EE560: Power Electronics Converters

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GRID FOLLOWING CONVERTER

1 Objective:

Simulate closed loop control of three-phase four-wire grid following converter using current control loop in dq0 frame. The total dc link voltage is maintained at 1000 V. Assume line of impedance R = 0.1 Ω, L = 0.01 mH and grid voltage is 400 V at 50 Hz. The converter is connected to grid through an LC filter. Choose appropriate value of L and C of filter. Show the performance during following cases (a) Supplying P = 5 kW, Q = 2 kVAr to grid. (b) Absorbing P = 5 kW, Q = 2 kVAr from grid.

2 Design of Grid Following Converter Design:

2.1 Calculation of LC filter

- $\omega_o = \frac{1}{\sqrt{LC}}$
- here ω_o= 314 rad/sec Assume L= 100 mH
- C = 20.26 μ F

2.2 Procedure

In Grid Following we usually use current control method

1. First we generate reference current I_{d^*}, Iq^*using series RLC load which is getting real power P = 5 kW, reactive power Q = 2 kVAr getting power from three phase source
2. Comparing the output current with reference current passing from PI controller to minimize the error , then give this to PWM block thus we generate pwm pluses and given them to switches.
3. After sending the PWM signal into 2 level inverter, connecting to load real power P = 5 kW, reactive power Q = 2 kVAr with by a LC filter .
4. For case 2 we change the value pf P and Q , P = -5 kW, reactive power Q = -2 kVA.

3 MATLAB simulation Grid Following Converter :

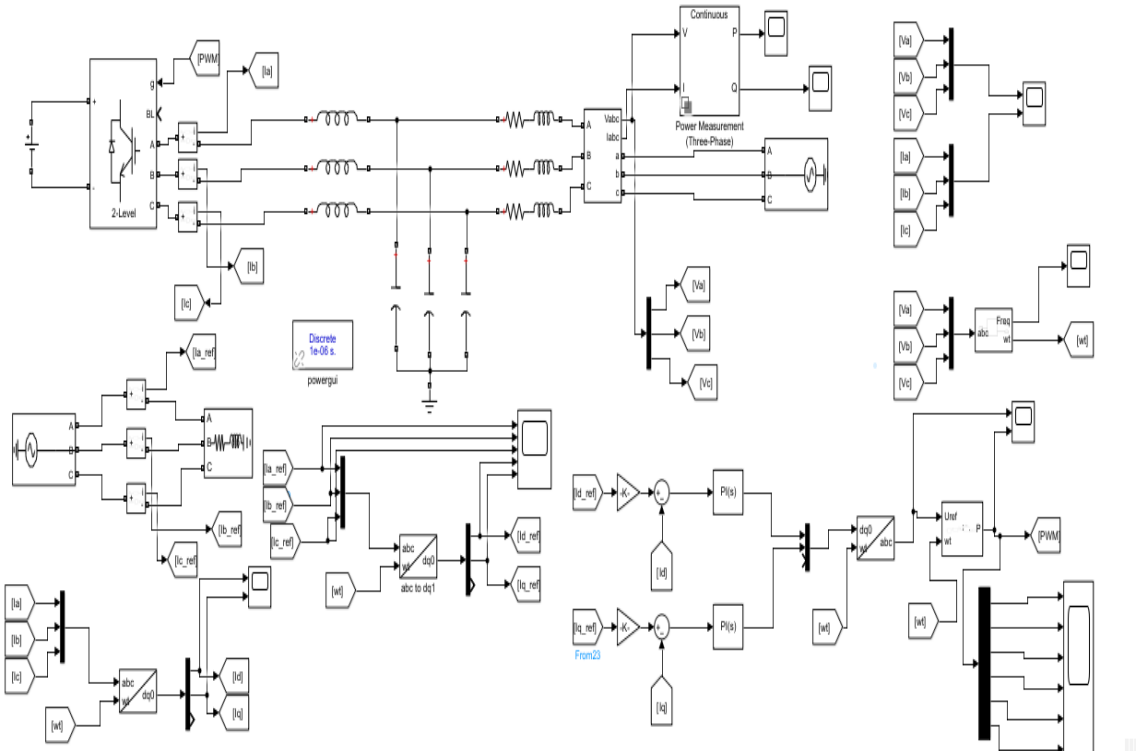

Fig. 1: Simulated Diagram of Grid Following Converter

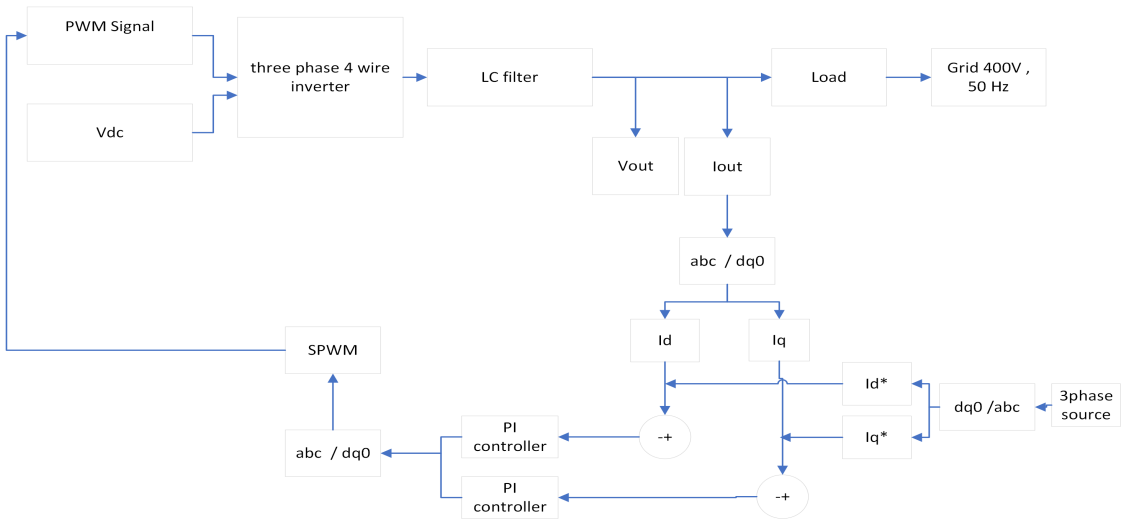

Fig. 2: Block Diagram of Grid Following Converter

3.1 waveform

3.2 Case 1 : Supplying P = 5 kW, Q = 2 kVAr to grid.

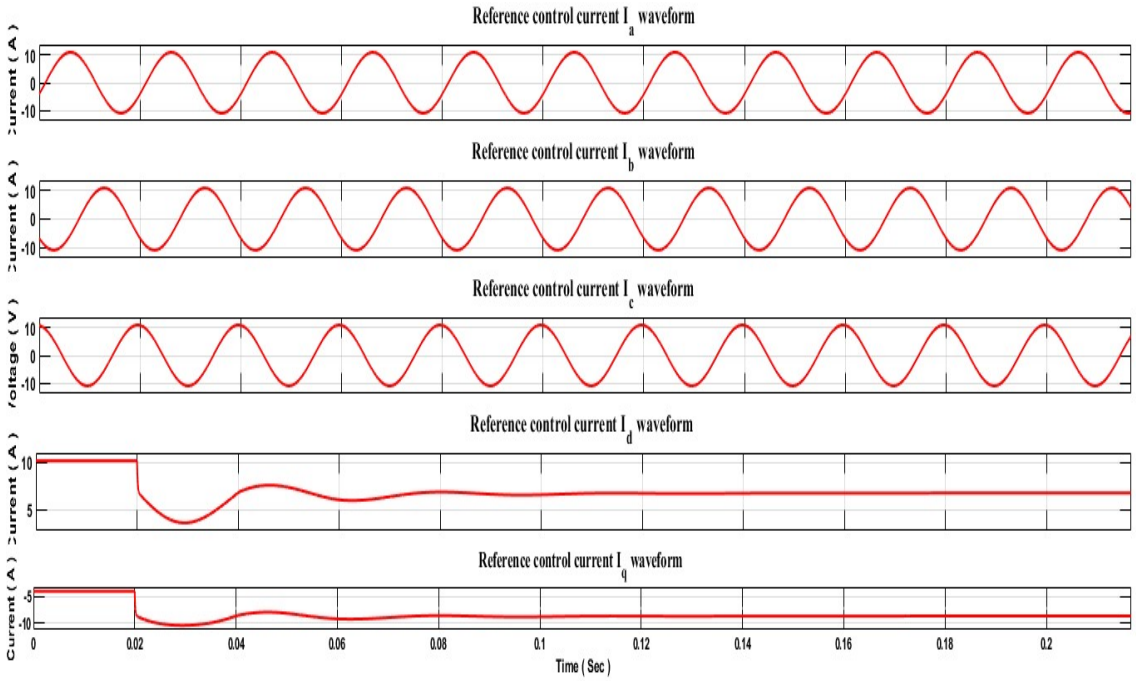

Fig. 3: Reference Control Voltage waveform

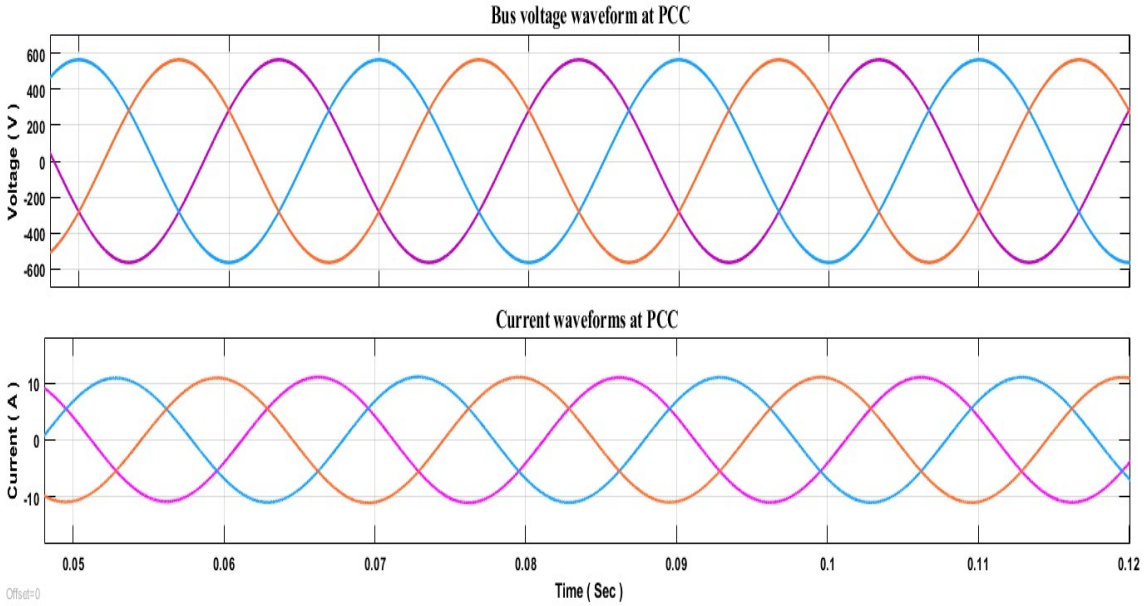

Fig. 4: Bus voltage and bus current waveform at PCC

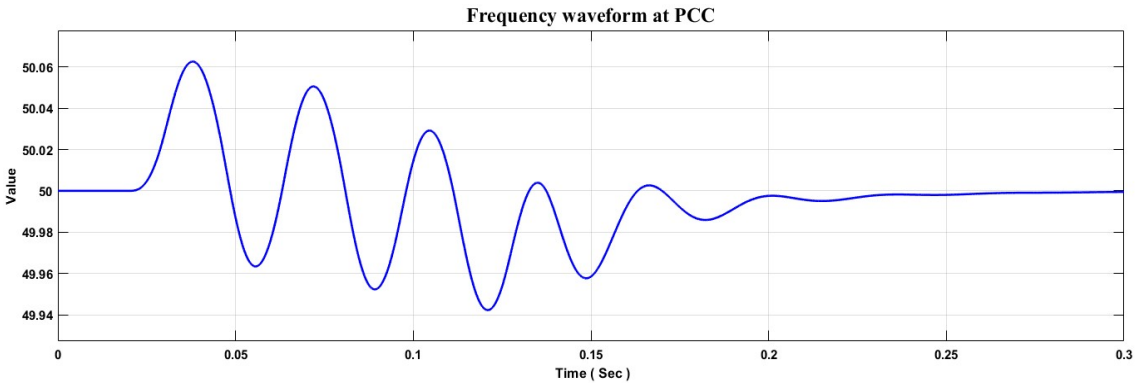

Fig. 5: Frequency at PCC

3.3 Observation

Parameter	Value
Active Power at PCC	4.98 kW
Reactive power at PCC	3.27 kVAr

Tabel 1: Active and Reactive power at PCC

3.4 Case 2 : Absorbing P = kW, Q = 2 kVAr from grid

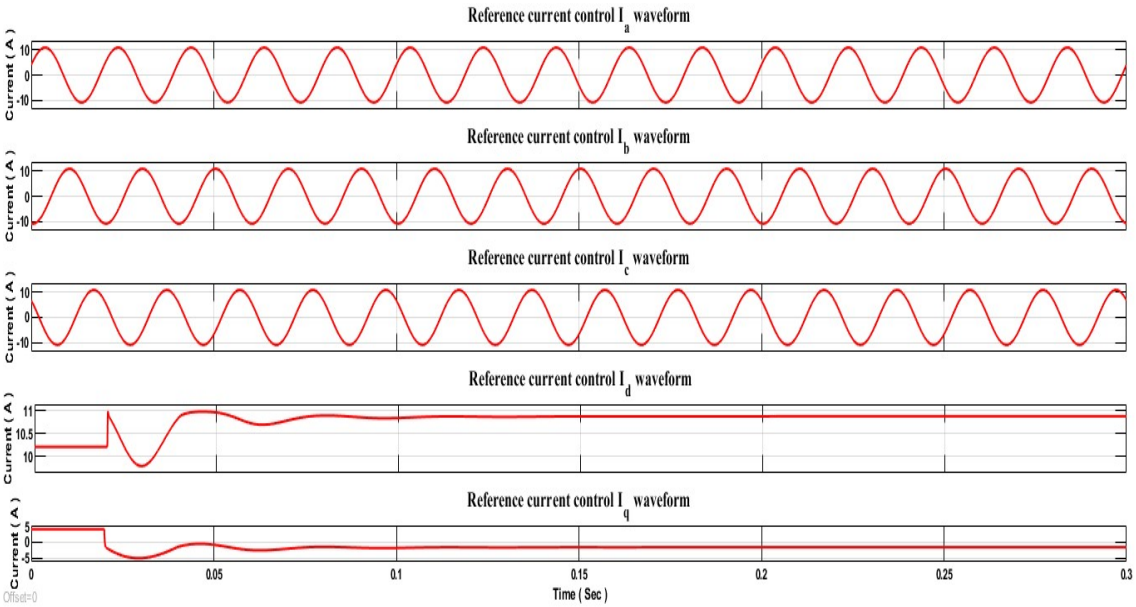

Fig. 6: Reference Control Voltage

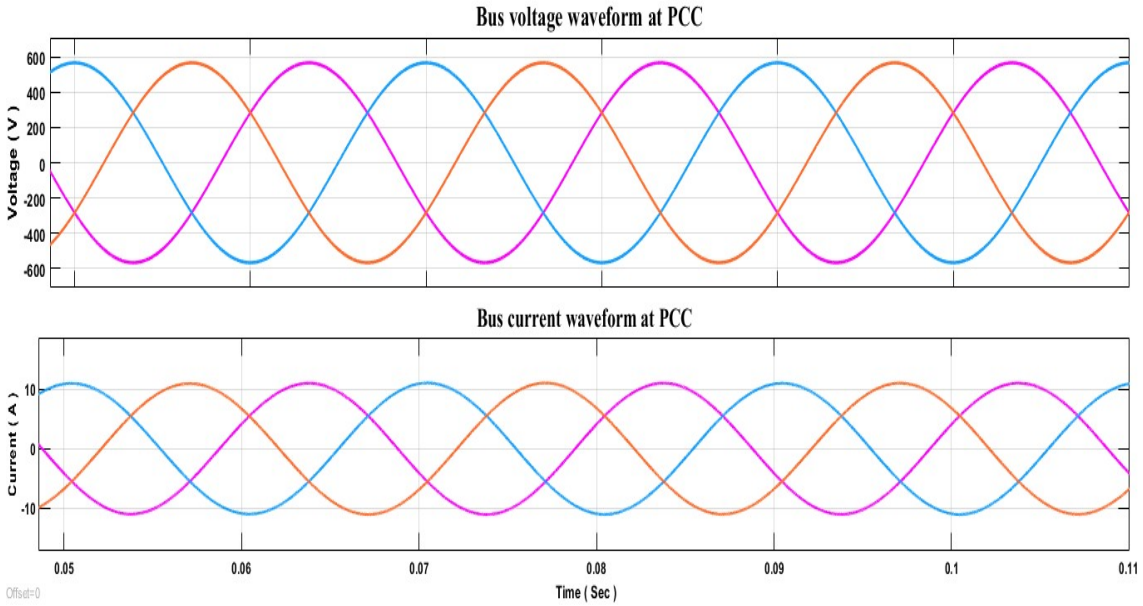

Fig. 7: Bus Voltage and bus Current at PCC

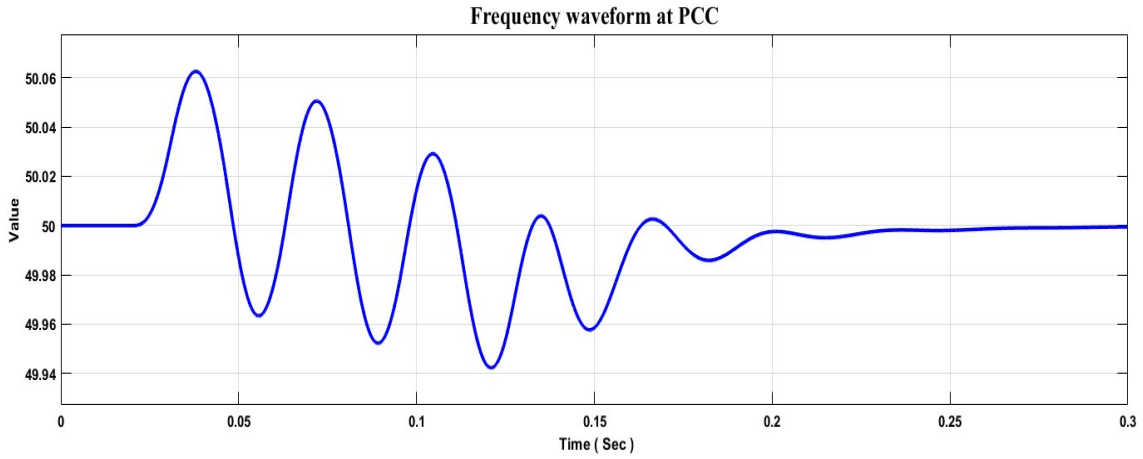

Fig. 8: Frequency at PCC

3.5 Observation

Parameter	Value
Active Power at PCC	- 5.12 kW
Reactive power at PCC	- 2.56 kVAr

Tabel 2: Active and Reactive power at PCC

GRID FORMING CONVERTER

1 Objective:

Simulate closed loop control of three-phase four-wire grid forming converter using current control loop in dq0 frame. The total dc link voltage is maintained at 1000 V. Grid voltage is 400 V at 50 Hz. The converter is connected to load through an LC filter. Choose appropriate value of L and C of filter. Show the performance when load changes from 10 kW to 12 kW.

2 Design of Grid Forming Converter Design:

2.1 Calculation of LC filter

- $\omega_o = \frac{1}{\sqrt{LC}}$
- here ω_o= 314 rad/sec Assume L= 100 mH
- C = 20.26 μ F

2.2 Procedure

In Grid Forming we usually use current control method

1. First we generate reference voltage V_{d^*}, V_{q^*}using three phase source
2. Comparing the output voltage with reference voltage passing from PI controller in order to minimize the error , then give this to PWM block thus we generate pwm pulses and given them to switches.
3. After sending the PWM signal into 2 level inverter, connecting with load by a LC filter .

3 MATLAB simulation Grid Forming Converter :

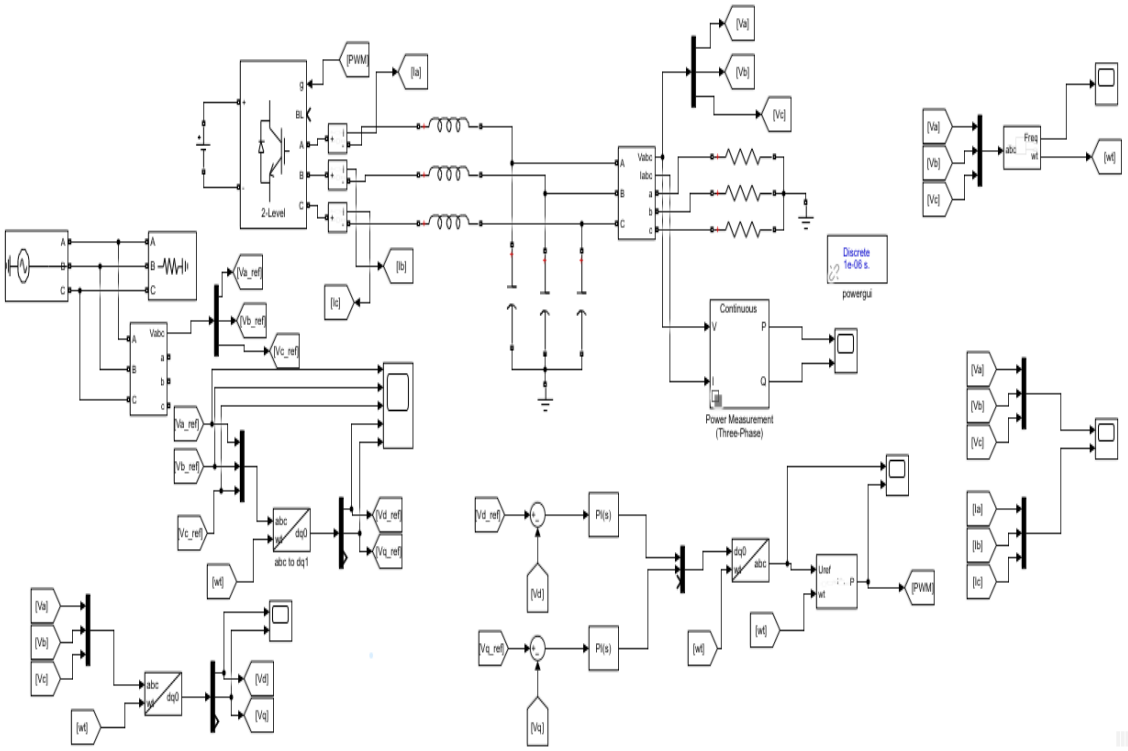

Fig. 1: Simulated Diagram of Grid Forming Converter

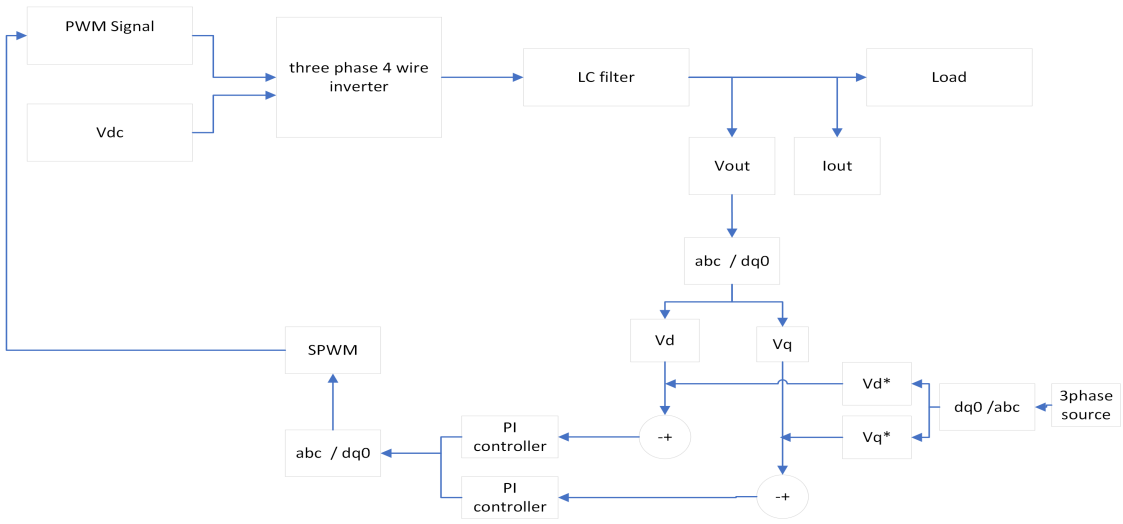

Fig. 2: Block Diagram of Grid Forming Converter

3.1 waveform

3.2 Case 1 : When Load = 10 kW

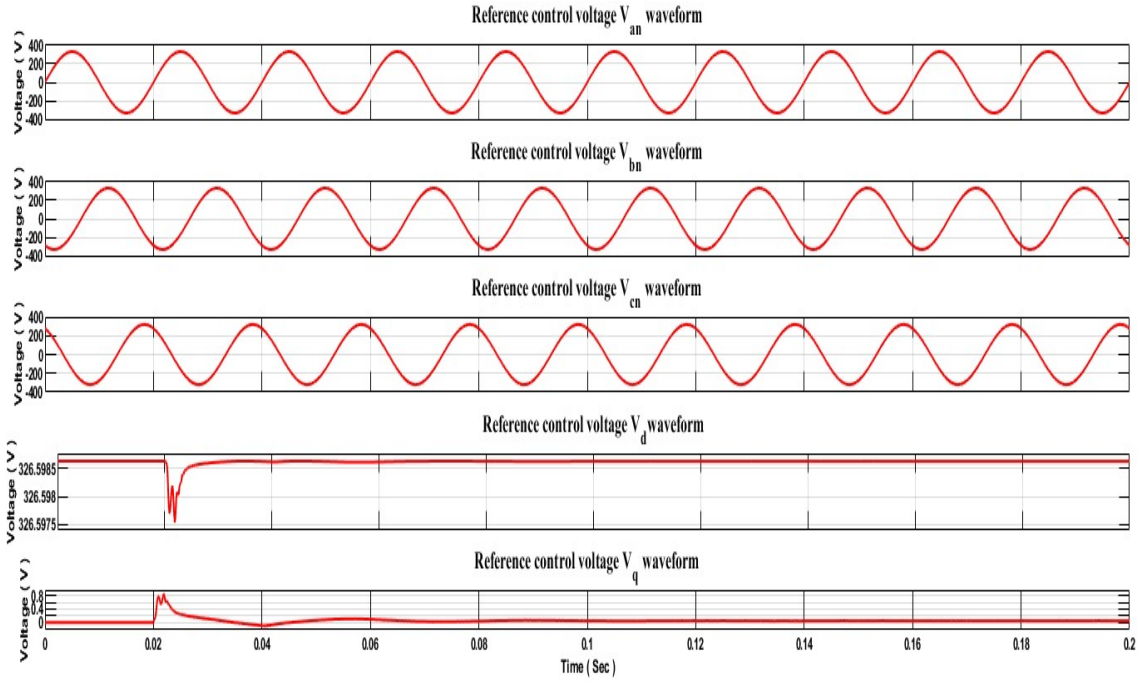

Fig. 3: Reference Control Voltage waveform

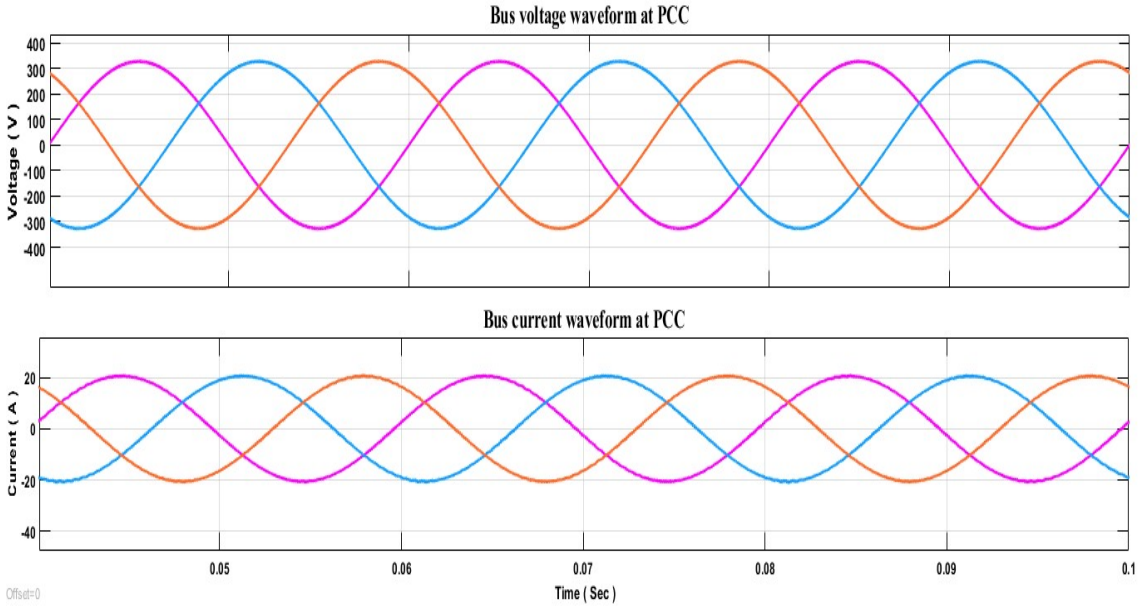

Fig. 4: Bus voltage and bus current waveform at PCC

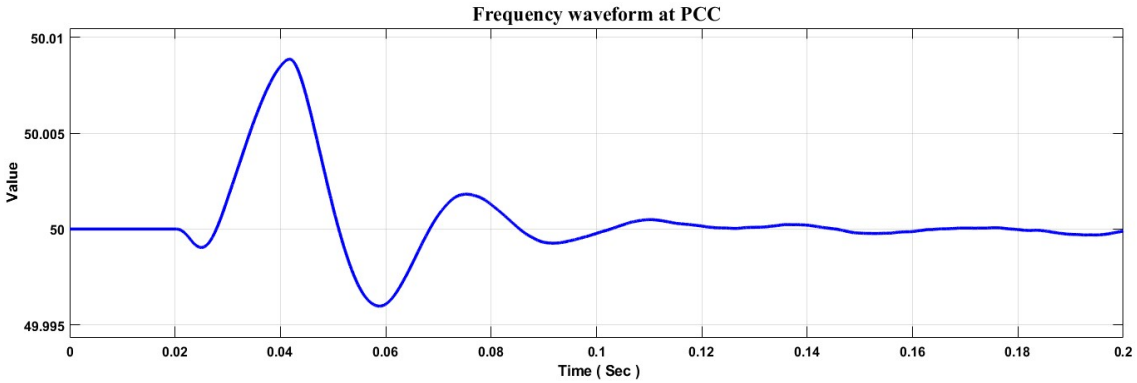

Fig. 5: Frequency at PCC

3.3 Observation

Parameter	Value
Active Power at PCC	9.96 kW
Reactive power at PCC	0 kVAr

Tabel 1: Active and Reactive power at PCC

3.4 Case 2 : When Load = 12 kW

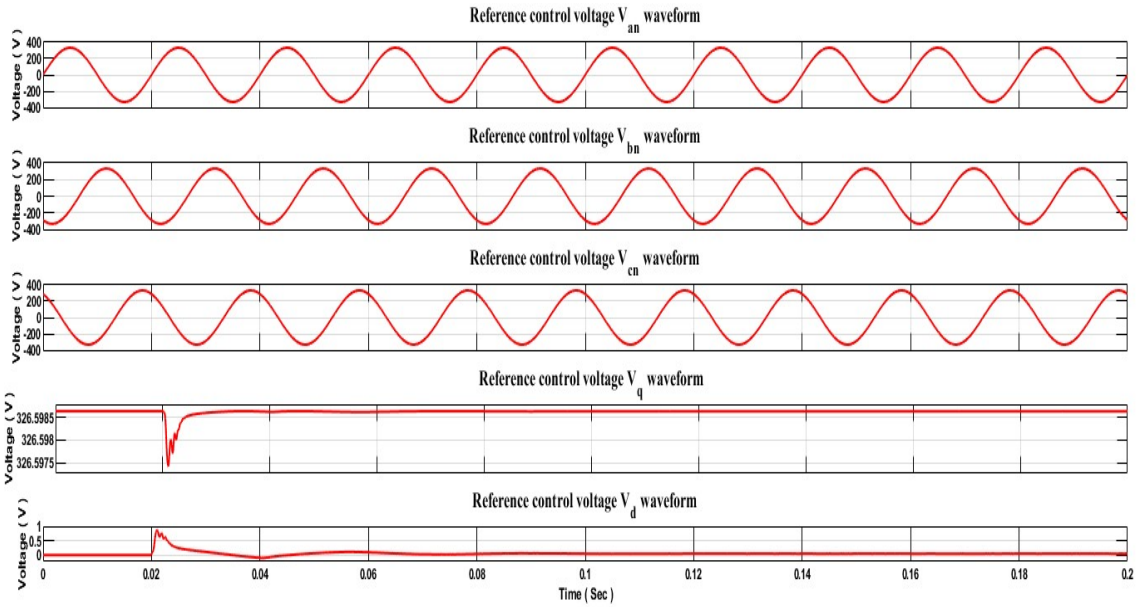

Fig. 6: Reference Control Voltage

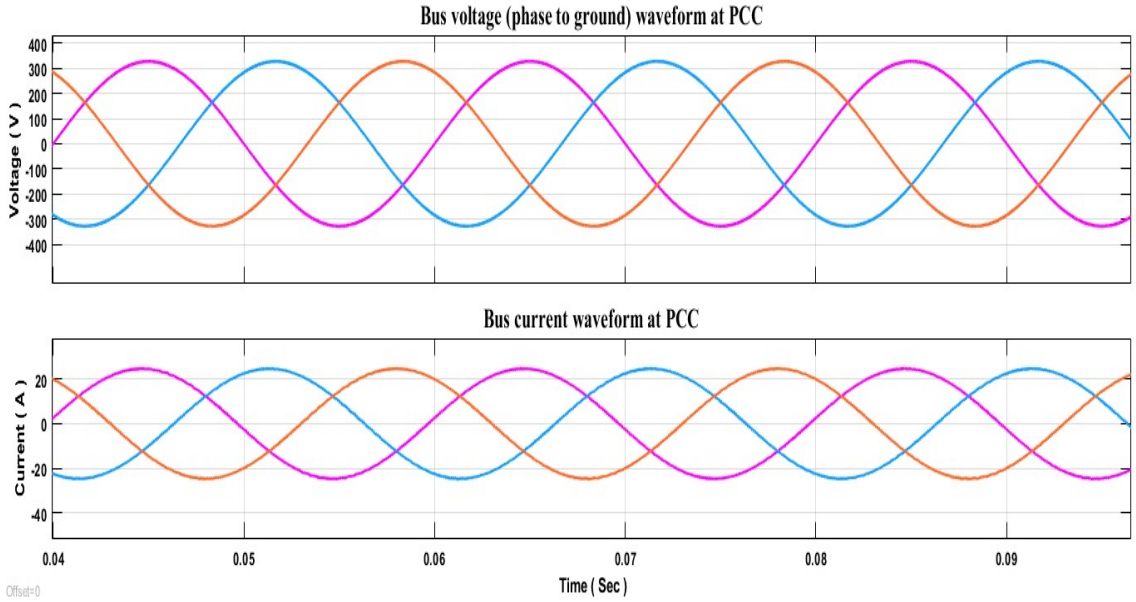

Fig. 7: Bus Voltage and bus Current at PCC

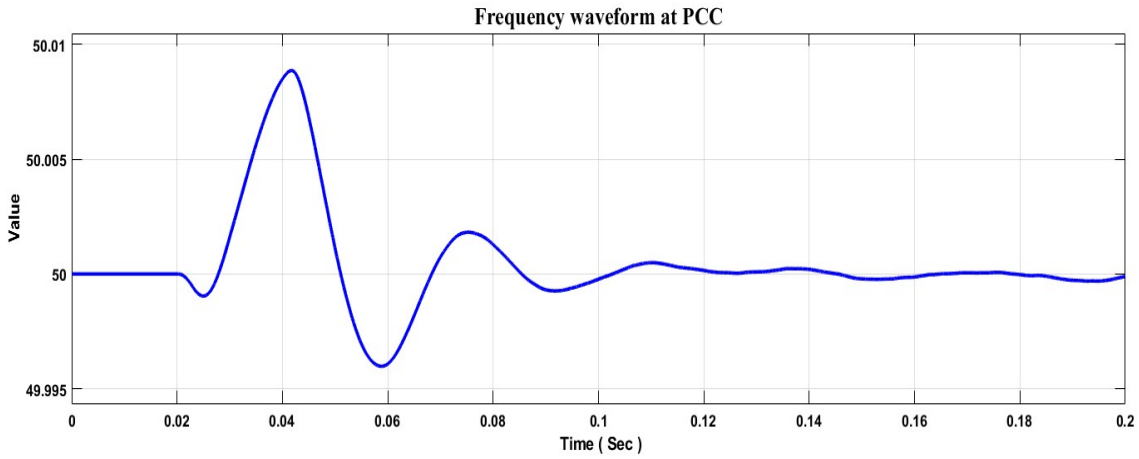

Fig. 8: Frequency at PCC

3.5 Observation

Parameter	Value
Active Power at PCC	11.64 kW
Reactive power at PCC	0 kVAr

Tabel 2: Active and Reactive power at PCC