Single-Sensor Based Low-Cost Current Control in SRM Drives for Electric Vehicle Applications

Nasir Ali[1,2] , Qingsong Wang[1], Qiang Gao[2], Ke Ma[2]
[1]*École de Technologie Supérieure*, ÉTS, Canada, [2]*Shanghai Jiao Tong University, Shanghai, China*

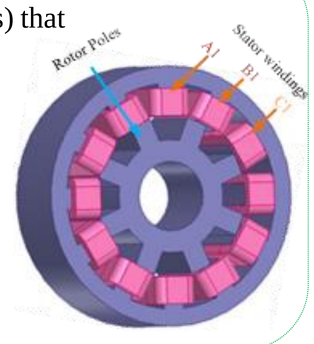
Abstract

A simple single-sensor-based current control method, without using complex algorithms/circuitries, to reduce the size, and cost of the drive system is investigated in this paper. During the commutation regions, where two phases are simultaneously conducted, the reference current is simply adjusted to maintain the current error at the normal limit. Closed-loop control is achieved using a single sensor.

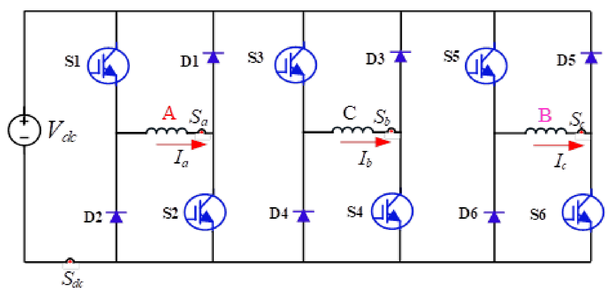
Research Objectives

A Low-cost drive system for switched reluctance Motors (SRMs) that equipped with the following features:

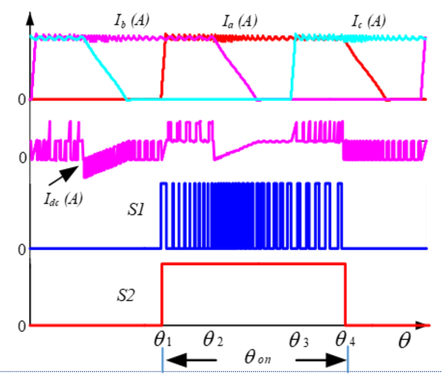
1. Closed-loop control using a single sensor,
2. No complex computation for the current reconstruction,
3. Easy for implementation,
4. No performance degradation such as ripple torque or noise



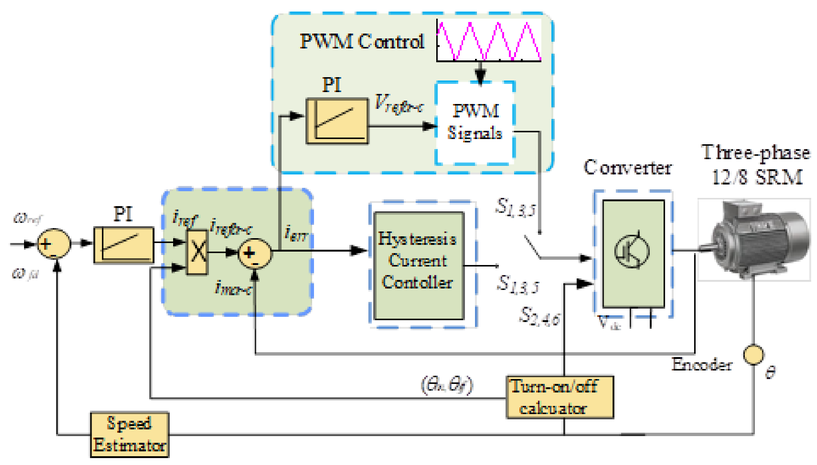
Asymmetric Half-Bridge (AHB) Converter with Dc-link Current Sensor



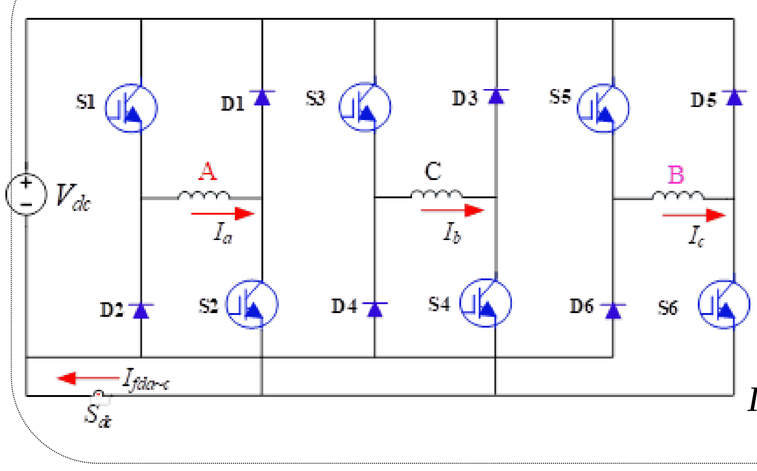
$$I_{dc} = I_a . S_2 + I_b . S_4 + I_c . S_6 \quad (1)$$



Typical CCC and PWM current Control schemes



Modified AHB converter with dc-link current sensor strategy

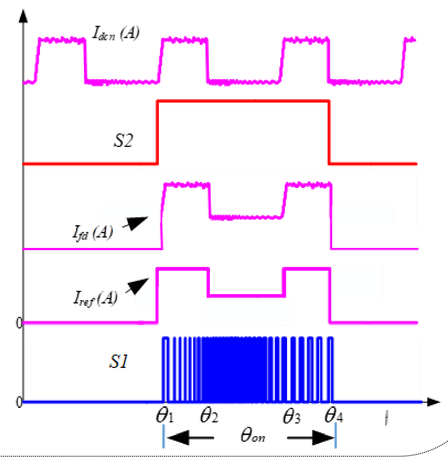


$$I_{fda} = I_{dcn} . S_2 \quad (2)$$

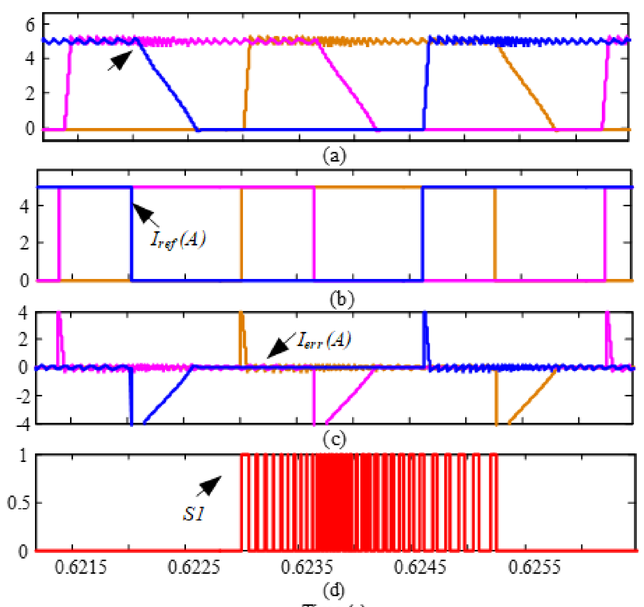
$$I_{fdb} = I_{dcn} . S_4 \quad (3)$$

$$I_{fdc} = I_{dcn} . S_6 \quad (4)$$

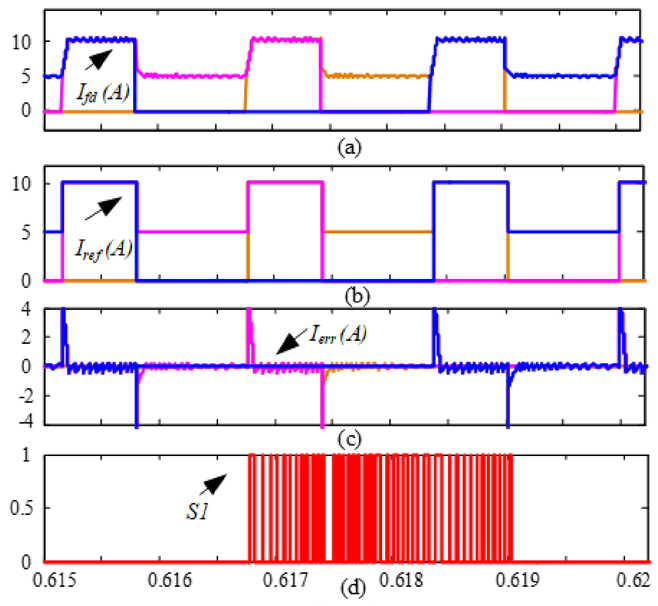
$$I_{rr} = 2.I_{ref} - If_{da\sim c} \quad (5)$$



Simulation Results under Steady State

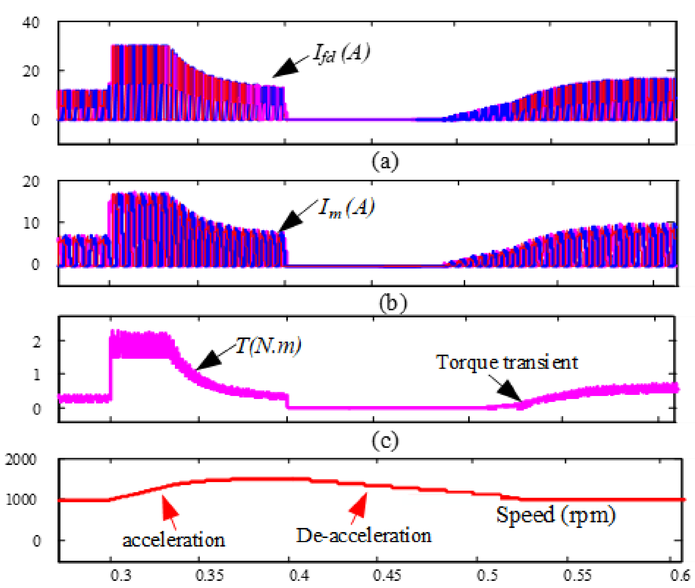


(a) Three-phase currents measured through individual sensors
(a) Reference currents,
(c)Current errors
(d) Switching signals generated by the errors



(a) Three-phase currents developed from the single sensor,
(a) Adjusted reference currents according to (2) and (5)
(c)Current errors generated using (5)
(d) Switching signals generated by the errors

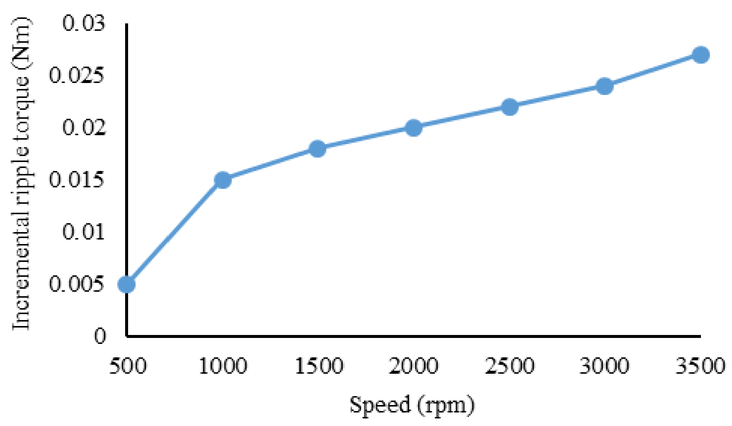
Simulation Results under dynamic Conditions



(a) Three-phase currents measured from the individual sensors
(a) Three-phase currents developed from the single sensor,
(c) Total torque (Nm)
(d) SRM's speed (rpm)

Conclusion

The main contribution and advantages of the proposed scheme are; A drive system that is simple for implementation, low-cost, and universality i.e. can be extended to multiphase SRMs, no incremental torque, and current ripples, and thus no incremental losses.



Comparison of torque ripple between the proposed and conventional current sensing schemes

References

1. C. Gan, J. Wu, S. Yang, and Y. Hu, "Phase current reconstruction of m switched reluctance motors from dc-link current under double high frequency pulses injection,"IEEE Trans Industrial Electronics., vol. 62, no. 5, pp. 3265–3276, May 2015.
2. N. Ali, Q. Gao and K. Ma, "A Cost-Effective Dual Bus Current Measurement Scheme for Current Control of Three-phase Switched Reluctance Motors," 2020 IEEE 9th International Power Electronics and Motion Control Conference (IPEMC2020-ECCE Asia), 2020, pp. 2562-2566