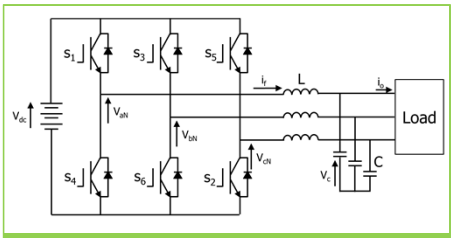
INU Power & Renewable Energy LAB

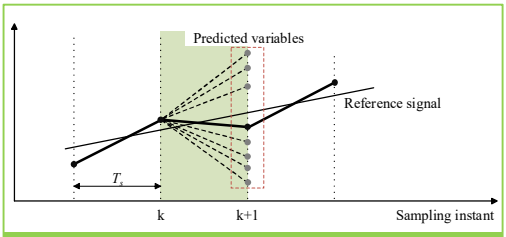
Model Predictive Control with Constant Switching Frequency

Hyeongjun Yoo*, Thai-Thanh Nguyen*, Hak-Man Kim*, Jin-Hong Jeon**
Incheon National University*, Korea Electrotechnology Research Institute Changwon**, Korea

Model Predictive Control (MPC) of Three-Phase Voltage Source Converter (VSC)



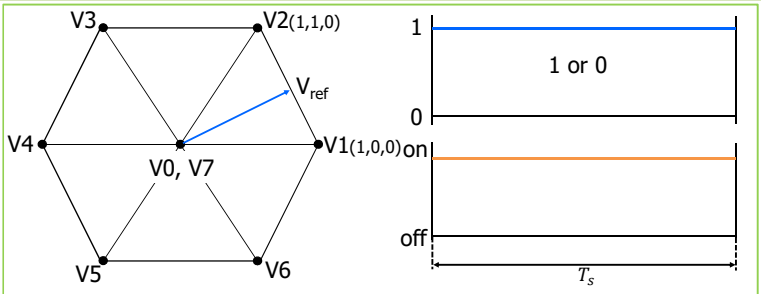
Configuration of VSC



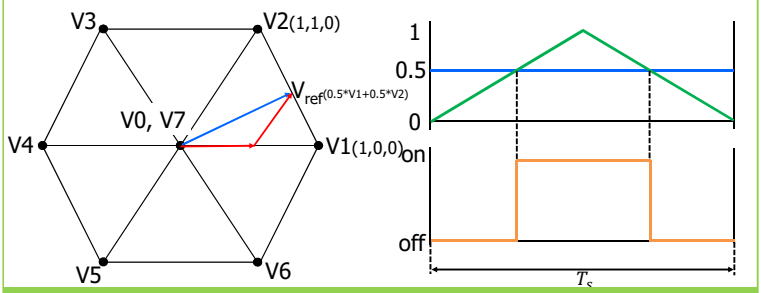
Predictive control strategy

- Finite states model predictive control (FS-MPC) appears as a promising control technique in the industry
- However, the FS-MPC presents some drawbacks
  - ✓ Non constant switching frequency
  - ✓ High sampling frequency
- The FS-MPC with constant switching frequency strategy was proposed

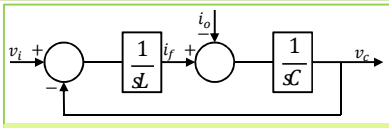
Predictive Voltage Control with Constant Switching Frequency (CSF)



Principle of Conventional MPC Strategy (Variable Switching Frequency)



Principle of Proposed MPC Strategy (Constant Switching Frequency)



LC filter Model

- The Model For a sampling Time T_s

$$x(k+1) = A_q x(k) + B_q v_i(k) + C_q i_o(k)$$

$$A_q = e^{AT_s} \qquad C_q = \int_0^{T_s} e^{A\tau} C d\tau$$

$$B_q = \int_0^{T_s} e^{A\tau} B d\tau$$

Discrete-Time Model of LC filter

- The equation of the filter inductance and output voltage

$$L\frac{dv_c}{dt} = i_f - i_o \;,\; L\frac{di_f}{dt} = v_i - v_c$$

- A state-space system

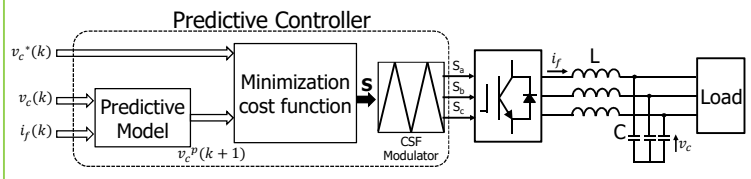
$$\frac{dx}{dt} = Ax + Bv_i + Ci_o$$

$$x = \begin{bmatrix} i_f \\ v_c \end{bmatrix} \qquad A = \begin{bmatrix} 0 & -1/L \\ 1/C & 0 \end{bmatrix}$$

$$B = \begin{bmatrix} 1/L \\ 0 \end{bmatrix} \qquad C = \begin{bmatrix} 0 \\ -1/C \end{bmatrix}$$

Continuous-Time Model of LC filter

Converter Model

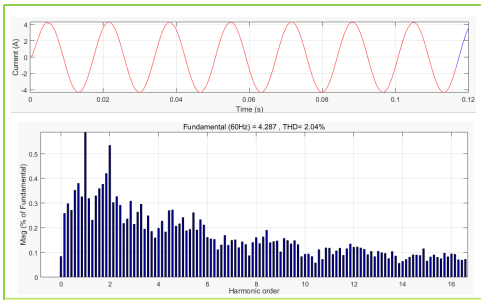


Proposed MPC Strategy

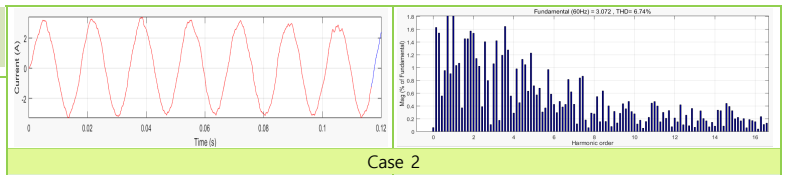
Simulation Results

Parameter	Value
v_{abc}	380 [Vrms]
f	60 [Hz]
L	4e-3 [mH]
C	40e-6 [uF]
Vdc	800 [V]

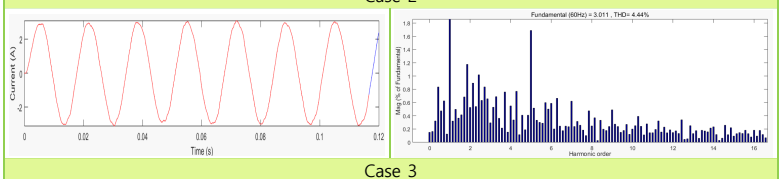
Parameters Values



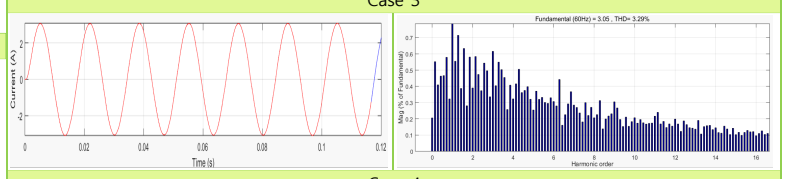
Case 1



Case 2



Case 3



Case 4

Current and FFT Analysis

Parameter	Sampling Time (Ts)	Switching Frequency (Fsw)	Number of Vector	Current THD (%)
Case 1	25 us	Variable	8	2.04
Case 2	100 us	Variable	8	6.74
Case 3	100 us	10kHz	49	4.44
Case 4	100 us	10kHz	145	3.29

Simulation Scenarios and Result

Acknowledgments

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea (No. 20168530050030).