12. Design and Troubleshooting of Solar Power Inverter circuit

Course: ECE1008 – Electronic Hardware Troubleshooting LAB

-Dr Richards Joe Stanislaus

Assistant Professor - SENSE

Email: 51749@vitstudent.ac.in

VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

CHENNAI

Aim

- To design the a solar Power inverter circuit

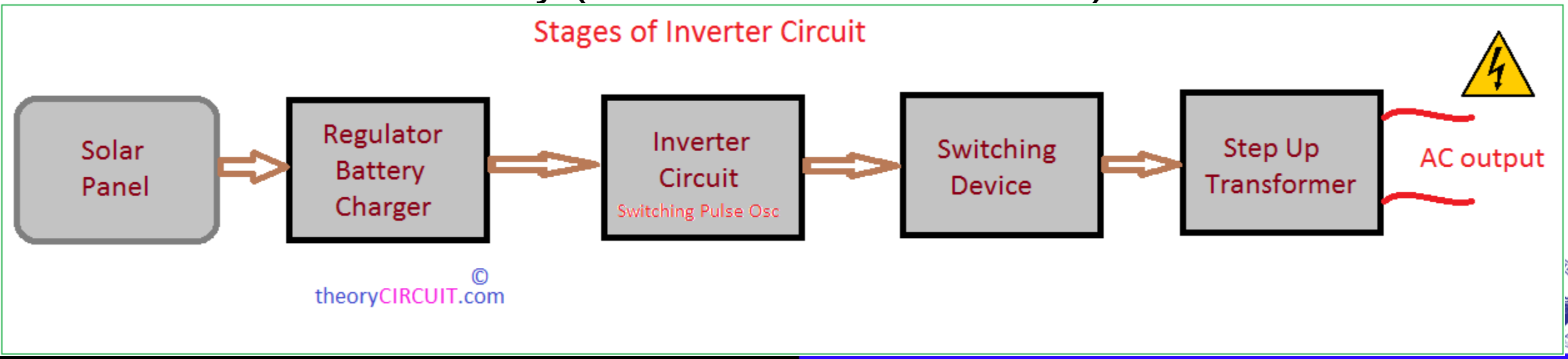
Stages:

- Photovoltaic solar based inverter circuit

- five different stages.
- PV Solar panel
- Regulator / Battery chagerg
- Inverter Circuit (Switching Pulse Oscillator)
- Switching Device
- Step Up transformer (Output stage)

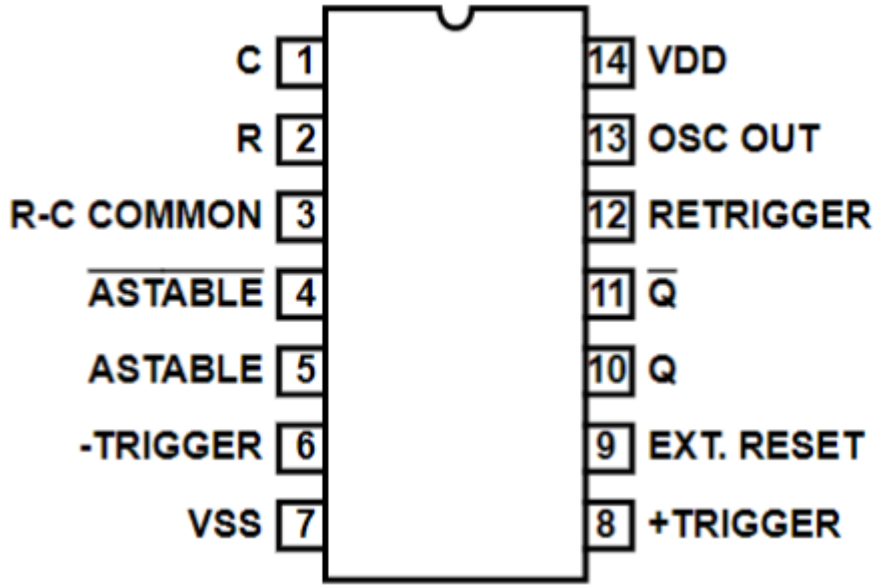
Components

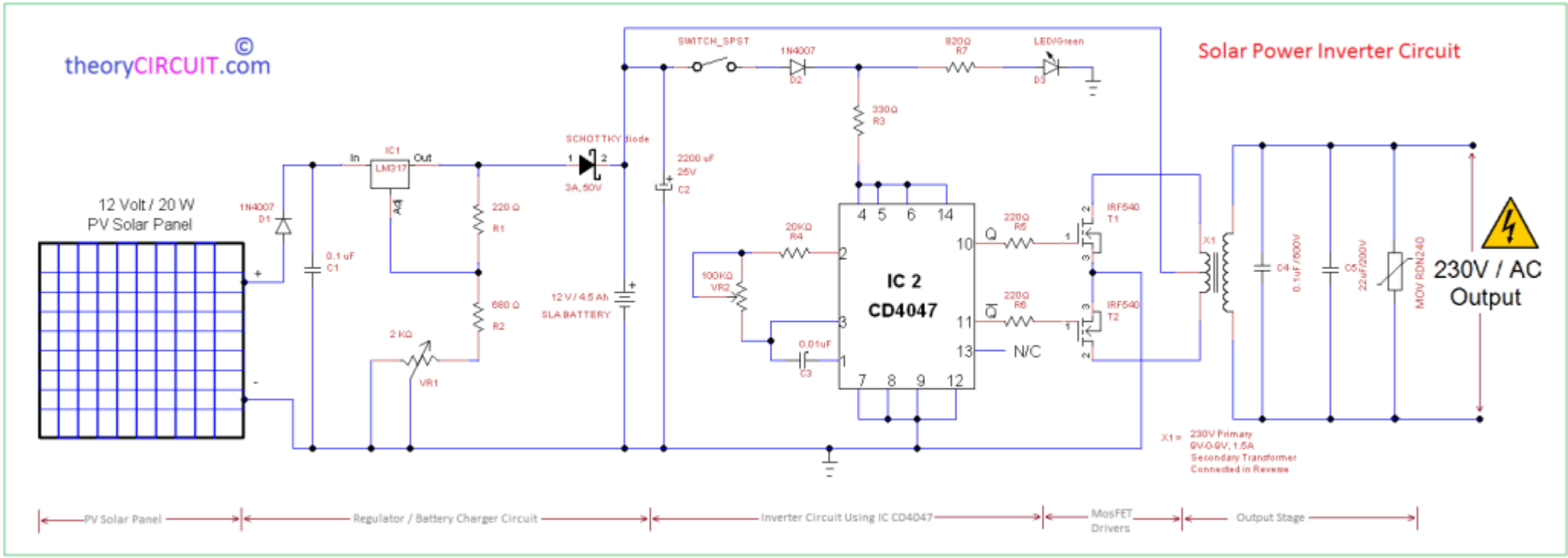
- Solar Panel : 12V 20watts (1600mA)
- LM317: Three terminal Positive voltage regulator (Output voltage from 1.25V to 37V with more than 1.5A current)
- 3A, 50V Shottky diode
- 12/4.5Ah SLA Battery (dc bias to inverter circuit)



Components

- CD4047
  PWM generator / ASTABLE multivibrator
- Produces switching waveform




theoryCIRCUIT.com
Solar Power Inverter Circuit
12 Volt / 20 W
PV Solar Panel
1N4007
D1
0.1 uF
C1
IC1
LM317
In
Out
Adj
220 Ω
R1
680 Ω
R2
2 KΩ
VR1
SCHOTTKY diode
3A, 50V
12 V / 4.5 Ah
SLA BATTERY
2200 uF
25V
C2
SWITCH_SPST
1N4007
D2
820Ω
R7
LED/Green
D3
330Ω
R3
20KΩ
R4
100KΩ
VR2
0.01uF
C3
IC 2
CD4047
220Ω
R5
220Ω
R6
IRF540
T1
IRF540
T2
N/C
X1
C4
0.1uF/600V
C5
22uF/200V
MOV RDN240
230V / AC
Output
X1 = 230V Primary
0V-0.9V, 1.5A
Secondary Transformer
Connected in Reverse
PV Solar Panel
Regulator / Battery Charger Circuit
Inverter Circuit Using IC CD4047
MosFET
Drivers
Output Stage

Components

- Inverter circuit using IC CD4047 (Switching Pulse Oscillator): Monostable / Astable multivibrator IC CD4047
- IC: 14 pin Dual in line package
- Full oscillation output F at Pin 13,
  Frequency: $f = \frac{1}{8.8RC}$ $R = R4 + VR2$ and $C = C3$

  ½ of oscillation at Pin 10 as Q and Pin 11 as Q'. (Each output pin gives 50% duty cycle)

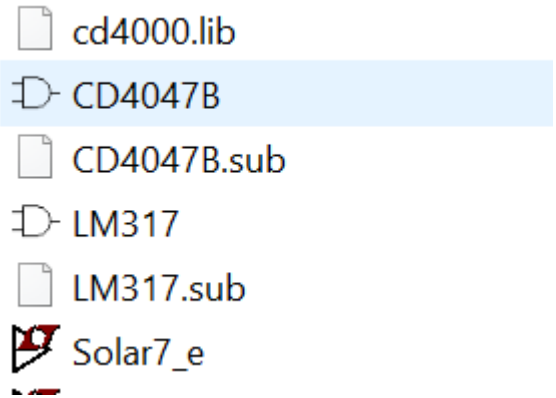
$$\text{Frequency: } f = \frac{1}{4.4RC}$$

Components

- MOSFET Drivers IRF540N (Power mosfet)
  Fast switching
- Transformer X1: Reverse with specifications as 230V primary
  9V-0-9V /1.5A secondary winding center tapped transformer
- Metal oxide Varistor protects electronic device connected at output.

Files:

- Extract the zip file given in attachment.
- Include the files given in the attachment in the same folder as the simulation file.



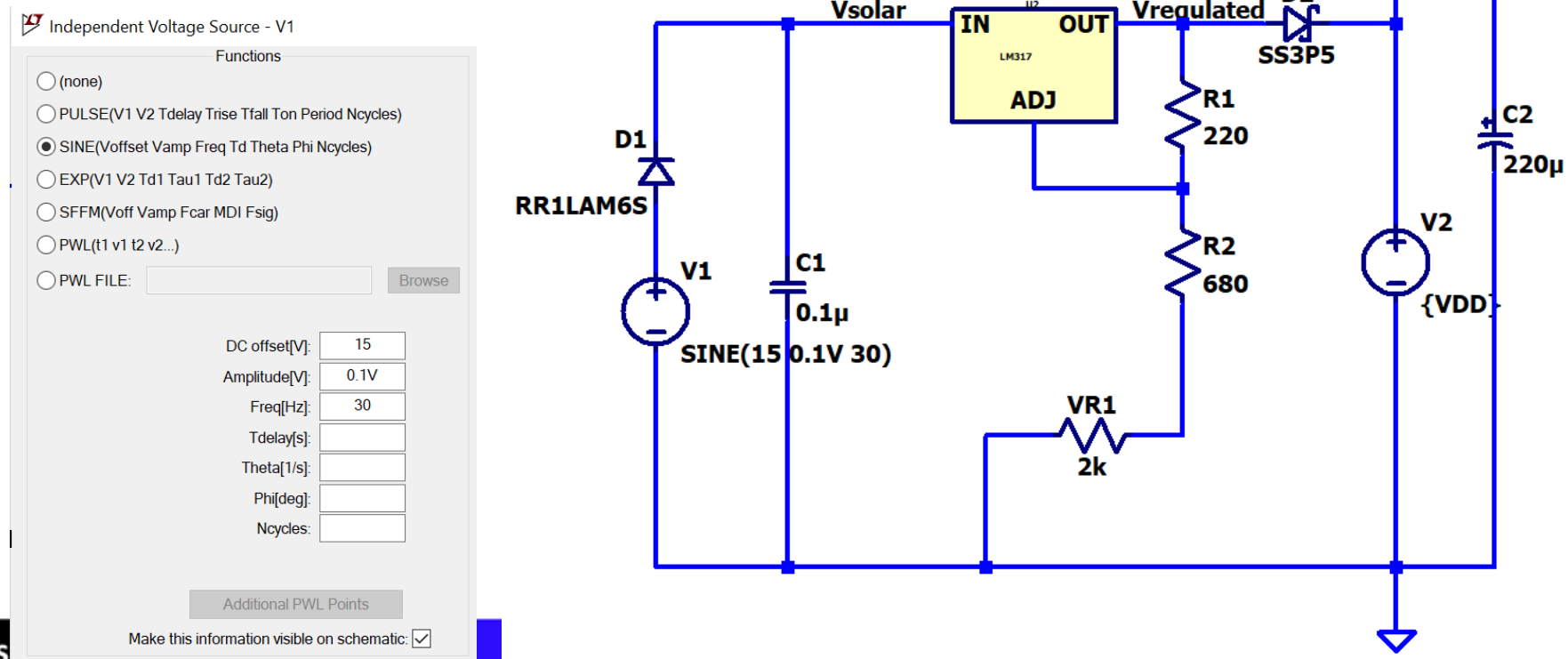
Regulated Power supply from Solar panel to Battery

- A regulator LM317 is used here. Include using spice directive.
- The voltage source V2 is Battery with value {VDD}. Give the value of VDD using spice directive.
- Connect the resistors and Capacitors as shown.
- Set input voltage V1 as given here 15V dc with small ac fluctuations.

.include LM317.sub

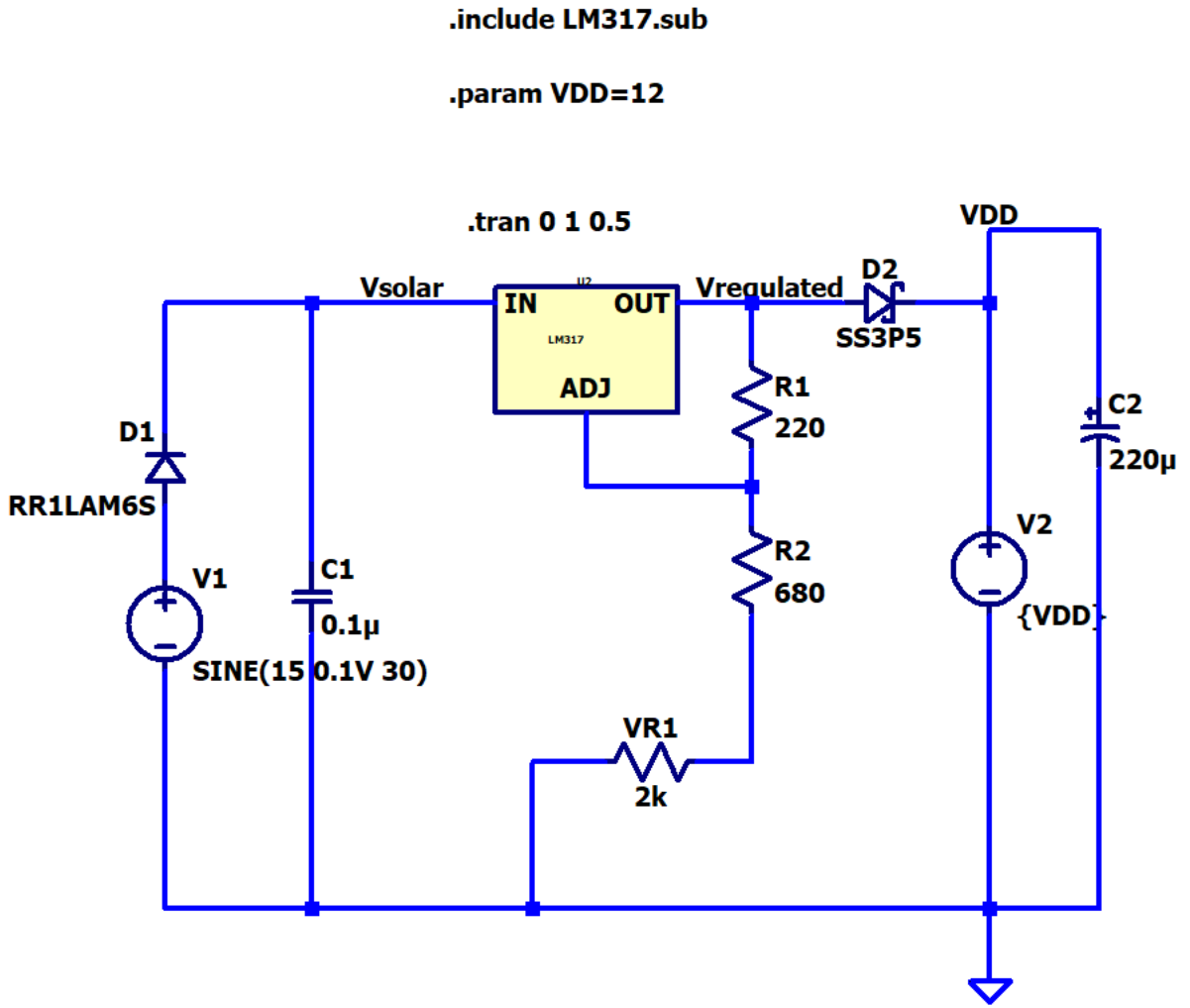
.param VDD=12

.tran 0 1 0.5



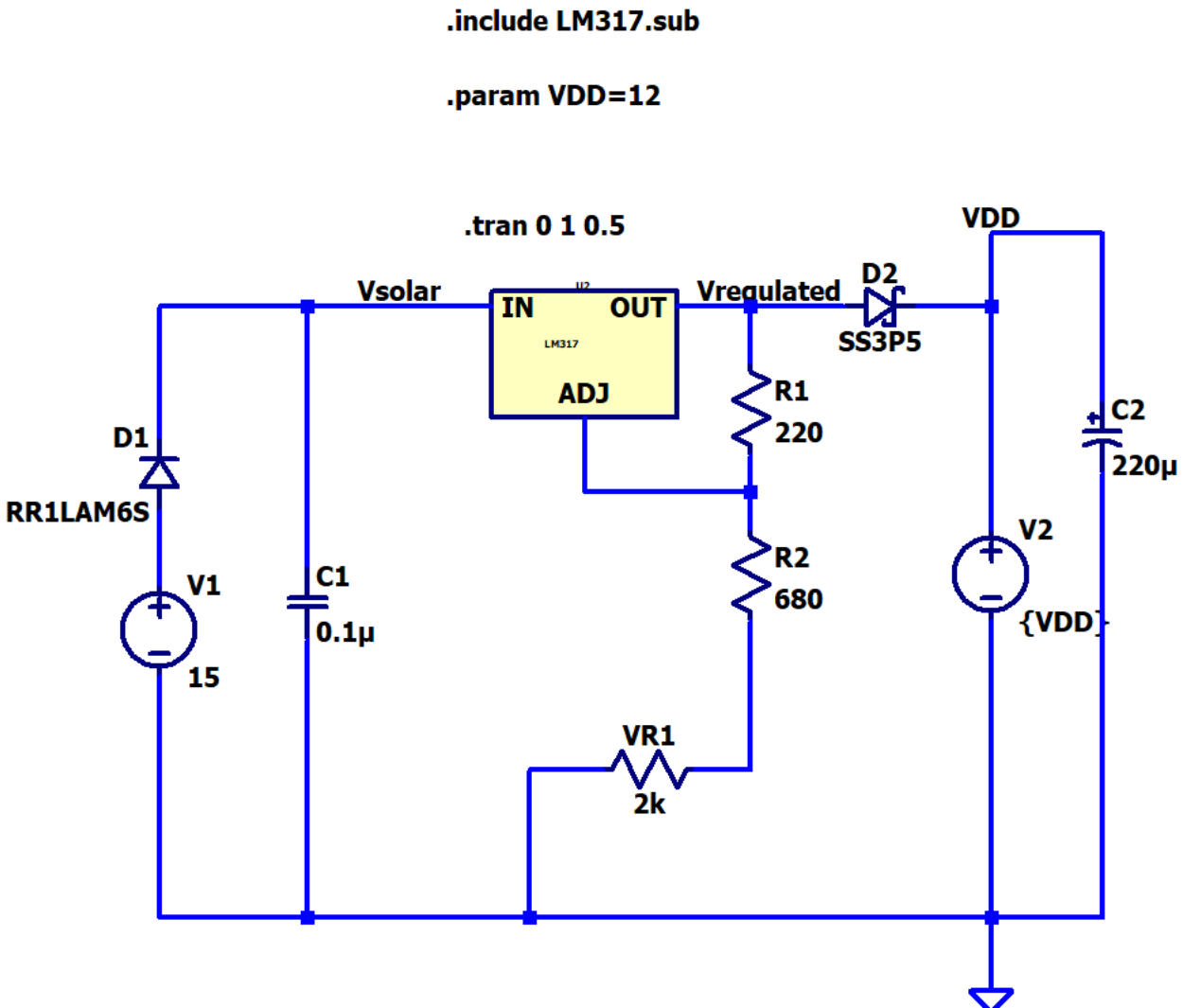
Task1: Plot the regulated voltage across Vregulated

- Plot the Vregulated.



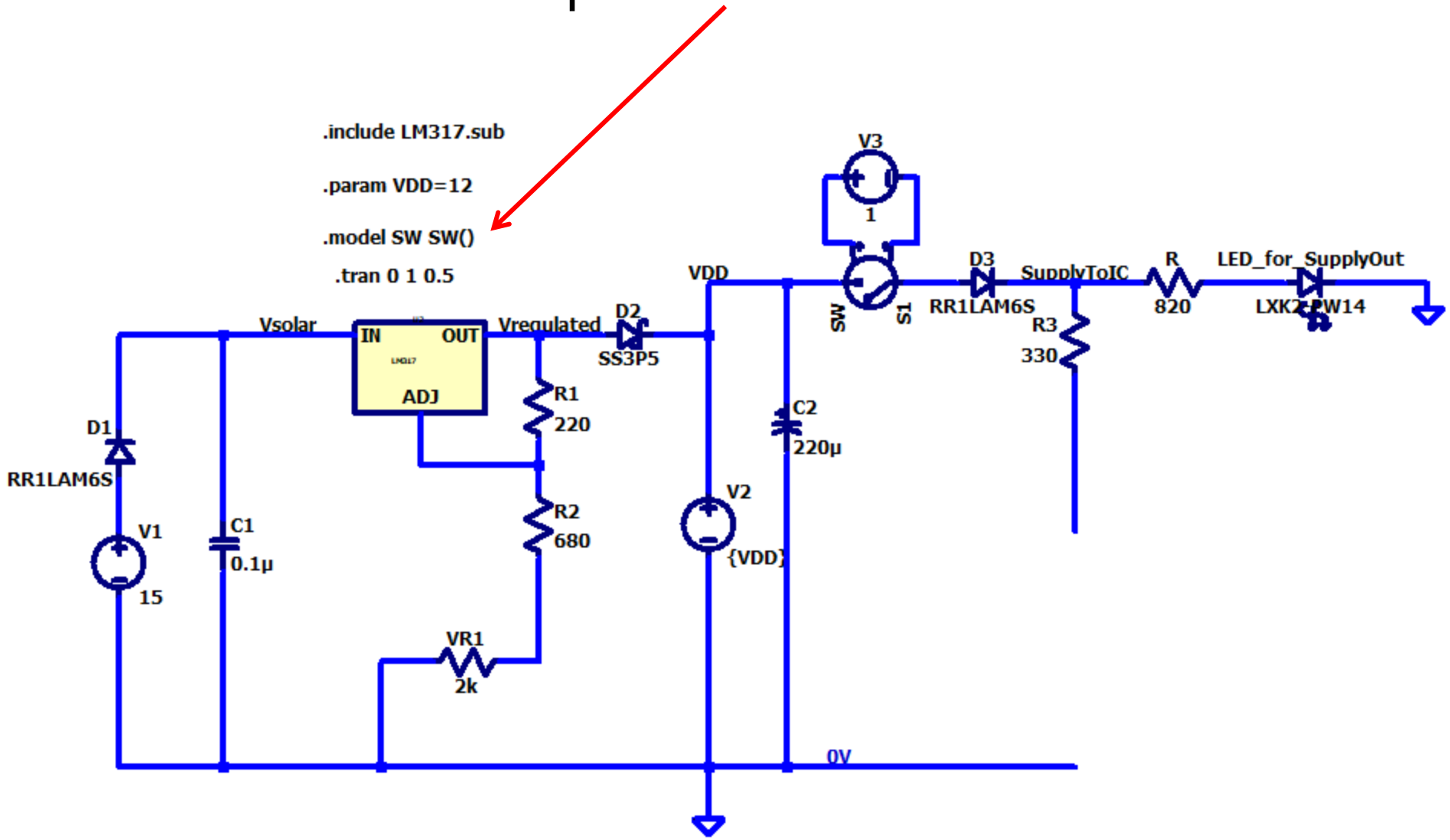
Regulated Power supply from Solar panel to Battery

- Change the supply voltage V1 to 15V for now.
- The vregulated is given through a Schottky diode (SS3P5) to battery for charging.



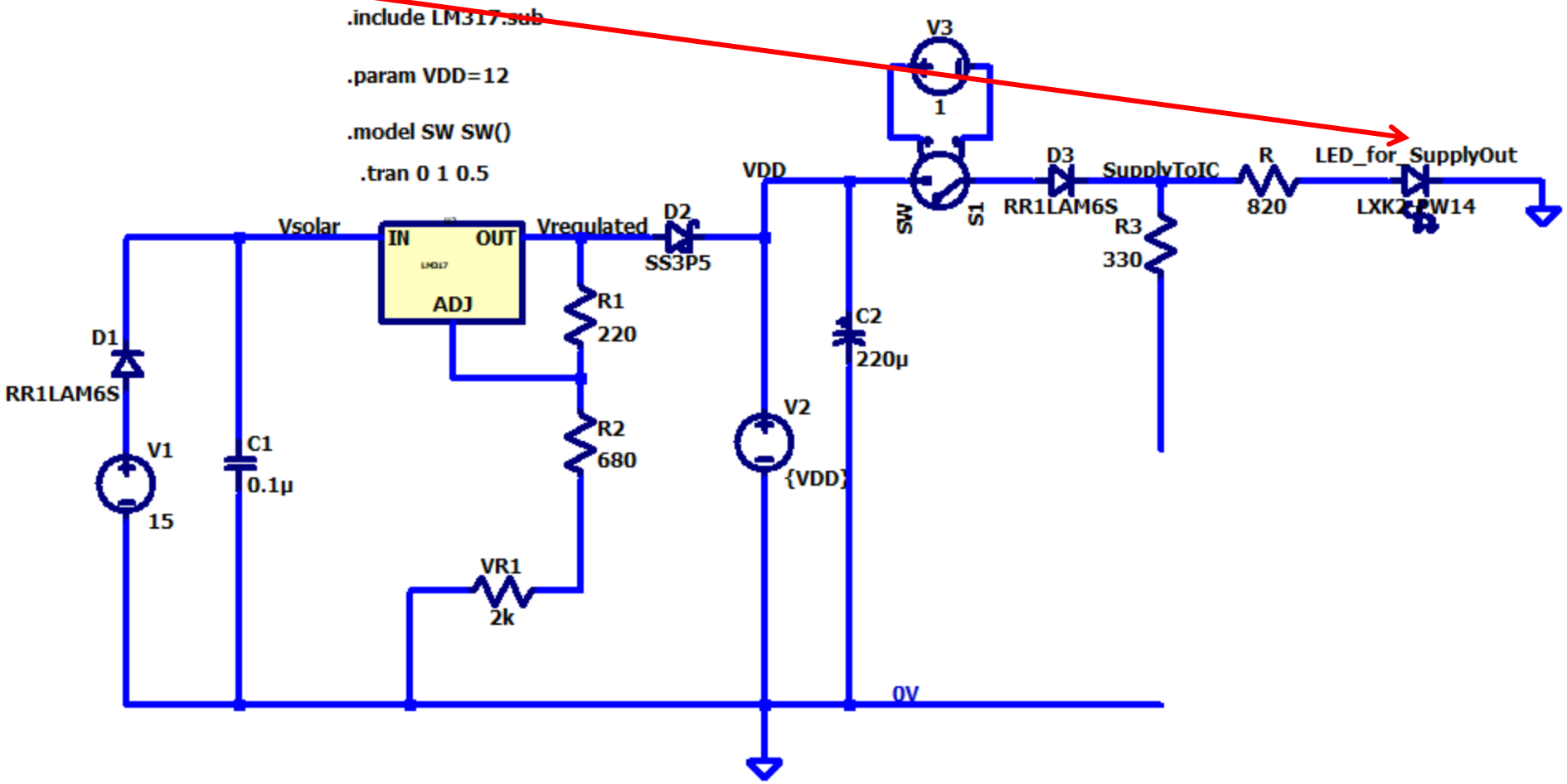
Switch and LED for Selecting the Battery out

- The switch S1 has to be included with spice directive as shown
- The switch is controlled by V3 which is 1V.
- Practically, this acts as relay (When supply is OFF, battery will be connected to convert stored dc to ac



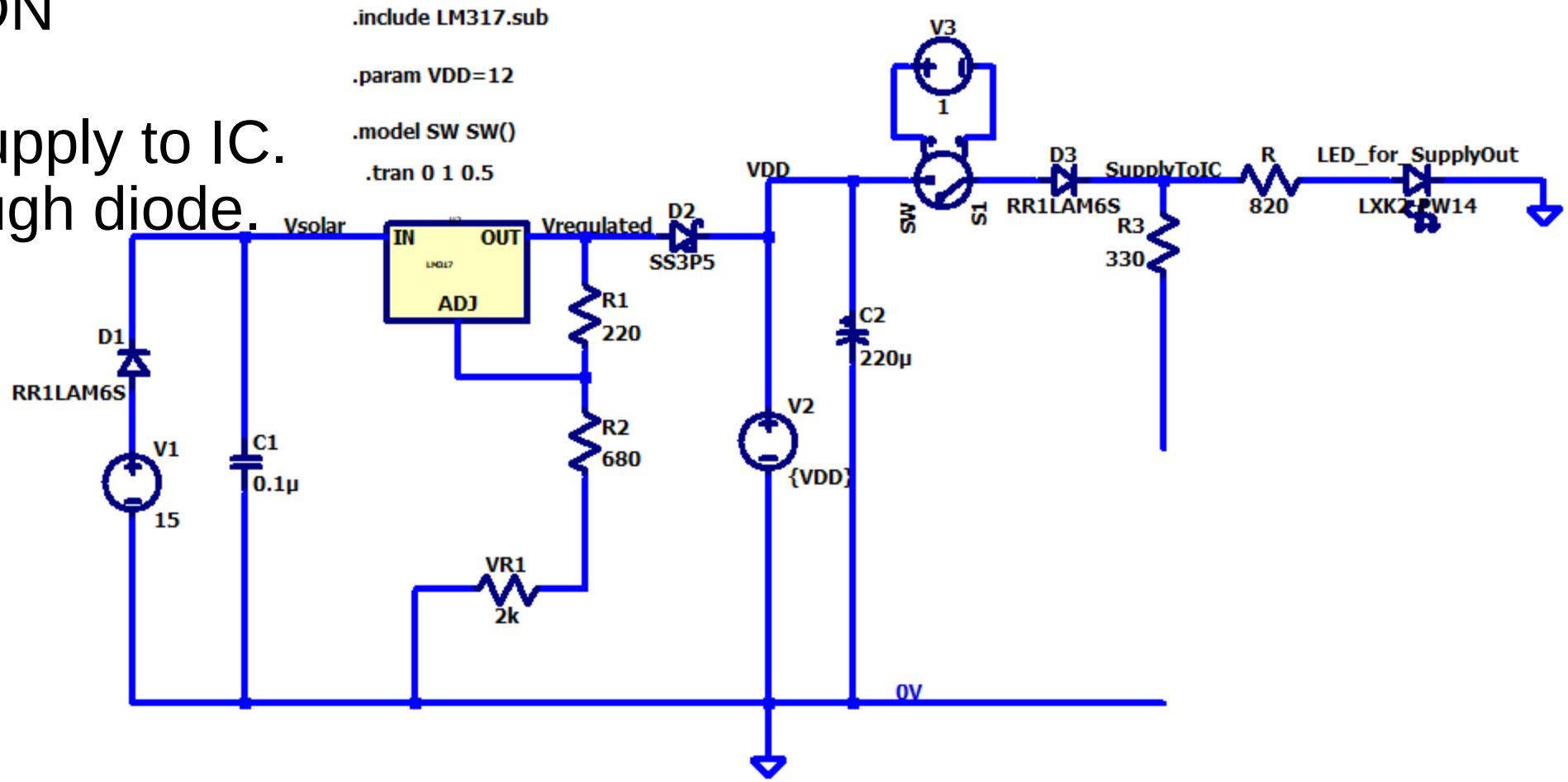
Switch and LED for Selecting the Battery out

- When switch is ON, the Supply to IC will be ON.
  LED will get voltage across it and it will glow(indicating, source as battery).
- LED used here is LXK2-PW14
- Diode D3 (RR1LAM6S) is to restrict current flow in one direction.
- R3 limits current to IC.



Task 2: IC supply and LED check

- When switch is OFF (with V3=0V), plot voltage at Supply to IC. Plot current through diode.
- When switch is ON (with V3=1V), plot voltage at Supply to IC. Plot current through diode.

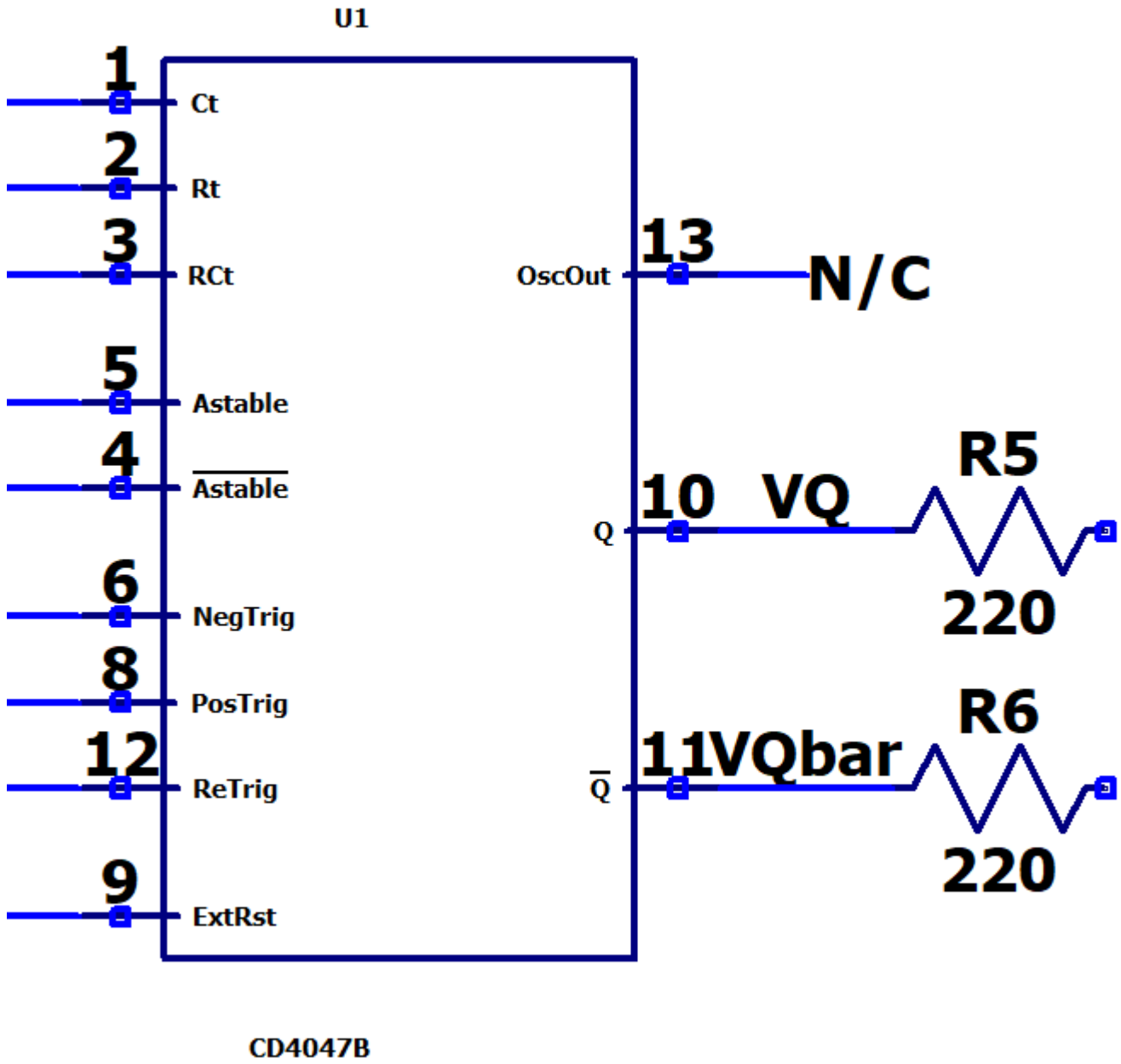


CD 4047

- Name the terminals
  1 to 6 and 8 to 13
- 7: Ground (default ground automatically selected)
- 14: VDD
  are assigned through spice directive:

```
.param VDD=12 SPEED=1.0 TRIPDT=5e-9

.include CD4047B.sub
 .include cd4000.lib
```



CD 4047

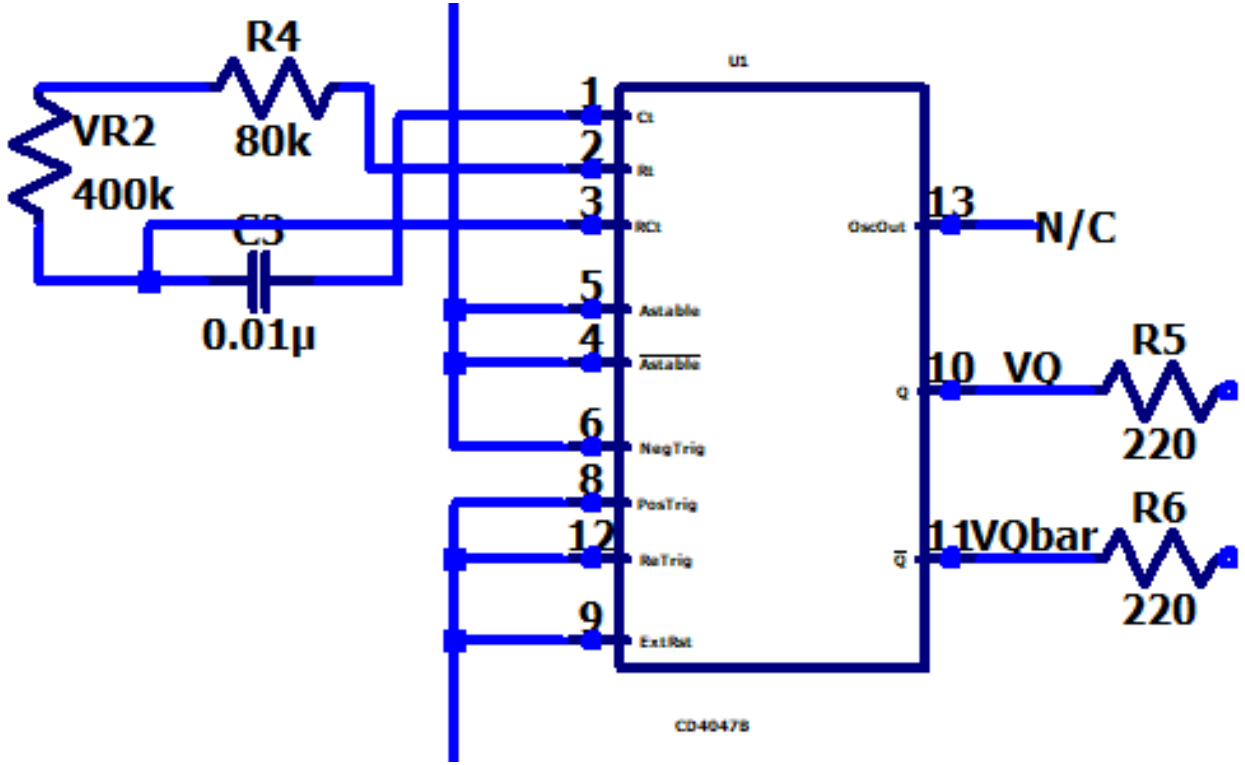
- Connect R4 and VR2(variable in reality) and Capacitor C5 as shown

The values of C5, R4, VR2 are such that

$$f \approx \frac{1}{4.4RC}$$

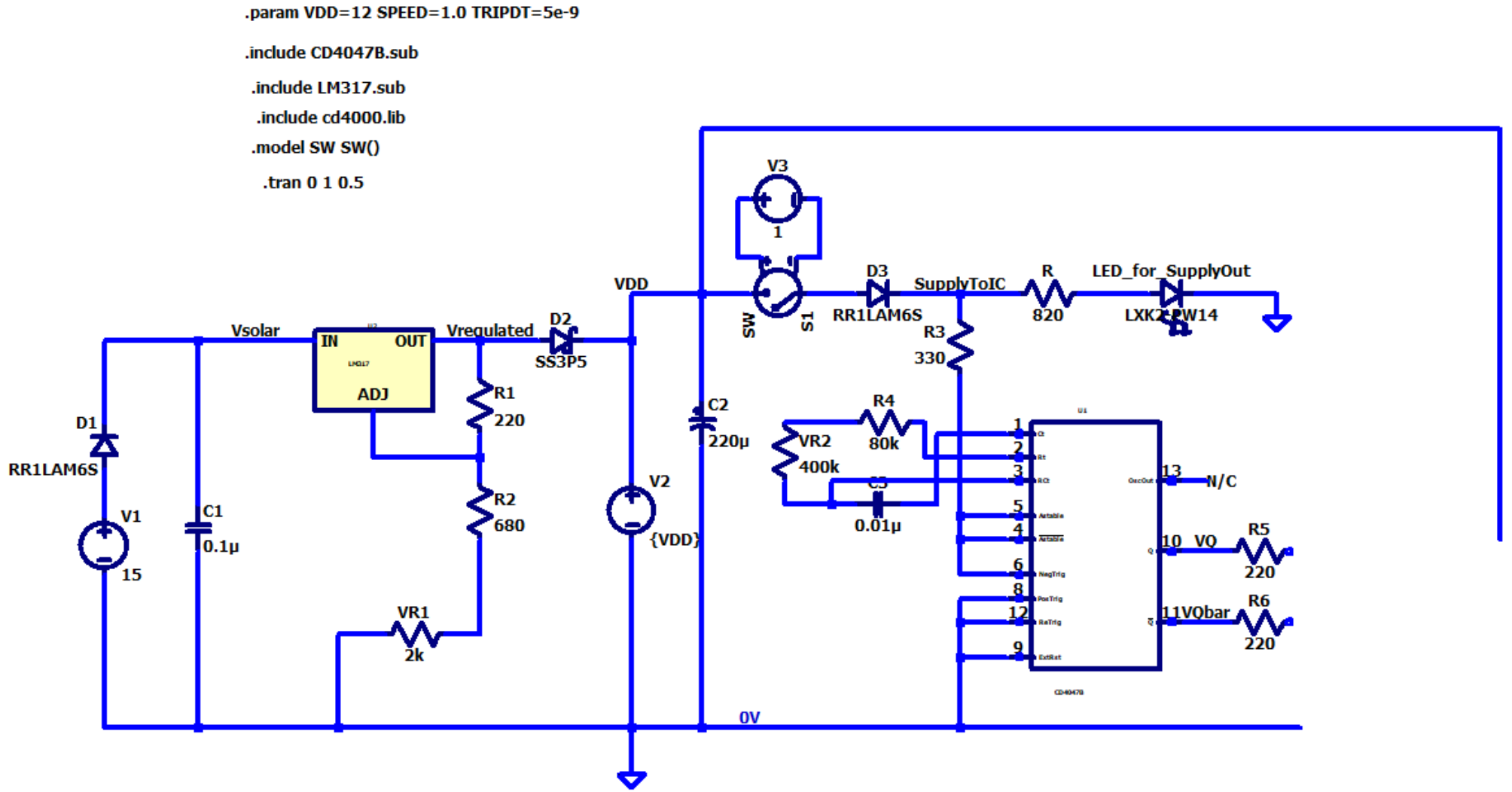
$$where\ R = VR2 + R4$$

$$C = C5$$



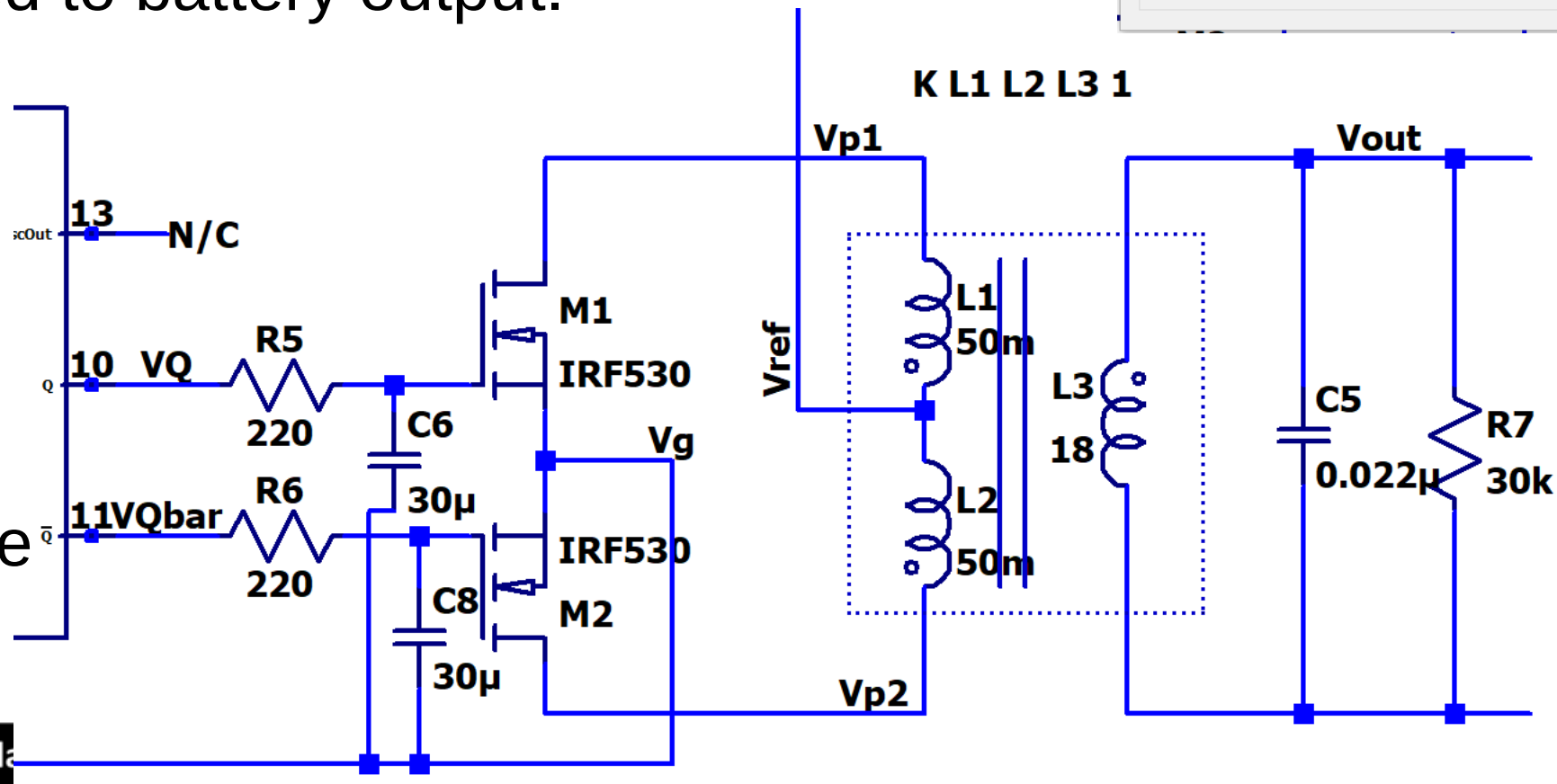
- This frequency sets the switching frequency at output (10 and 11) of CD4047
- Connect R5 and R6 for resisting current at output

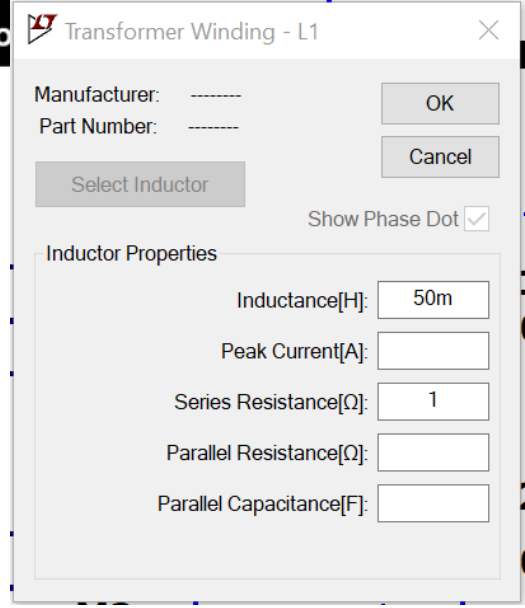
Task 3: Plot the waveform at VQ and VQbar



Final stage: Step-up transformer

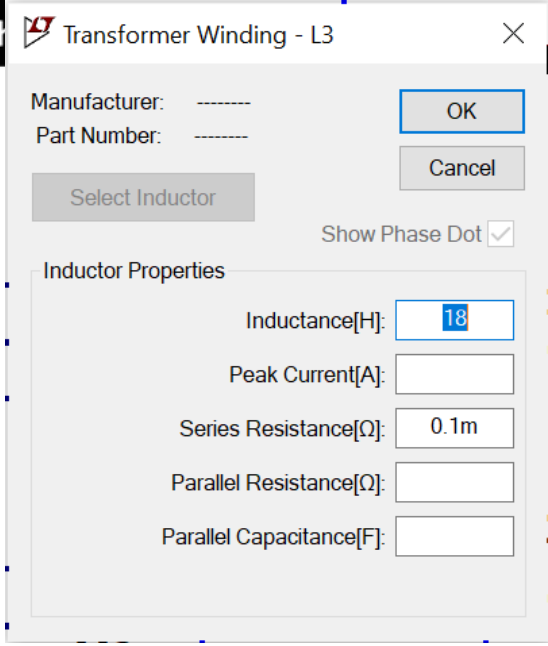
- To convert the switching input, first R5, C6 and R6,C8 are connected to produce sharp triangular waveform.
- The Vref is connected to battery output.
- The MOSFETs IRF530 are used for producing switching.
- The inductor L1 and L2 set as 50mH with series resistance 1ohm.

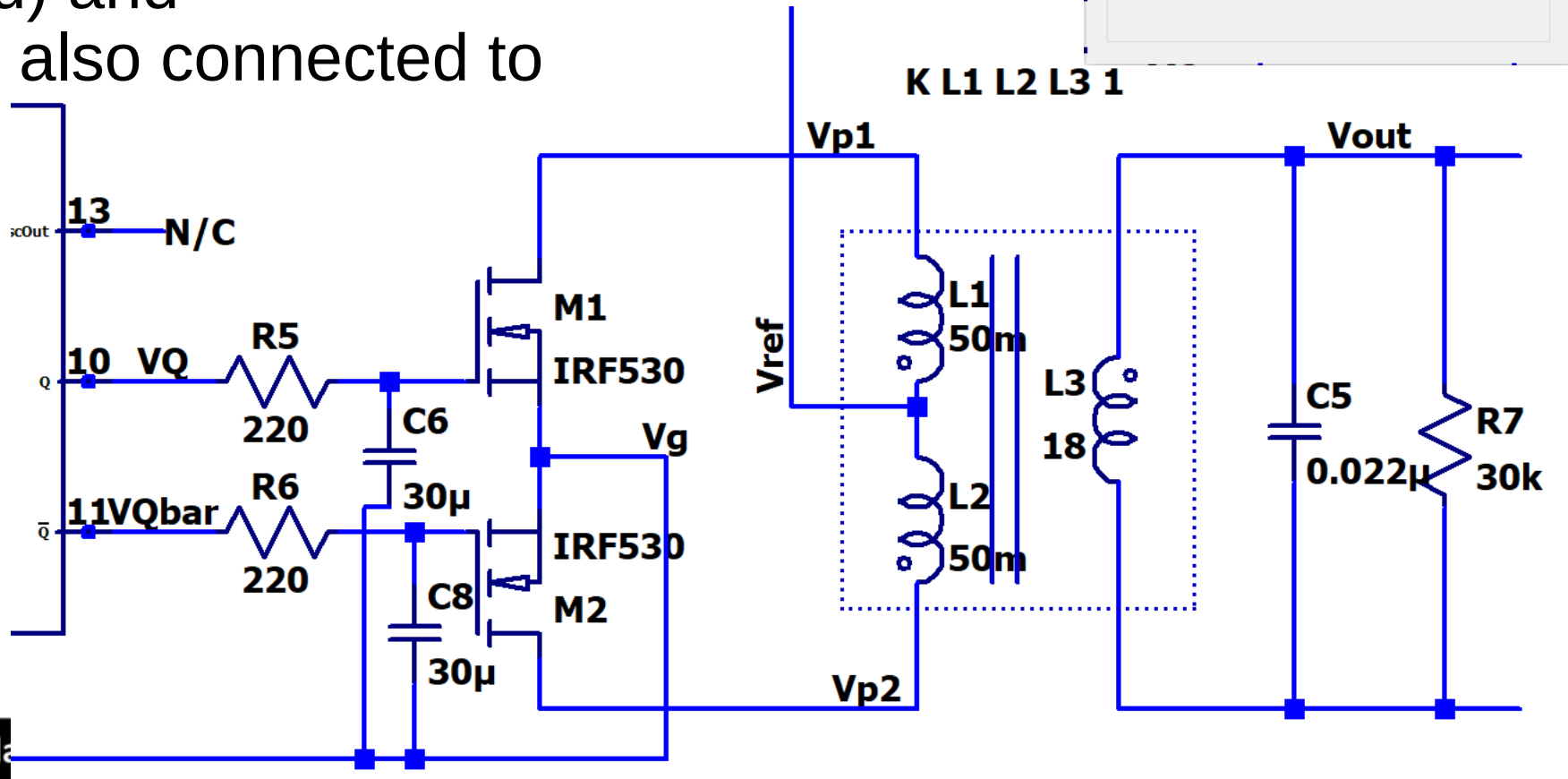




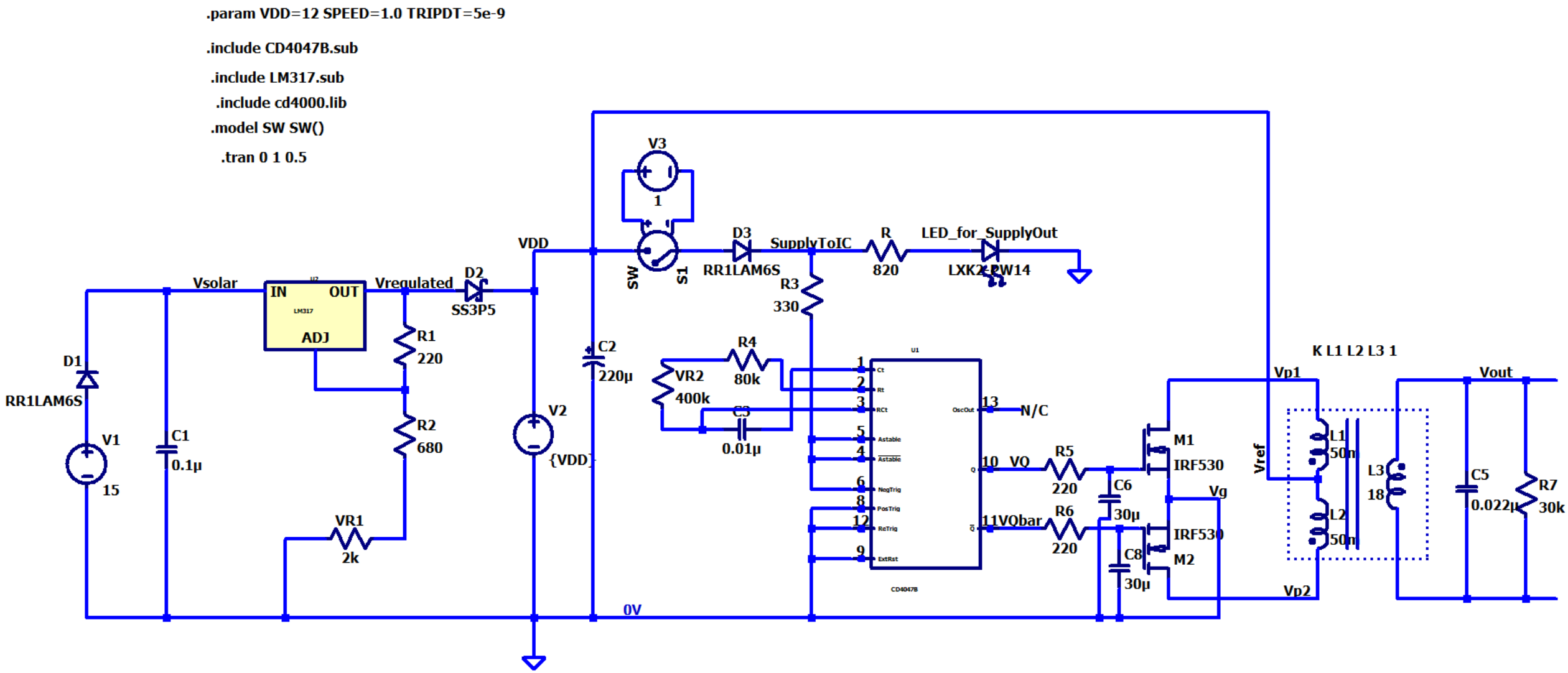
Final stage: Step-up transformer

- The secondary coil is set as 18H and 0.1mohms as series resistance.
- Capacitor C5 (0.022u) and resistor R7 (30k) are also connected to take smooth output waveform.

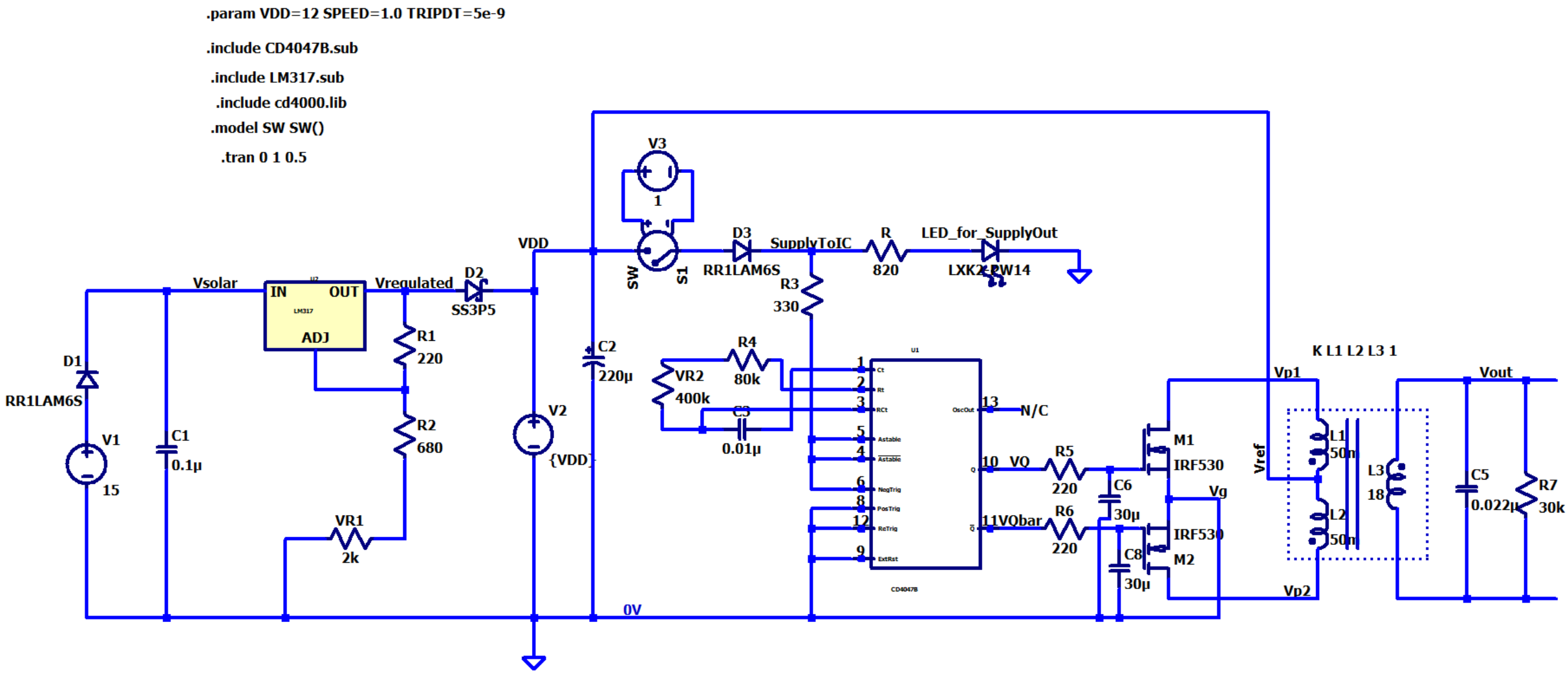




Complete circuit



Task 4: Plot Vp1, Vp2, Vp1-Vp2, Vout



Important NOTE

- Enter your **registration number** and **Full Name** next to

  all your circuits and
  the output plots.
- Keep the background of circuit and plot as white.

LAB record instructions:

For the lab experiment,

- Write the **Aim**.
- Complete the **Software/Hardware components used**.
- **Obtain the expression for the outputs.**
- Place the respective **circuits in LT Spice**.
- Connect the inputs and outputs. Name them and **write the same in the lab copy(inputs and outputs section)**.
- Use probe in LT spice to plot all possible combinations.
- Write a **concluding statement for each circuit**.
- **Submit** the document's soft copy **on time** in lms.vit.ac.in when available.

Source

- https://theorycircuit.com/pv-solar-inverter-circuit-diagram/