

國立台北科技大學 電機系 馬達技術實驗室

Motor Technology Lab. (綜合科館417)

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Research Directions

■ Research Area

- DC, AC, and switched reluctance motor design
- PMAC, BLDC motor, generator, drive system and control
- Servo motor drive and control strategies
- Magnetically levitated electric machines, electromagnetic actuator

■ Recent Research Topics

- Flux switching motor design, drive system, and control
- Automatic control loop gain tuning for PMAC servo motor drives
- Servo motor drive resonance frequency detection and suppression
- Sensorless PMAC motor control



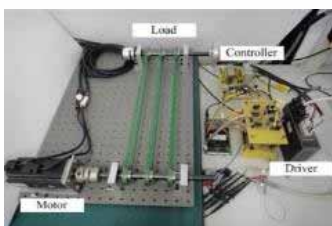
Switched Reluctance Machine



(a) Rotor (b) Stator



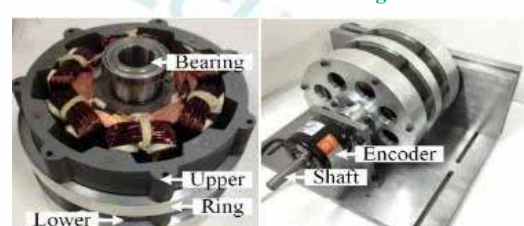
(c) Stator and Rotor (d) Assembled
Flux Switching Machine



Vibration detection



Sensorless Control



Flux Switching Machine

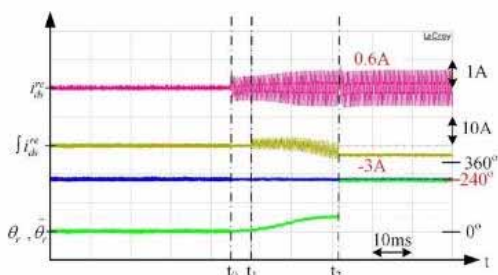
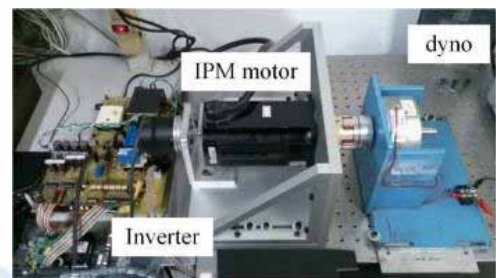
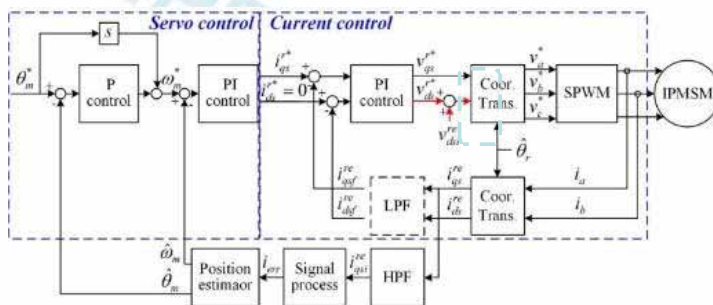
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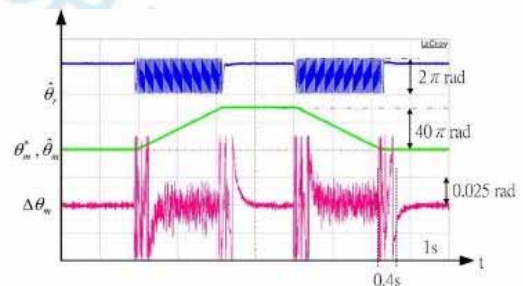
Recent Researches

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PMSM Shaft Position Sensorless Control



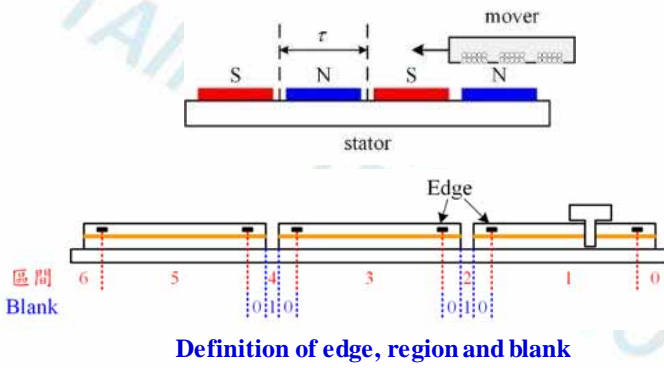
PMSM initial position detection



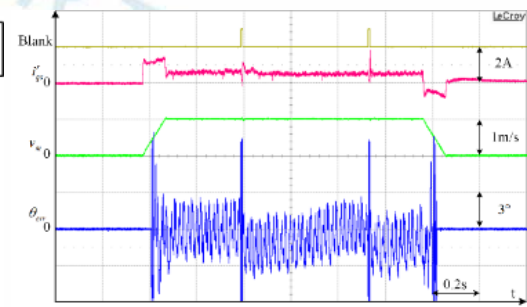
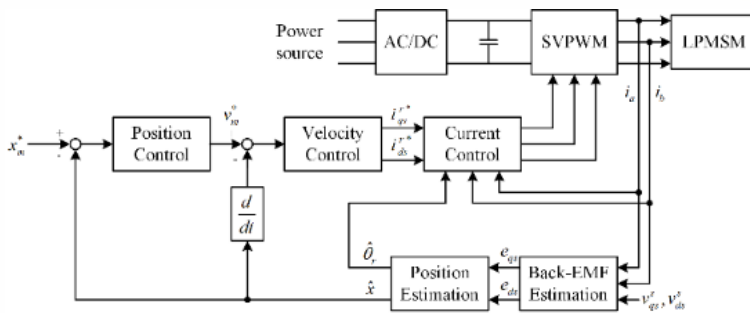
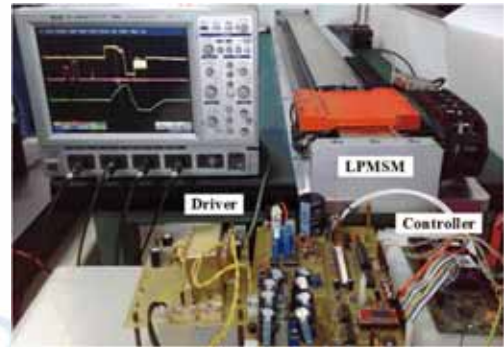
PMSM position sensorless control

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Linear PMSM Machine Control



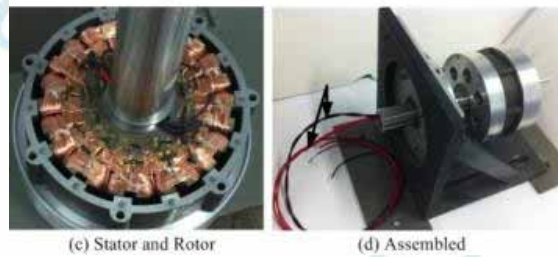
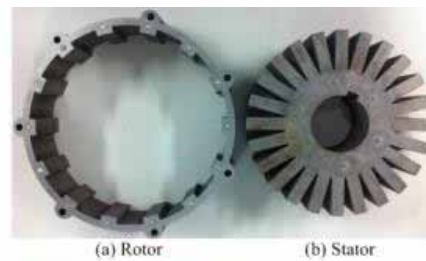
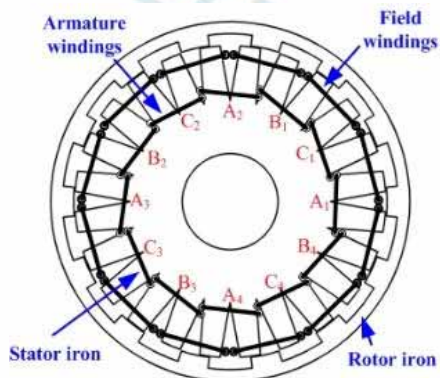
Definition of edge, region and blank



馬達動子以 1 m/s 正向行進 1.2 公尺並經過兩個間隙的實驗結果

Three-phase, External Rotor DC-Excited Flux Switching Machine Design

Designed for light-weight electric scooter



Parameter	Value	Parameter	Value
Stator slot number	24	Air-gap length	0.5 mm
Rotor pole number	14	Armature coil turns per phase	55
Stack length	5 mm	Field coil turns	55
Stator outer radius	60 mm	Rated speed	600 rpm
Rotor outer radius	75 mm	Rated torque	5 Nm
Rotor back iron thickness	5 mm	DC input voltage	300 V

Two-Step 12-slot, 7-pole, DC-Excited Flux Switching Machine Design



stator

rotor

Stator and rotor



Assembled

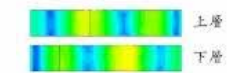
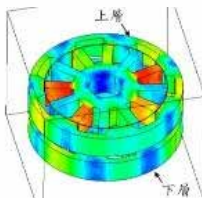
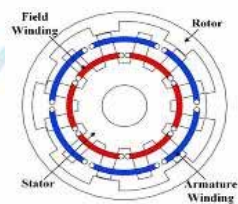
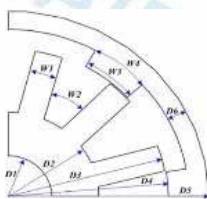
Two-step design to reduce radial magnetic force.

Armature		Field	
Resistance	1.5 Ω	Resistance	4 Ω
q-axis inductance	17.5 mH	Inductance	44 mH
d-axis inductance	19.5 mH		

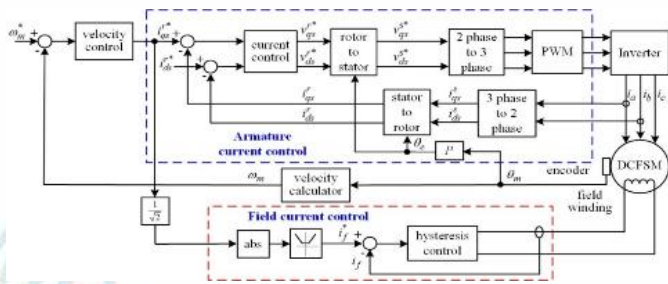
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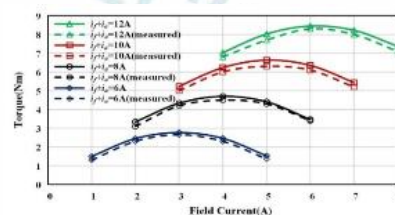
Design and Control of Flux Switching Machine



Dual structure to reduce shaft magnetic force



尺寸名稱	代號	數值	尺寸名稱	代號	數值
轉子型式		外轉子	氣隙長度		0.5 mm
定子槽數		12槽	定子外徑	R3	59.5 mm
轉子極數		7極	定子內徑	R2	34 mm
轉子外徑	R5	75 mm	定子齒寬	W1	10 degree
轉子內徑	R4	60 mm	疊積		55 mm
轉子背鐵	R6	7.5 mm	軸徑	R1	16.5 mm
轉子外極寬	W4	19 degree			
轉子內極寬	W3	19 degree			



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Part of Past Researches

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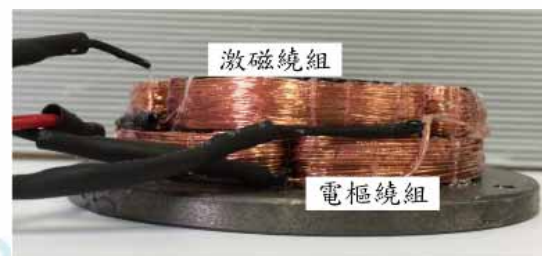
Single-phase, Axial-Flux 8-slot, 4-pole DC-Excited Flux Switching Machine

Designed for home appliance.



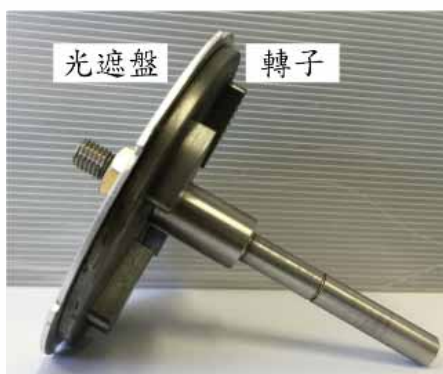
定子

轉子



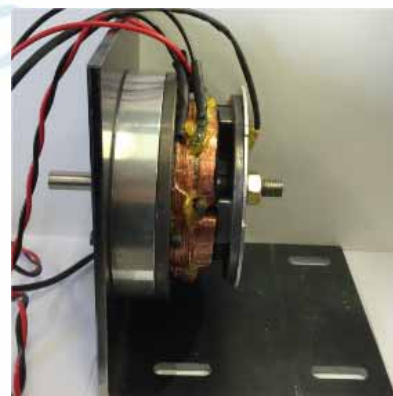
激磁繞組

電樞繞組



光遮盤

轉子



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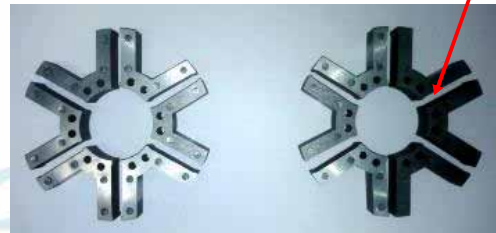
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Three-phase, 6-slot, 7-pole PM type Flux Switching Generator

- PM-type flux switching machine.
- Designed for scooter generator.
- Two-step stator and rotor to reduce radial magnetic force.



rotor core



stator core



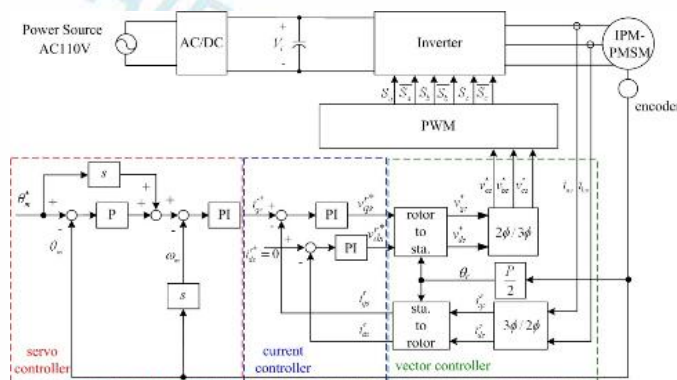
assembled stator



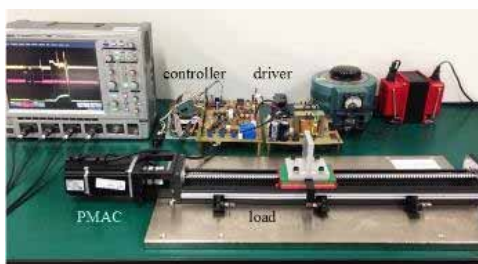
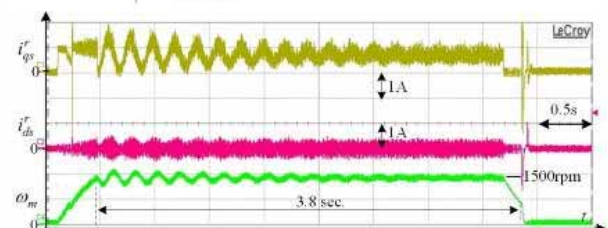
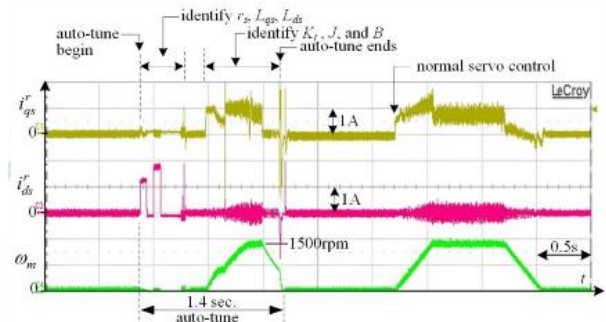
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Automatic Control Loop Tuning for PMSM Servo Motor Drive



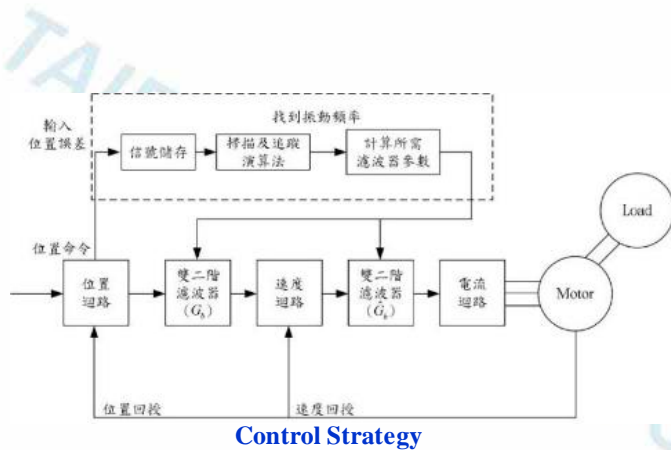
- Current and Servo control loops can be tuned within 1.4 seconds.
- All measured parameters errors < 10%



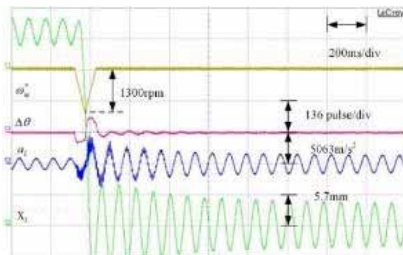
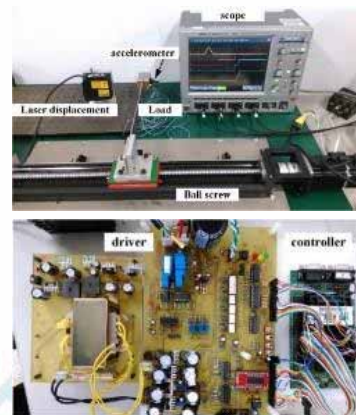
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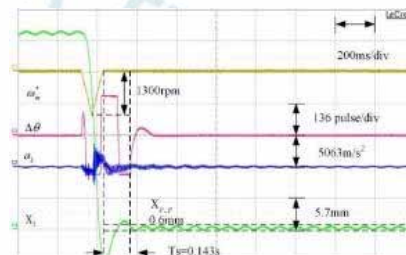
Vibration Suppression in Servo Control System



Control Strategy



Before vibration suppression

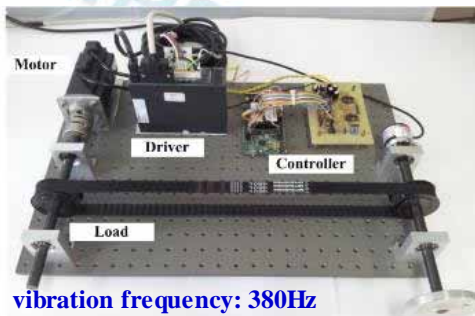


After vibration suppression

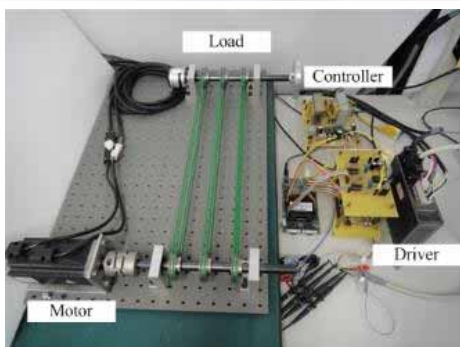
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Resonant Vibration Detection in Servo Motor Drives

Experimental systems used:

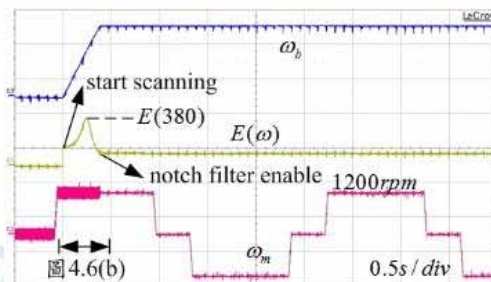


vibration frequency: 380Hz

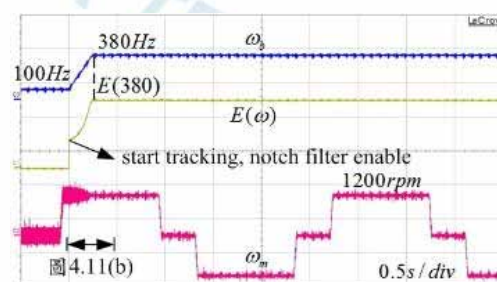


vibration frequency: 30Hz

Scanning:



Tracking:



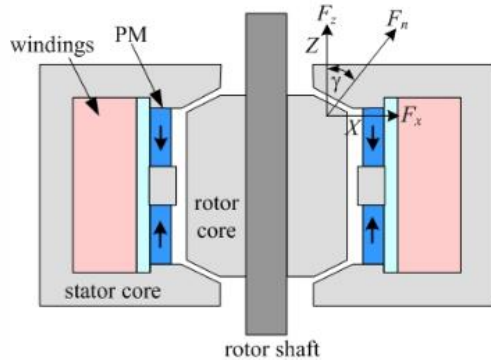
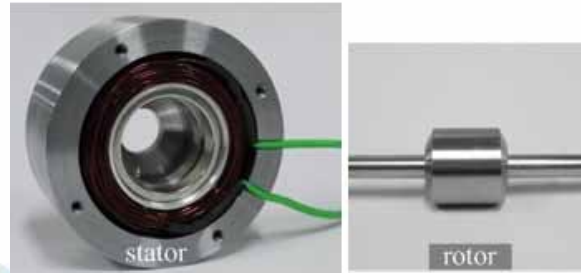
Both methods are effective in suppressing vibrations.

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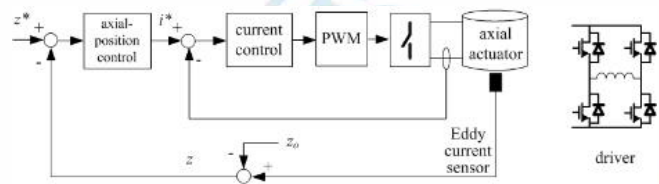
Axial Electromagnetic Actuator

Actuator 結構:

定子為U型環結構，其中包含一組繞線、兩個環形永久磁鐵、及一個環形導磁鐵環；磁鐵與線圈之間為不導磁之填充物，轉子則為環形之鐵心。



Actuator produces 150N with 4A.

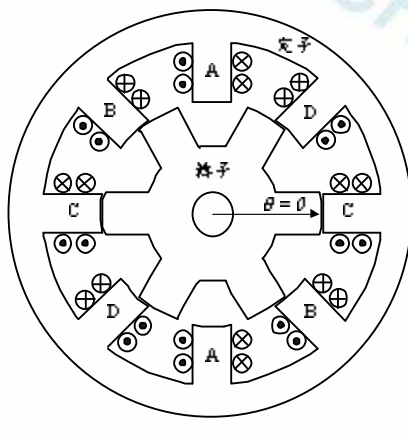


Switched Reluctance Motor Drive

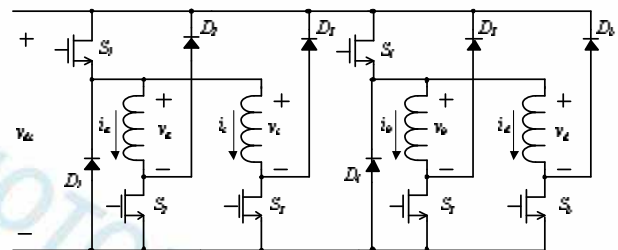
Two researches on SRM:

- two phase excitation for SRM braking to prevent DC bus over voltage
- 6/4 SRM for hand dryers

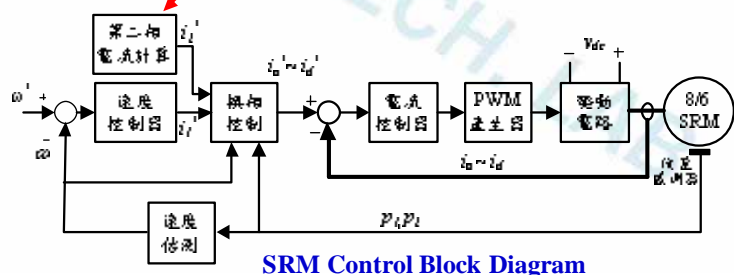
Miller 2N+1 Power Stage, V_{dc} is from the rectified 220VAC.



8/6 pole SRM

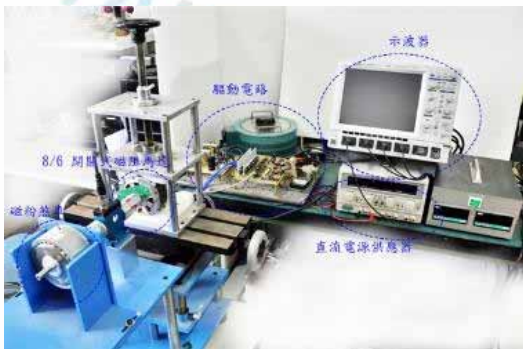


an additional phase is excited during braking period.

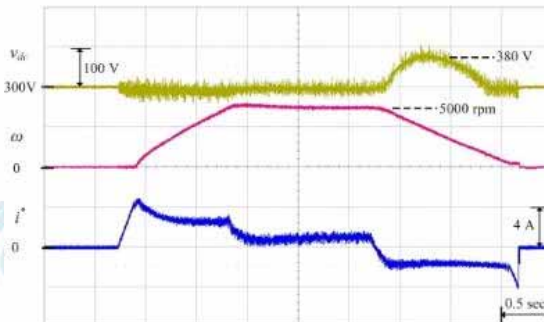


SRM Control Block Diagram

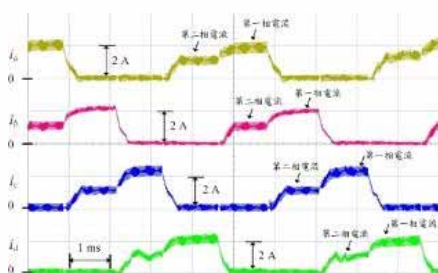
Two-Phase Excitation for SRM Braking



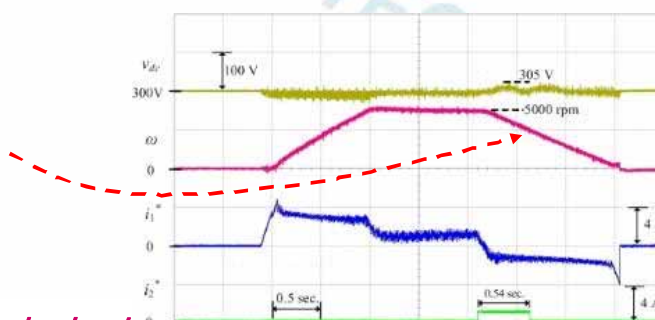
Normal excitation (1 phase), peak Vdc about 380V.



Phase current waveform at 3800rpm:



2 phase excitation, peak Vdc about 305V.



Taipei Tech. Electrical Engineering, Motor Technology Lab., 2011

SRM Drive for Hand Dryer Applications

- 6/4 pole SRM
- maximum speed about 15000rpm
- controller: FPGA
- Input: 110 VAC with PFC



Hand Dryer



Stator and rotor:



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