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

GANPOWER INTERNATIONAL
Schematic

Boost Converter:
Vin = 45 V
Vout = 345V
I_in = 16.4 A
Gate driver = UCC27611
GanPower model used: GPI65015 (15A)
V_ripple <3V
I_ripple <100mA

V_i = 45V

STPSC20065D

UCC27611_TRANS

GND_PAD
OUTH
IN+
OUTL
VDD
IN-
VREF

R3 1
R2 0.35
V4
V3
VG
G
S
D
M1
C1 0.68μ
R1 180

PULSE(0 6 0 0 0 856.5ns 1000ns)
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

\[ \frac{V_{out}}{V_{in}} = \frac{1}{1-D} = \frac{345V}{45V} \rightarrow D = 0.87 \]

- Frequency (1MHz)
  - Theoretical: \( T_{on} = 870\text{ns}, T_{period} = 1000\text{ns} \)
  - Simulated: \( T_{on} = 856.5\text{ns}, T_{period} = 1000\text{ns} \)
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
- \[ L = \frac{(V_{in} - V_{out}) \times D}{f_s \times \Delta I_L} \] Choose \( L = 250\mu H \)
- 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)
- \[ C = \frac{I \cdot D}{f_s \cdot \Delta V_{out}} = 0.58uF \] (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

\[ \text{eff} = \frac{P_{\text{out}}}{P_{\text{in}}} = \frac{660W}{730W} = 90\% \text{ (steady state)} \]

- 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