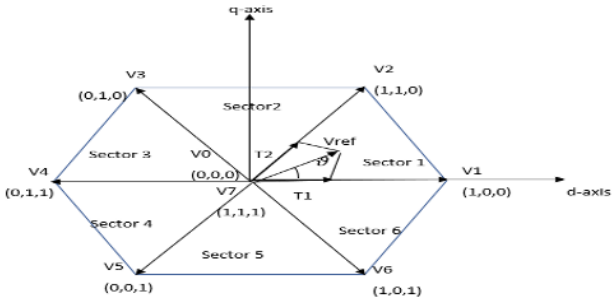


**Fig. 7** Basic Switching Vector and Sectors

In SVPWM the total harmonic distortion is reduced and no need for over-modulation as the SVPWM switching signal contains the high order harmonics as shown ***Fig. 8***. So RMS voltage value is higher than sinusoidal pulse width modulation. Moreover, the space Vector pulse width modulation provide more efficient and reliable use of phase supply voltage as compared to sinusoidal pulse width modulation

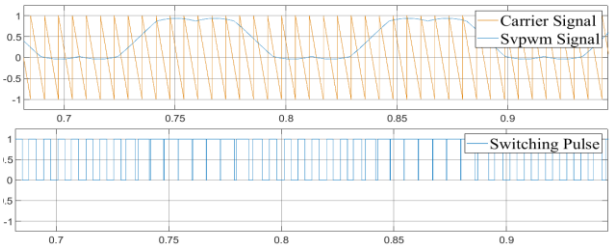


**Fig. 8** Pulse Order of SVPWM

## 4 Results and Discussion

In MATLAB/Simulink workspace, the vector control techniques based on different switching pulses algorithm were built. The speed and the current regulator were driven by PI controllers. Synchronous machines are widely used both in industry and home applications due to small size, high power density and efficient performance, so in this paper SPMSM is utilized for modeling and simulation results. Motor parameters are given in **Table 1**

**Table 1.** Simulation Parameter

| Parameters | Value |
|---|---|
| $T_s/T_{pwm}$ | 1us/100us |
| Stator Resistance | 0.675 ohm |
| Stator Inductance | 0.000835 |
| Pole pairs | 4 |
| Inertia | 0.01 |
| Rotor Flux Linkage | 0.11 |

***Fig. 9*** Shows the speed response during startup at 0s under 5Nm load condition. At 0.3s the speed is increased from 100rad/s to 300rad/s. At 1s the load torque of 8Nm is applied. Simulation result shows

**Table 2**. THD Across Phase Current

| $T_L$ | Time(THD) | HPWM | DPWM | SPWM | SVPWM |
|---|---|---|---|---|---|
| 5Nm | 0.8s | 29.57 % | 13.05 % | 13.03 % | 9.75% |
| 8Nm | 1.9s | 16.97 % | 9.87% | 10.14 % | 8.08% |

that in SVPWM switching technique the rise time of speed response is faster as compared to other switching techniques. The overall performance of the system is fast and good. FFT analysis on the phase current of the speed control model with fundamental frequency equaling 50Hz is analyzed and shown in ***Fig. [10-13]***. The THD across phase current under different load conditions are shown in **Table 2.** So the less THD in SVPWM across the load makes it an efficient technique for closed-loop speed control of motor drive under variable load conditions.

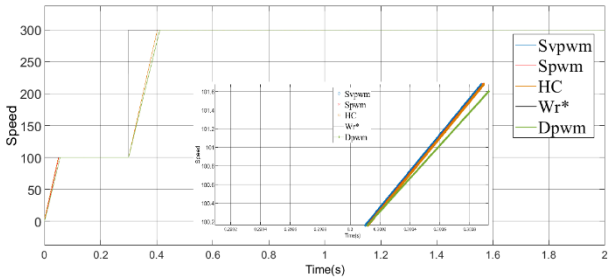


**Fig. 9** Speed Response

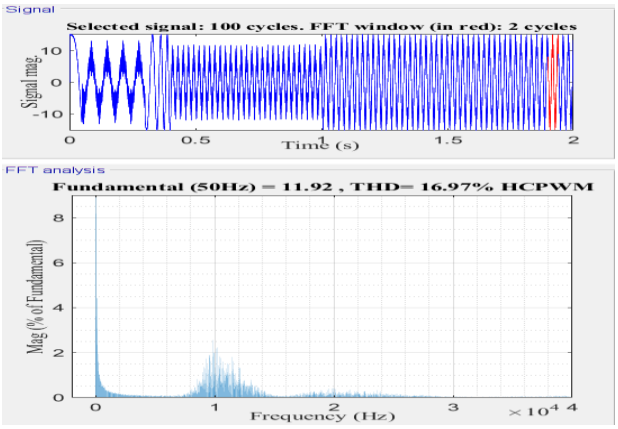


**Fig. 10** FFT analysis of HCPWM

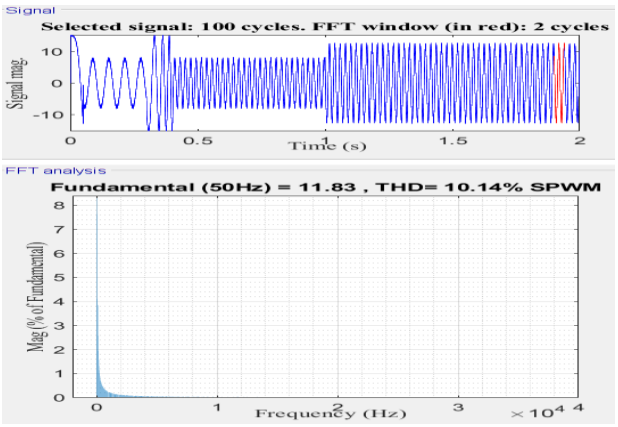


**Fig. 11** FFT analysis of SPWM