INTRODUCTORY LTSPICE SIMULATIONS

ENERGY HARVESTING

EH-202420

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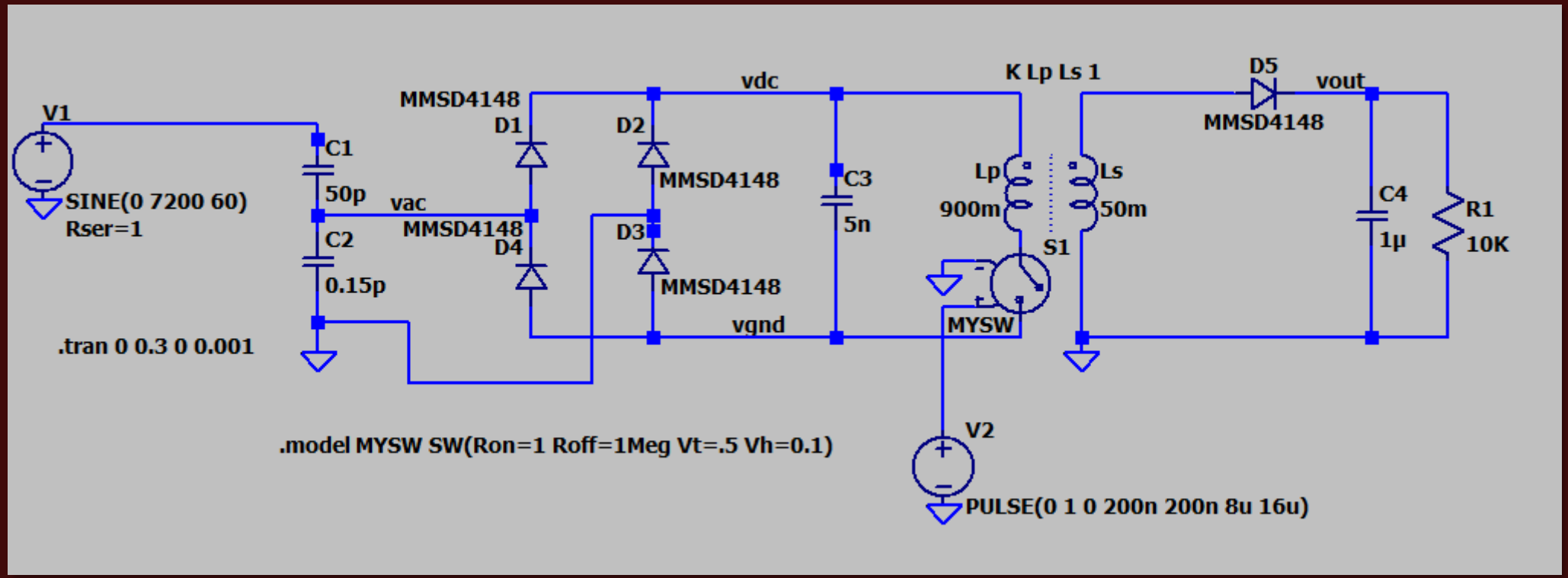
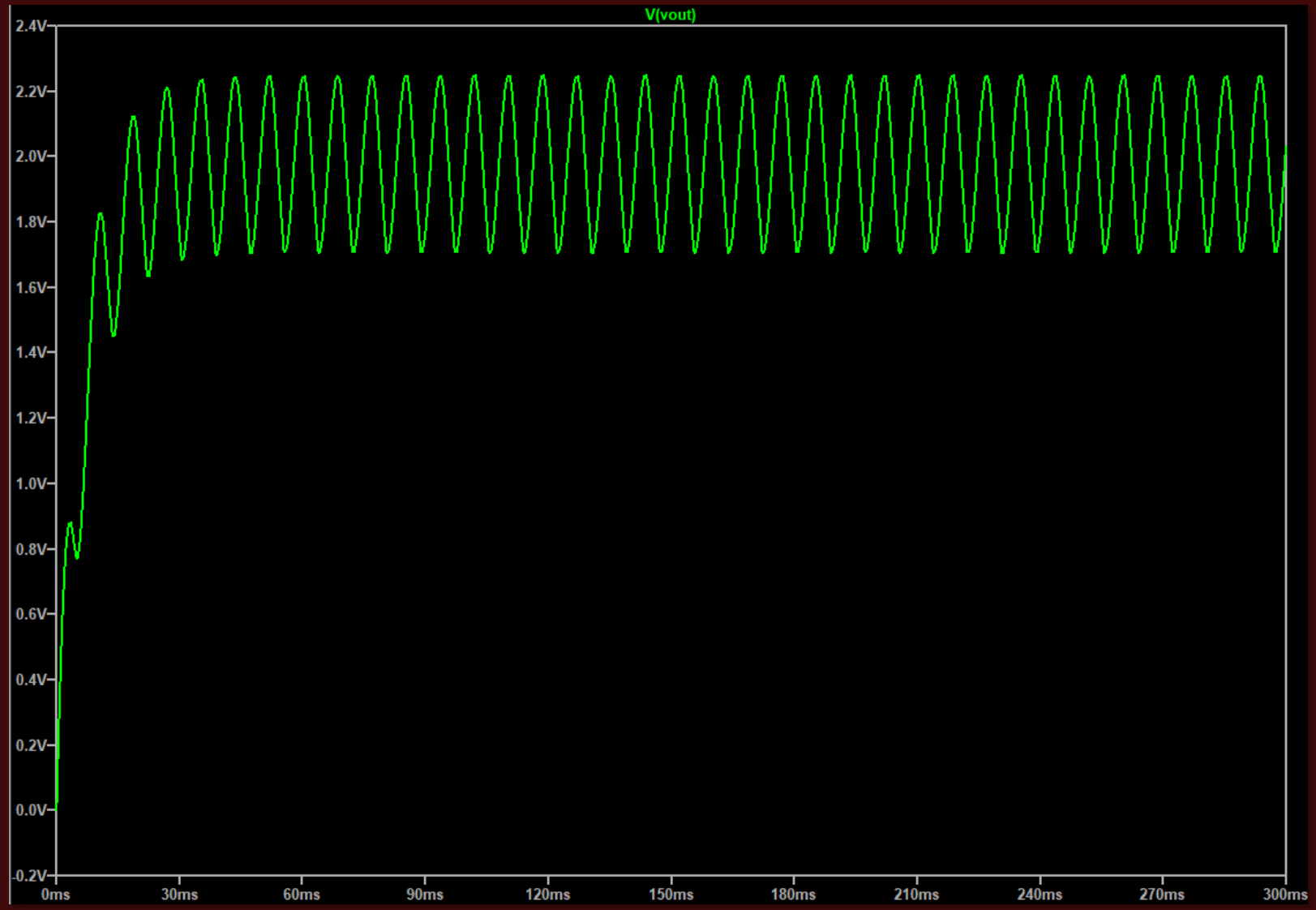
Circuit I - Schematic

- Switching element on bottom of primary coil, 50% duty cycle.

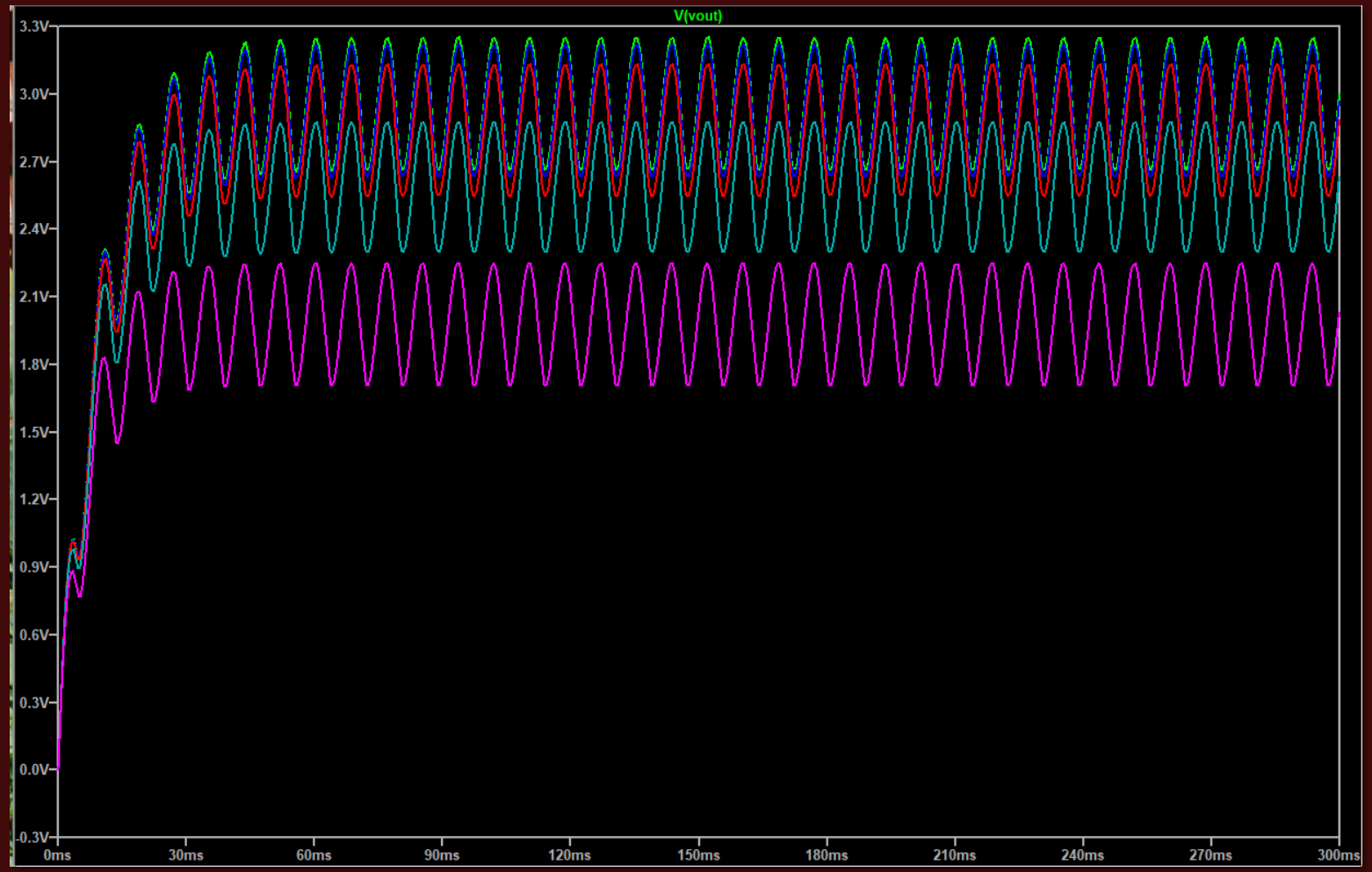


Circuit I - Waveforms



Circuit I – Waveforms (cont.)

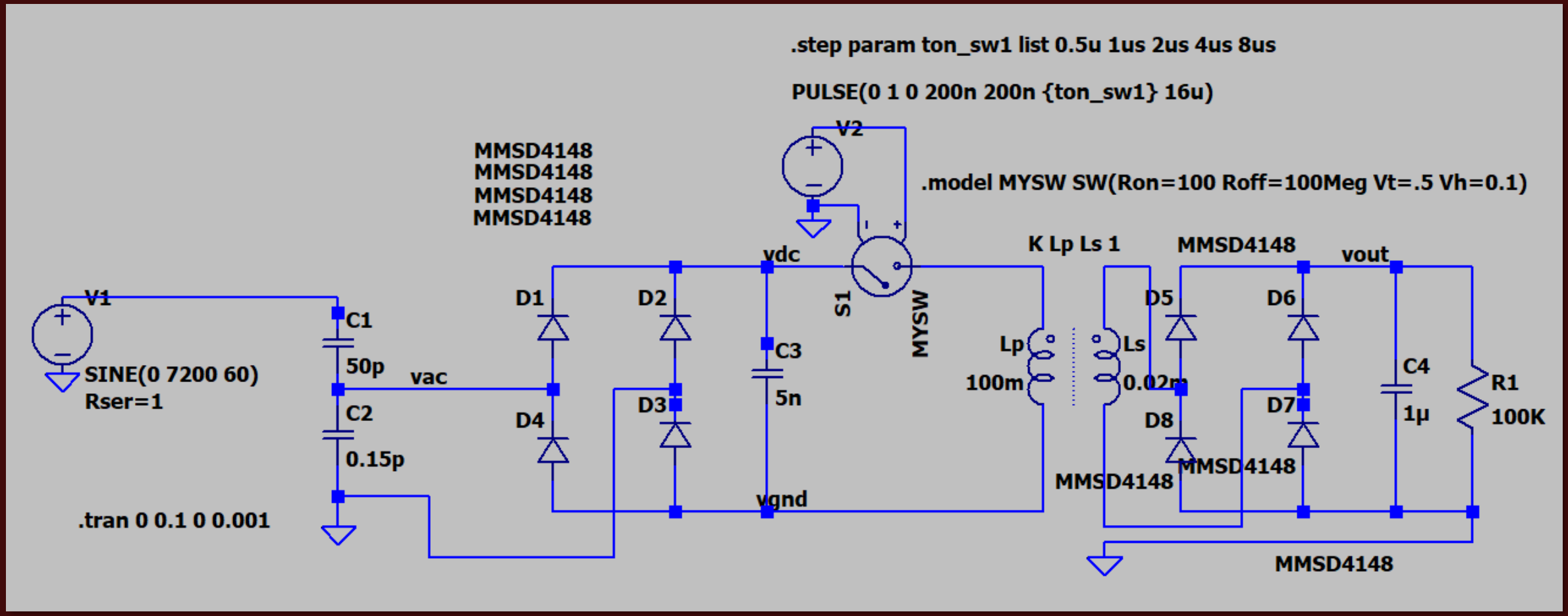
Doing a parametric sweep of the switching element’s on-time, i.e. a sweep of duty cycle.



Increasing Duty Cycle

Circuit II - Schematic

- Switching element on top of primary coil, 3.125% duty cycle.
- Second rectifier on secondary side.
- After 100ms, V_L=46.65V, I_L=466.5µA → P_L=21.7mW (Spot on with 2nd paper.)



Circuit II - Waveforms

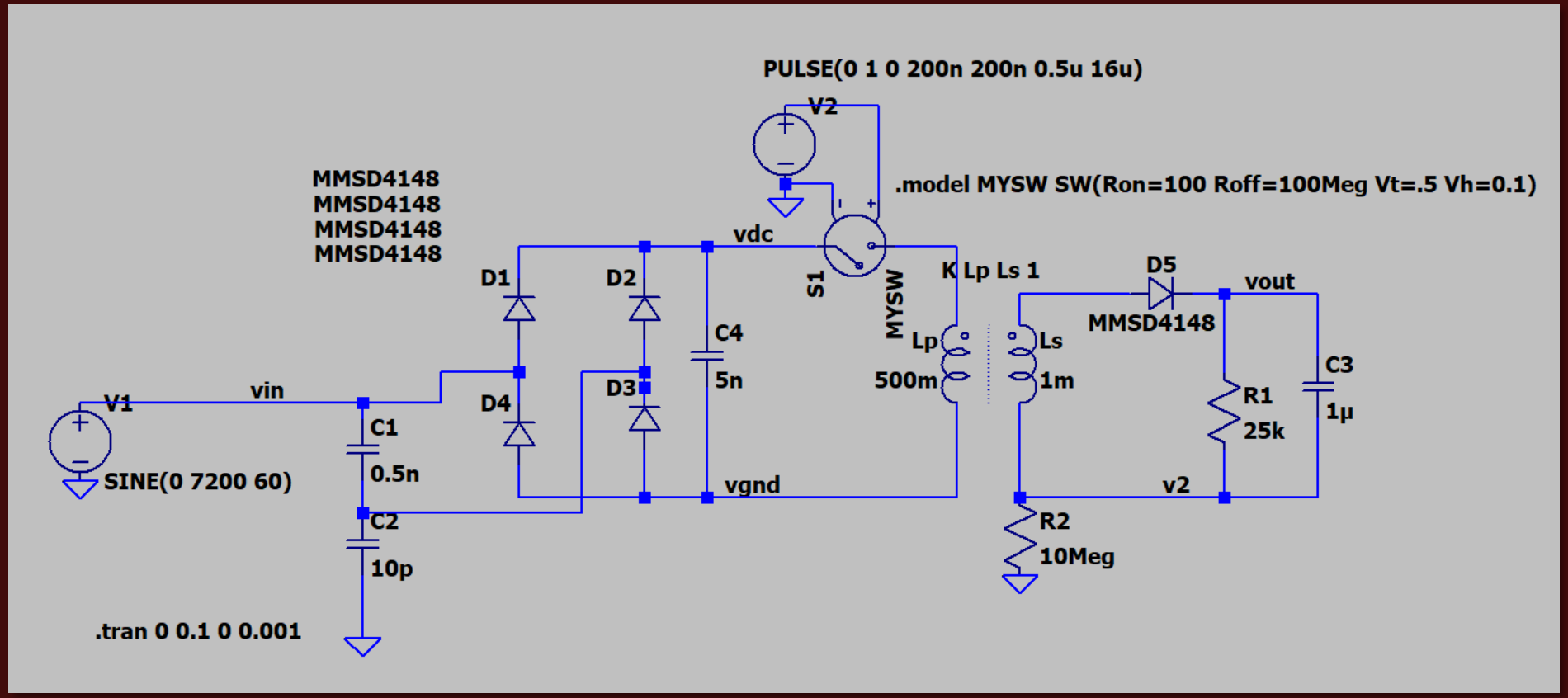
A more effective parametric sweep of switching duty cycle.

Smaller duty cycles increase power extraction.

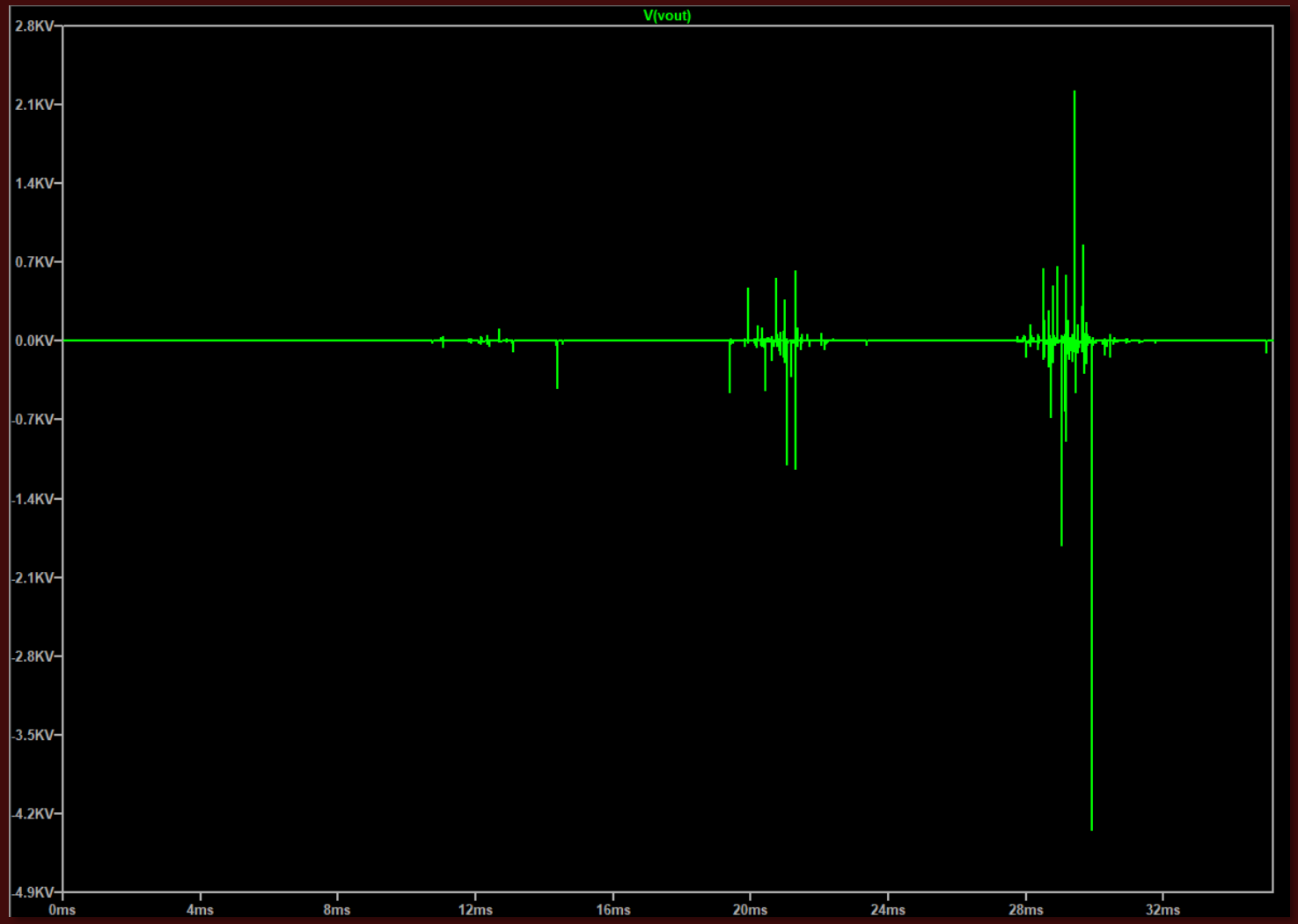
Circuit III - Schematic

- Zangl Topology: Taking PWS input off C1 (Harvester Capacitance)

- Much harder to get clean simulations.



Circuit III - Waveforms

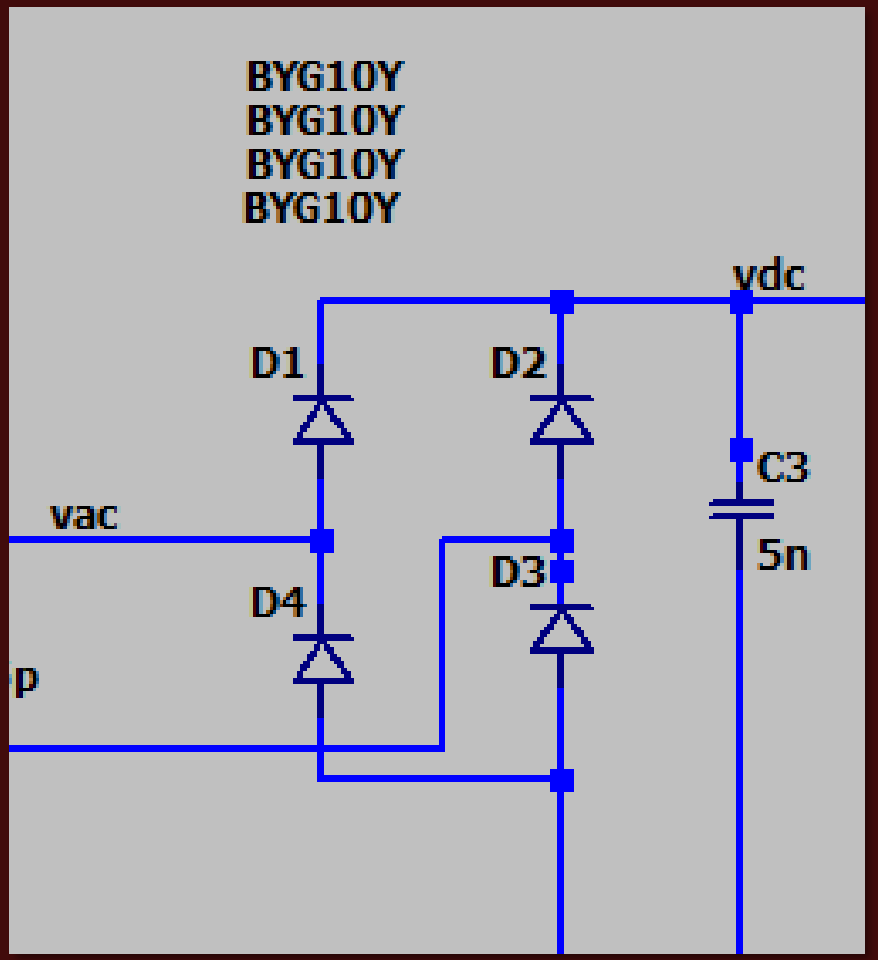


Circuit III - Waveforms

- Increasing C_1=35nF:
  - V_{out}=1.91mV
  - I_L=75.95nA
  - P_{out}=145pW

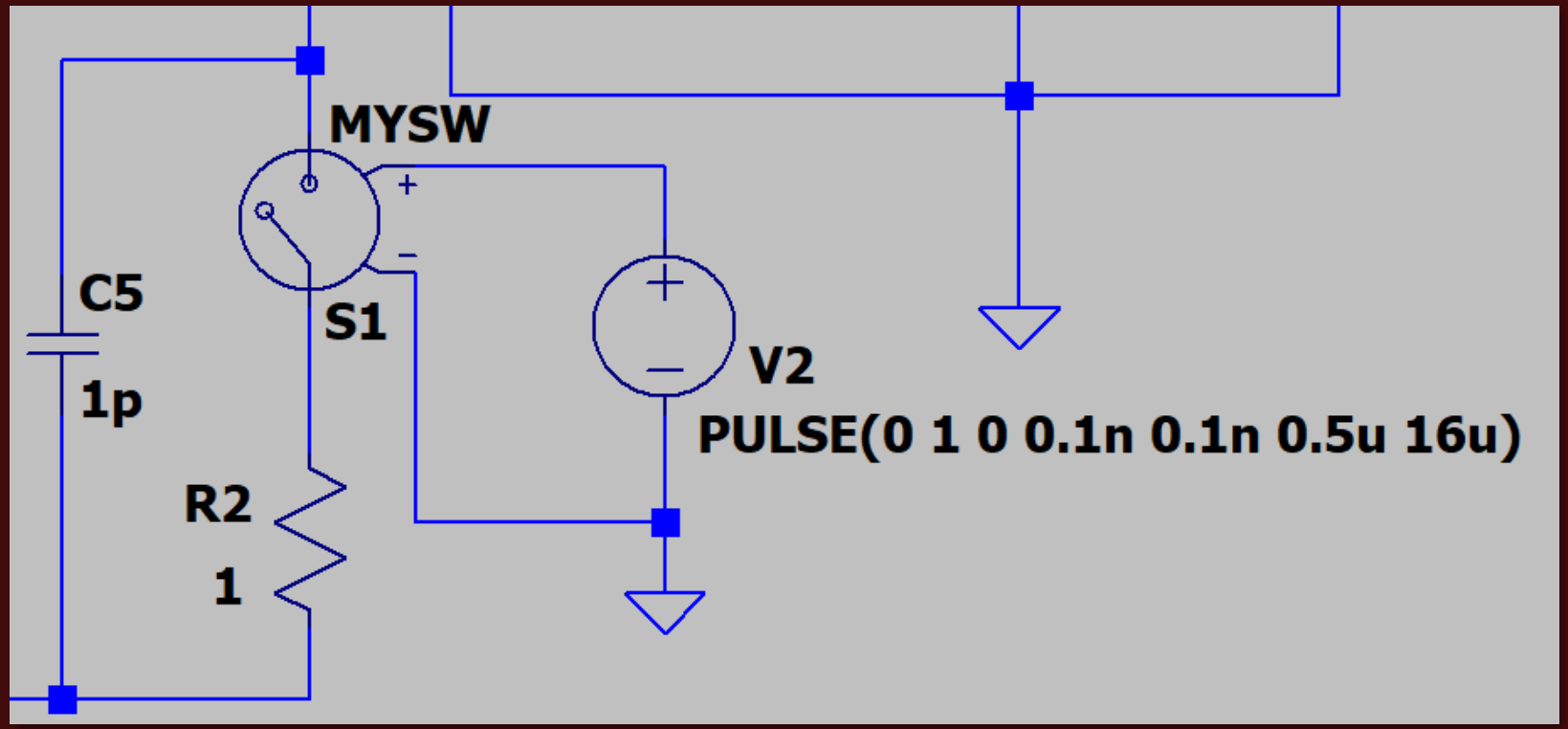
MODELLING COMPONENTS: Rectifier Diodes

Following Rodriguez, we added the BYG10Y rectifier diodes rated for $1600V_{peak}$ reverse.



MODELLING COMPONENTS: NMOS

Drain-Source Resistance and Capacitance modelled for Wolfspeed C2M1000170 NMOS (V_{DS}=1700V).



EH-202420 - SEC
ECE495E - ELECTRIC FIELD ENERGY HARVESTER

MODELS / SUBCIRCUITS

Switch Model:

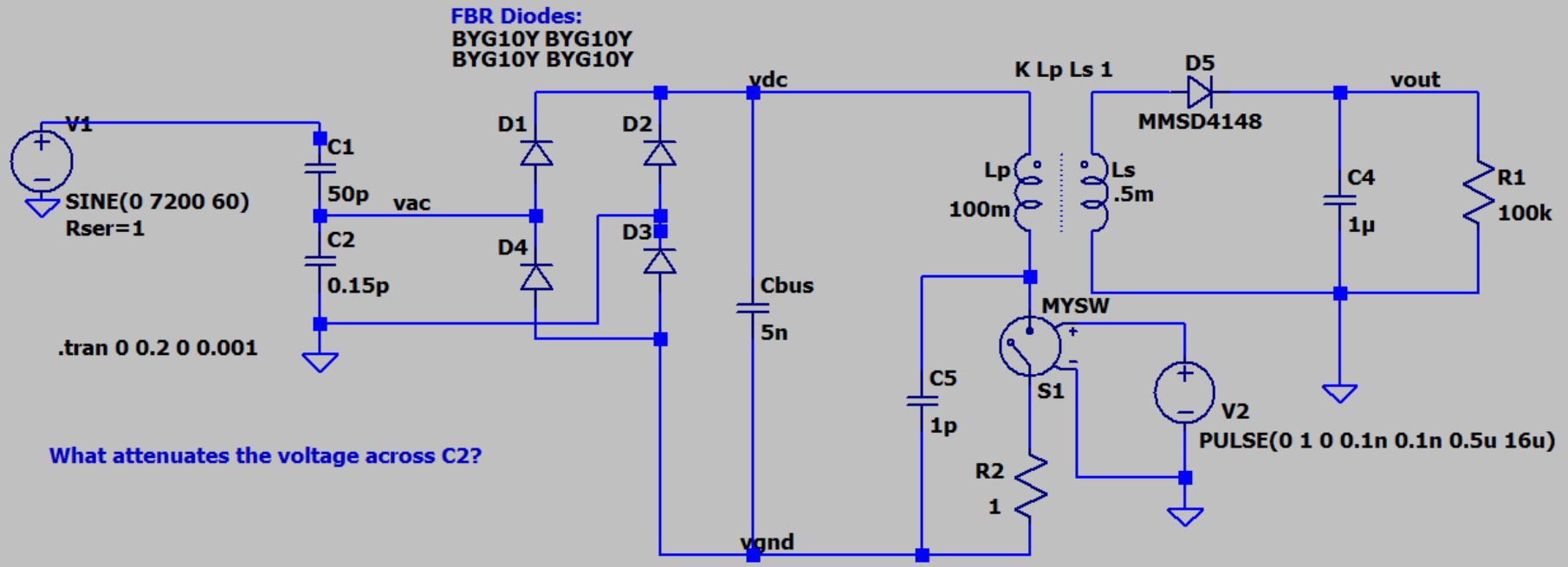
```
.model MYSW SW(Ron=100 Roff=100Meg Vt=.5 Vh=0.1)
```

FBR Diode Model:

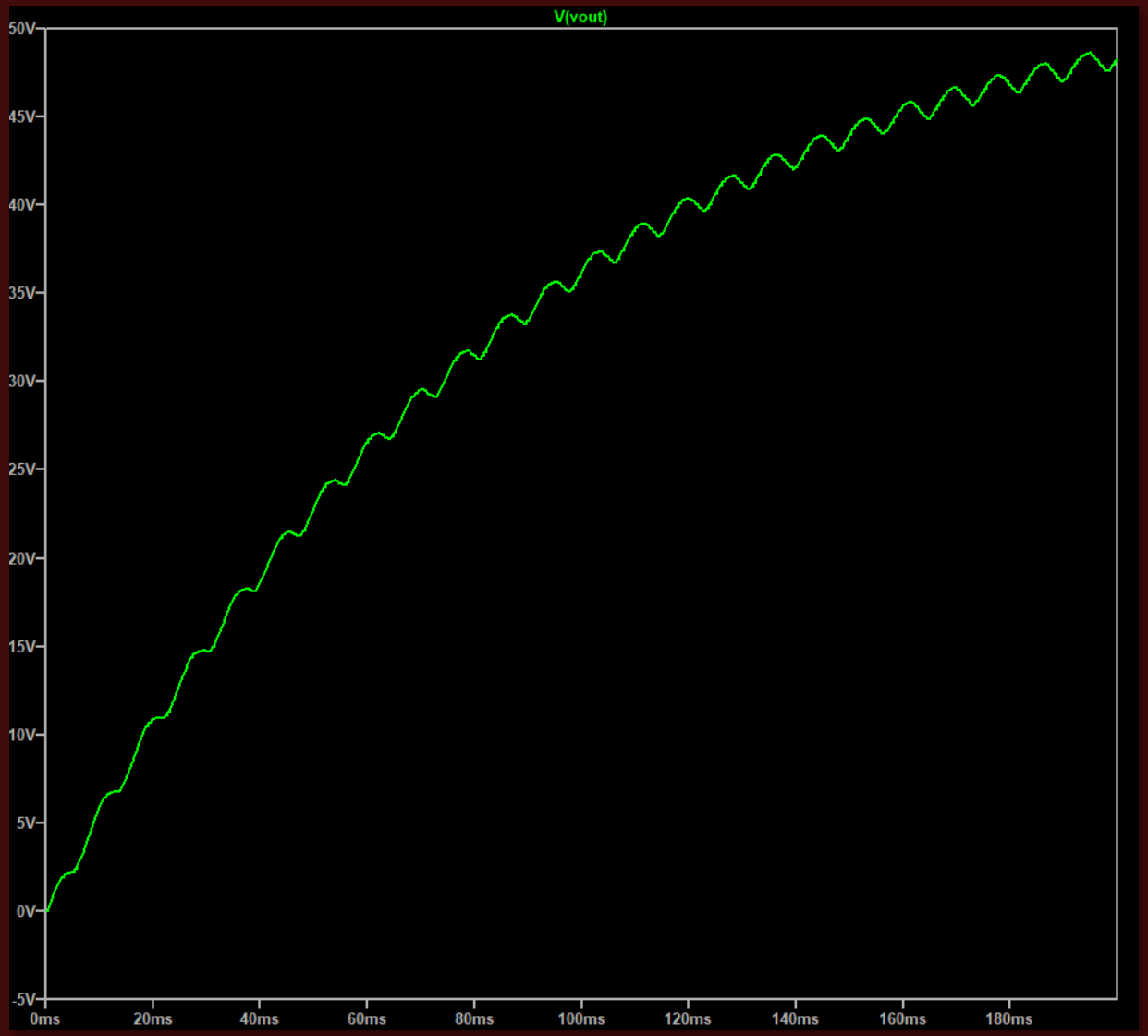
```
.model byg10y d is = 1.81766E-009 n = 1.87266 rs = 0.102527
+ eg = 1.25284 xti = 0.357254 t_measured = 27
+ cjo = 2.4451E-011 vj = 0.7 m = 0.41827 fc = 0.5
+ tt = 9.66791E-006 bv = 1760 ibv = 10 af = 1 kf = 0
```

PARAMETRIC SWEEPS

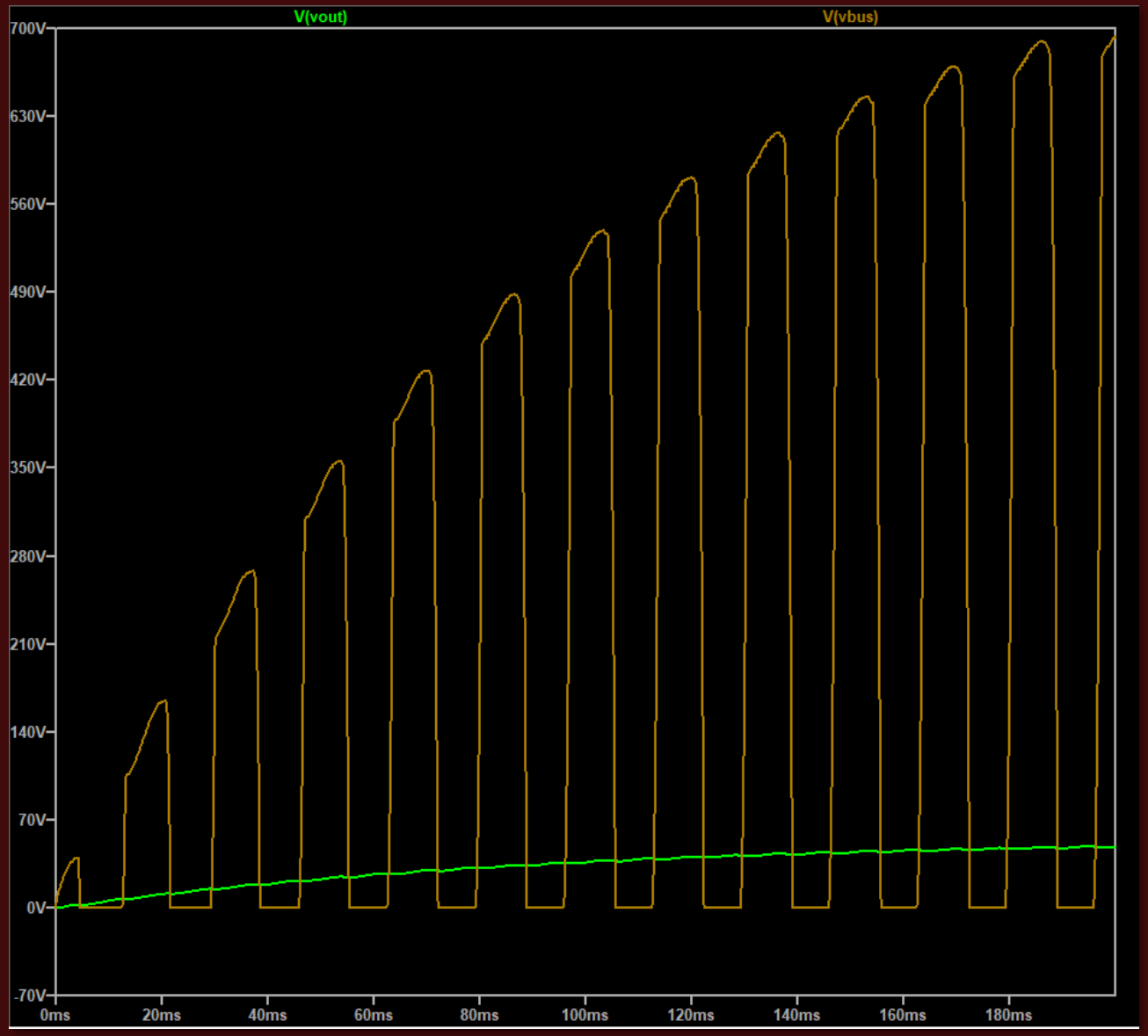
```
.step param ton_sw1 list 0.5u 1us 2us 4us 8us
```



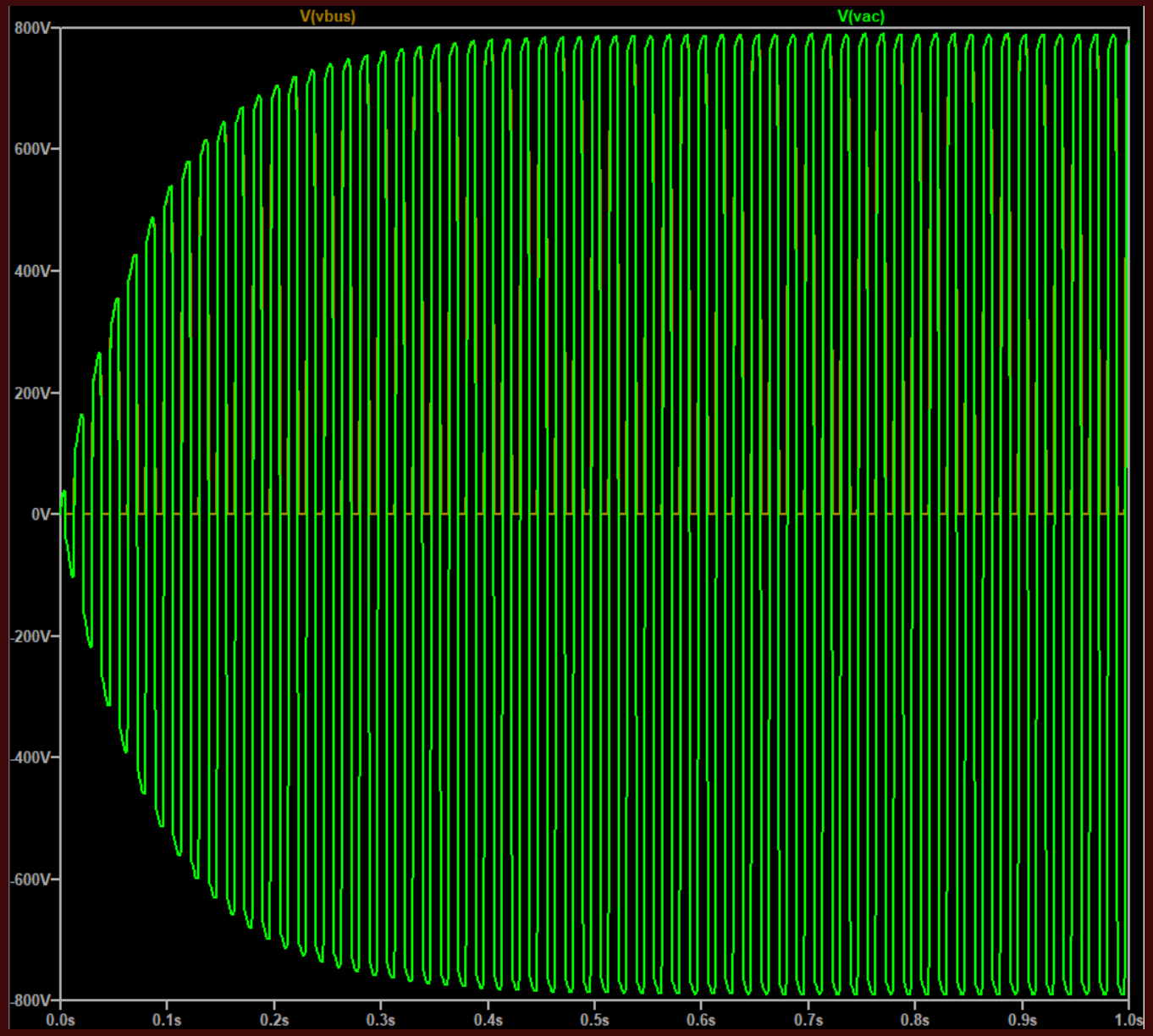
What attenuates the voltage across C2?



(t=0.2s) => P = (46V)(475uA) = 21.9mW

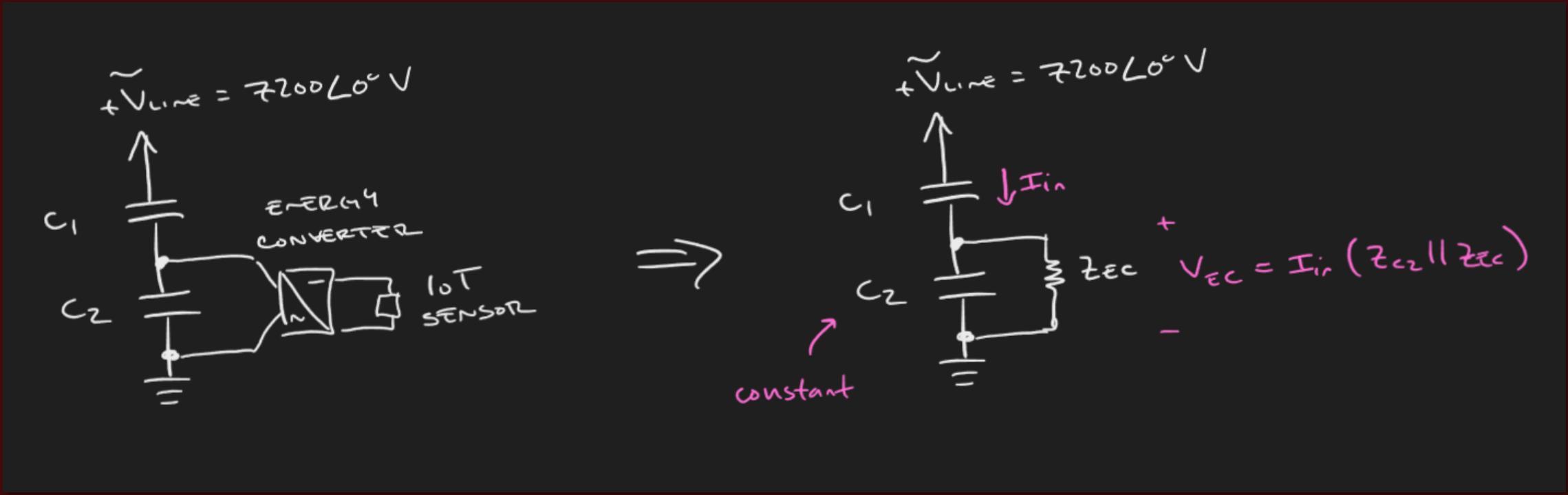


V_{out} rises as V_{bus} saturates



V_{AC} rises as time passes, nearing 795VAC @ t=1.0s.

POSSIBLE GOAL: Maximizing Energy Converter Impedance



$C_1 \approx 50pF$, $C_2 \approx 0.15pF \Rightarrow Z_{EC} = 1.8\,G\Omega$, $I_{in} = 180\mu A$ (SIM)