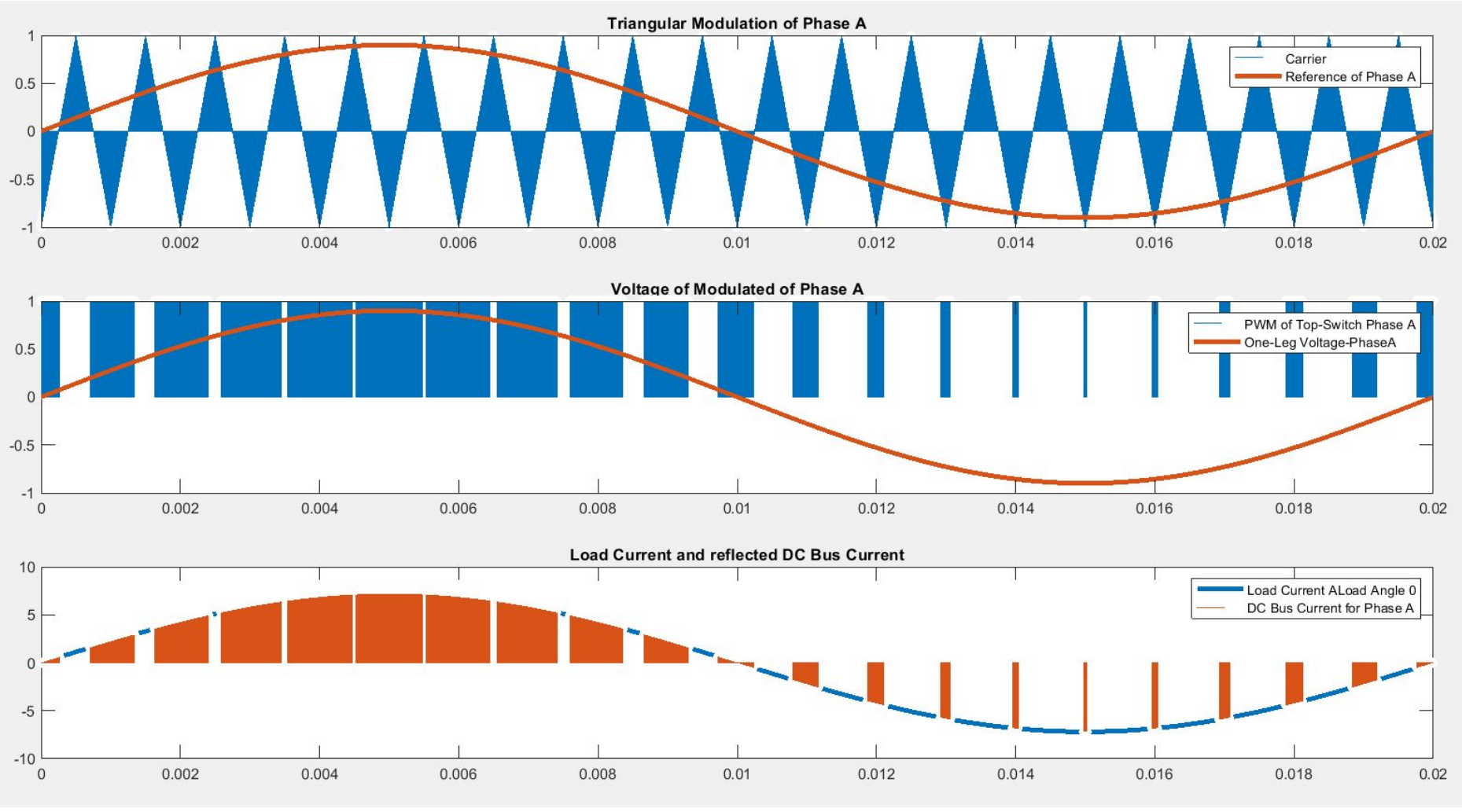
DC BUS MODELLING

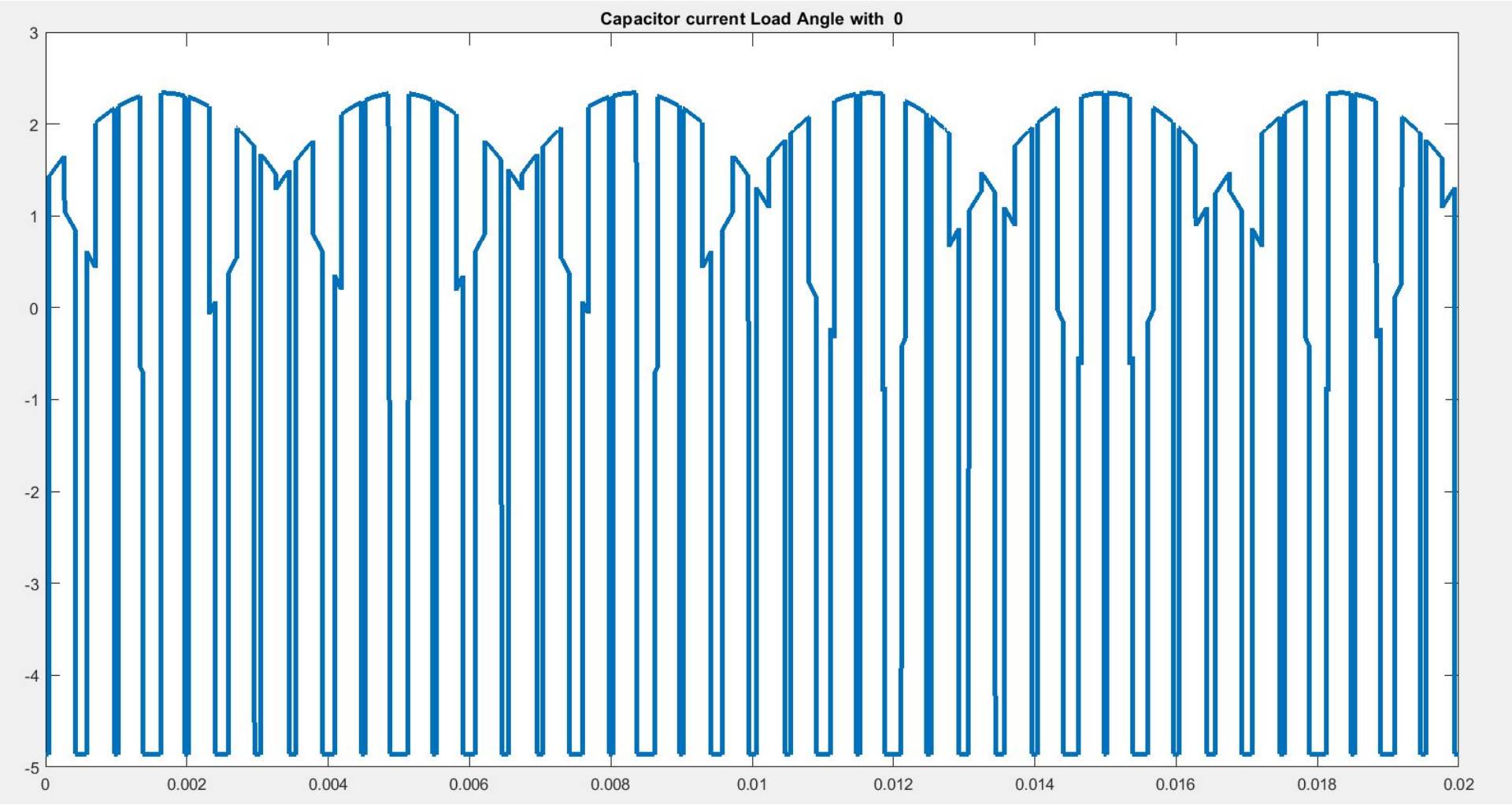
- Switching Modelling
- Capacitor Response Modelling
- Rectifier Modelling

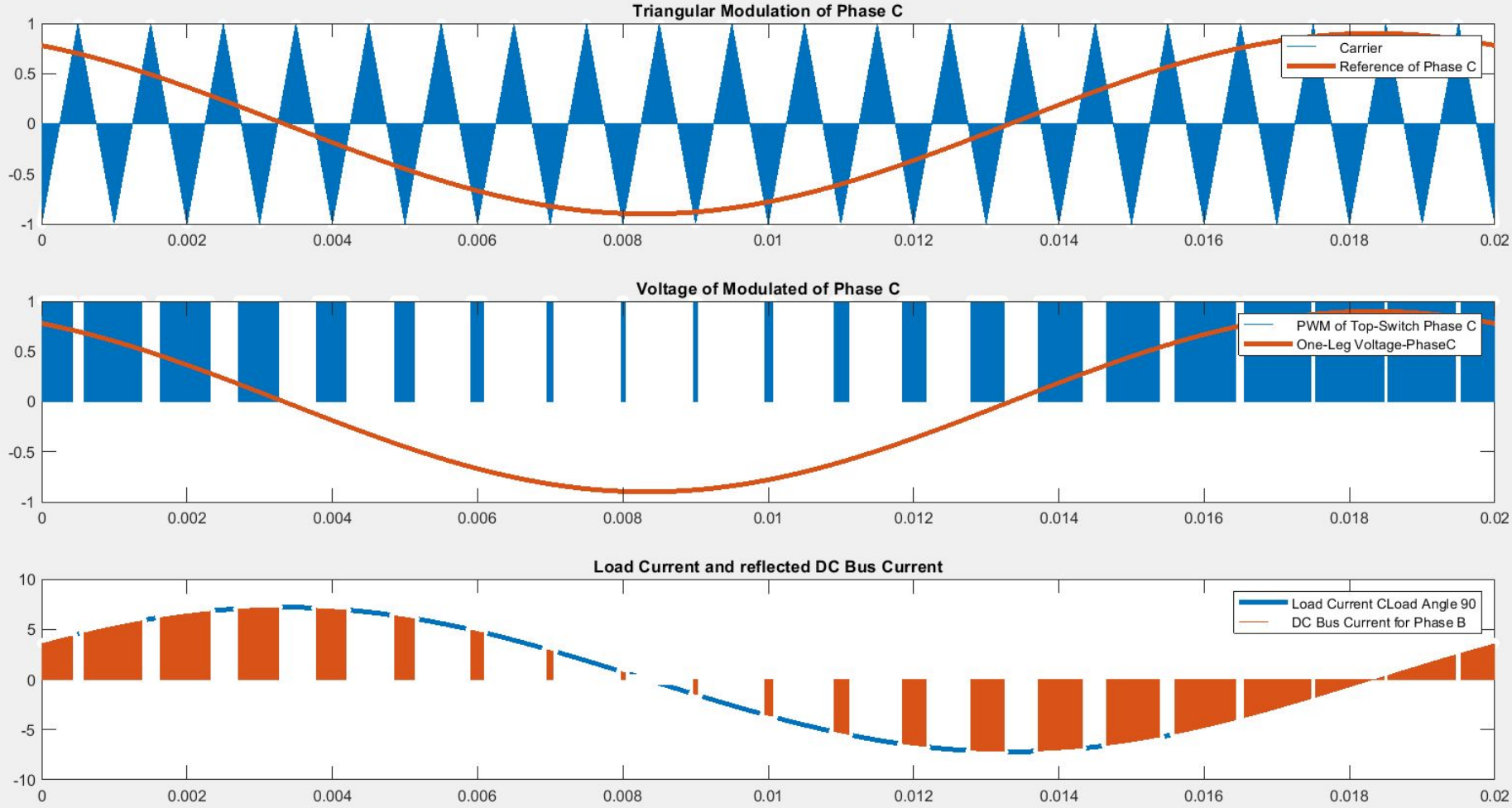
Geometric Model

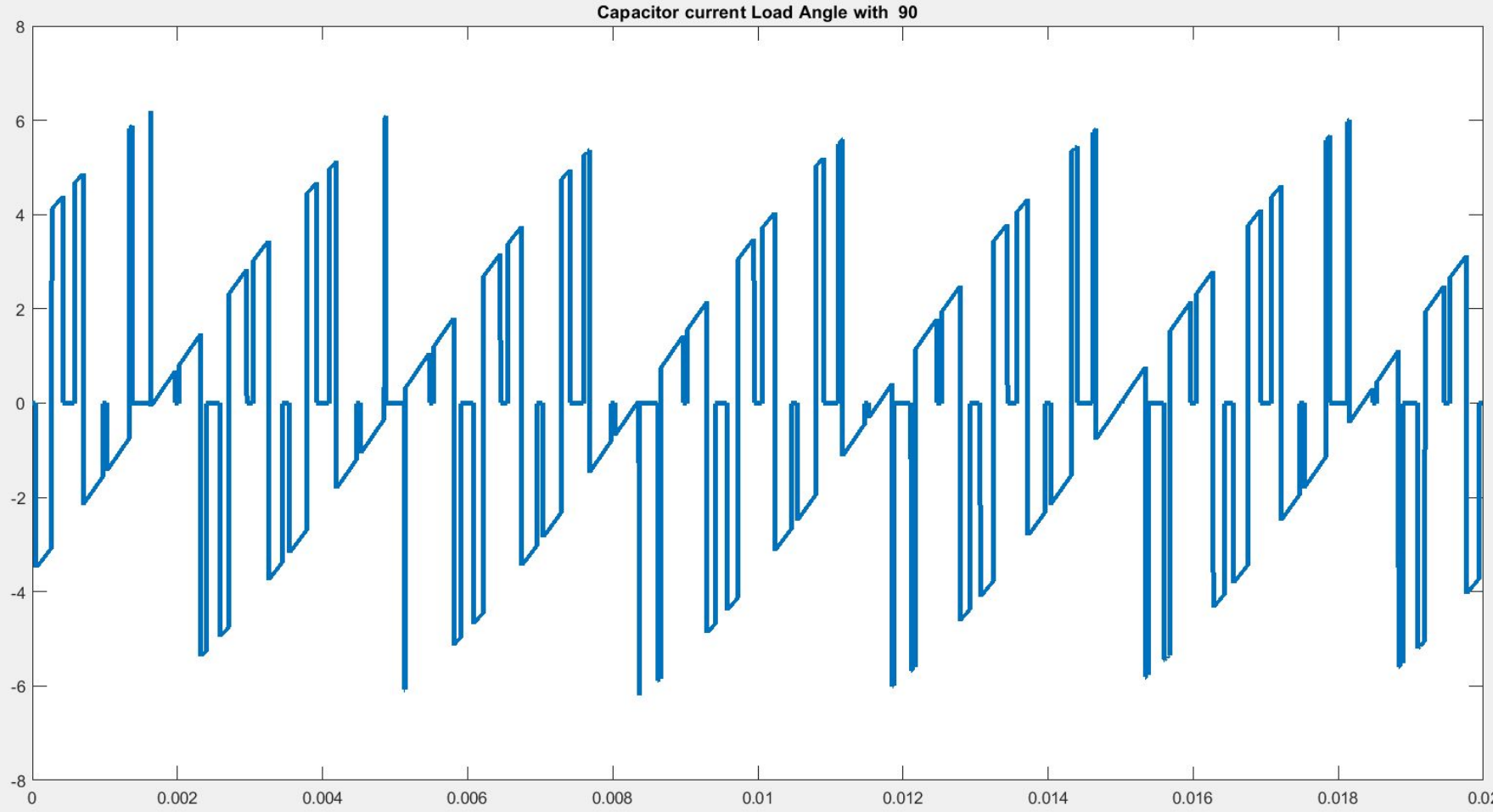
- In literature, the model is used for confirming the mathematical model and visualization of the DC bus current as expected.

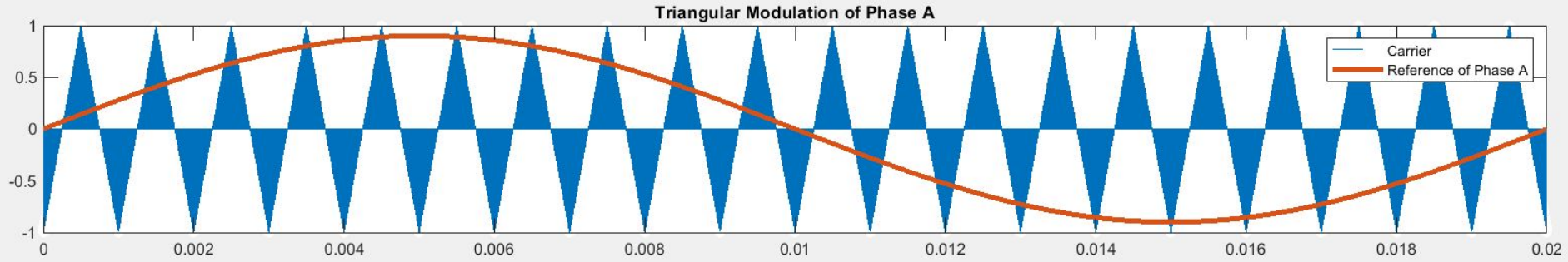
- Power factor and DC BUS ripples can be linked.

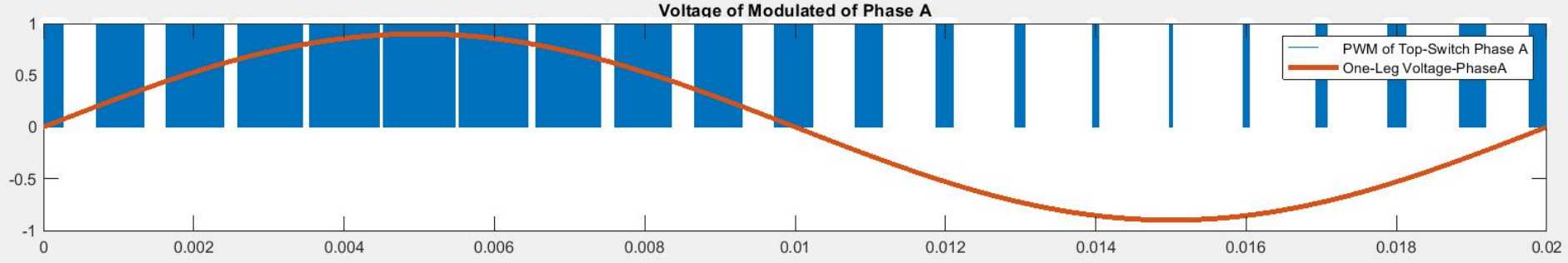

Triangular Modulation of Phase A
Carrier
Reference of Phase A
Voltage of Modulated of Phase A
PWM of Top-Switch Phase A
One-Leg Voltage-PhaseA
Load Current and reflected DC Bus Current
Load Current ALoad Angle 0
DC Bus Current for Phase A

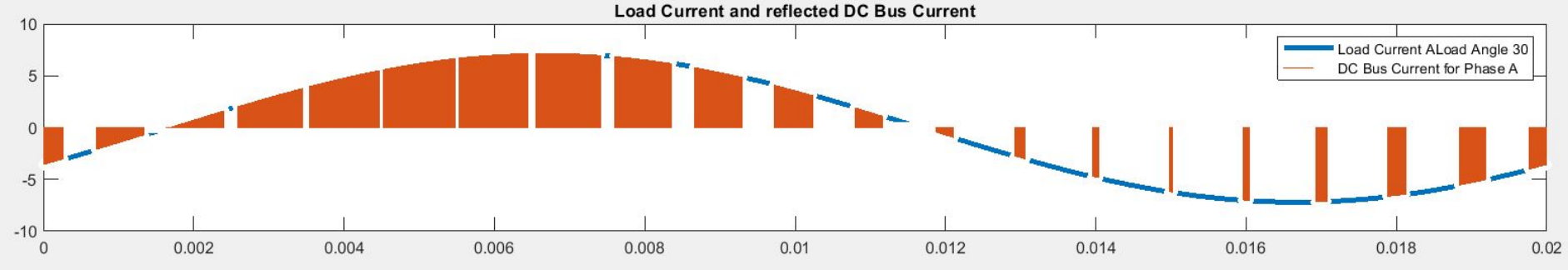

Capacitor current Load Angle with 0
3
2
1
0
-1
-2
-3
-4
-5
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

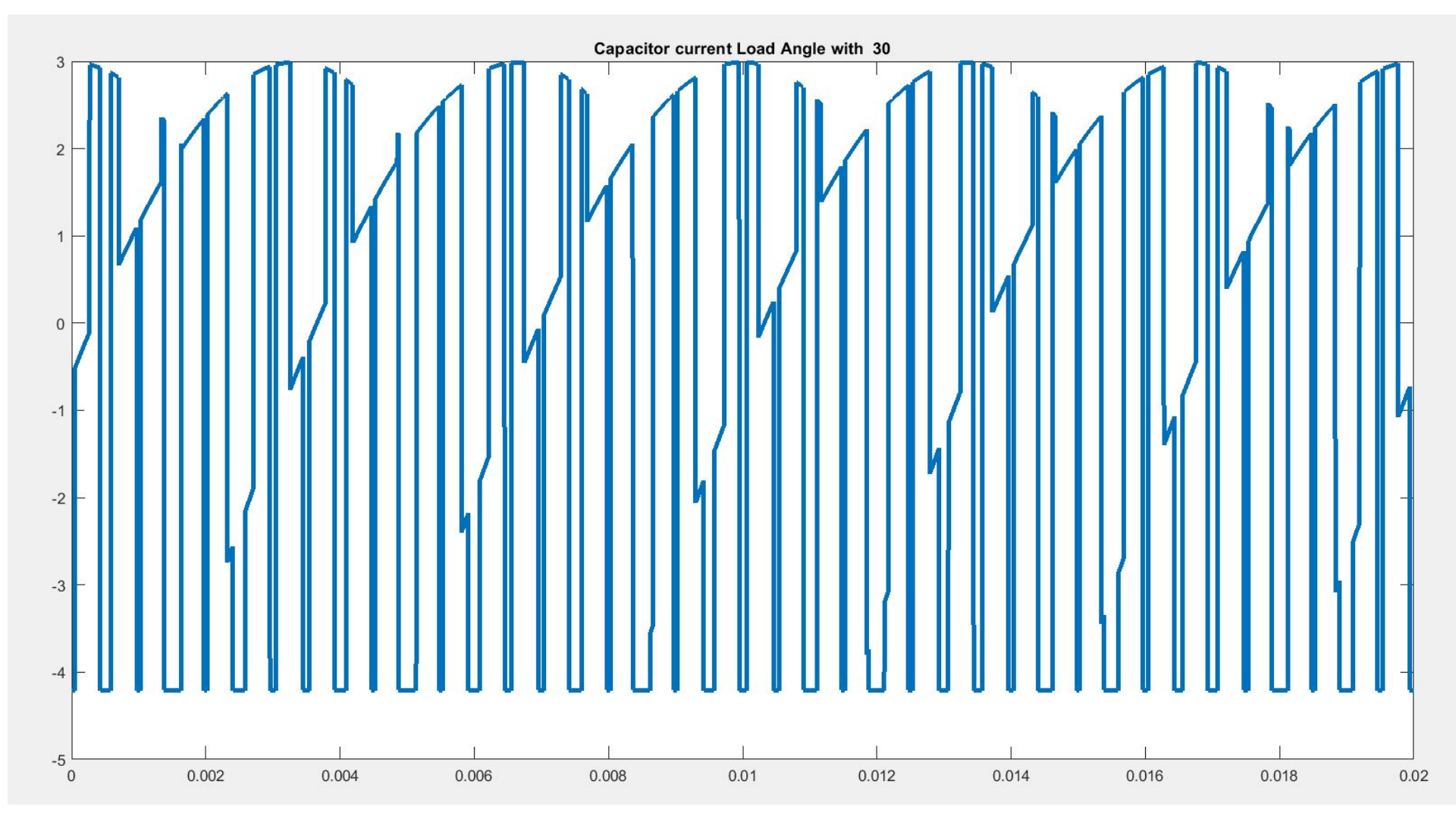

Triangular Modulation of Phase C
Carrier
Reference of Phase C
Voltage of Modulated of Phase C
PWM of Top-Switch Phase C
One-Leg Voltage-PhaseC
Load Current and reflected DC Bus Current
Load Current CLoad Angle 90
DC Bus Current for Phase B


Capacitor current Load Angle with 90
8
6
4
2
0
-2
-4
-6
-8
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


Triangular Modulation of Phase A
Carrier
Reference of Phase A
1
0.5
0
-0.5
-1
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


Voltage of Modulated of Phase A
PWM of Top-Switch Phase A
One-Leg Voltage-PhaseA
1
0.5
0
-0.5
-1
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


Load Current and reflected DC Bus Current
Load Current ALoad Angle 30
DC Bus Current for Phase A
10
5
0
-5
-10
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


Capacitor current Load Angle with 30
3
2
1
0
-1
-2
-3
-4
-5
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

Switching Function

- Switching Function can be written in frequency domain.

- It is converted in time-domain to validate with simulation results.

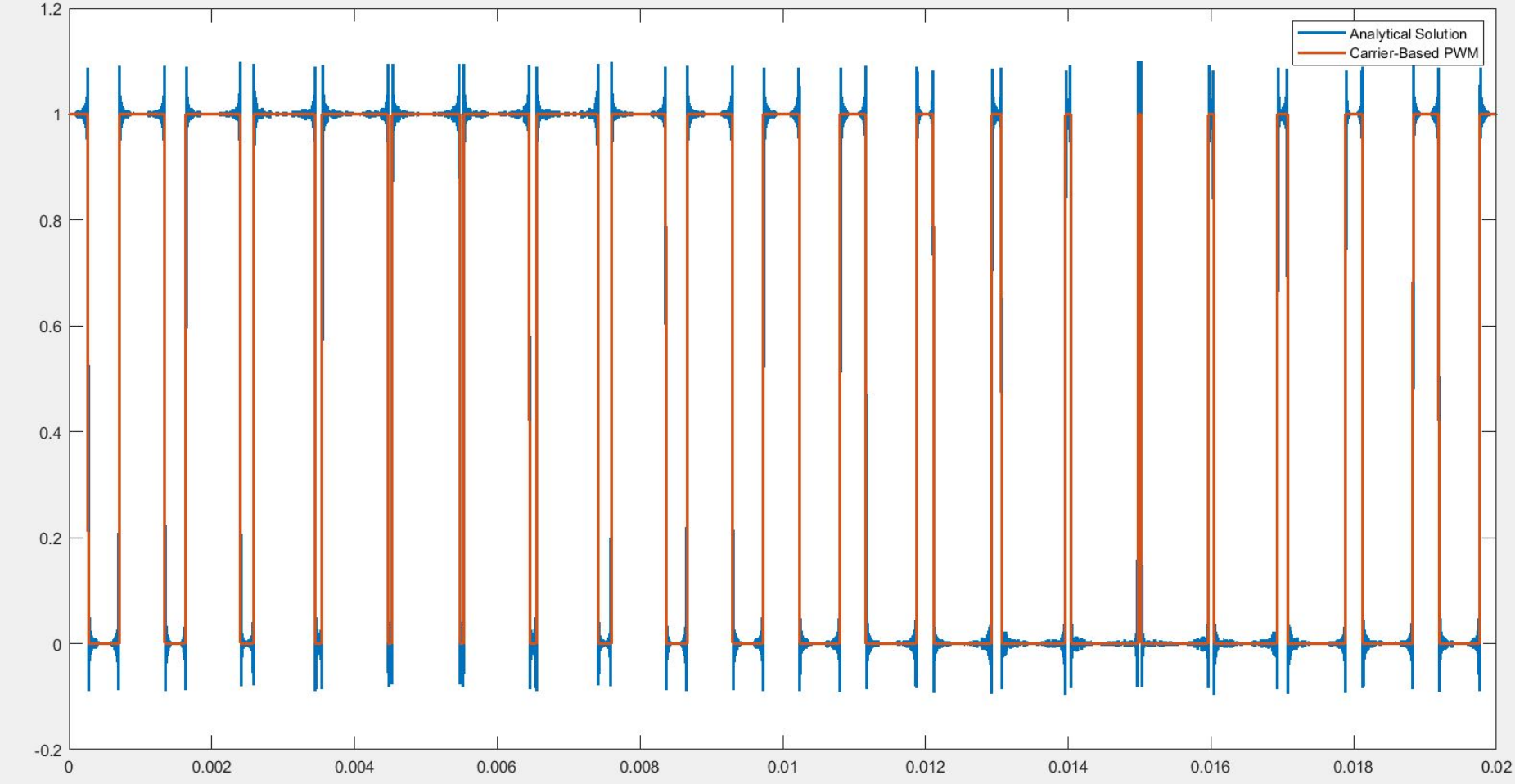
$$S_a = \frac{1}{2} + \frac{M}{2}\cos(w_o + \theta_o) + (\frac{2}{\pi})\sum_{m=1}^{inf} J_o(m\pi\frac{M}{2}))sin(m\frac{\pi}{2})cos(m(w_c + \theta_c)) +$$

$$(\frac{2}{pi})\sum_{m=1}^{inf}\sum_{n=-inf}^{inf}(\frac{1}{m})J_n(\frac{mM\pi}{2}))sin(\frac{(m+n)\pi}{2})cos(m(w_c + \theta_c) + n(\theta_o + w_o))$$

Problems

- Frequency components of square wave with sinusoidal duty cycle go to infinity. We can not calculate this, we can restrict our frequencies.

- Gibbs Phenomena, discontinuity (turn-on, turn-off)


Analytical Solution
Carrier-Based PWM
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

- For cosine reference voltage, the reference phase is chosen as pi/2.
- m and n value is restricted by 100.
- we observe ringing