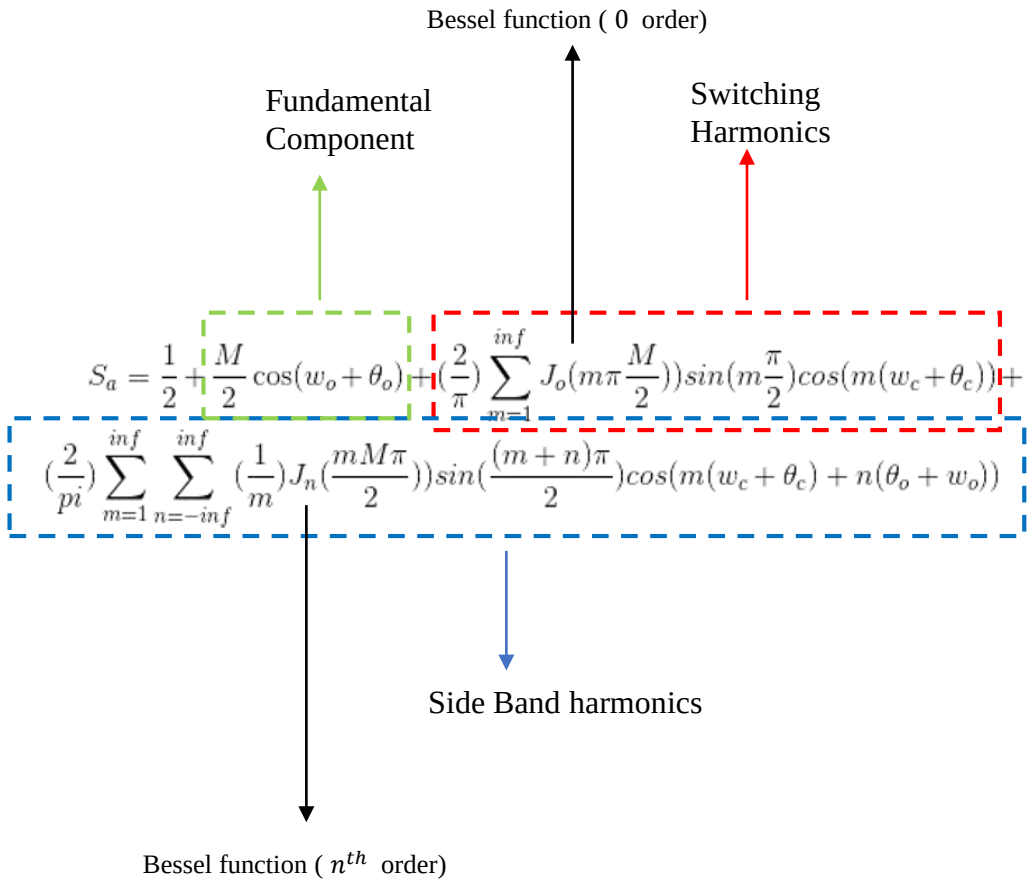


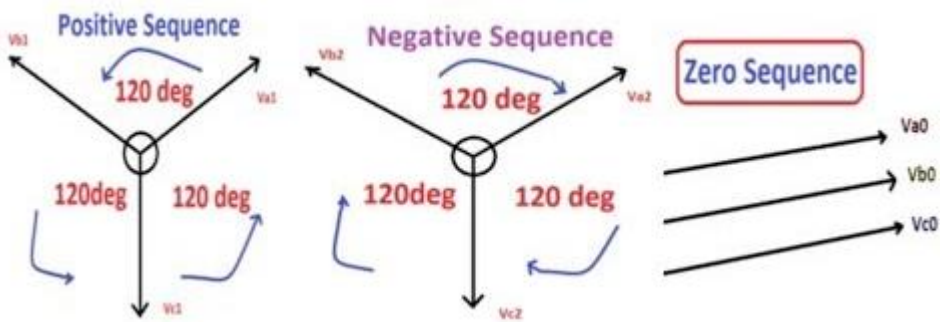

Parameters:

$M$ => modulation index
$\omega_o$=> output(fundamental) frequency
$\omega_c$ => carrier(switching) frequency
$\theta_o$ => output phase
$\theta_c$ => carrier phase

## Deductions

- Fundamental component is independent from carrier(switching) frequency and phase
- There is no even harmonics of the switching and the sign of the odd harmonics is alternated.
- The switching harmonics are independent from fundamental frequency and phase.
- The side band harmonics are affected by all fundamental and carrier frequency and phases.

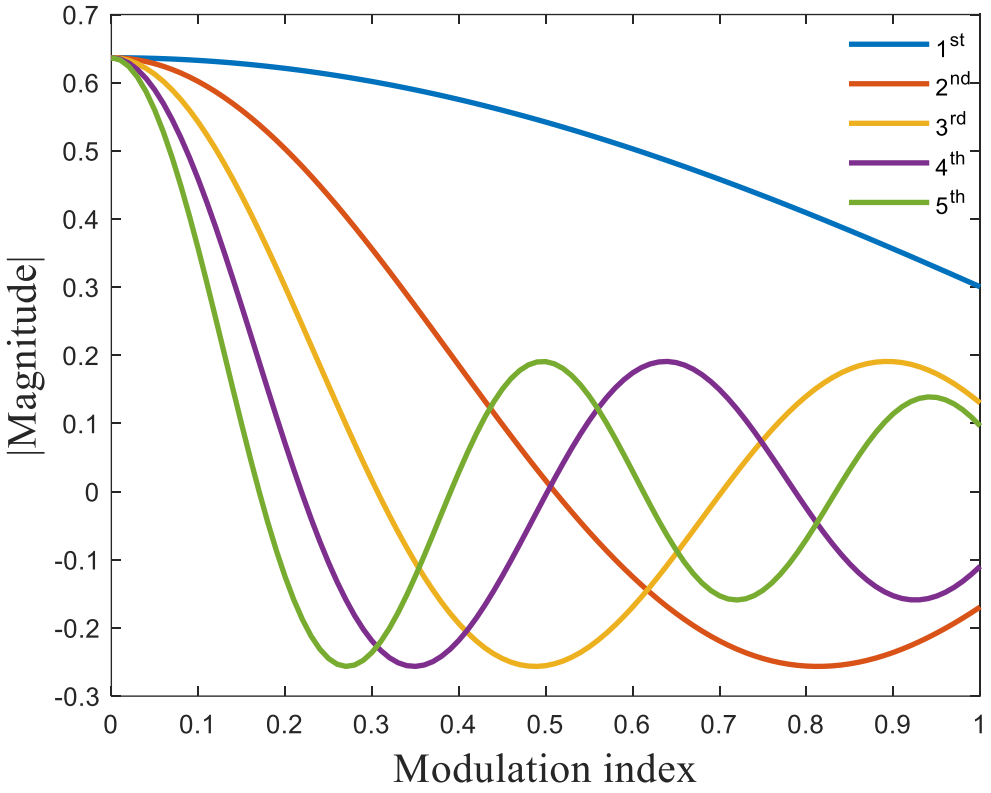
# Sequences of the Switching Harmonics and Side Bands




If the fundamental is positive sequences

| Frequency | Phase A | Phase B | Phase C |
|---|---|---|---|
| $f_o$ | $\theta_o = 0^o$ | $\theta_o = 120^o$ | $\theta_o = -120^o$ |
| $f_s - 4f_o$ | $0^o$ | $240^o$ | $120^o$ |
| $f_s - 2f_o$ | $180^o$ | $300^o$ | $60^o$ |
| $f_s$ | $0^o$ | $0^o$ | $0^o$ |
| $f_s + 2f_o$ | $180^o$ | $60^o$ | $300^o$ |
| $f_s + 4f_o$ | $0^o$ | $120^o$ | $240^o$ |

# Switching Harmonics

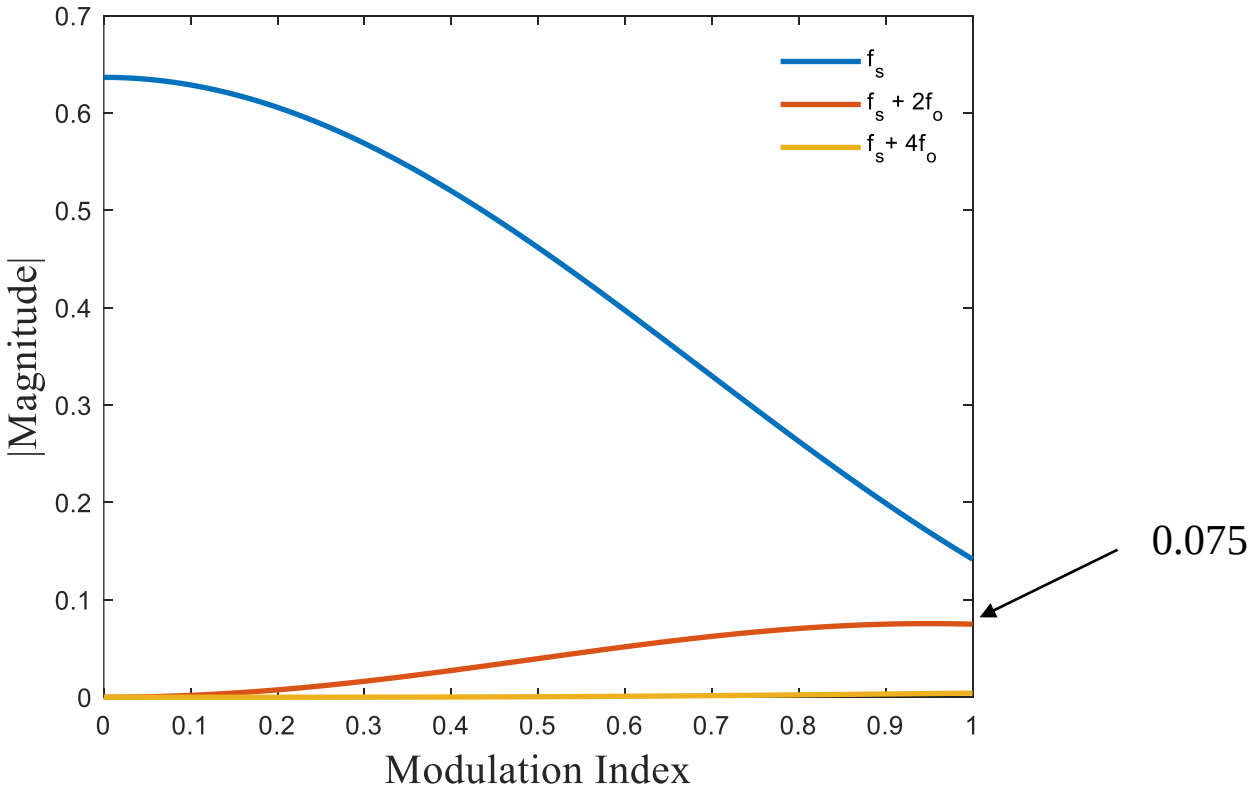



Max = 0.6366 (ma=0 for 1st)
Min = 0.3005 (ma=1 for 1st)

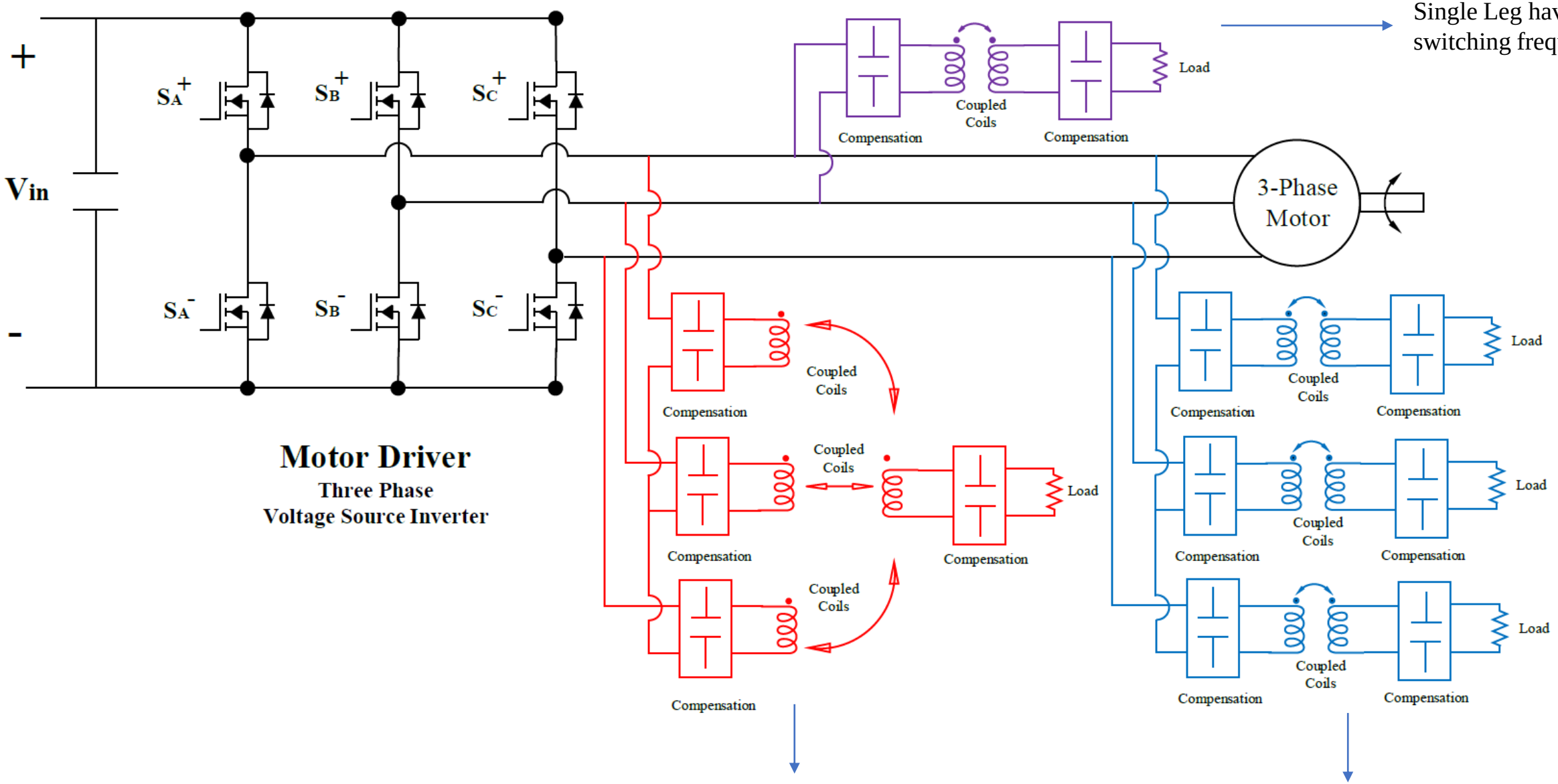


It is very promising if we think the duty cycle control of DC motor

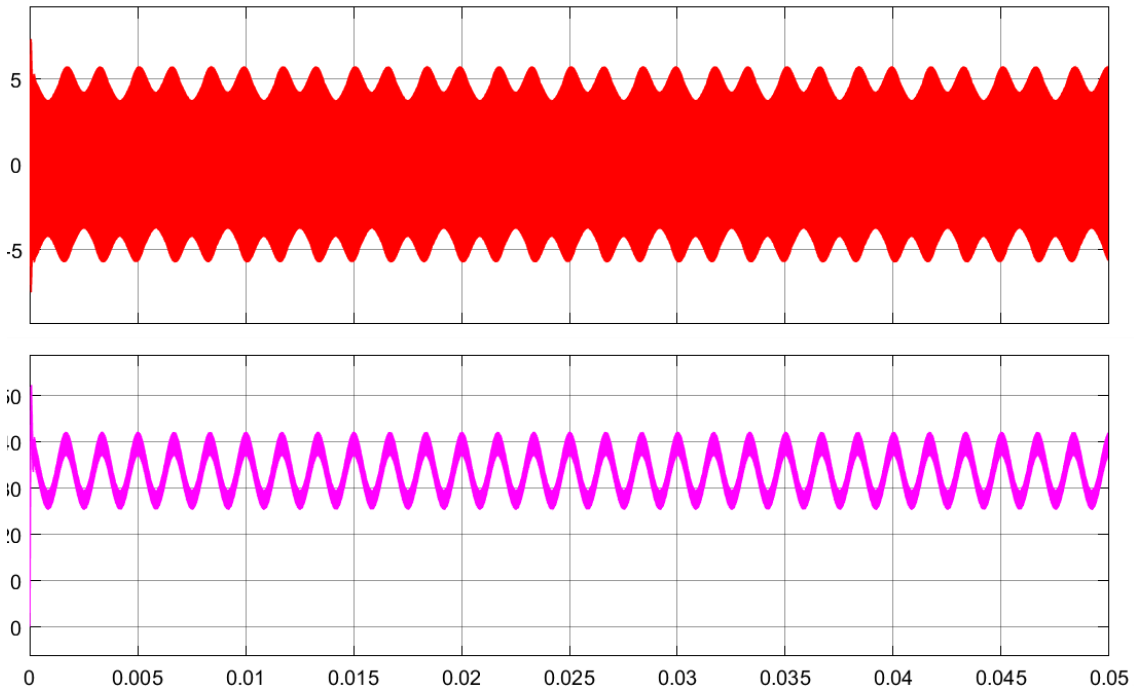
# Side Band Harmonics



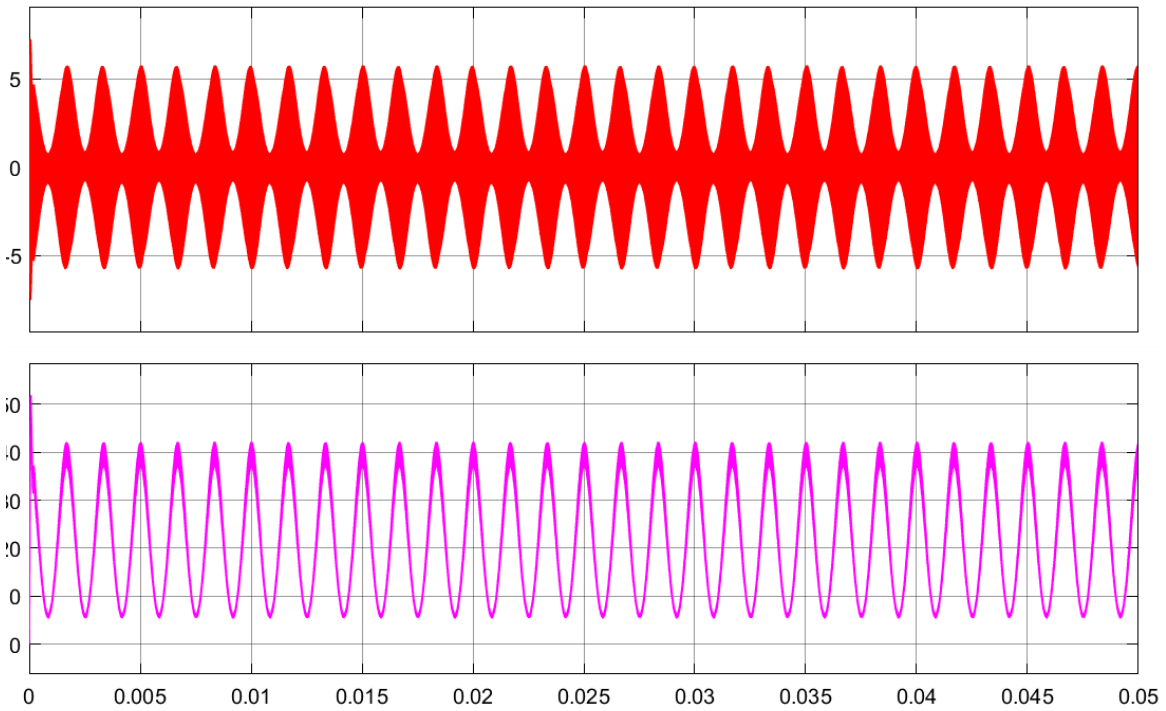

0.075


+
Vin
-
$S_A^+$
$S_B^+$
$S_C^+$
$S_A^-$
$S_B^-$
$S_C^-$
Motor Driver
Three Phase
Voltage Source Inverter
Compensation
Coupled Coils
Compensation
Load
Single Leg having higher switching frequency
3-Phase Motor
Compensation
Coupled Coils
Compensation
Load
Compensation
Coupled Coils
Compensation
Load
Compensation
Coupled Coils
Compensation
Load
Compensation
Coupled Coils
Compensation
Load
Compensation
Coupled Coils
Compensation
Load
Compensation
Coupled Coils
Compensation
Load
Removed side-bands
(positive, negative sequences)
Having side-bands

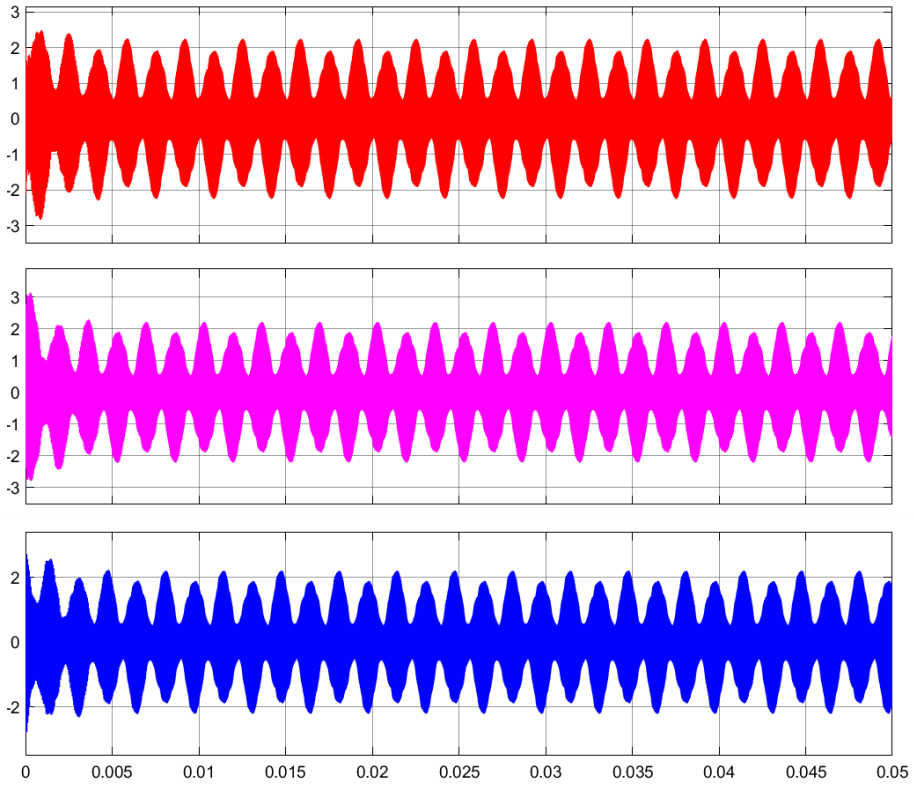
ma=0.5

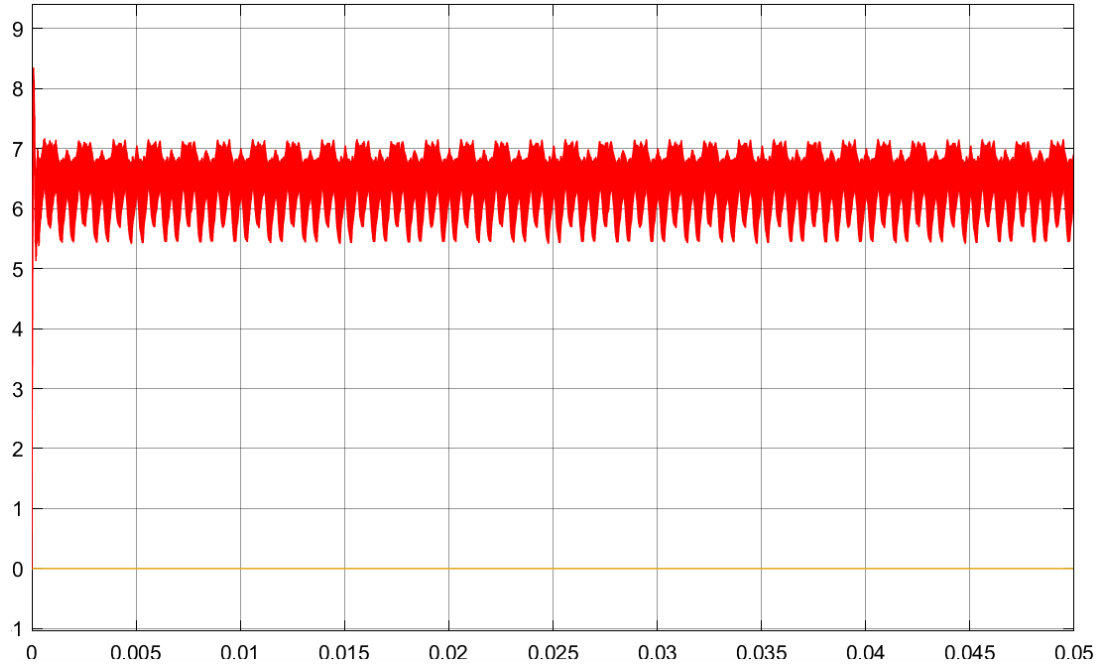

5
0
-5
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05

ma=0.9


5
0
-5
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05

Side-Bands create the envelopes

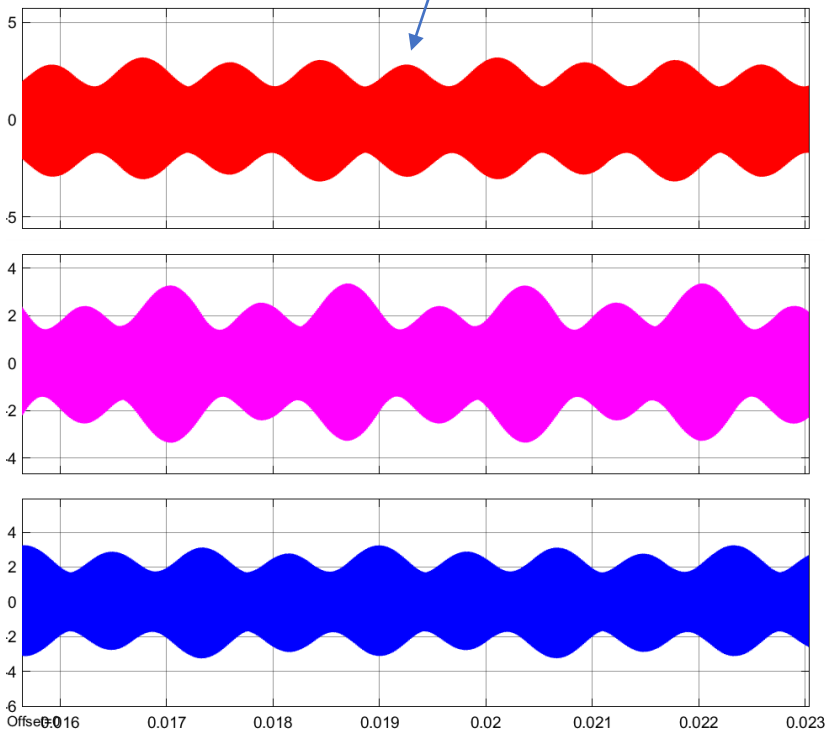


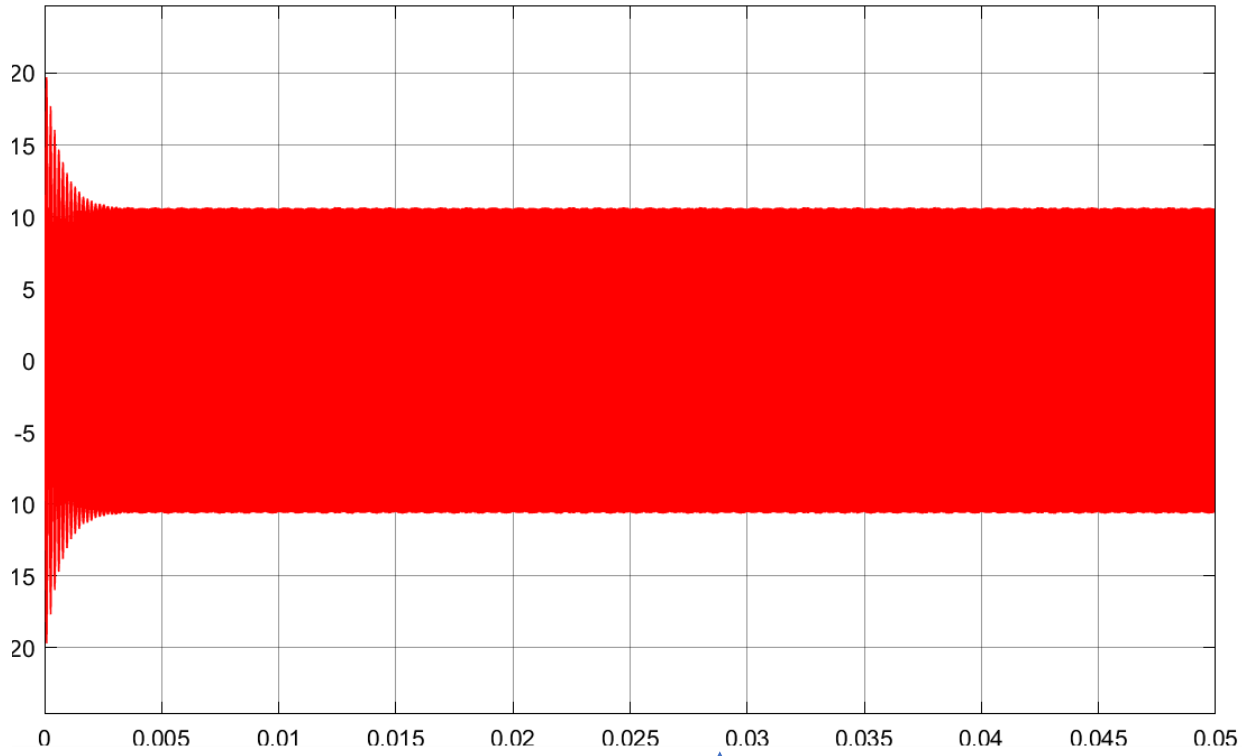

Tx Currents

Output  has only switching harmonics

Side-Bands create the envelopes




Tx Currents




Output  has only switching harmonics