ANALYSIS OF POWER ELECTRONIC CONVERTERS DC/AC

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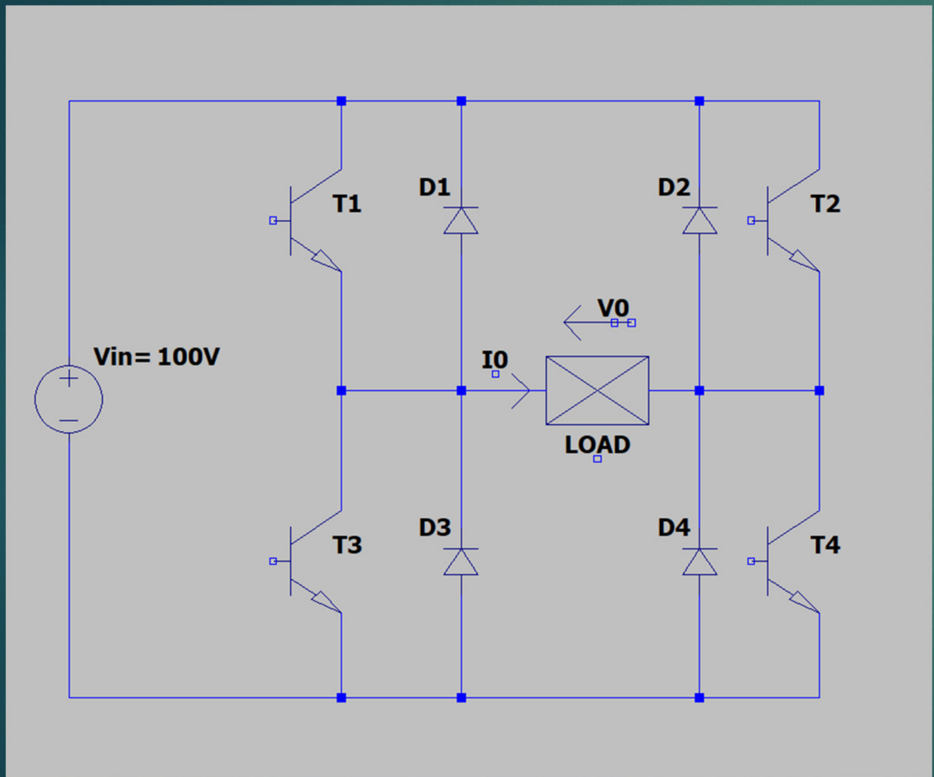
exercises 25, 26

ΑΣΚΗΣΗ 25

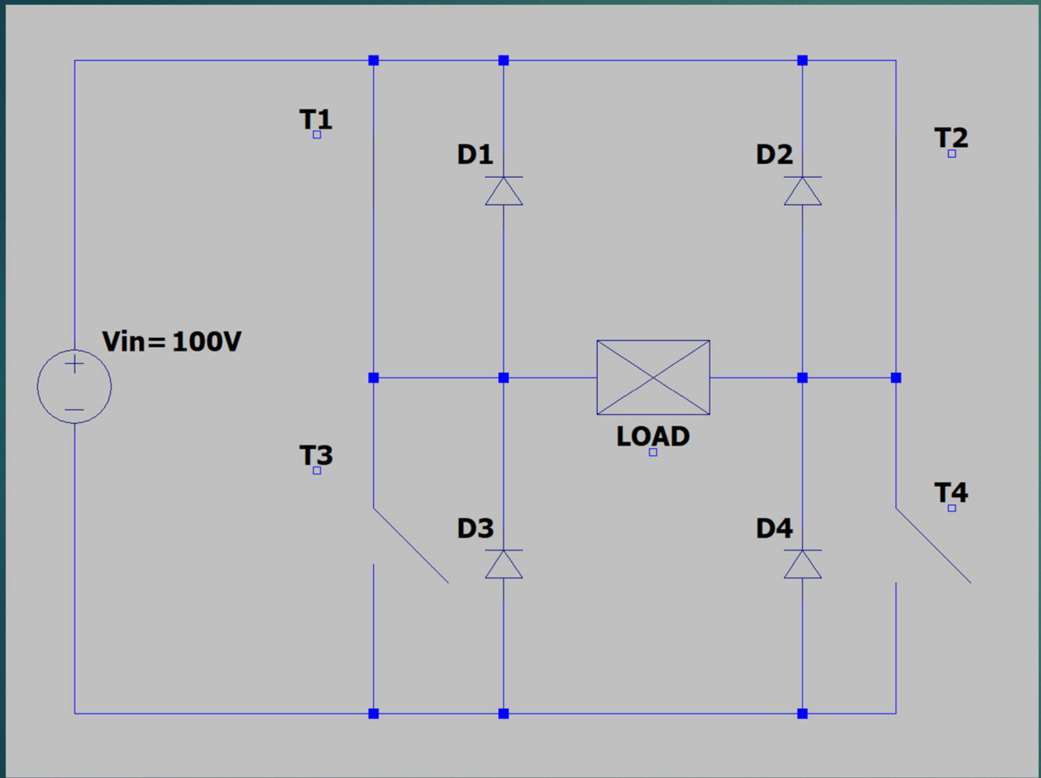


For the inverter of the adjacent figure, design the ignition pulses of the transistors, so that the output voltage of the inverter consists of rectangular pulses of 120^o width

Theoretical concepts:

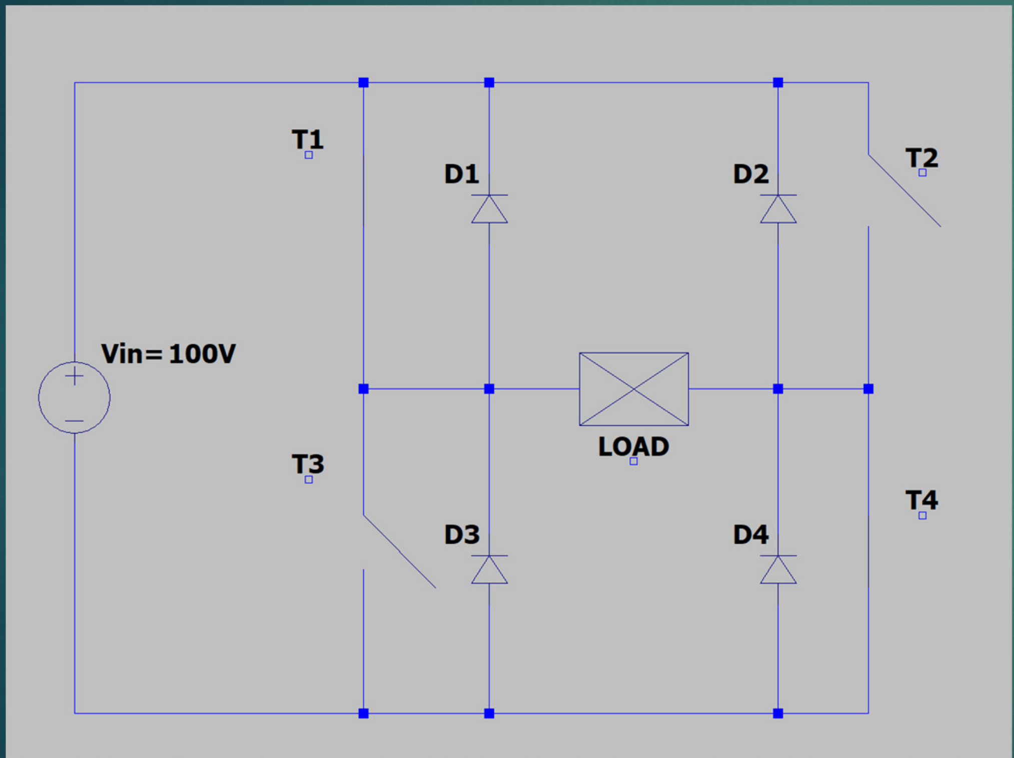
- We have 2 states that produce voltage at the output in which two diagonal transistors close at the same time.
- We have 2 redundant states V0 = 0 where in practice we get the same result. We use both states, so that all transistors have the same thermal stress. Otherwise <<hotspots>> will be created.
- Deadtime mode is the period of time during which no transistor conducts to make the transition from one state to another (one of 4) without a short circuit.
- Each transistor opens and closes once in each period in order to simplify the implementation of the digital pulsation circuit or the programming of the microcontroller.
- Each transistor opens and closes once in each period in order to simplify the implementation of the digital pulsation circuit or the programming of the microcontroller.
- The interpolation of zeros (V0 = 0) allows us to change the Rms value of the output voltage.
- With 90 degrees symmetry avoid harmonic components.

Transistor conduction T1, T2



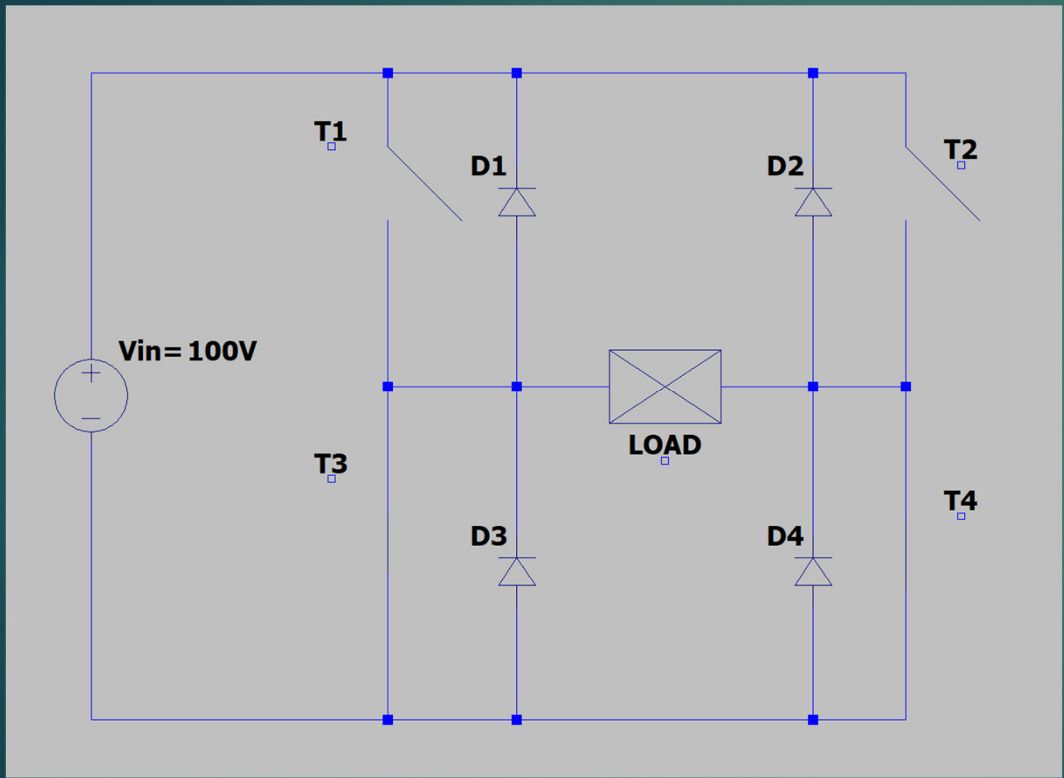
When transistors T1, T2 are pulsed, the voltage on load is V0 = 0 V, regardless of the current flow.

Transistor conduction T1,T4



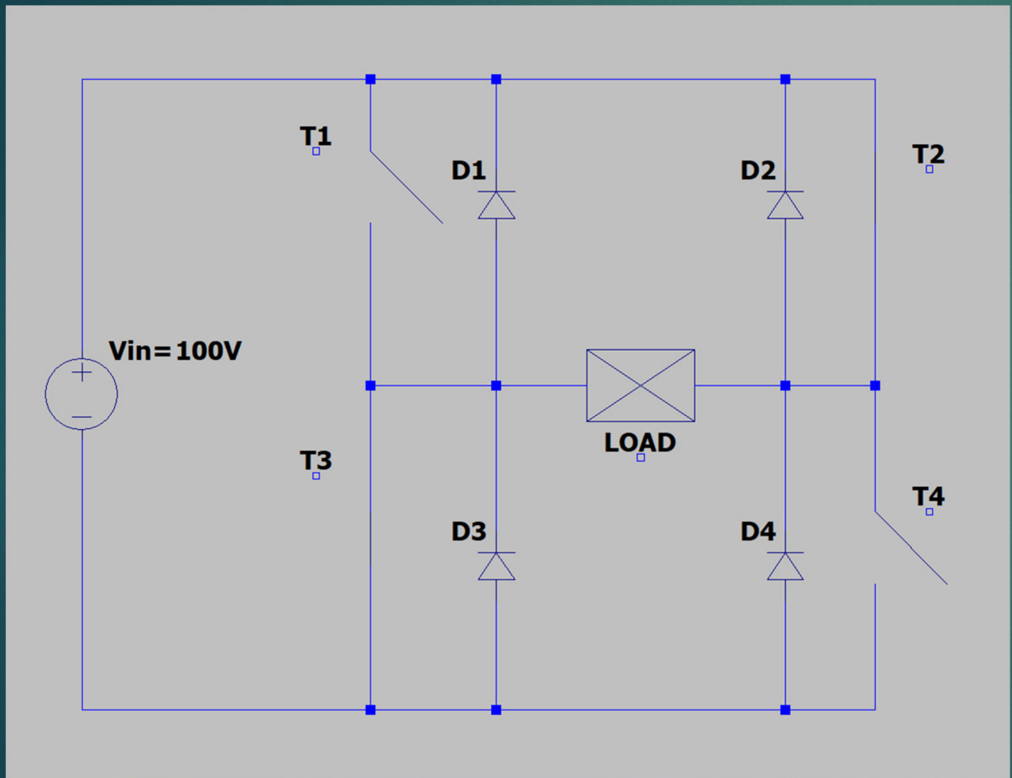
When transistors T1, T4 are pulsed, the voltage on load is V0 = 100V

Transistor conduction T3,T4



When the transistors T3, T4 are pulsed, the voltage on load is V0 = 0V, regardless of the load current flow.

Transistor conduction T2,T3

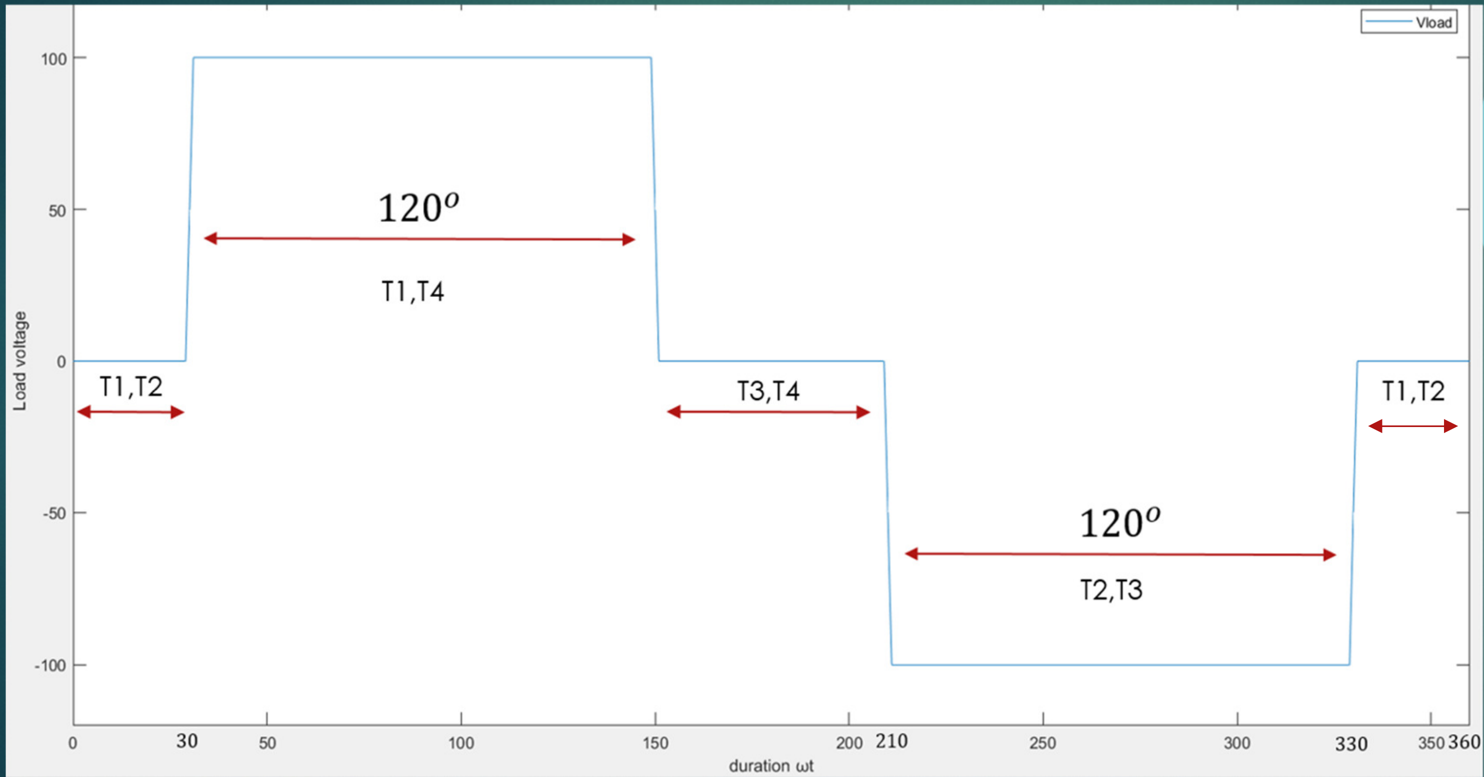


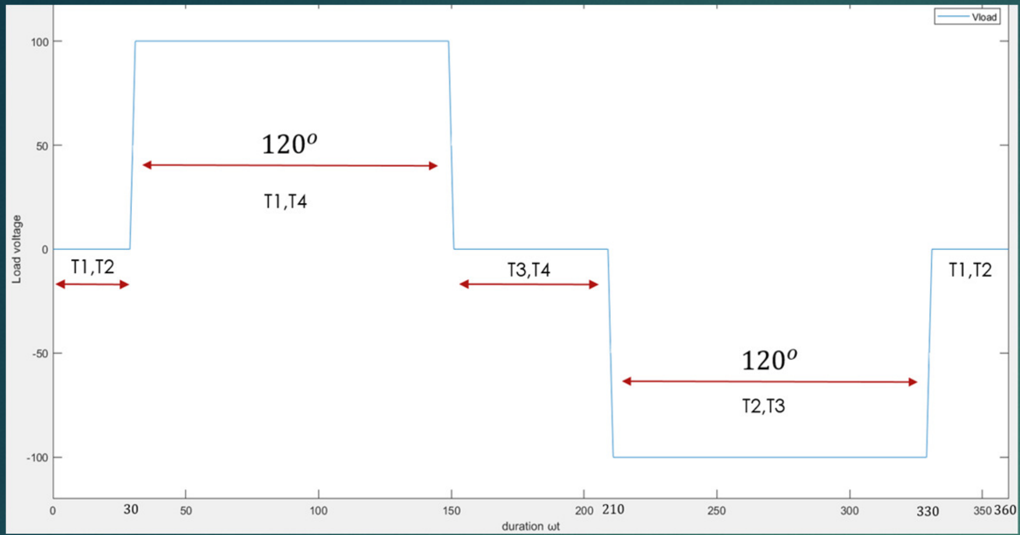
When transistors T2, T3 are pulsed, the voltage on load is V0 = -100V

- According to what has been said before, the conduction intervals in a period are the following:

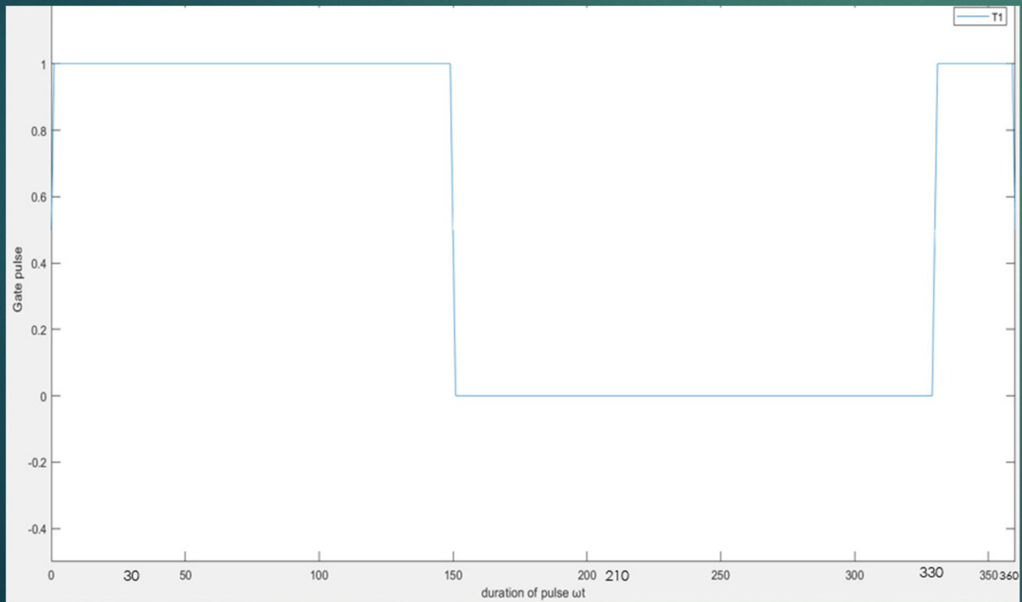
- Interval 1: pulses T1, T2 from 330 to 30 degrees (0V)
- Interval 2: T1, T4 are pulsed from 30 to 150 degrees (100V)
- Interval 3: pulses T3, T4 from 150 to 210 degrees (0V)
- Interval 4: T2, T3 are pulsed from 210 to 330 degrees (-100V)
- Between 2 consecutive intervals is the dead time, in which T1, T2, T3, T4 are open.

All the previous lead to this type o Load Voltage

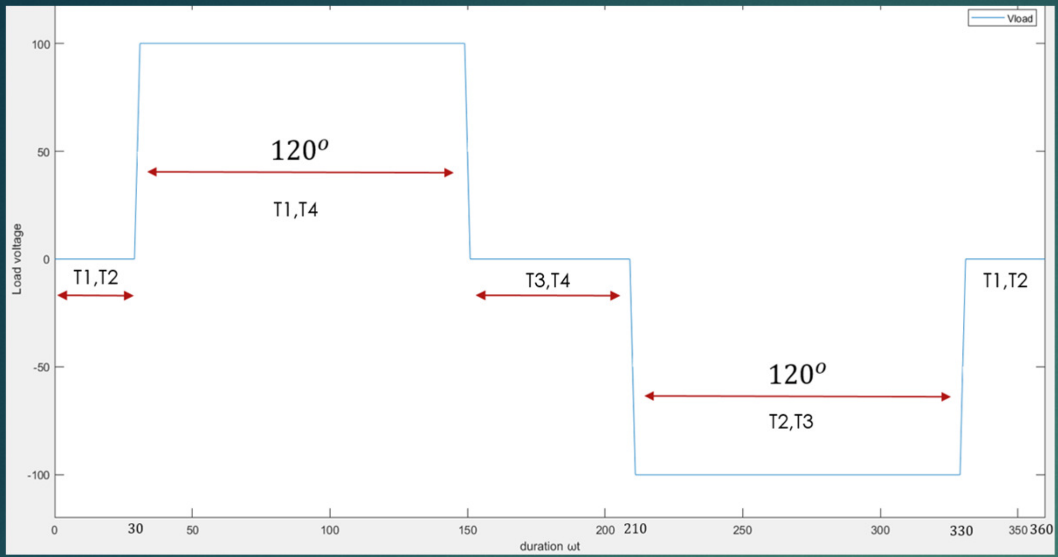




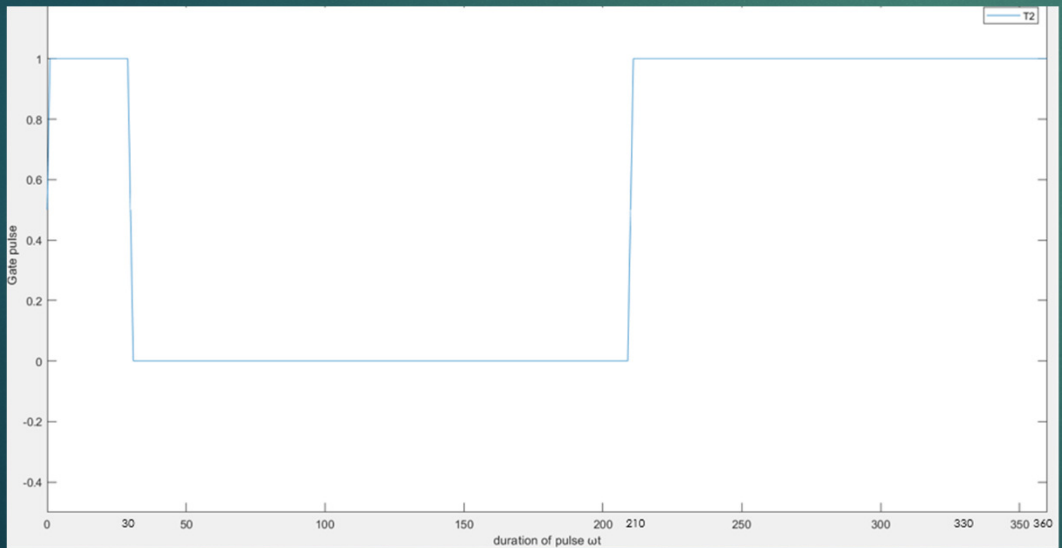
Waveform of Load voltage



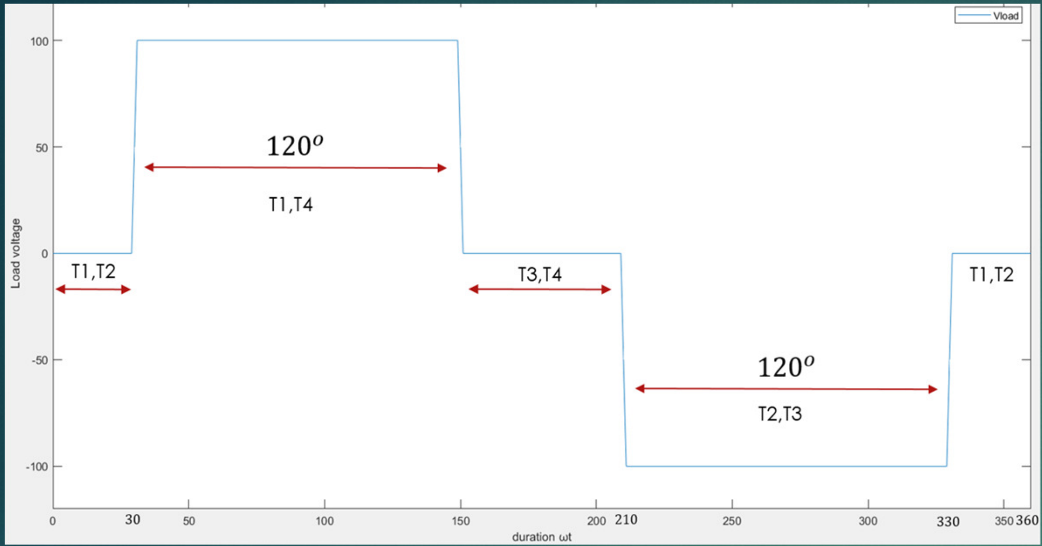
Pulse on T1's base



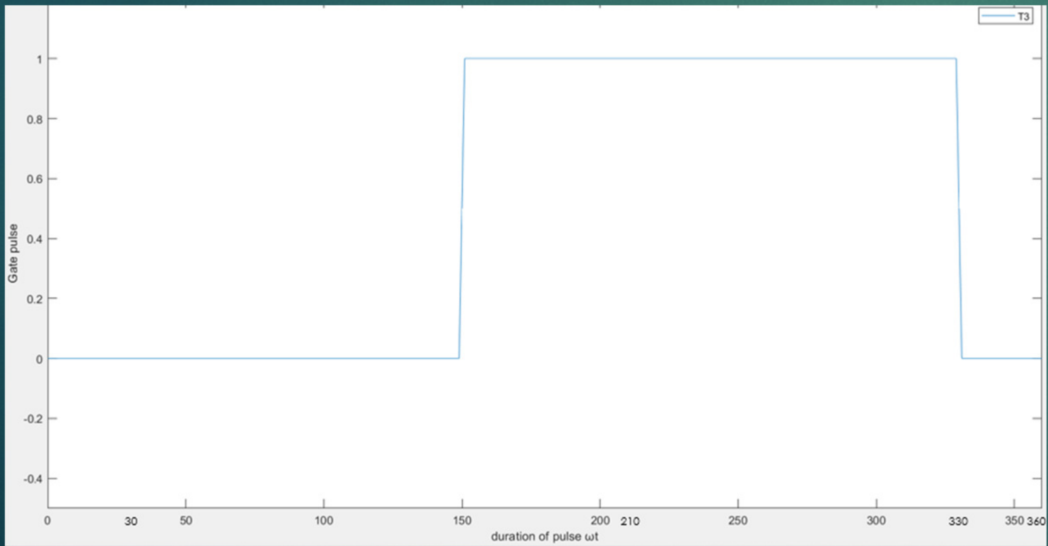
Waveform of Load voltage



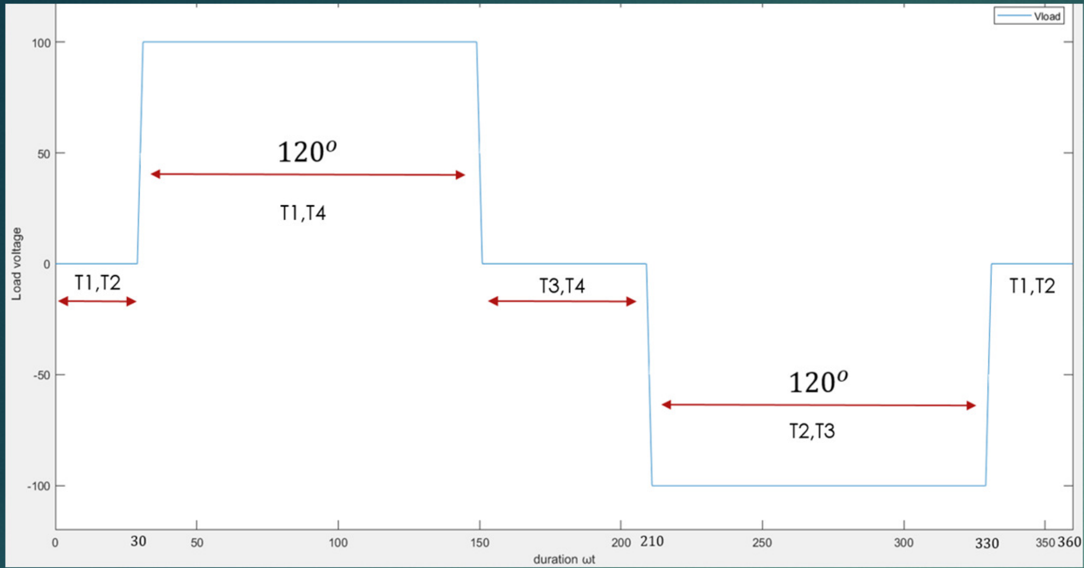
Pulse on T2's base



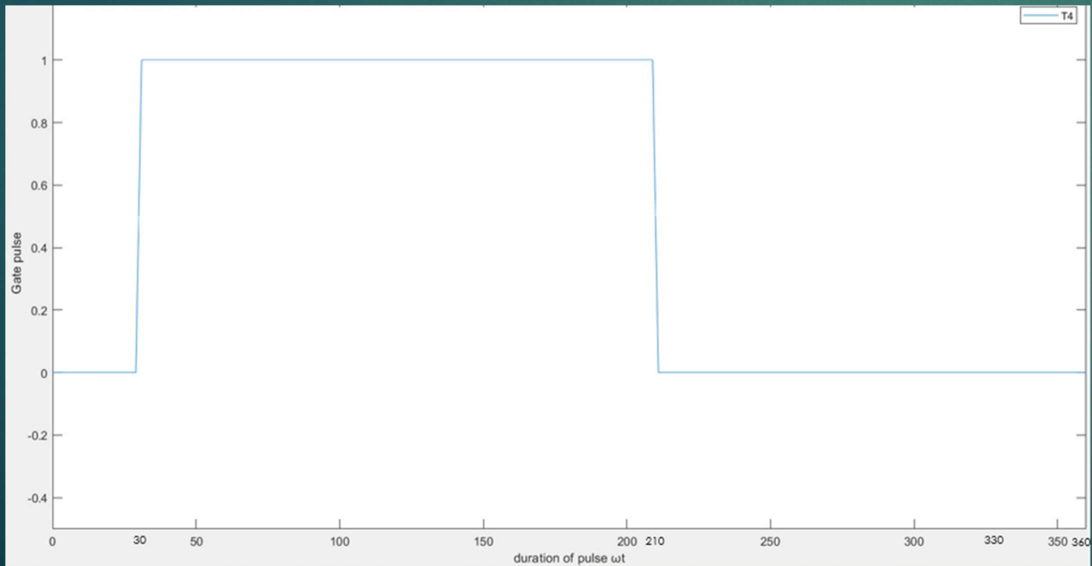
Waveform of Load voltage



Pulse on T3's base

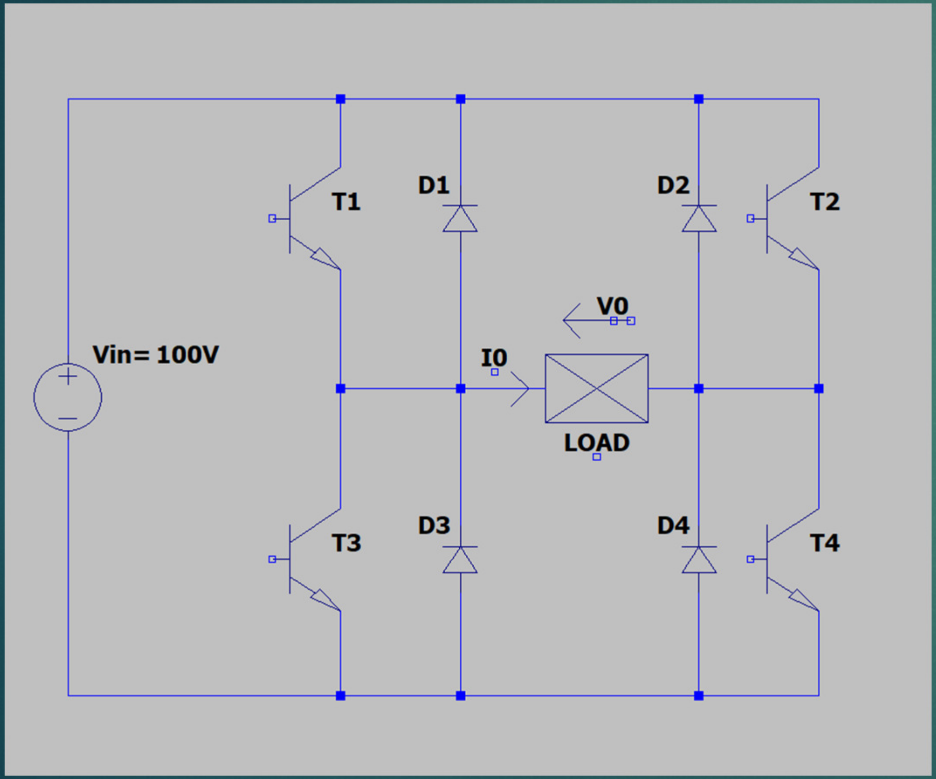


Waveform of Load voltage

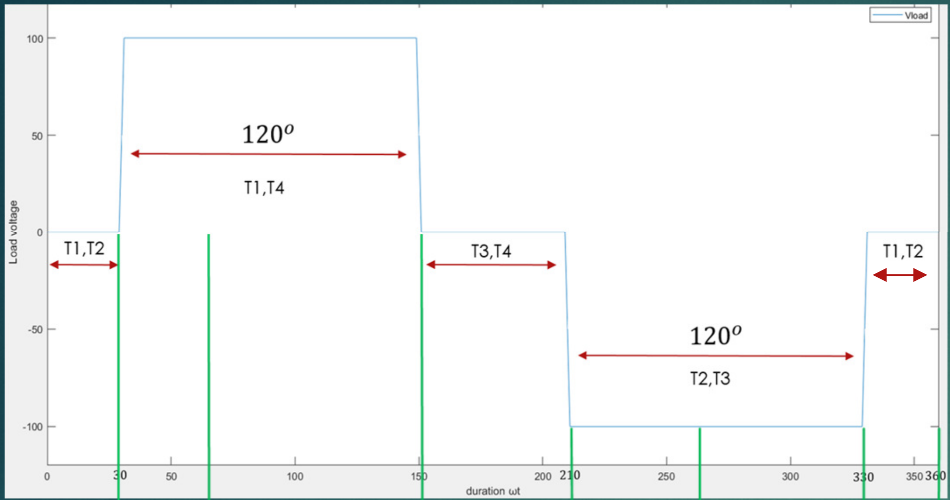


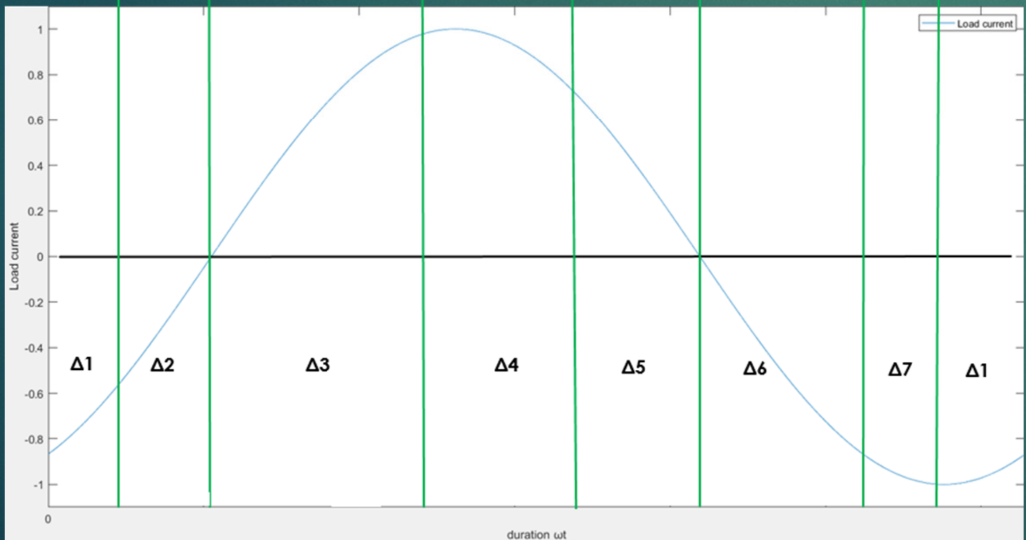
Pulse on T4's base

EXERCISE 26



For the inverter of the previous example, the voltage and current waveform are shown above. What are the waveforms of current of the semiconductor devices?



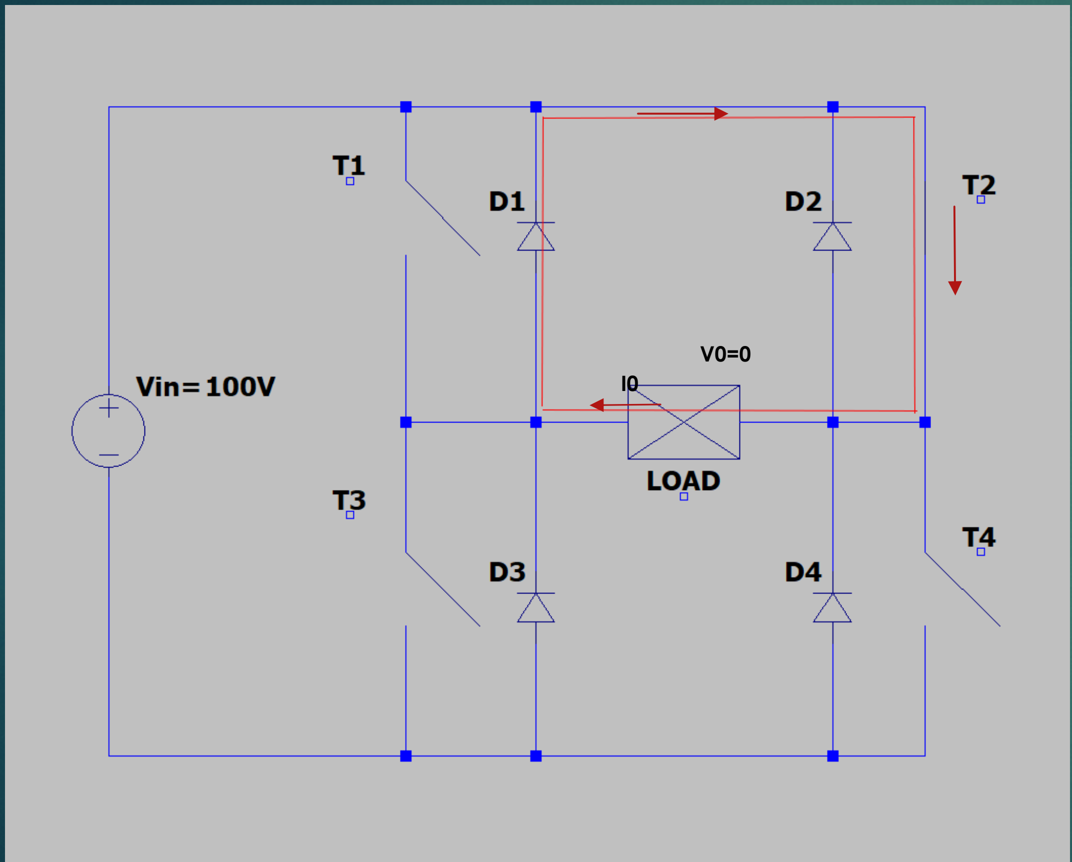


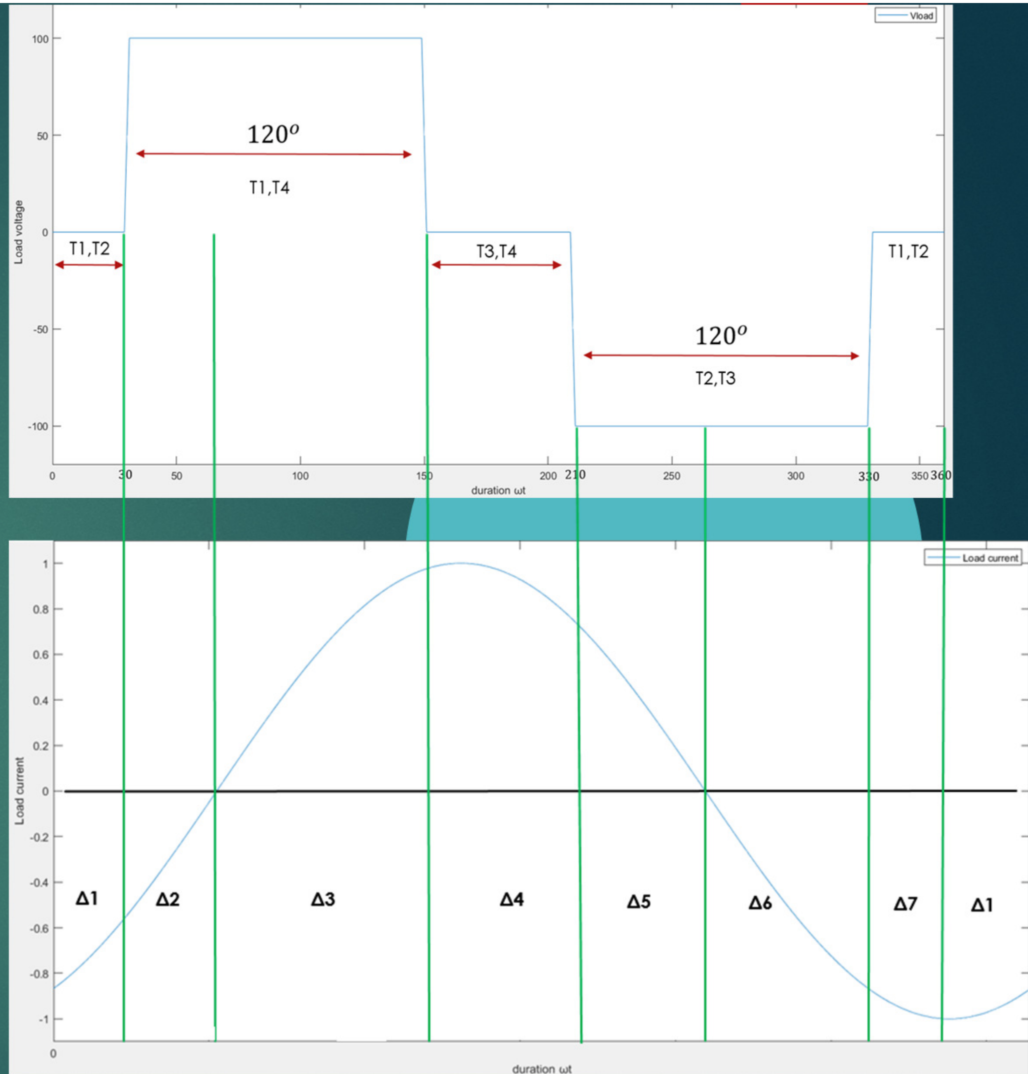
Waveform of voltage

and

Waveform of current

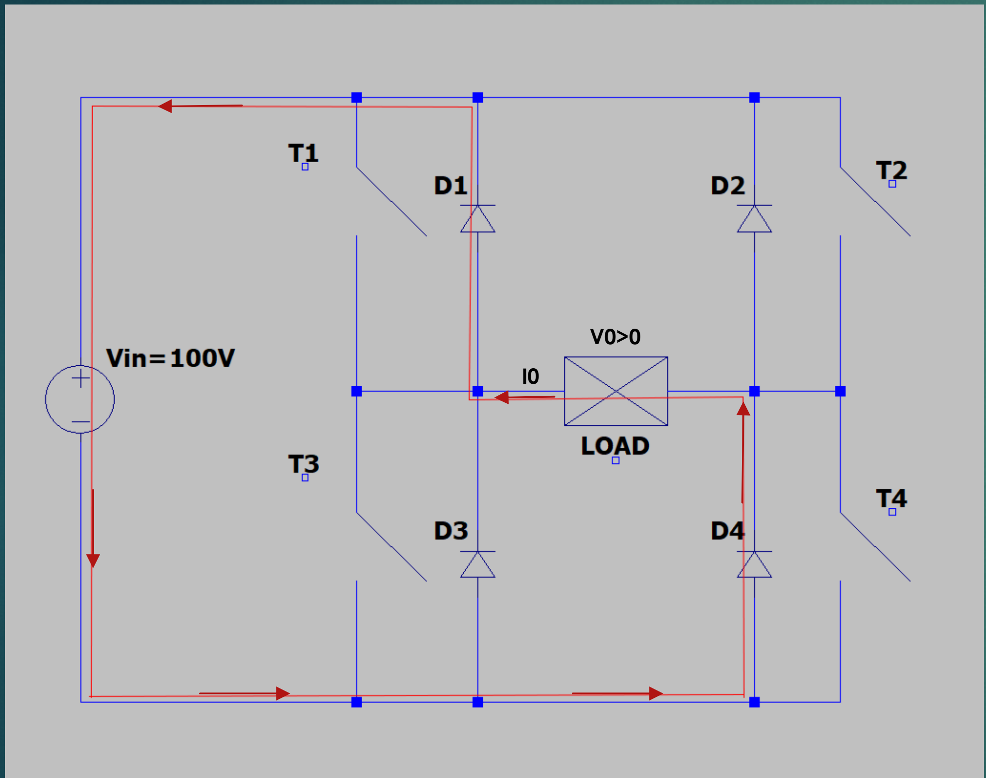
TIME INTERVAL 1

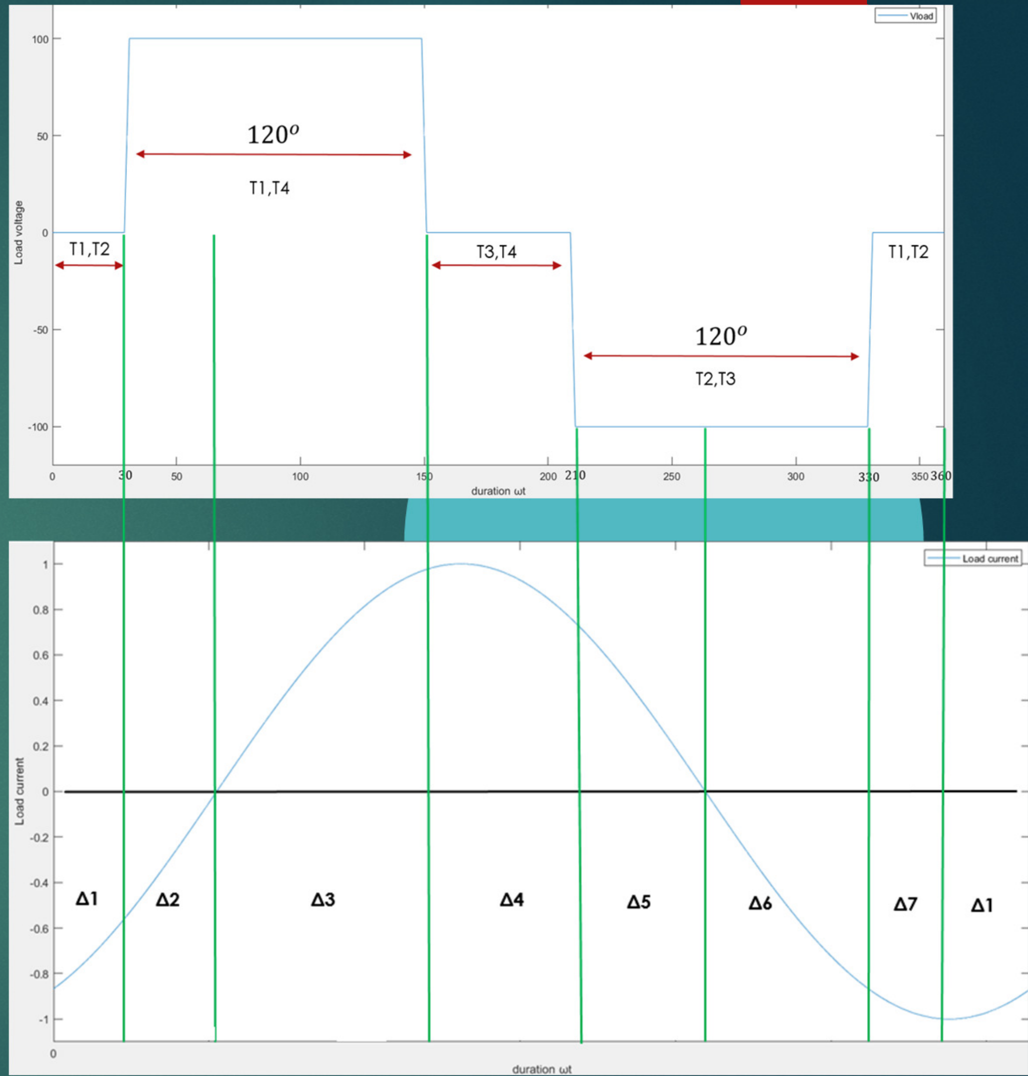




*0 voltage and negative output current -> zero power (V0 * I0 = 0), there is no energy transfer. In conduction: D1,T2*

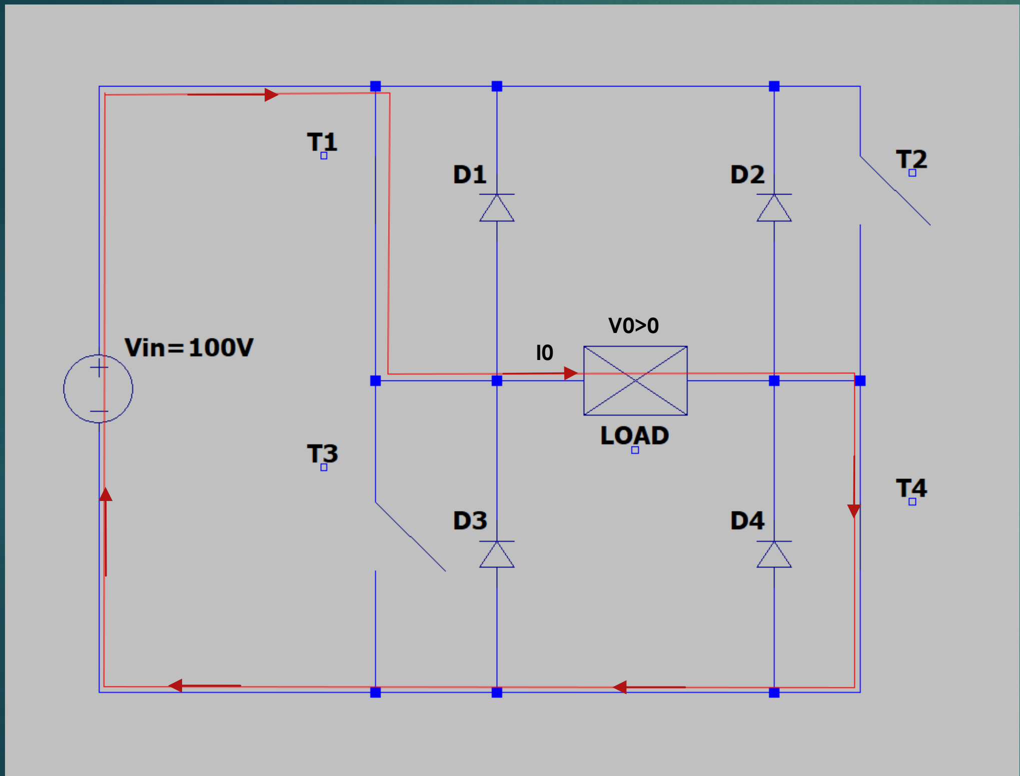
TIME INTERVAL 2

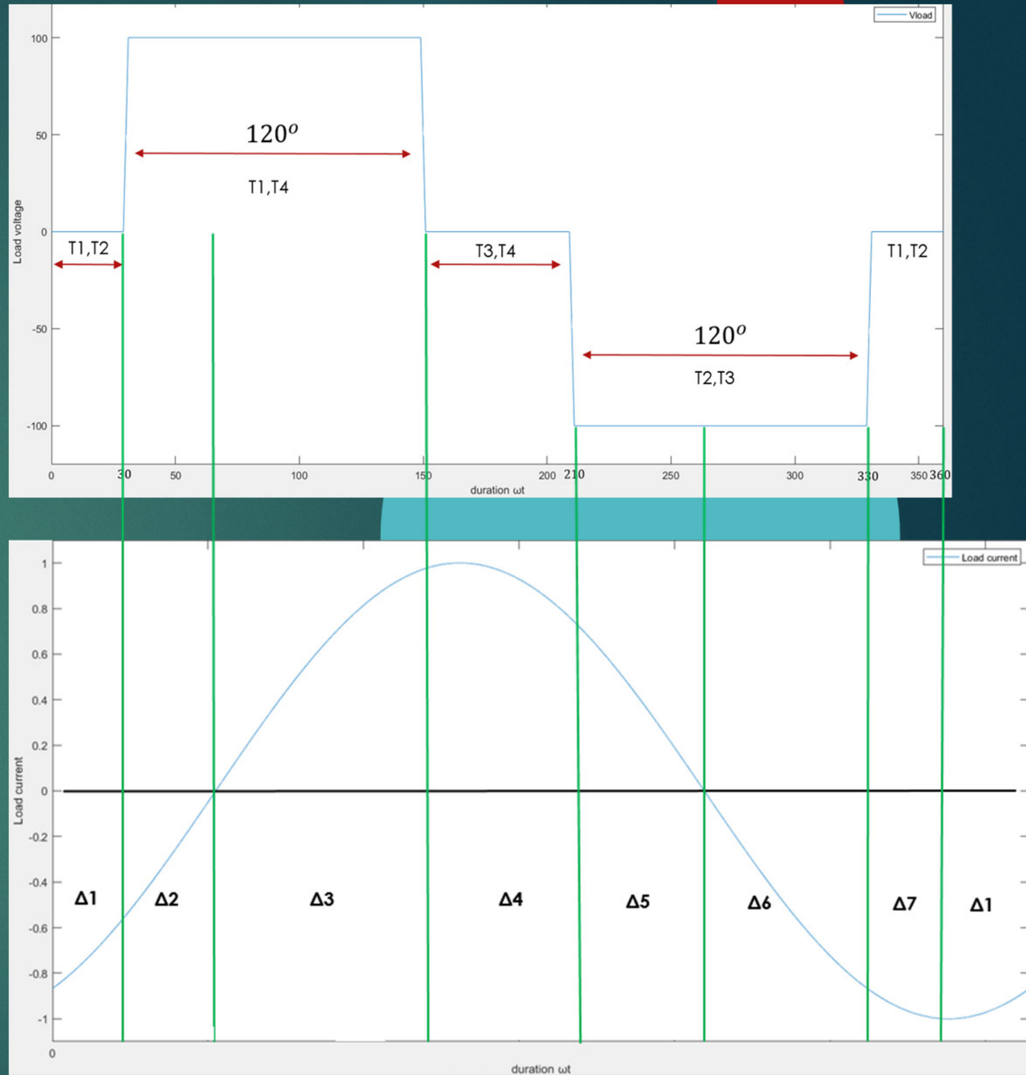




Positive voltage and negative current -> negative power($V0 * I0 < 0$), energy is transferred from load to source. In conduction: D1,D4.

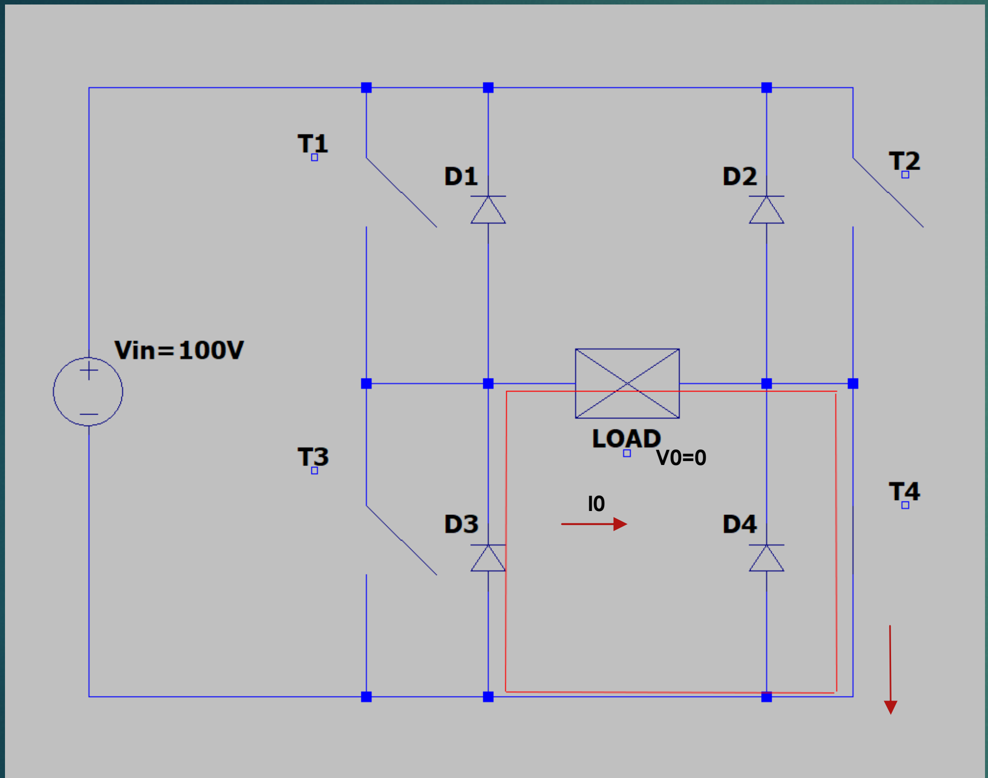
TIME INTERVAL 3

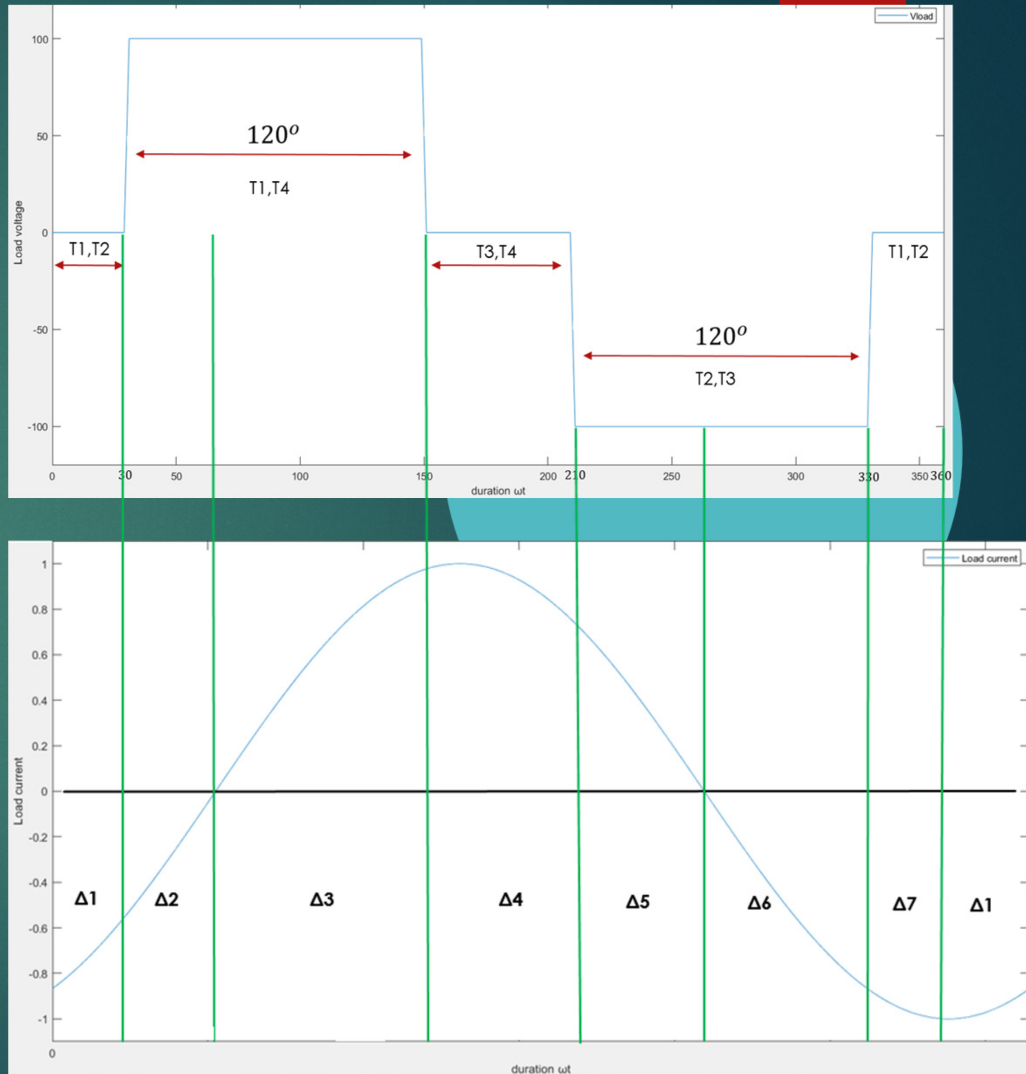




Positive voltage and positive current-> positive power ($V0 * I0 > 0$), energy is transferred from source to load. In conduction : T1,T4.

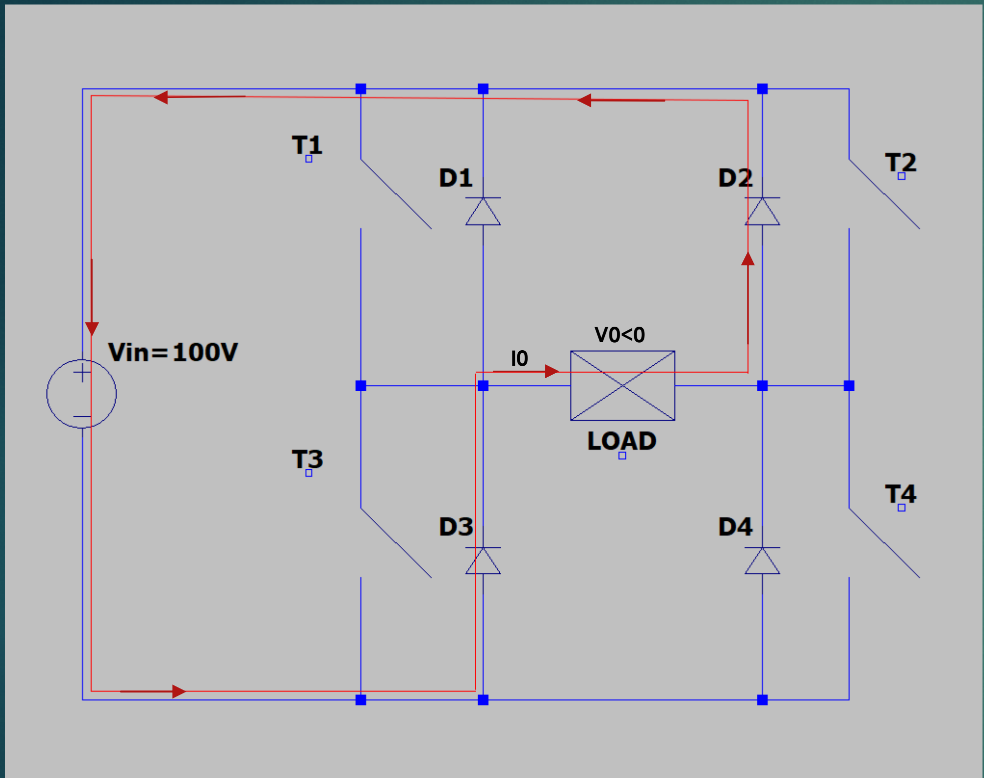
TIME INTERVAL 4

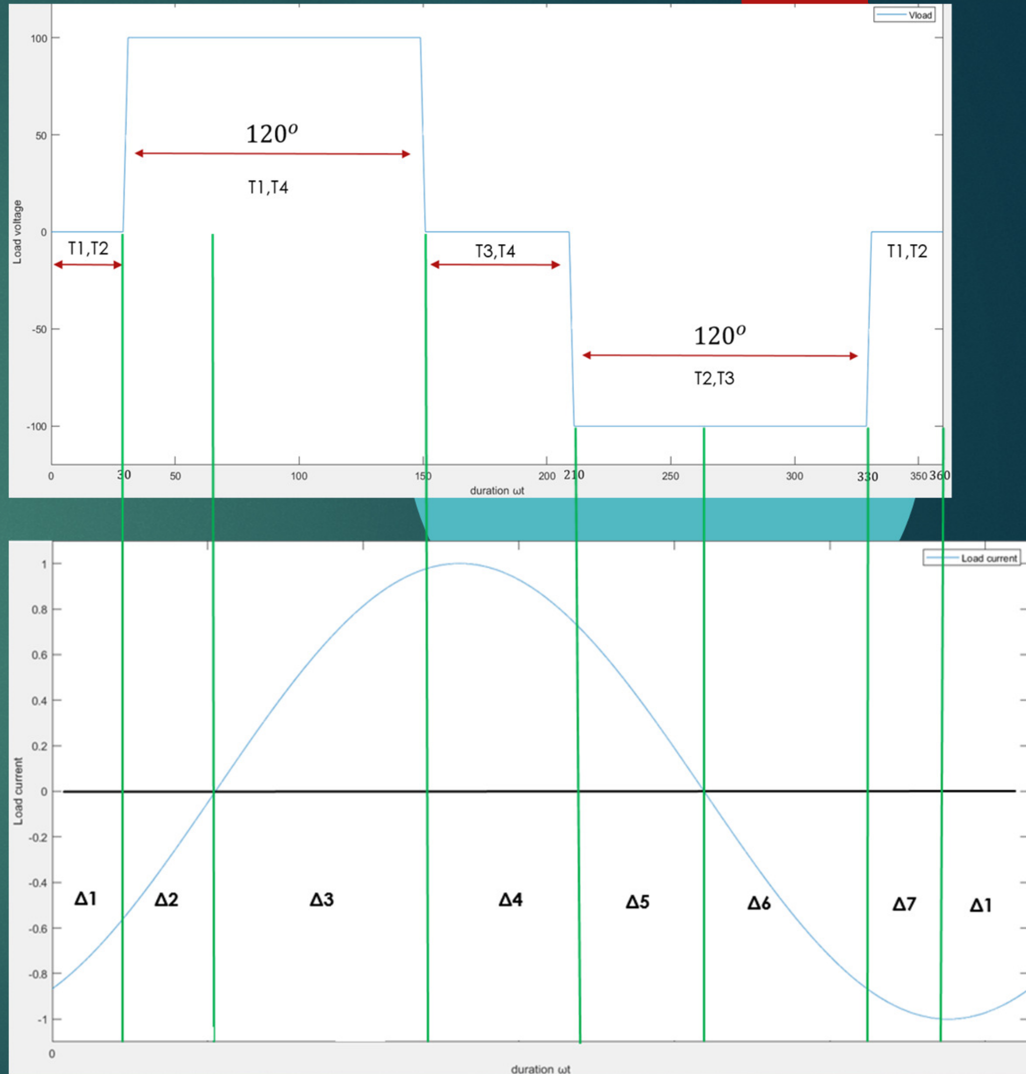




0 voltage and positive output current -> zero power ($V0 * I0 = 0$), there is no energy transfer. In conduction : T4,D3.

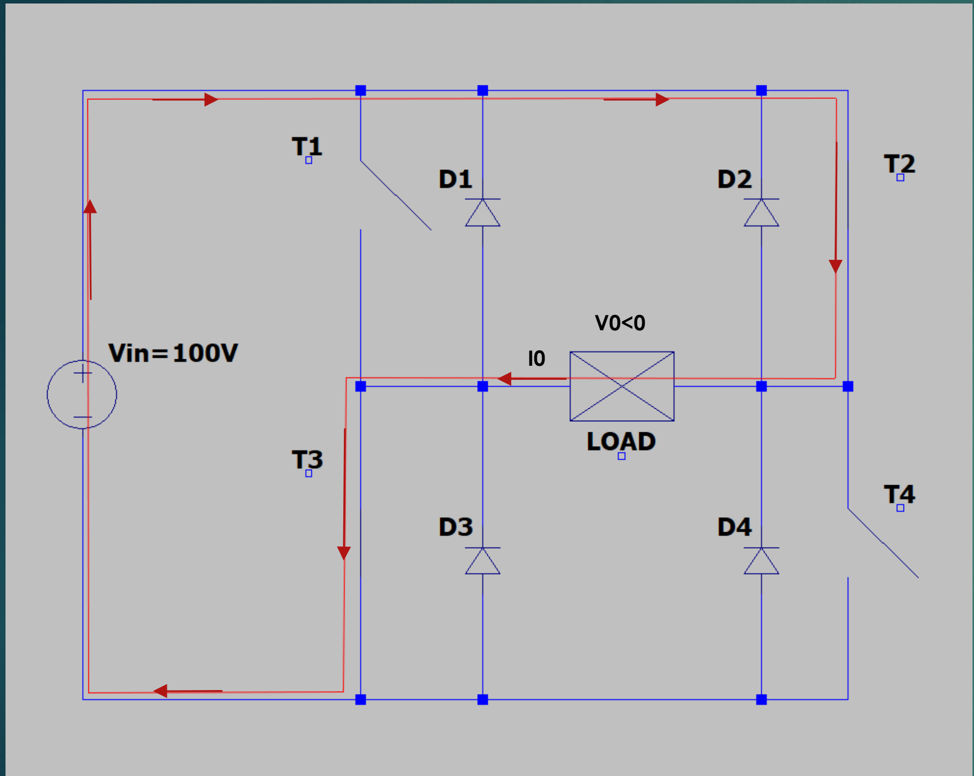
TIME INTERVAL 5

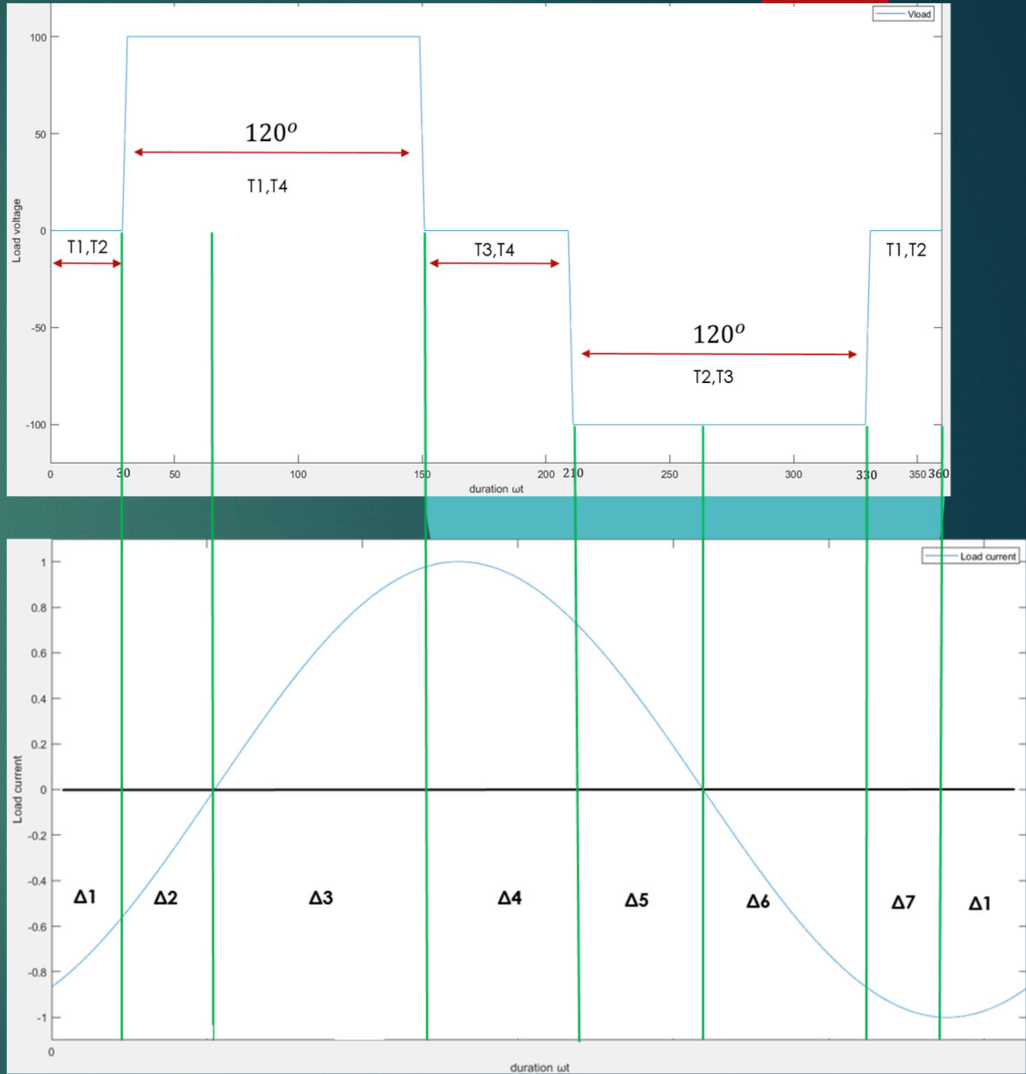




Negative voltage and positive output current-> negative power ($V0 * I0 < 0$), energy transferred from load to source. In conduction : D2,D3.

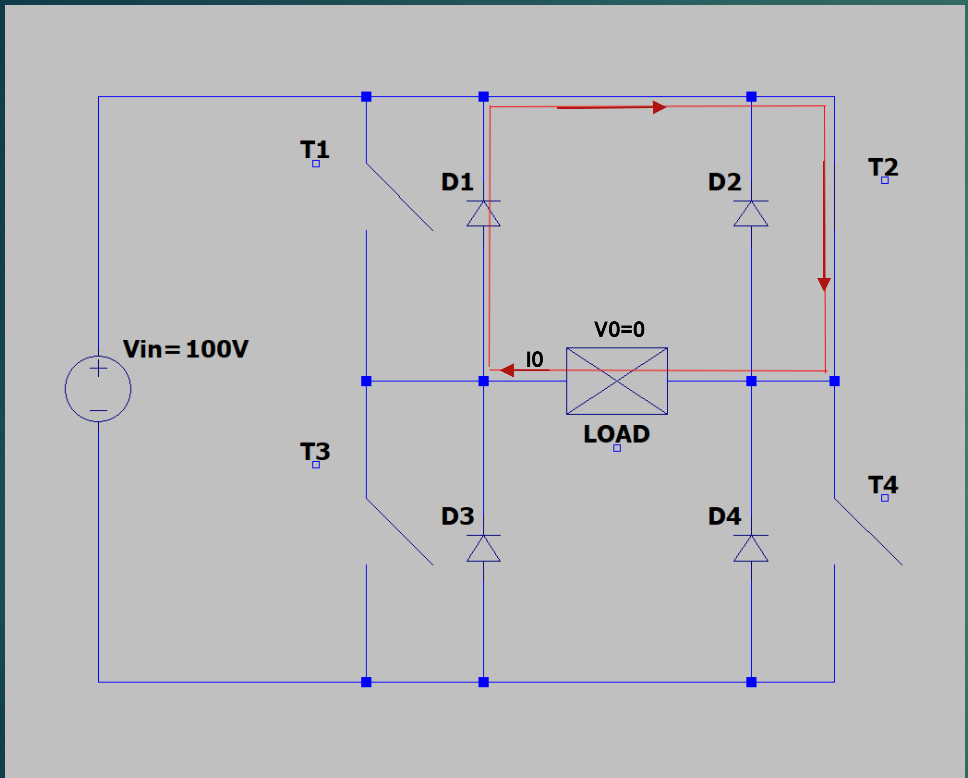
TIME INTERVAL 6

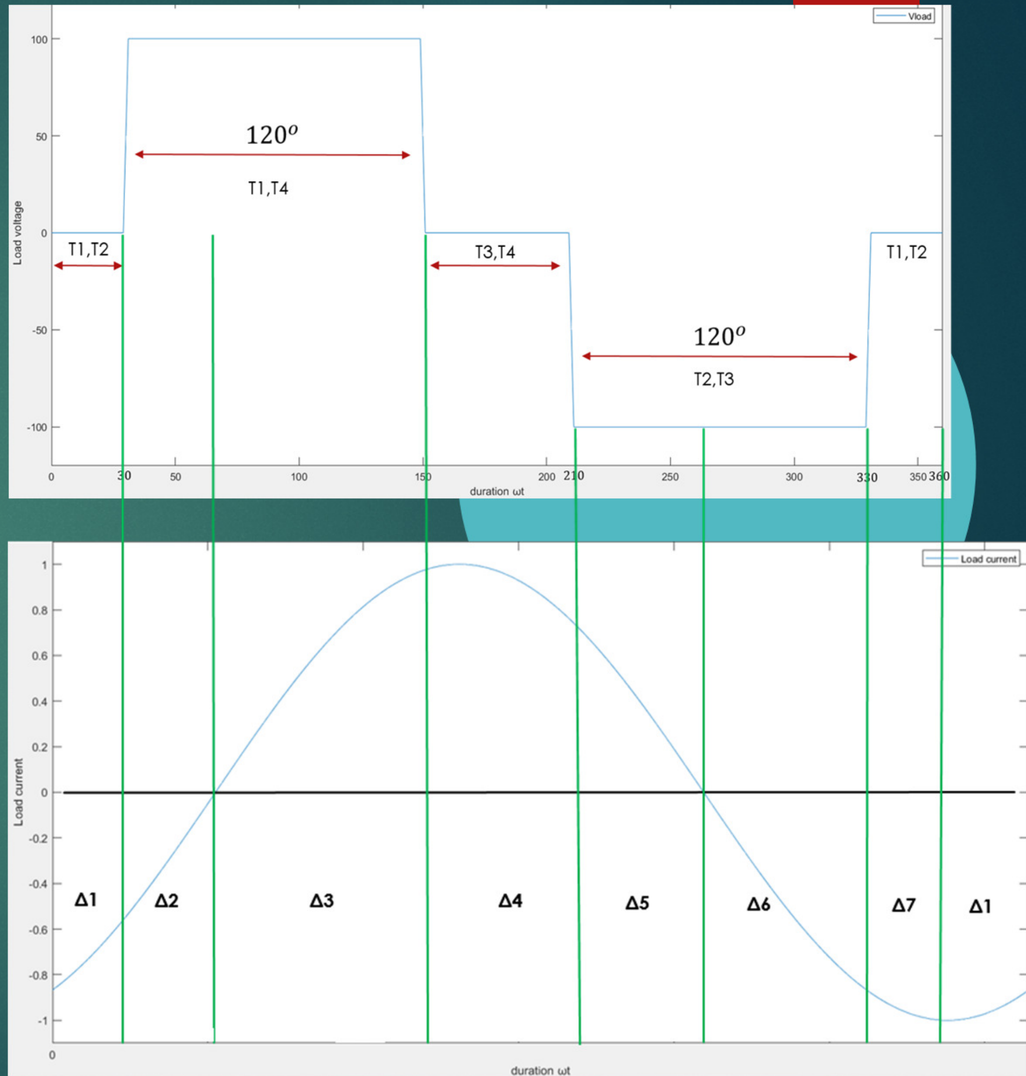




Negative voltage and negative output current -> positive power ($V0 * I0 > 0$), energy is transferred from source to load. In conduction : T2,T3.

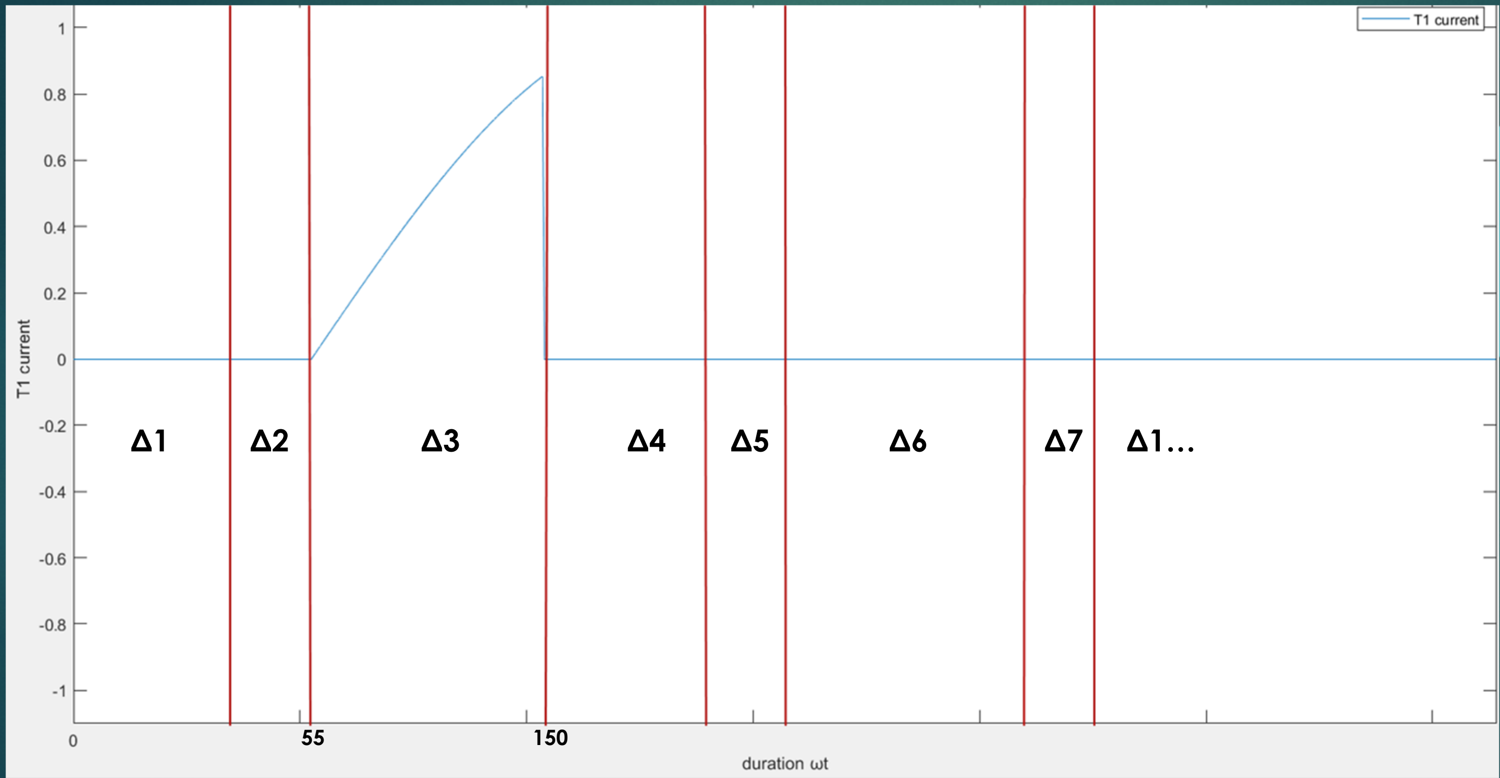
TIME INTERVAL 7





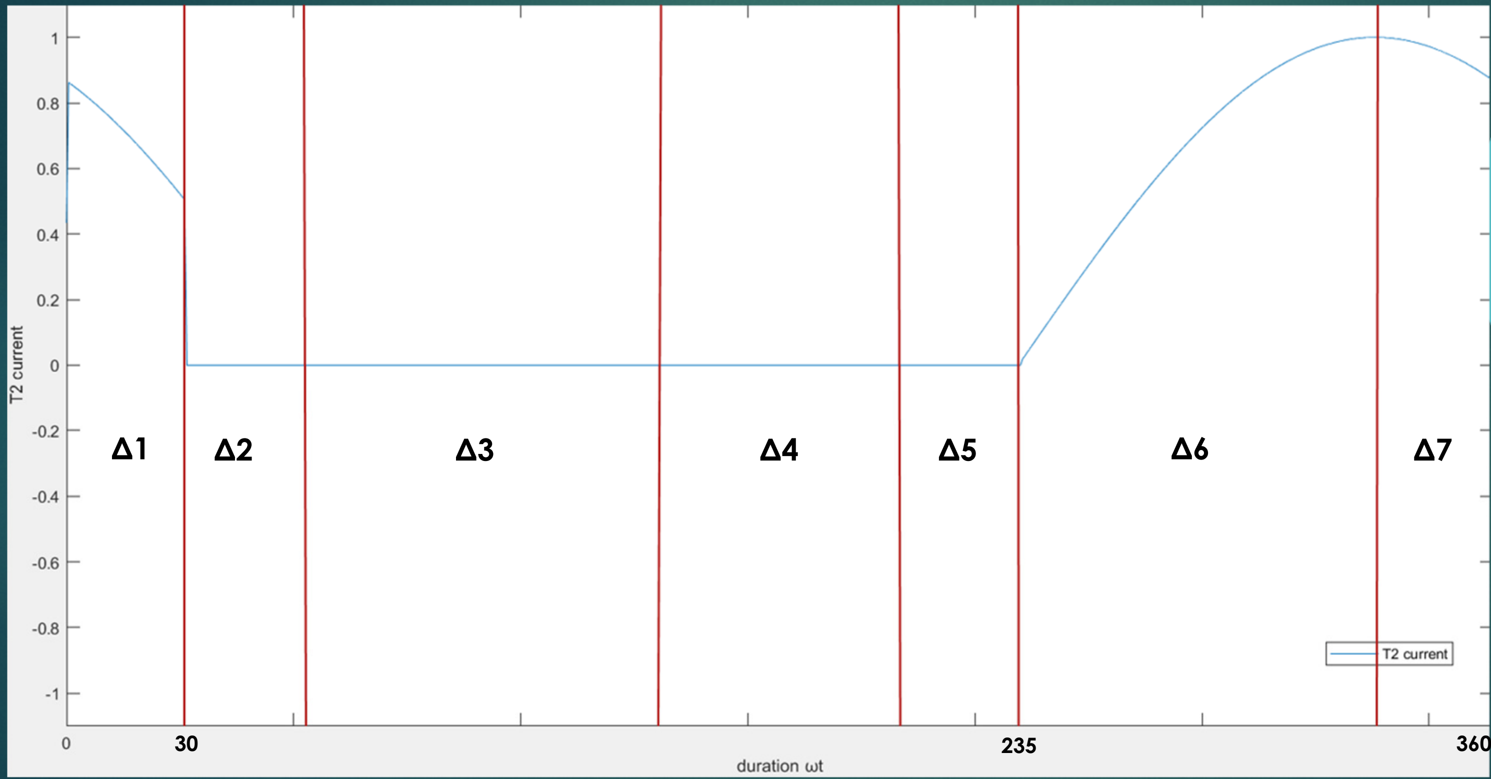
0 voltage and negative output current-> zero power $(V0 * I0 = 0)$*, there is no energy transfer.*
In conduction : D1,T2.

T1's current



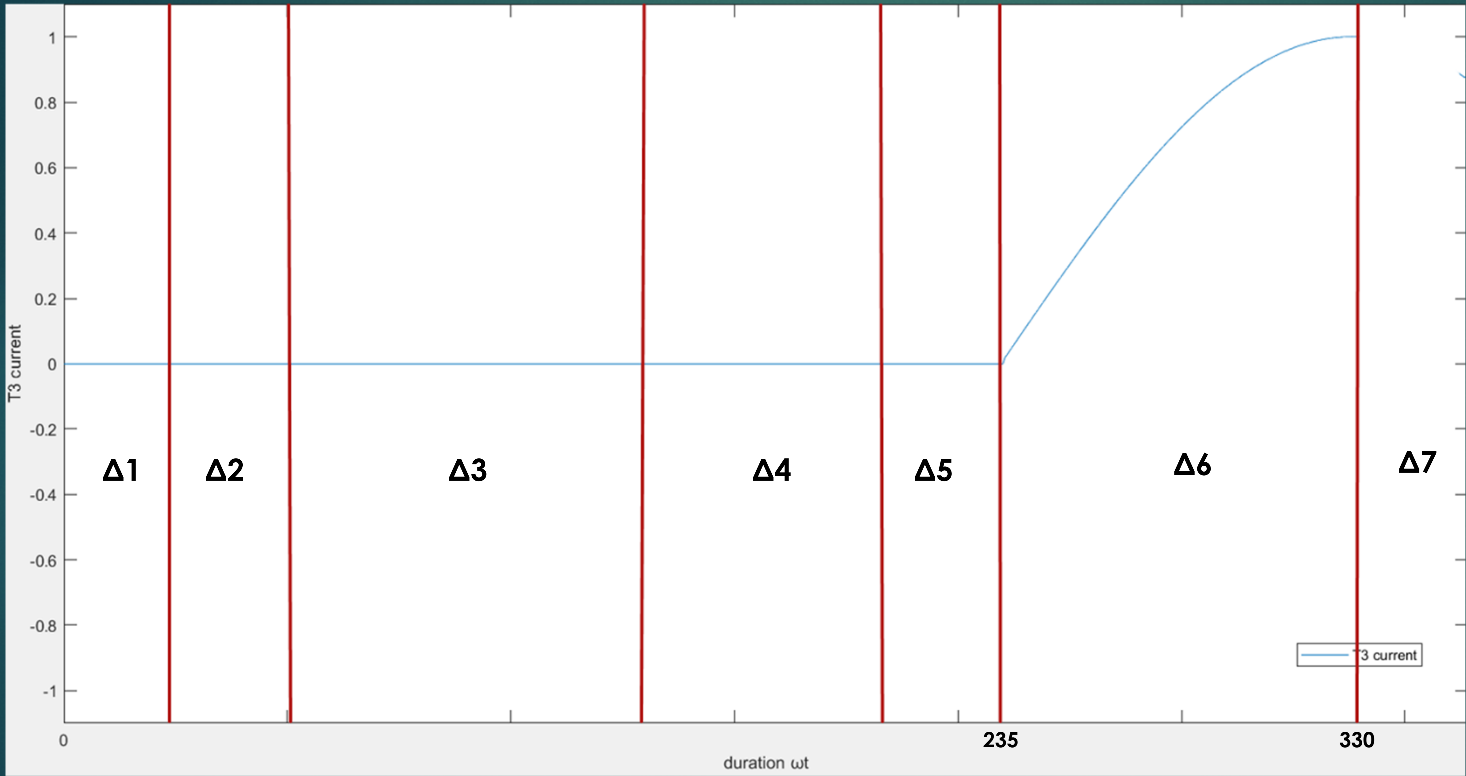
T1 current
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
T1 current
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7
Δ1…
0
55
150
duration ωt

T2’s current



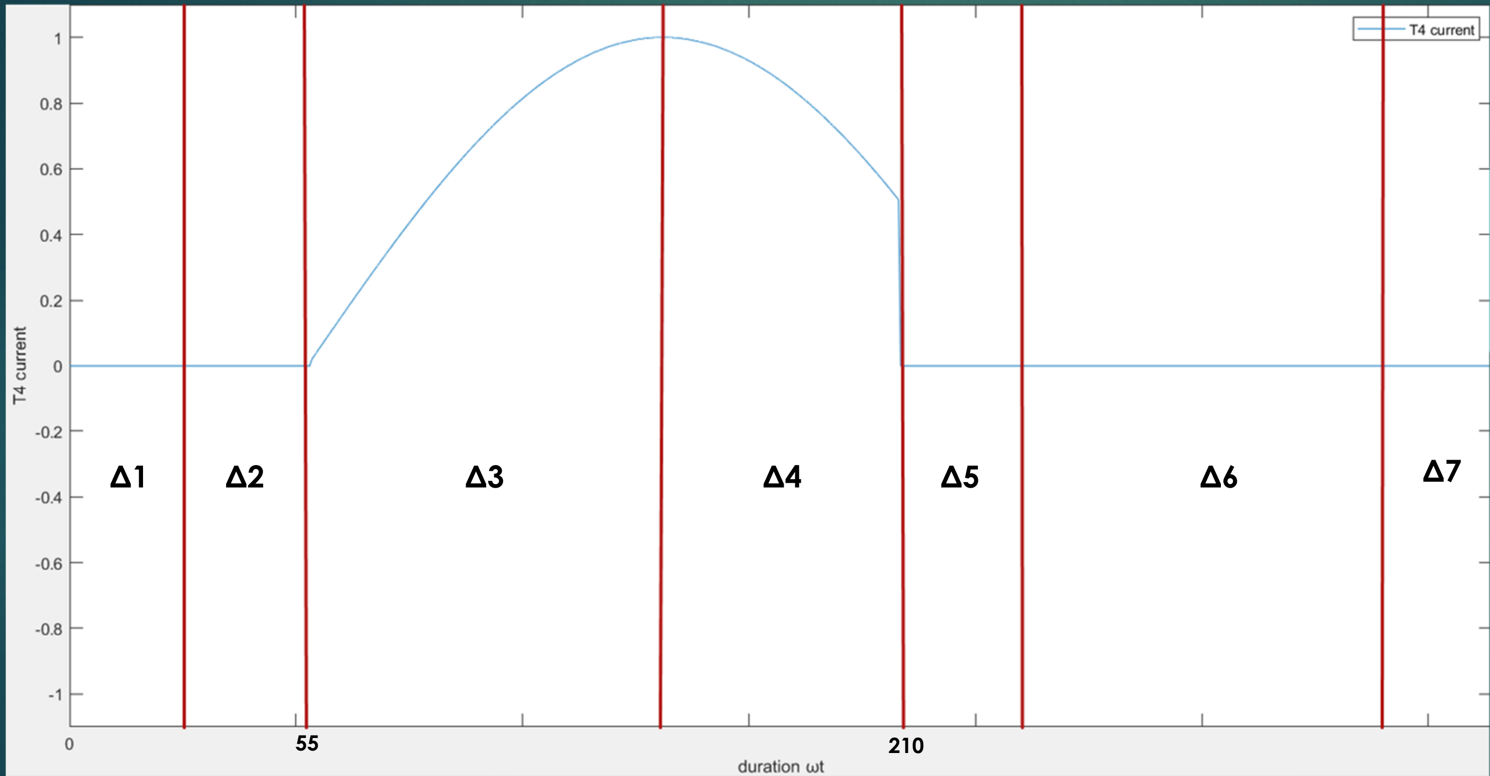
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
T2 current
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7
T2 current
0
30
235
360
duration ωt

T3's current



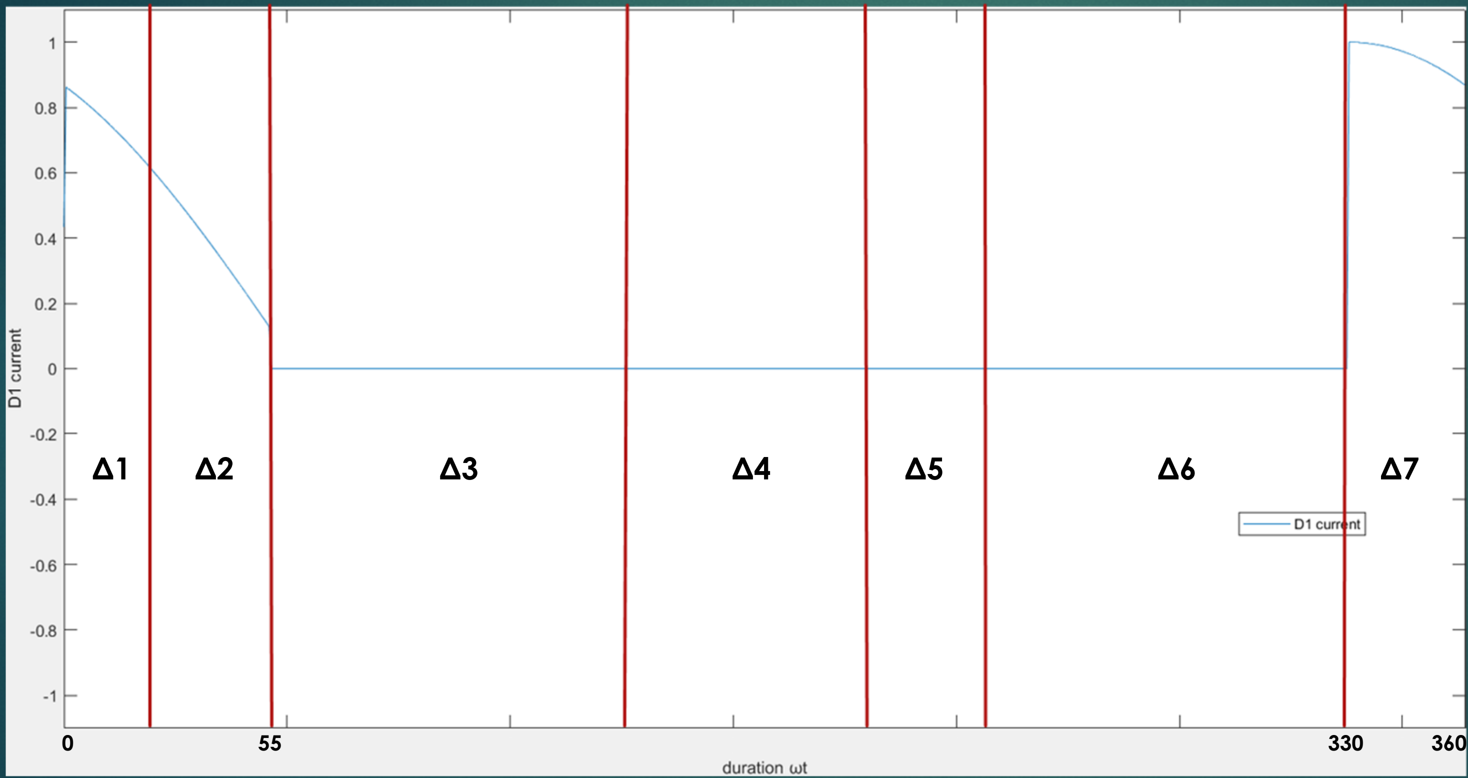
T3 current
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7
T3 current
0
235
330
duration ωt

T4's current



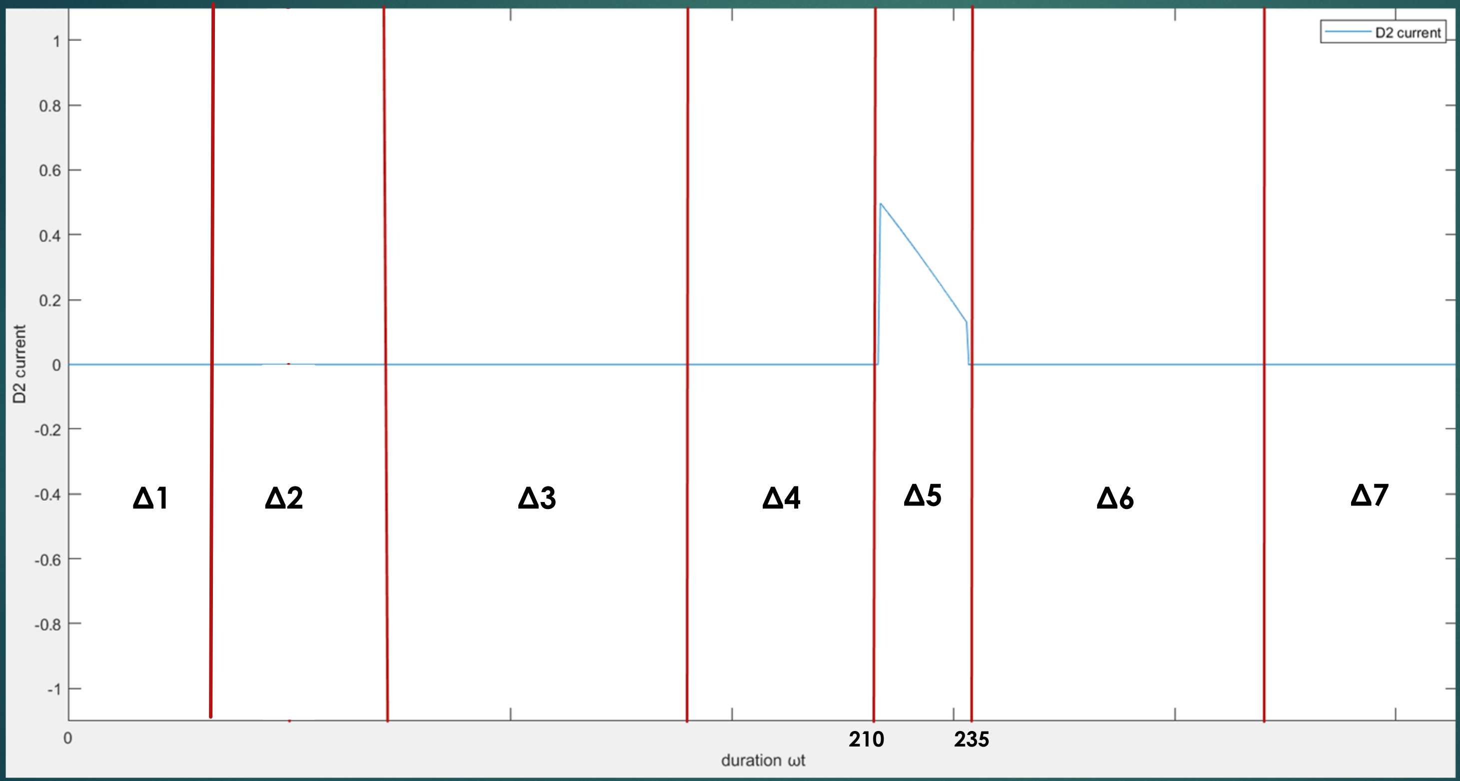
T4 current
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
55
210
duration ωt
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7

D1's current



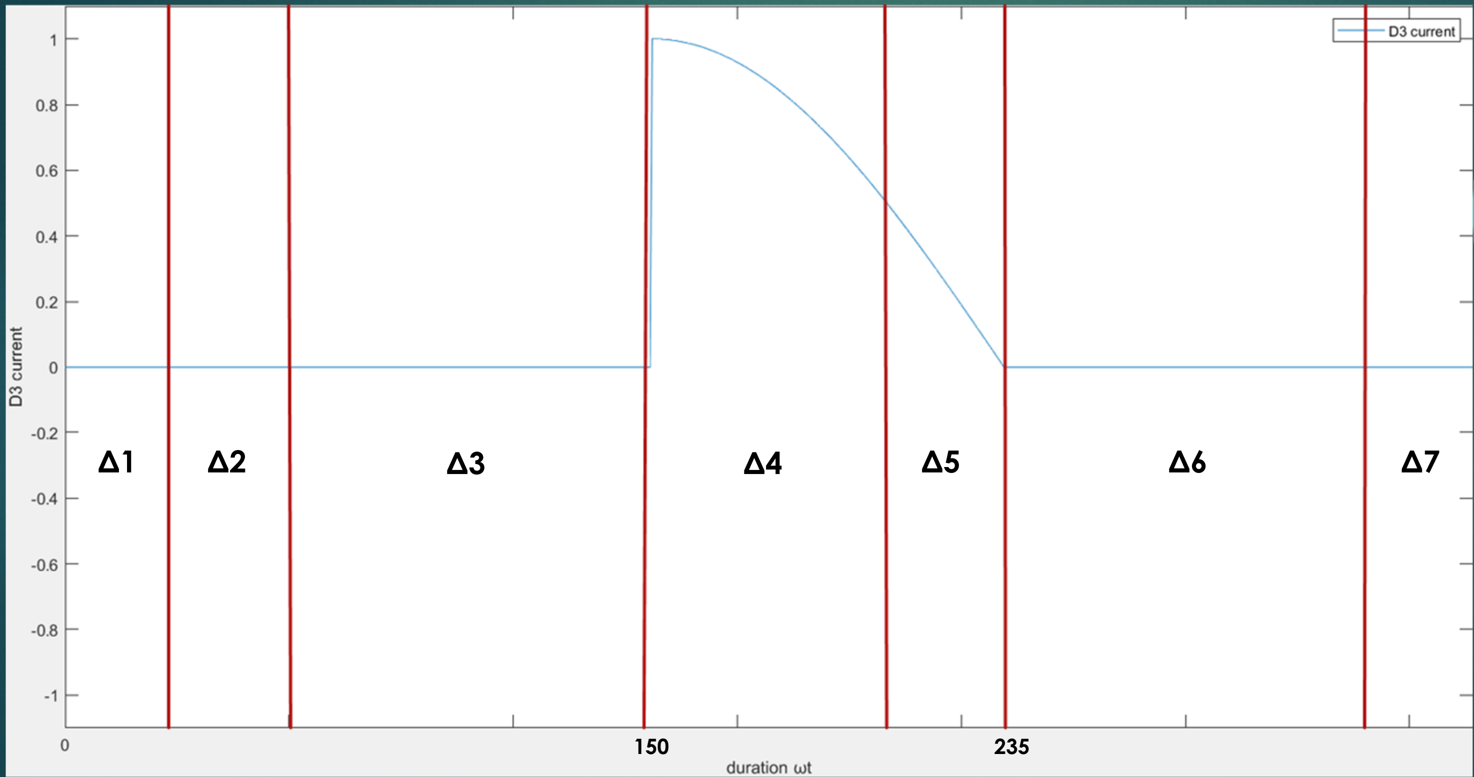
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
D1 current
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7
D1 current
0
55
330
360
duration ωt

D2's current



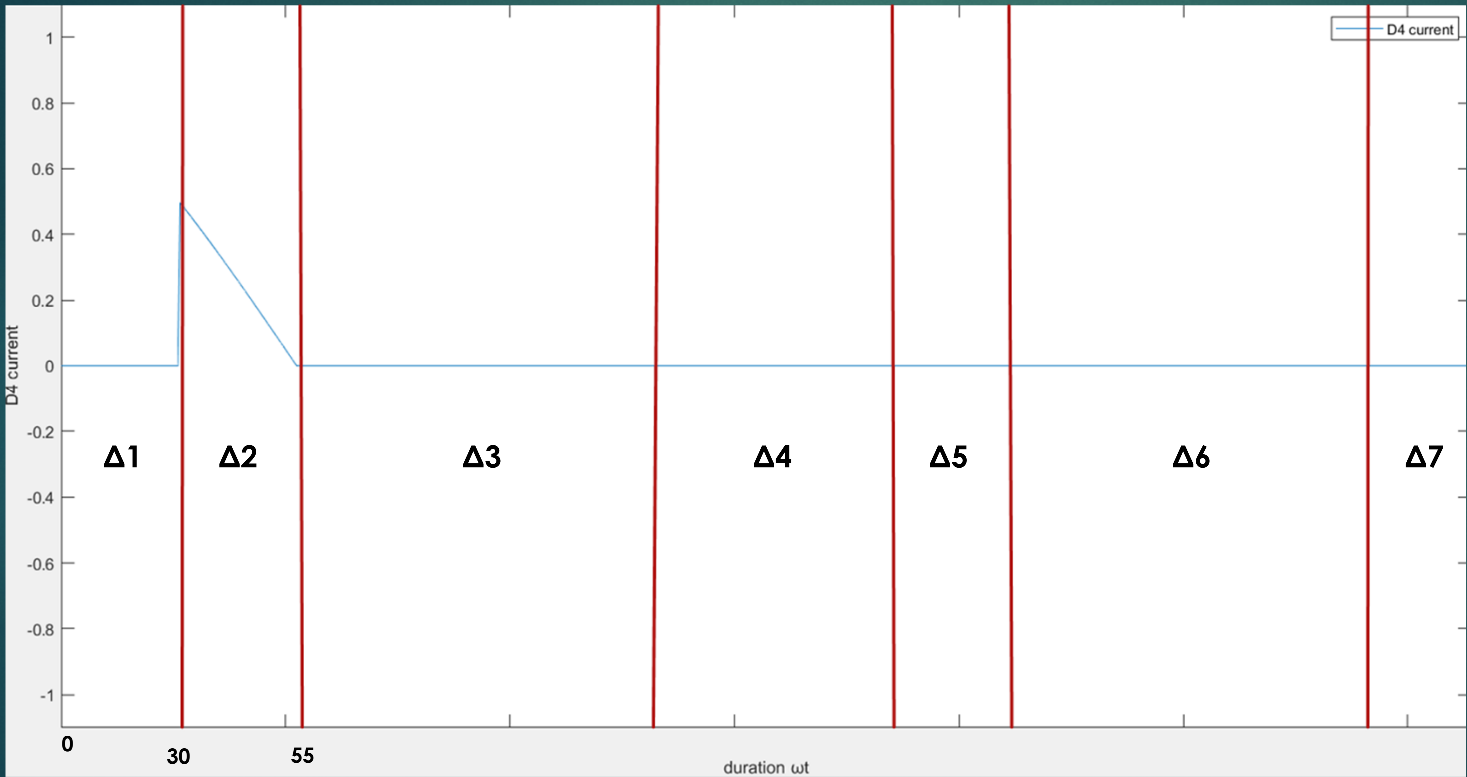
D2 current
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7
0
210
235
duration ωt

D3's current



D3 current
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
150
235
duration ωt
D3 current
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7

D4's current



D4 current
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
D4 current
Δ1
Δ2
Δ3
Δ4
Δ5
Δ6
Δ7
0
30
55
duration ωt