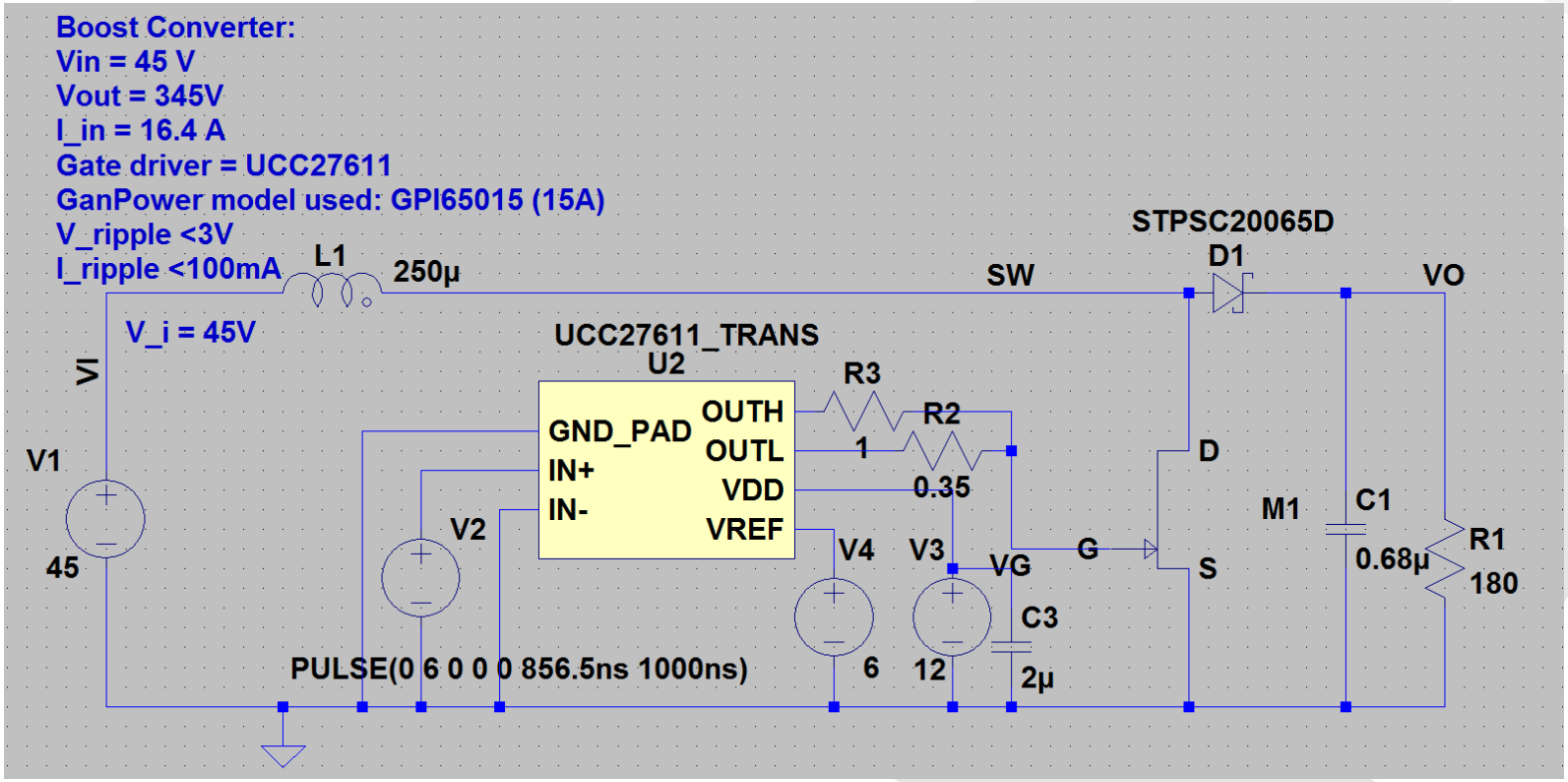
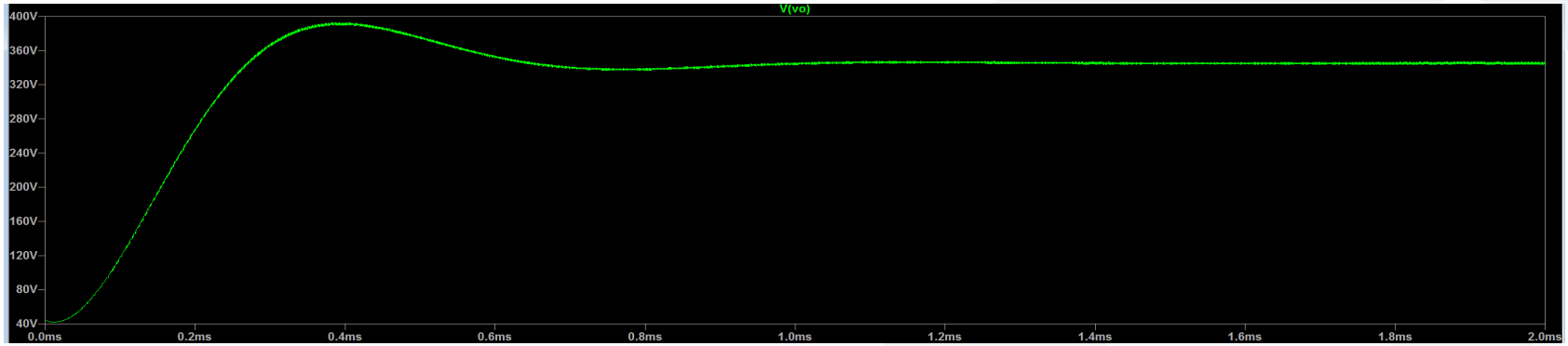
45V to 345V Boost Converter Example using GPI65015TO LTSPICE Model

GANPOWER INTERNATIONAL

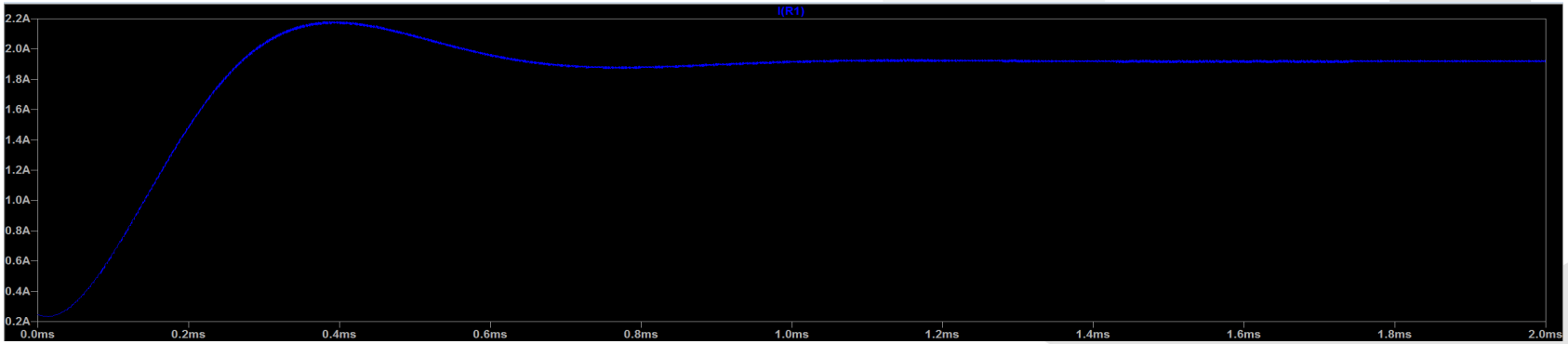
Schematic



Output Voltage and Current

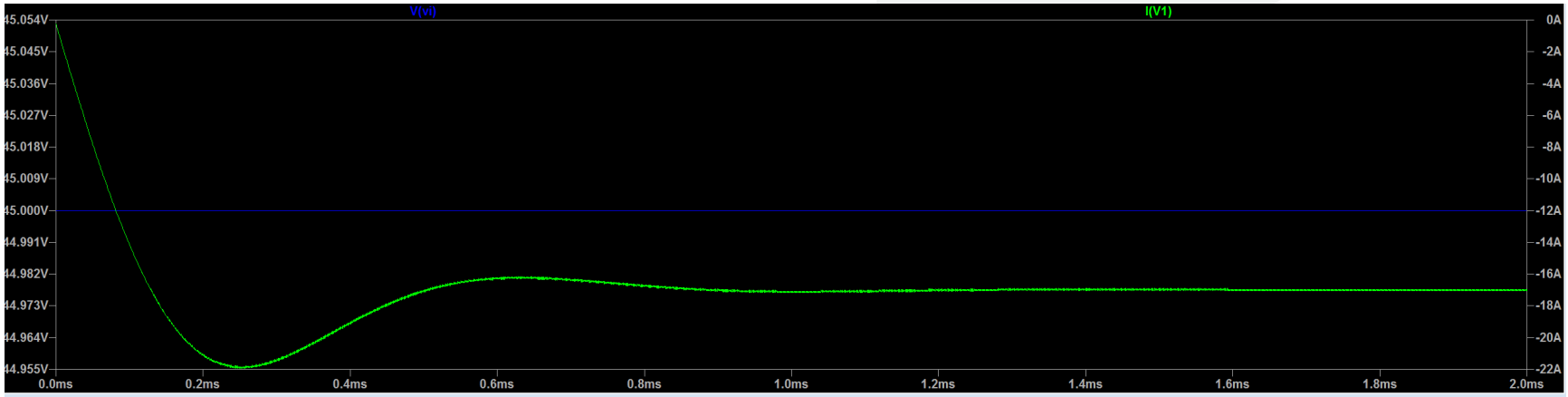


V_{out} Plot (V)



I_{out} Plot (V)

Input Voltage and Current



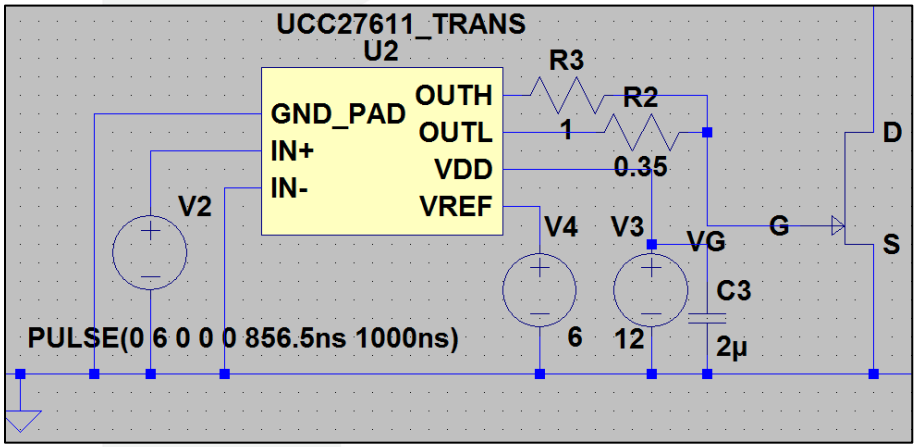
V_{in} Plot (V) Blue
I_{in} Plot (A) Green

Duty Cycle and Frequency

- $\frac{V_{out}}{V_{in}} = \frac{1}{1-D} = \frac{345V}{45V}$ → D = 0.87
- Frequency (1MHz)
- Theoretical: T_on = 870ns, T_period = 1000ns
- Simulated: T_on = 856.5ns, T_period = 1000ns

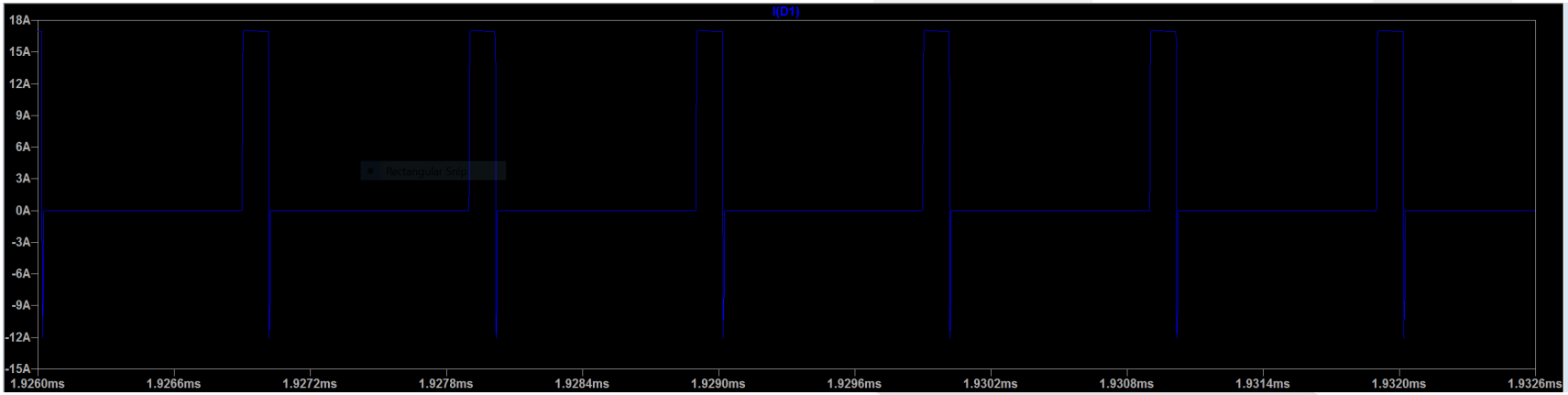
Gate Driver Requirements

- UCC27611 is a high speed gate driver for E-mode GaN devices
- 2uF ceramic bypass capacitor should be connected between VDD and GND per the data sheet
- OUTH and OUTL are connected in parallel to the gate of the transistor
- IN+ supplies a positive voltage signal to the driver
- GND_PAD is referenced to the ground node
- The transistor is driven with a 6V pulse
- VDD requires a 12V power supply
- Set R_OH to 1 Ohm and ROL to 0.35 Ohms



Diode (STPSC20065)

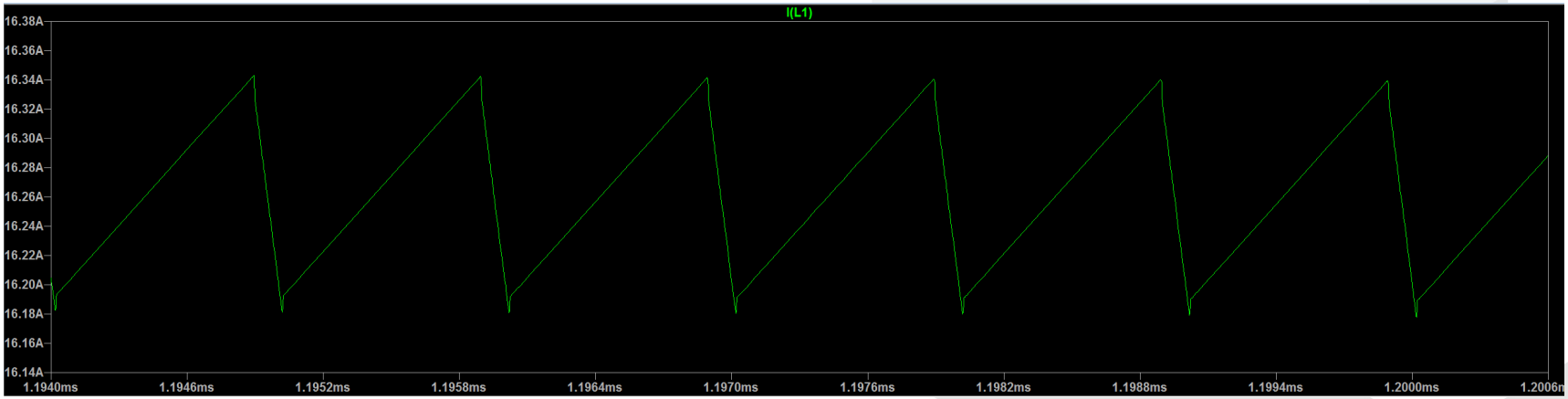
- SiC Diode with high breakdown voltage (650V) and max current (20A)
- Schottky Diode for fast switching times and minimal power loss (~ns)
  - ~2.5W power loss at steady state compared to ~700W output
  - 1.6V forward voltage drop



Diode Current Plot (A) Blue

Inductance and Inductor Ripple

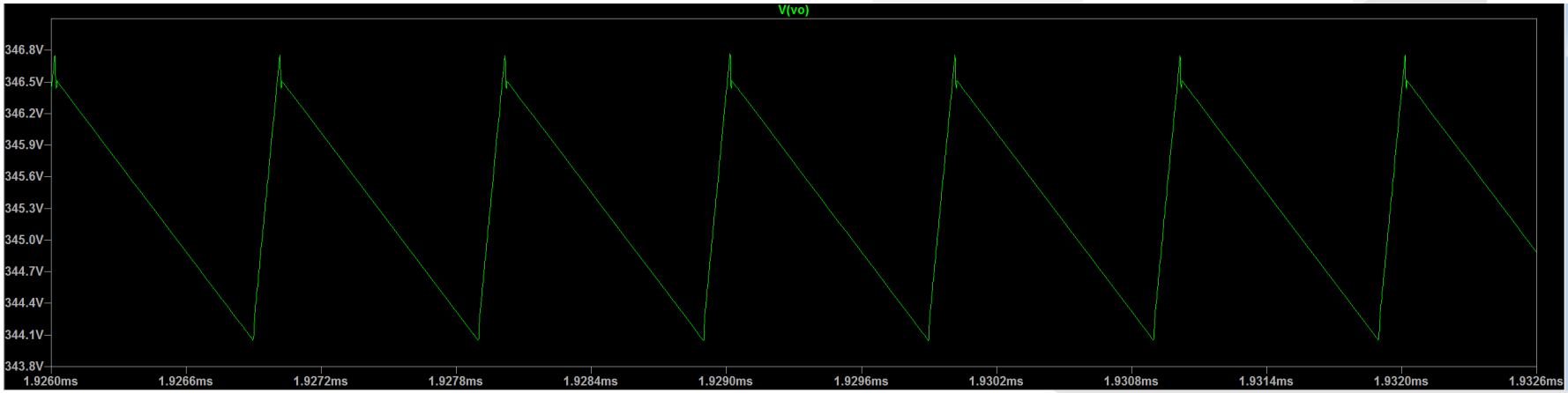
- Inductor Ripple less than 100mA
- $L = \frac{(V_{in} - V_{out}) * D}{f_s * \Delta I_L}$ Choose L = 250uH
- Current rating > 20A (Abracon ATCA-08-251M-H), ESR = 27 mOhms
- Favour inductors with lower ESR (more power efficient)



Inductor Current Plot (A) Green

Capacitor and Voltage Ripple

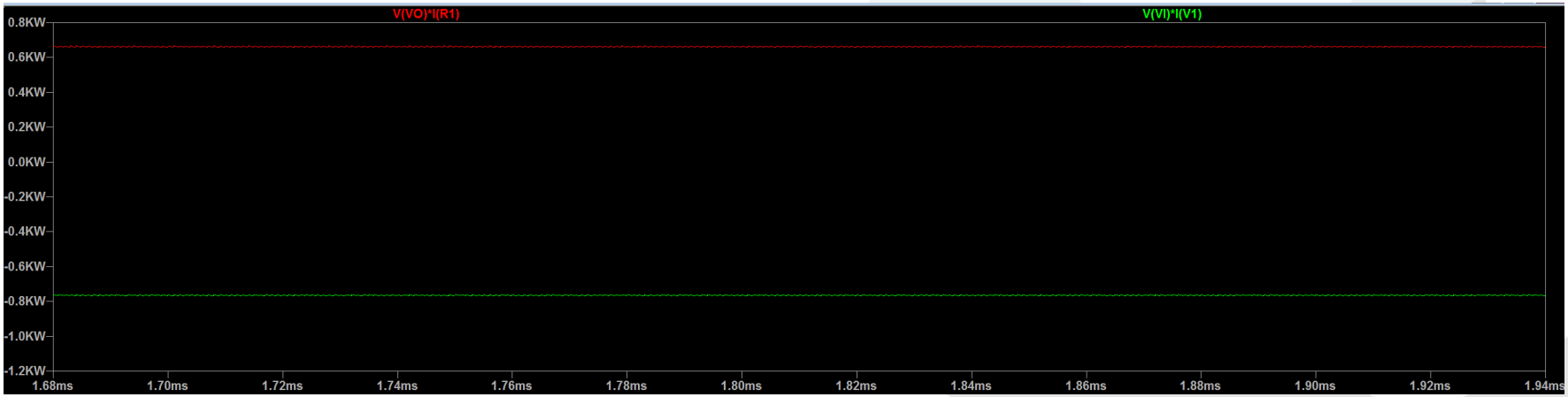
- Voltage ripple less than 3V (C = 0.58uF)
- $C = \frac{I * D}{f_s * \Delta V_{out}} = 0.58uF$ (Adjusted to 0.68uF after simulation)
- Voltage rating > 350V and current rating > 5A RMS
- Lower series resistance reduces output voltage ripple
  - Chose capacitor with 10 mOhm ESR and 450V rating
  - (Murata KR355TD72W684MH01)



Capacitor Voltage Plot (V) Green

Power Efficiency

- $eff = P\_out/P\_in$ =660W/730W=90% (steady state)
- Largest power losses are due to the inductor and transistor
  - Inductor (8W) and Transistor (60W)
  - Capacitor (75mW) and Diode (2.5W)



Input Power Green
Output Power Red