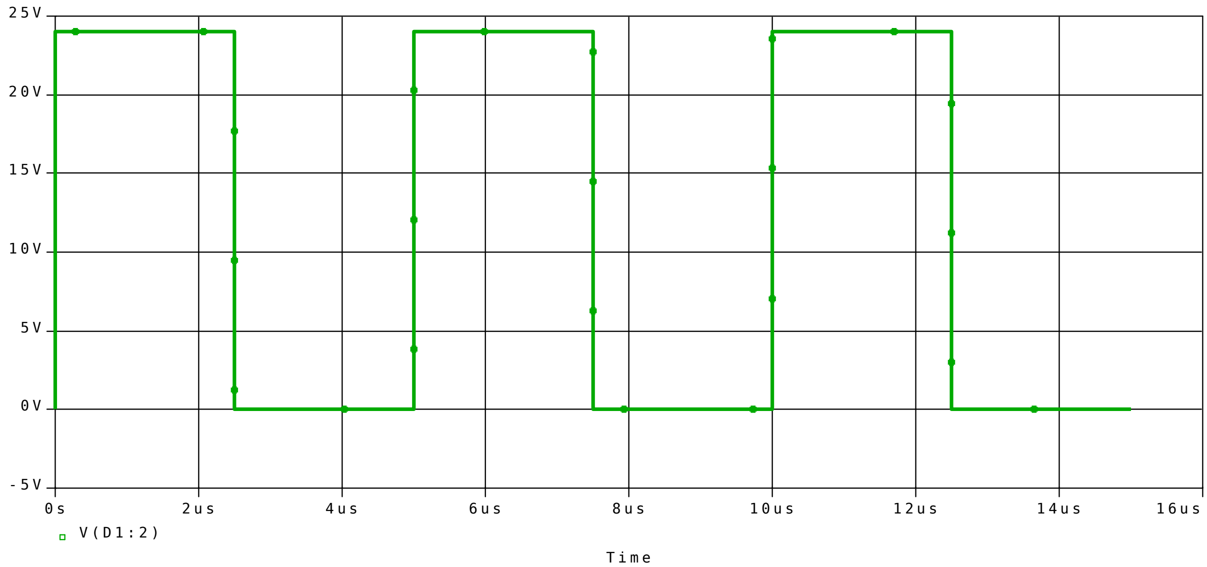


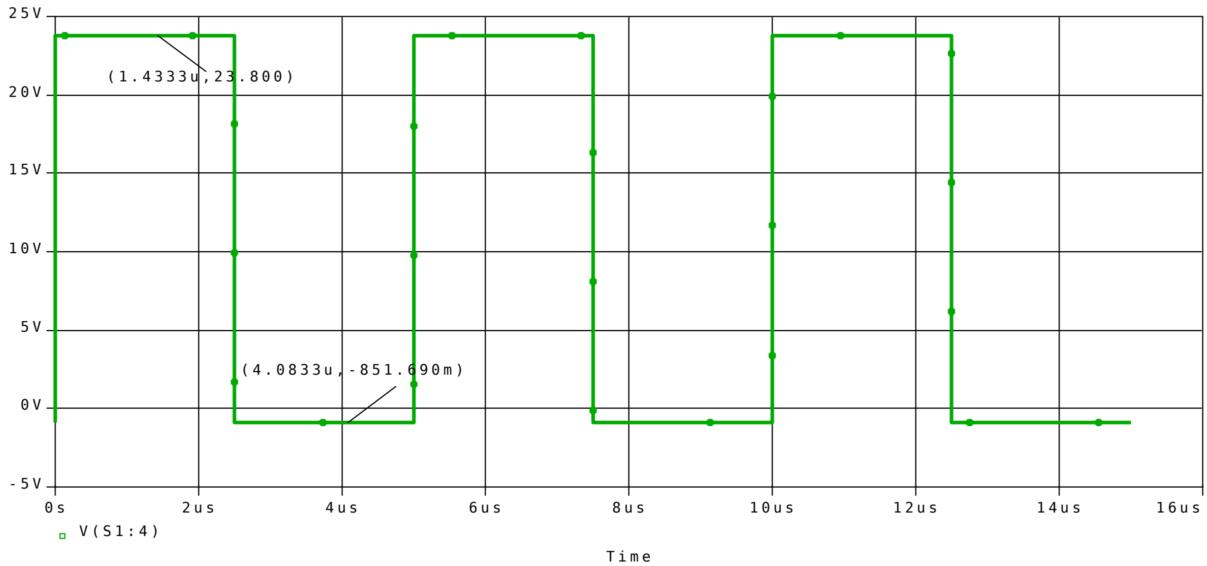
(1-2)


V1
24
S1
Sbreak
2
I1
V
D1
Dbreak
0
V2
V1 = 0
V2 = 1
TD = 0
TR = 1n
TF = 1n
PW = {1/400k}
PER = {1/200k}
0


Simulation Settings - 1
General
Analysis
Configuration Files
Options
Data Collection
Probe Window
Analysis type:
Time Domain (Transient)
Options:
General Settings
Monte Carlo/Worst Case
Parametric Sweep
Temperature (Sweep)
Save Bias Point
Load Bias Point
Save Check Points
Restart Simulation
Run to time:
15us
seconds (TSTOP)
Start saving data after:
0
seconds
Transient options
Maximum step size:
seconds
Skip the initial transient bias point calculation (SKIPBP)
Run in resume mode
Output File Options...
OK
Cancel
Apply
Help

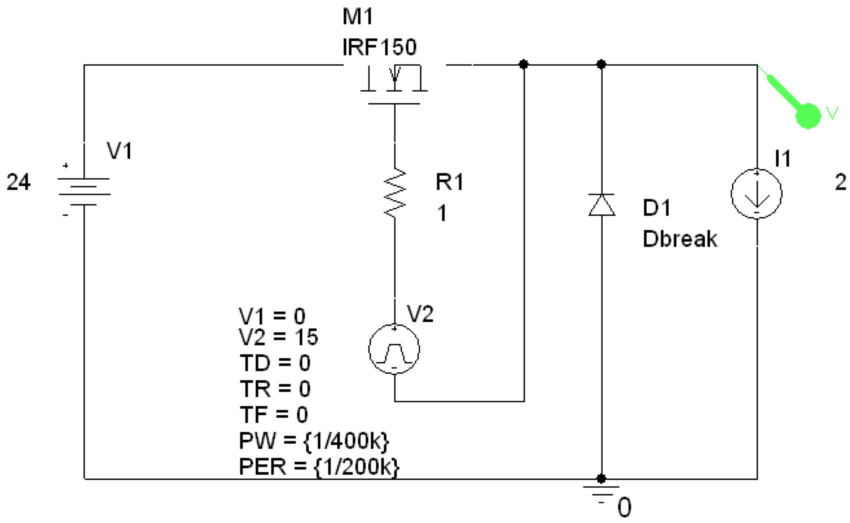

problem 1-2.lib:Sbreak - PSpice Model Editor - [Model Text]
File Edit View Model Plot Tools Window Help
cadence
Models List
Model Na...
Type
Sbreak*
VSwitch
.model Sbreak VSWITCH Roff=1e6 Ron=.001 Voff=0.0 Von=1.0
Ready
NUM

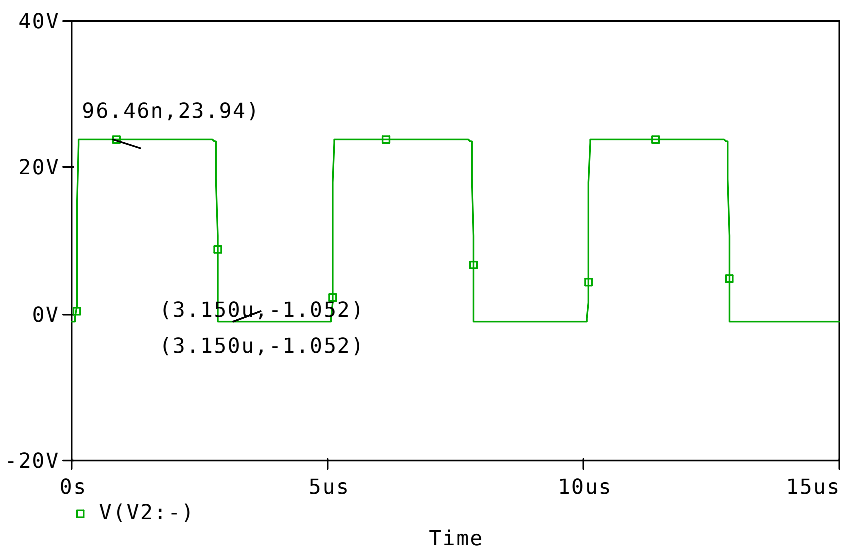




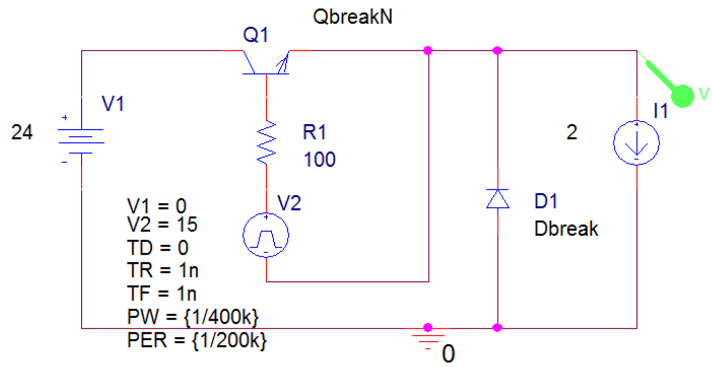
In part (b), the voltage across the current source is reduced from 24 V by the switch resistance and diode voltage drop.

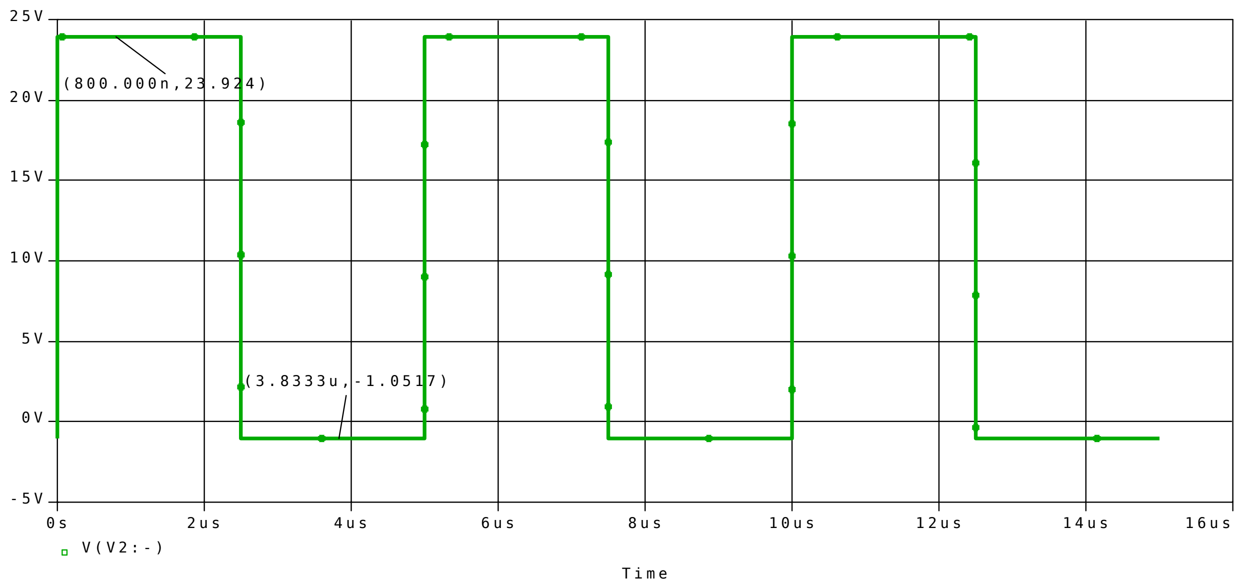
(1-3)


M1
IRF150
V1
24
R1
1
D1
Dbreak
I1
2
V2
V1 = 0
V2 = 15
TD = 0
TR = 0
TF = 0
PW = {1/400k}
PER = {1/200k}
0


40V
20V
0V
-20V
96.46n,23.94)
(3.150u,-1.052)
(3.150u,-1.052)
0s
5us
10us
15us
V(V2:-)
Time

(1-4)


QbreakN
Q1
V1
24
R1
100
V2
2
I1
D1
Dbreak
V1 = 0
V2 = 15
TD = 0
TR = 1n
TF = 1n
PW = {1/400k}
PER = {1/200k}
0


25V
20V
15V
10V
5V
0V
-5V
(800.000n,23.924)
(3.8333u,-1.0517)
0s
2us
4us
6us
8us
10us
12us
14us
16us
V(V2:-)
Time

CHAPTER 2 SOLUTIONS

2/21/10

2-1) Square waves and triangular waves for voltage and current are two examples.

2-2) a) $p(t) = v(t)i(t) = \frac{v^2(t)}{R} = \frac{[170\sin(377t)]^2}{10} = 2890\sin^2 377t\ W.$

b) peak power = 2890 W.

c) P = 2890/2 = 1445 W.

2-3)

v(t) = 5sin2πt V.

a) 4sin2πt A.; p(t) = v(t)i(t) = 20 $\sin^2$2πt W.; P = 10 W.

b) 3sin4πt A.; p(t) = 15sin(2πt)sin(4πt) W.; P = 0

2-4) a)

$$p(t) = v(t)i(t) = \begin{cases} 0 & 0 < t < 50\,ms \\ 40 & 50\,ms < t < 70\,ms \\ 0 & 70\,ms < t < 100\,ms \end{cases}$$

b)

$$P = \frac{1}{T}\int_0^T v(t)i(t)\,dt = \frac{1}{100\,ms}\int_{50ms}^{70ms} 40\,dt = 8.0\ W.$$

c)

$$W = \int_0^T p(t)\,dt = \int_{50ms}^{70ms} 40\,dt = 800\ mJ.; \quad or \quad W = PT = (8W)(100\,ms) = 800\ mJ.$$

2-5) a)

$$p(t) = v(t)i(t) = \begin{cases} 70\ W. & 0 < t < 6\,ms \\ -50\ W. & 6\,ms < t < 10\,ms \\ 40\ W. & 10\,ms < t < 14\,ms \\ 0 & 14\,ms < t < 20\,ms \end{cases}$$

b)

$$P = \frac{1}{T}\int_0^T p(t)\,dt = \frac{1}{20\,ms}\left[\int_0^{6ms} 70\,dt + \int_{6ms}^{10ms}(-50)\,dt + \int_{10ms}^{14ms} 40\,dt\right] = 19\ W.$$

c)

$$W = \int_0^T p(t)\,dt = \left[\int_0^{6ms} 70\,dt + \int_{6ms}^{10ms} (-50)\,dt + \int_{10ms}^{14ms} 40\,dt \right] = 0.38\ J.;$$

$$or \quad W = PT = (19)(20\,ms) = 380\ mJ.$$

2-6)

$$P = V_{dc} I_{avg}$$

$$a)\quad I_{avg} = 2\ A., \quad P = (12)(2) = 24\ W.$$

$$b)\quad I_{avg} = 3.1\ A., \quad P = (12)(3.1) = 37.2\ W.$$

2-7)

a)

$$v_R(t) = i(t)R = 25\sin 377t\ V.$$

$$p(t) = v(t)i(t) = (25\sin 377t)(1.0\sin 377t) = 25\sin^2 377t = 12.5(1 - \cos 754t)\ W.$$

$$P_R = \frac{1}{T}\int_0^T p(t)\,dt = 12.5\ W.$$

b)

$$v_L(t) = L\frac{di(t)}{dt} = 10(10)^{-3}(377)(1.0)\cos 377t = 3.77\cos 377t\ V.$$

$$p_L(t) = v(t)i(t) = (3.77\cos 377t)(1.0\sin 377t) = \frac{(3.77)(1.0)}{2}\sin 754t = 1.89\sin 754t\ W.$$

$$P_L = \frac{1}{T}\int_0^T p(t)\,dt = 0$$

c)

$$p(t) = v(t)i(t) = (12)(1.0\sin 377t) = 12\sin 377t\ W.$$

$$P_{dc} = \frac{1}{T}\int_0^T p(t)\,dt = 0$$

2-8) Resistor:

$$v(t) = i(t)R = 8 + 24\sin 2\pi 60t \; V.$$

$$p(t) = v(t)i(t) = (8 + 24\sin 2\pi 60t)(2 + 6\sin 2\pi 60t)$$

$$= 16 + 96\sin 2\pi 60t + 144\sin^2 2\pi 60t \; W.$$

$$P = \frac{1}{T}\int_0^T p(t)\,dt = \frac{1}{1/60}\left[\int_0^{1/60} 16\,dt + \int_0^{1/60} 96\sin 2\pi 60t\,dt + \int_0^{1/60} 144\sin^2 2\pi 60t\right]$$

$$= 16 + 72 = 88 \; W.$$

Inductor: $P_L = 0.$

dc source: $P_{dc} = I_{avg}V_{dc} = (2)(6) = 12 \; W.$

2-9) a) With the heater on,

$$P = \frac{V_m I_m}{2} = 1500 \; W. \;\rightarrow\; I_m = \frac{(1500)(2)}{120\sqrt{2}} = 12.5\sqrt{2}$$

$$p(t) = V_m I_m \sin^2 \omega t = \left(120\sqrt{2}\right)\left(12.5\sqrt{2}\right)\sin^2 \omega t = 3000\sin^2 \omega t$$

$$\max\left(p(t)\right) = 3000 \; W.$$

b) P = 1500(5/12) = 625 W.
c) W = PT = (625 W)(12 s) = 7500 J. (or 1500(5) = 7500 W.)

2-10)

$$i_L(t) = \frac{1}{L}\int v_L(t)\,dt = \frac{1}{0.1}\int_0^t 90\,d\lambda = 900t \qquad 0 < t < 4\,ms.$$

$$i_L(4\,ms) = (900)(4)(10)^{-3} = 3.6 \; A.$$

a)

$$W = \frac{1}{2}Li^2 = \frac{1}{2}(0.1)(3.6)^2 = 0.648 \; J.$$

b) All stored energy is absorbed by R: W_R = 0.648 J.

c)

$$P_R = \frac{W_R}{T} = \frac{0.648}{40\,ms} = 16.2 \; W.$$

$$P_S = P_R = 16.2 \; W.$$

d) No change in power supplied by the source: 16.2 W.
