An Improved PWM Technique of Three_Phase Motor Drives for Common Mode Voltage Reduction

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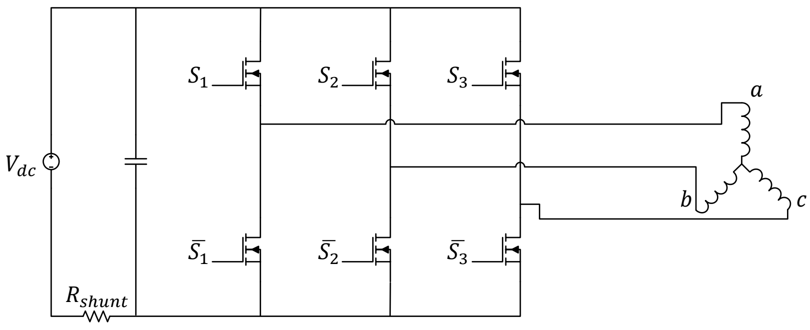
1. Introduction

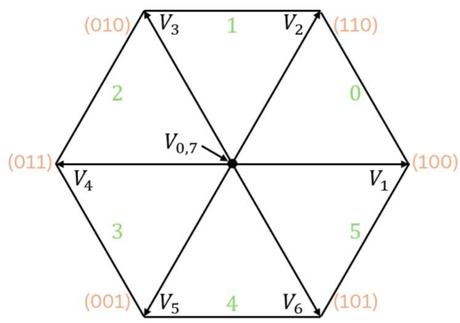
- Research Background
  - Miniaturization and efficiency of the system ← High-speed switching of switch elements
  - EMI and CMV issues need to be resolved
  - Must be compatible with 1-shunt inverter systems

- Proposed solution
  - Solve the problem with just a software change
  - Improved PWM available for 1-shunt inverters

2. Conventional Algorism

- Three-Phase, two-level voltage source 1-shunt inverter
  - Active Voltage Vector : $V1 \sim V6$
  - Zero Voltage Vector : $V0, V7$

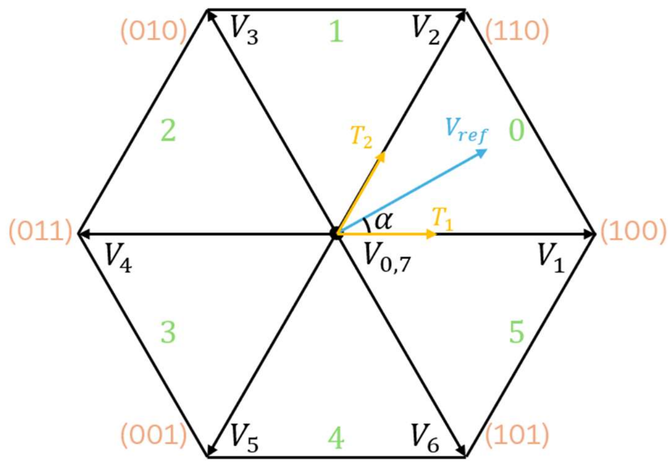




2. Conventional Algorism

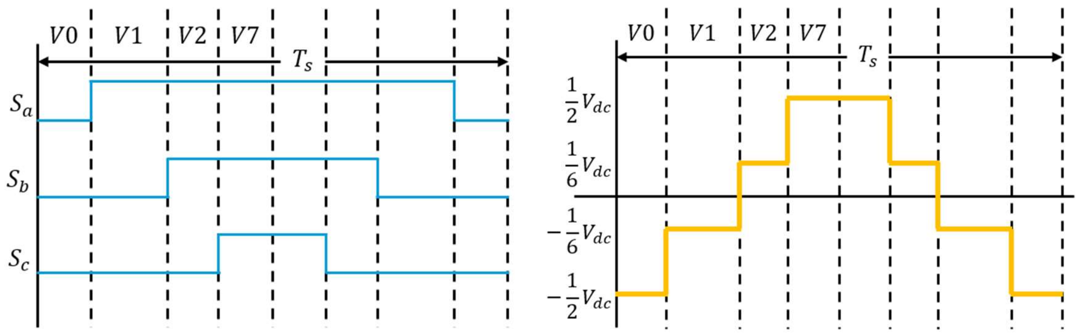
- MI (Modulation Index)
  - A method to systematize and utilize the magnitude of voltage output
  - $m_i = \frac{V_{1peak}}{V_{dc}/2}$
  - V_{1peak} : Magnitude of the fundamental wave

- CSVPWM (Conventional Space Vector PWM)
  - $T_1 = \frac{2\sqrt{3}}{\pi} M_i sin(60° - \alpha) T_s$
  - $T_2 = \frac{2\sqrt{3}}{\pi} M_i sin(\alpha) T_s$
  - $T_0 = T_s - T_1 - T_2$



2. Conventional Algorism

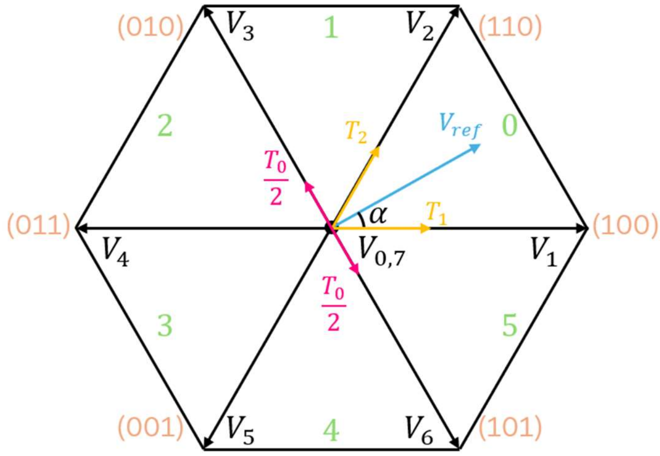
- CSVPWM CMV (Common Mode Voltage)
  - $\Delta CMV = V_{dc}$
  - Number of Changes per switching cycle : 6



Sector 0

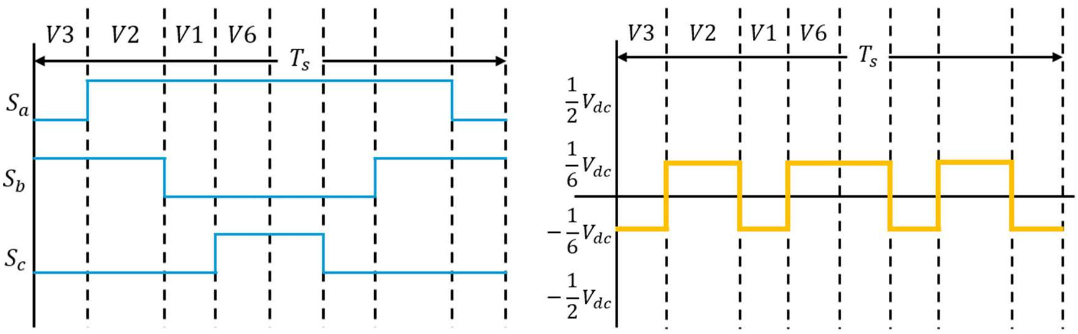
2. Conventional Algorism

- CAZSPWM
  - Zero voltage vector -> Use two opposite active voltage vectors
  - $T_1 = \frac{2\sqrt{3}}{\pi} M_i sin(60° - \alpha) T_s$
  - $T_2 = \frac{2\sqrt{3}}{\pi} M_i sin(\alpha) T_s$
  - $T_0 = T_s - T_1 - T_2$
  - But, CAZSPWM Can't use at 1-shunt Inverter



2. Conventional Algorism

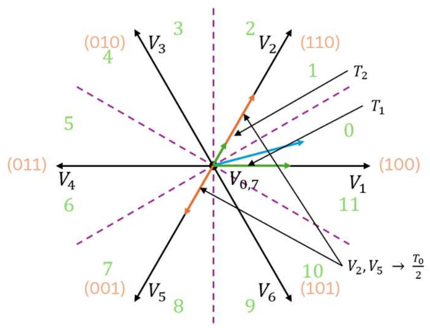
- CAZSPWM CMV
  - $\Delta CMV = \frac{V_{dc}}{3}$
  - Number of Changes per switching cycle : 6



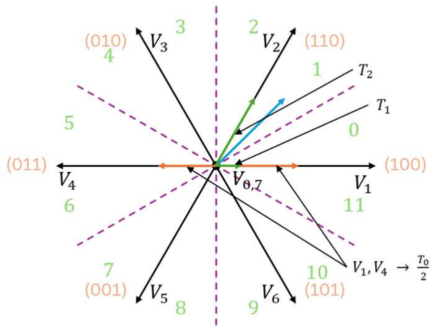
Sector 0

3. Proposed PWM

- Proposed AZSPWM can using 1-shunt inverter
  - Divide the sector into 12 sections at a 30-degree angle.
  - Case 1, Sector 0, 3, 4, 7, 8, 11 : Using vector for active zero V(N+2), V(N+5)
  - Case 2, Sector 1, 2, 5, 6, 9, 10 : Using vector for active zero V(N+1), V(N+4)
  - * N : Sector number at CSVPWM



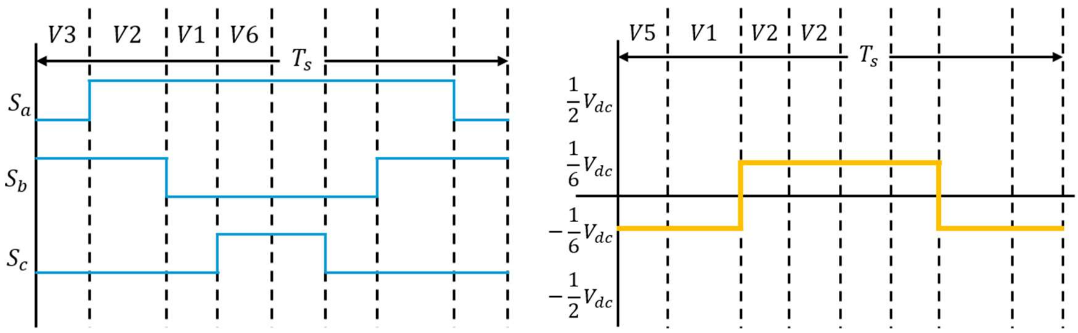
Case 1



Case 2

3. Proposed PWM

- Proposed CAZSPWM CMV
  - $\Delta CMV = \frac{V_{dc}}{3}$
  - Number of Changes per switching cycle : 2

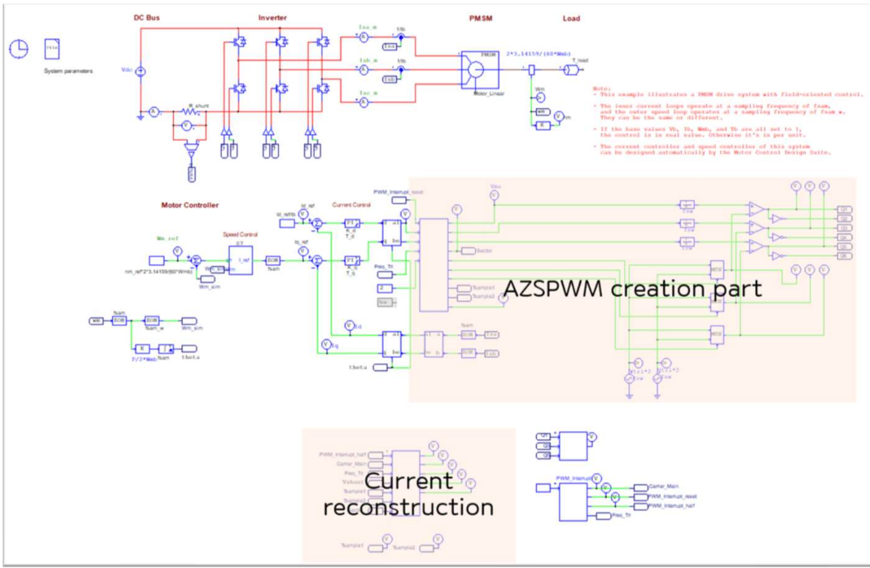


Sector 0

Integrated Power Electronics Lab

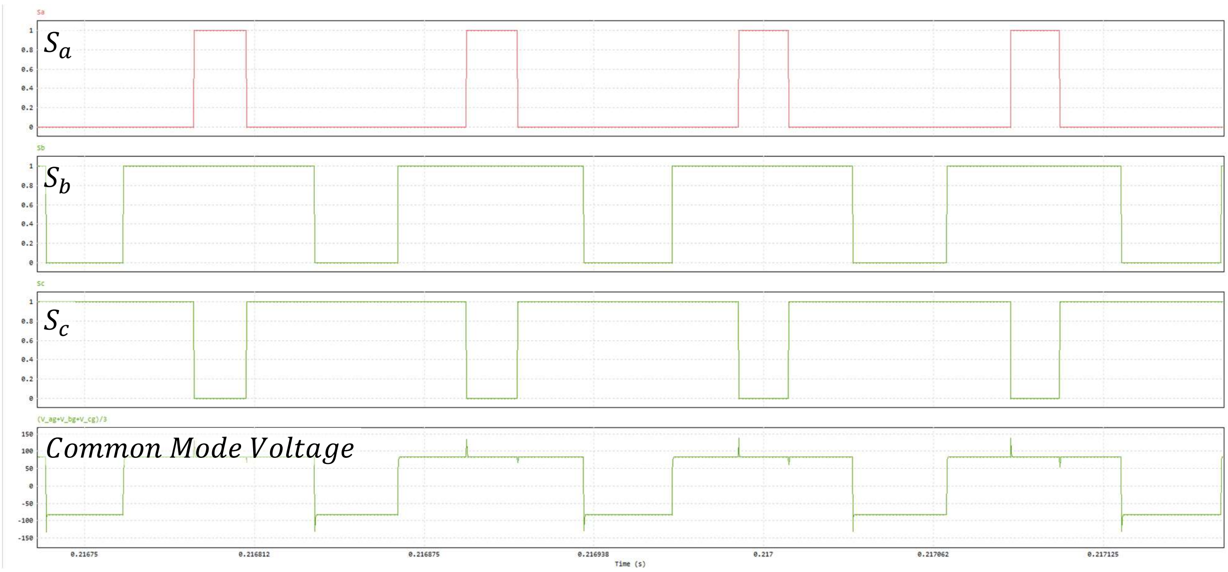
4. Simulation

- Circuit



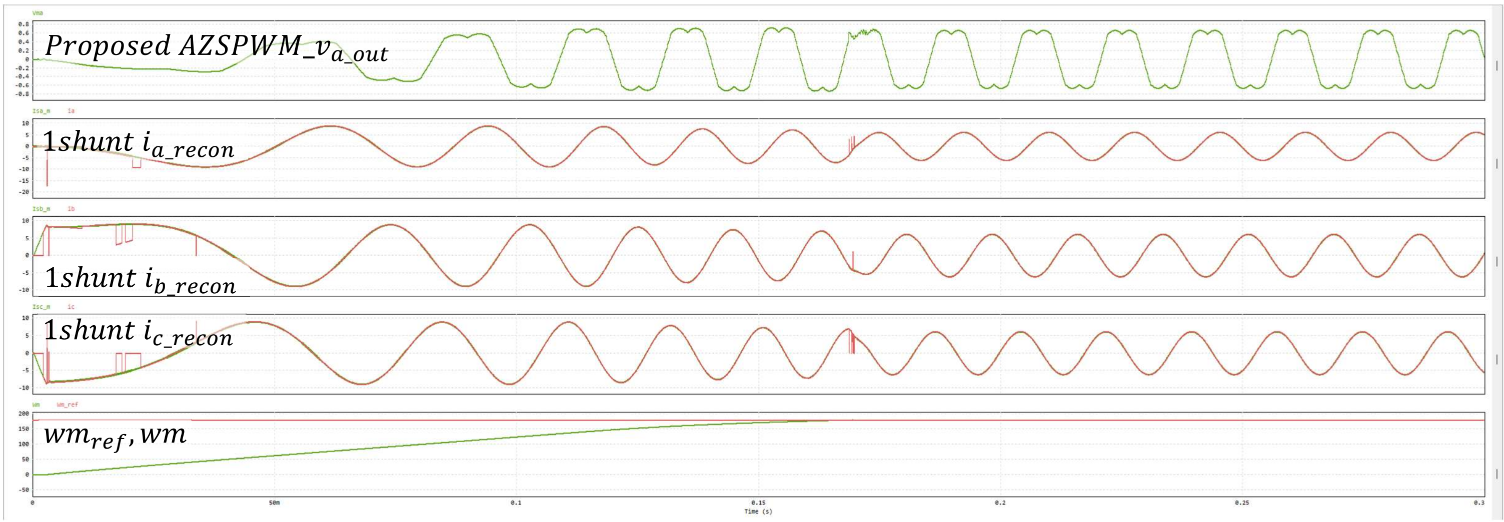
4. Simulation

- Common Mode Voltage waveform



4. Simulation

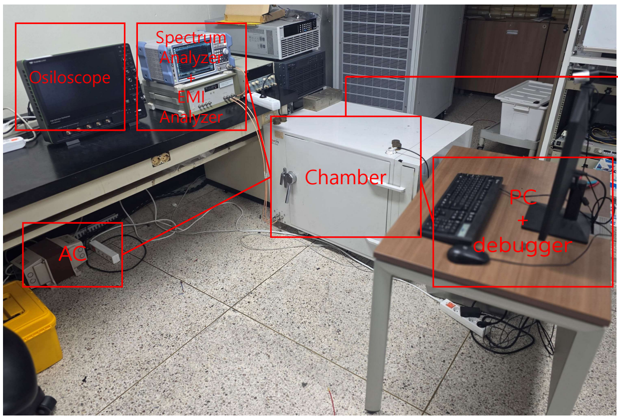
- Current reconstruction waveform



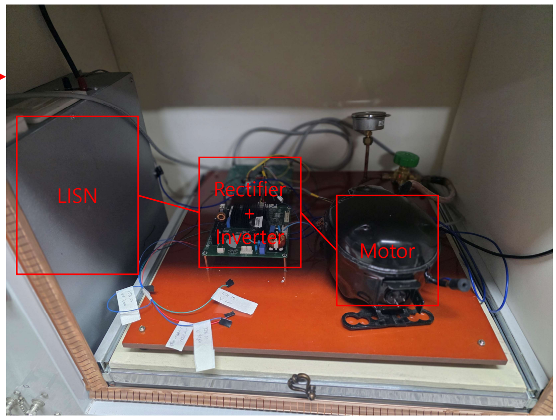
5. Experiment

- Environment

Outerior



Chamber interior



5. Experiment

- VCM, Leakage Current SVPWM and Proposed AZSPWM Waveform

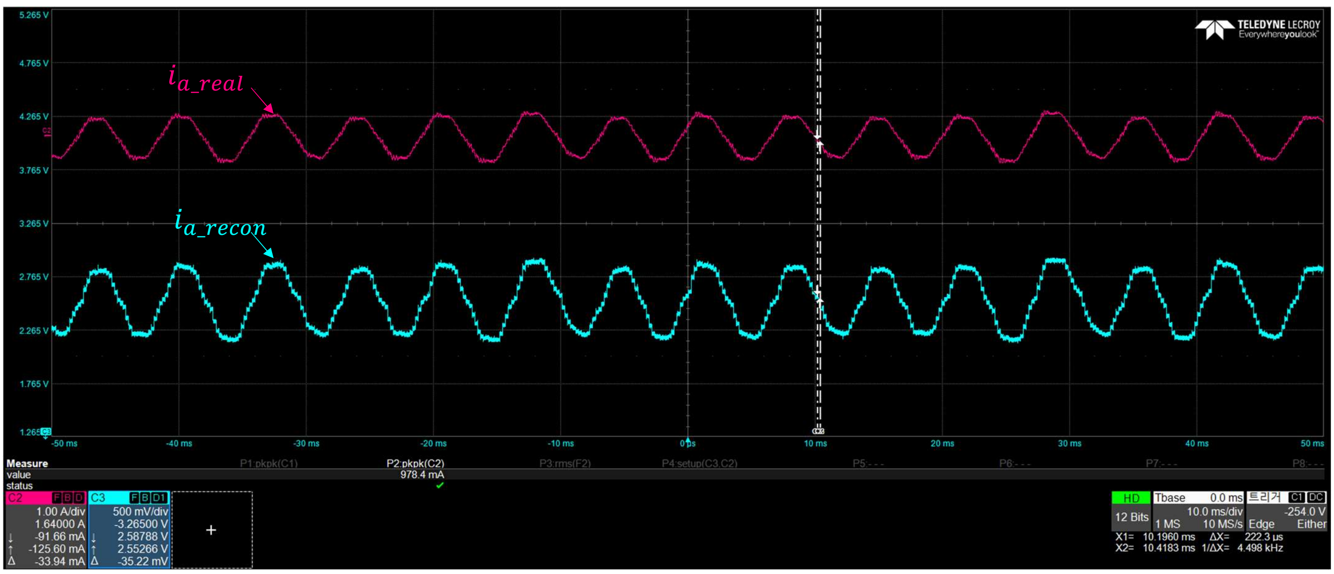
SVPWM

Proposed AZSPWM

	SVPWM	Proposed AZSPWM
ΔVCM	500 [V]	166 [V]
i_{leak}	5.77 [mA]	3.2 [mA]

5. Experiment

- Current reconstruction waveform



6. Conclusion

- Summation
  - Proposal of an AZSPWM technique usable in 1-shunt inverters
  - Verification through simulation and experiment

	CSVPWM	CAZSPWM	Proposed AZSPWM
ΔCMV	V_{dc}	$V_{dc}/3$	$V_{dc}/3$
CMV change time Per switching cycle	6	6	2
i_{leak}	5.77 [mA]	-	3.2 [mA]

SVPWM

Proposed AZSPWM