Faculty of Engineering - Power Department

# Copper losses flow based doubly fed reluctance machine

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Topics

- Brushless Doubly Fed Reluctance machine (BDFRM) construction and behaviours

- V/f principle
- Practice Result
- Losses behavior

Mathematical Expression and block diagram of BDFR Machine

$$\begin{cases} v_{pd} = R_p i_{pd} + \dfrac{d}{dt}\bar{\lambda}_{pd} - \omega\lambda_{pq} \\[2mm] v_{pq} = R_p i_{pq} + \dfrac{d}{dt}\lambda_{pq} + \omega\lambda_{pd} \\[2mm] v_{sd} = R_s i_{sd} + \dfrac{d}{dt}\lambda_{sd} - (\omega r - \omega)\lambda_{sq} \\[2mm] v_{sq} = R_s i_{sq} + \dfrac{d}{dt}\lambda_{sq} + (\omega r - \omega)\lambda_{sd} \end{cases}$$
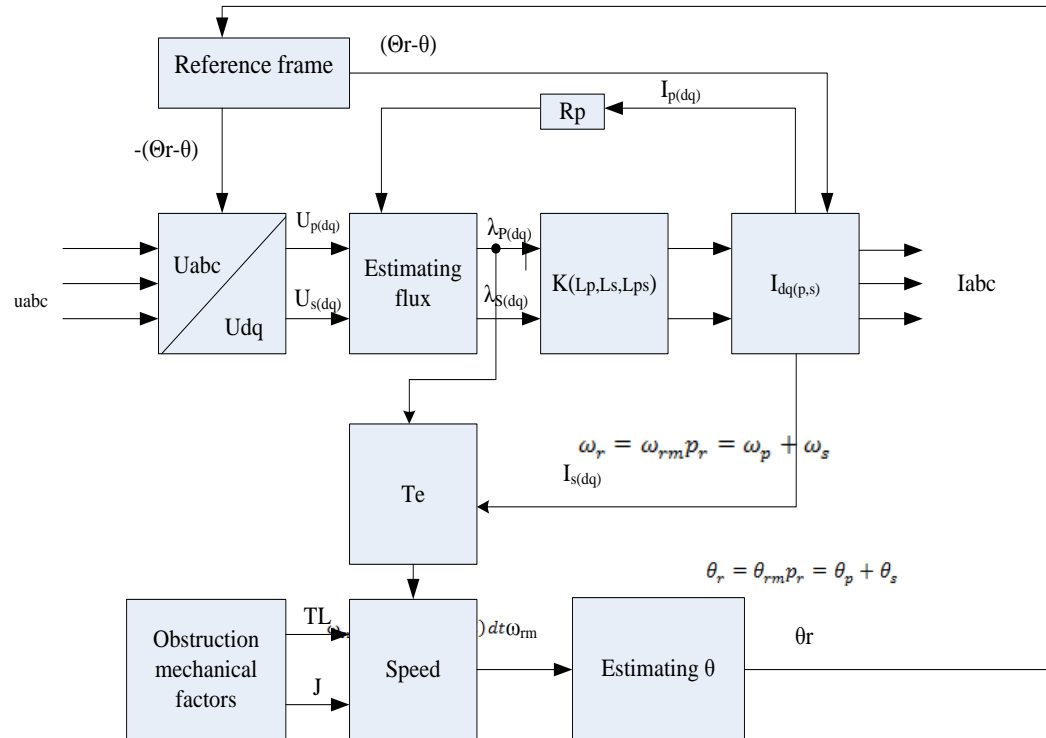
Feature and Classification of BDFR Machine

Feature:

1. Higher efficiency and simpler control as compared to the BDFIM such as wound rotor which is closely relevant in design to BDFRM machine
2. Higher reliability and free maintenance owing to its brushless structure compared with others slip ring recovery machines
3. BDFRM capability to operate in different mode as:
❑ conventional induction machine by simply shorting the secondary winding even such action protect the control side in the case of inverter failure.
❑ A second feature is that when the secondary winding is fed with DC voltage, the machine behaves like synchronous-machine.
❑ Finally, when partially coupled with a converter, BDFRM acts in a manner similar to any conventional doubly exited induction machine that is commonly used for wind power conversion and its association electronics with each case accordingly.
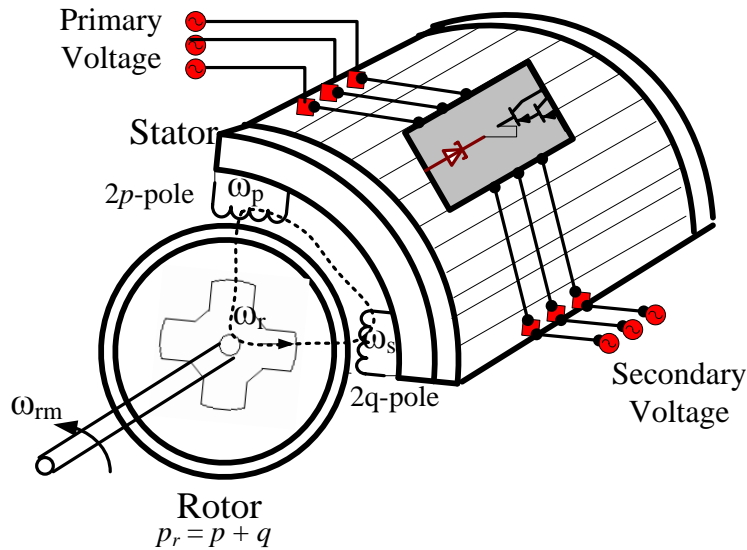
Classification:

BDFRM is classified as closely related with the brushless doubly fed induction machine (BDFIM).
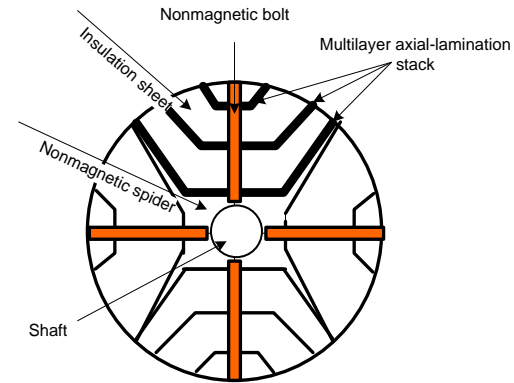
BDFRM- Fundamentals

BDFRM

- Configuration Brushless doubly fed Reluctance machine.
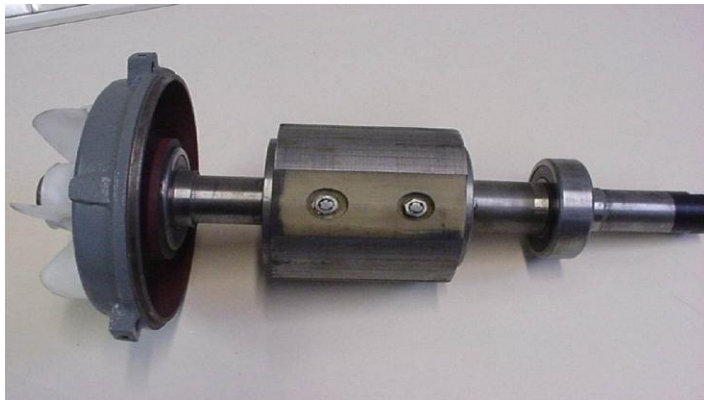
Silense rotor of BDFRM

- Unwounded multi layer axial lamination stack
- Use to provide power flow through the machine sides by exaltation the primary and secondary winding through the rotating prime mover

Primary
Voltage

Stator

$2p$-pole ω_p

ω_r

ω_s

ω_{rm} $2q$-pole

Secondary
Voltage

Rotor
$p_r = p + q$

Nonmagnetic bolt

Multilayer axial-lamination stack

Insulation sheet

Nonmagnetic spider

Shaft

Construction of BDFRM
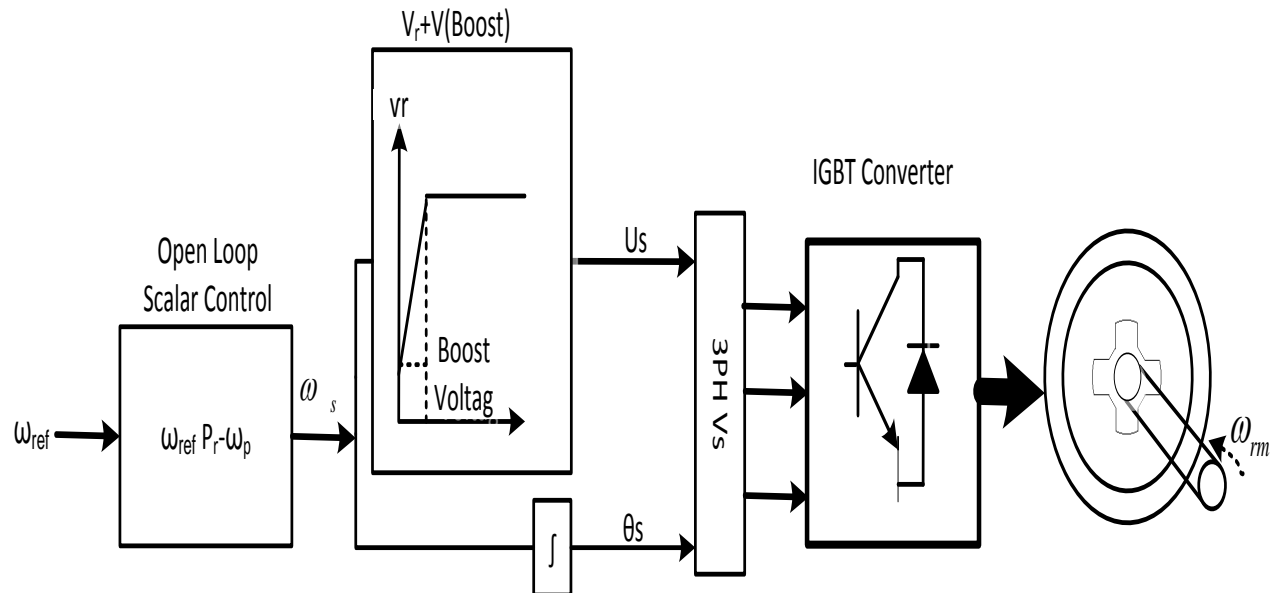
Salience Rotor

- Reluctance Rotor

Double coile Stator
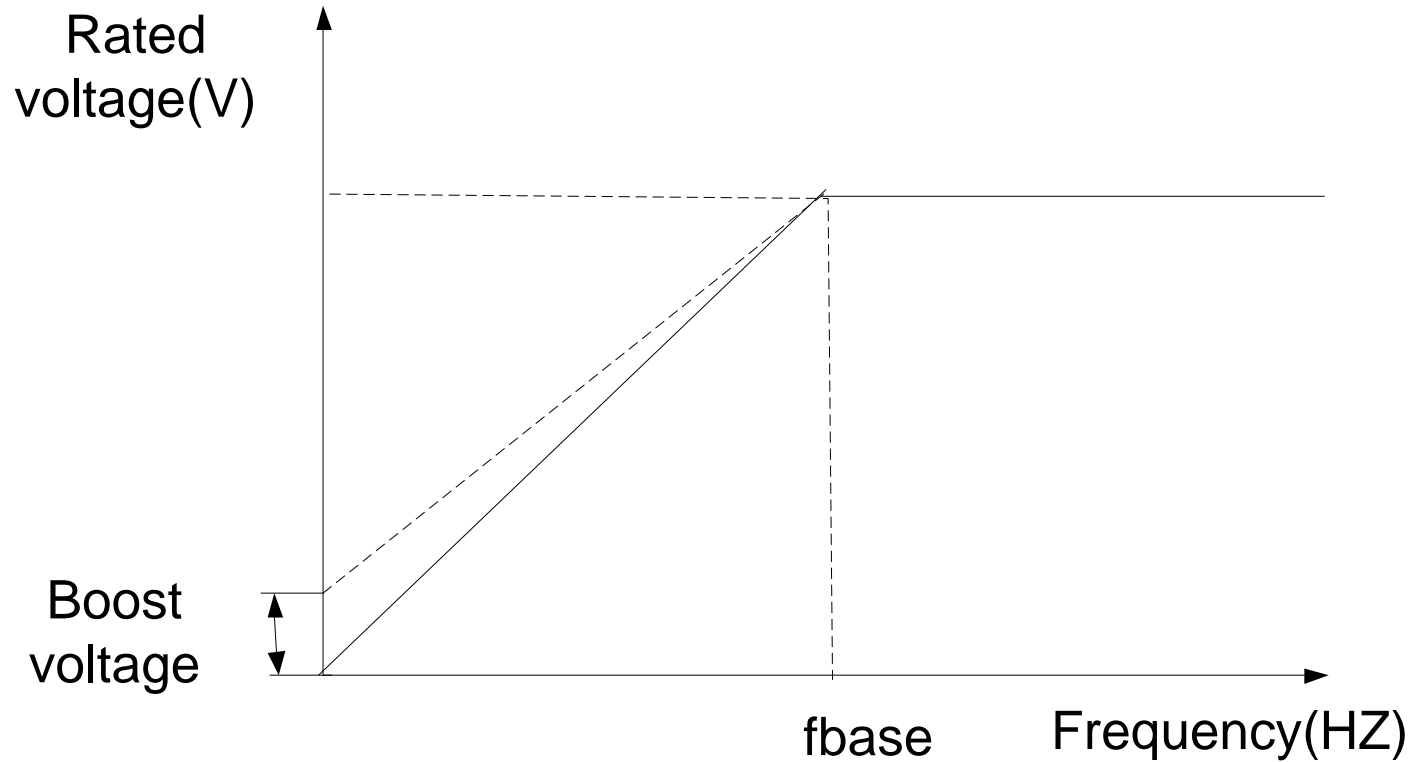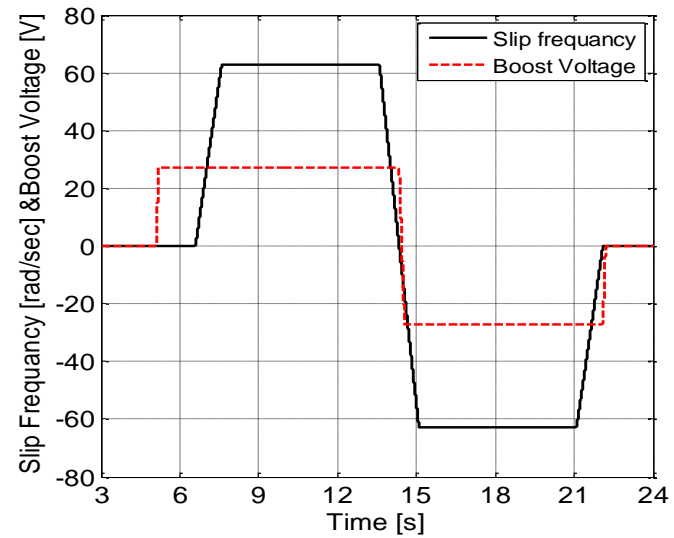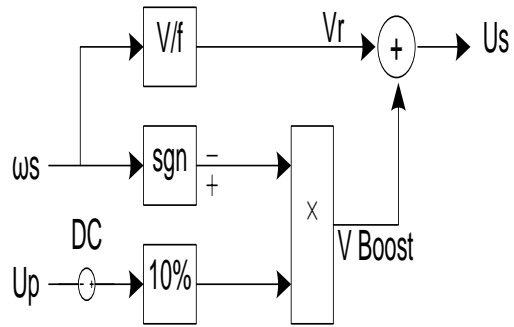
- Stator of BDFRM

Control method

$$\omega_{rm} = \frac{\omega_p + \omega_s}{P_r} \leftrightarrow \omega_r = \omega_{rm} p_r = \omega_p + \omega_s$$

V/f principle
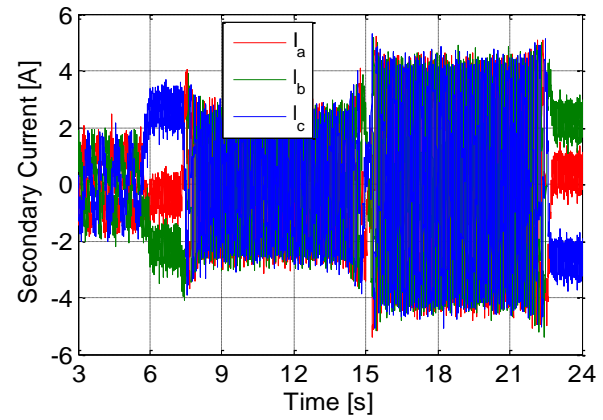
Rated voltage(V)
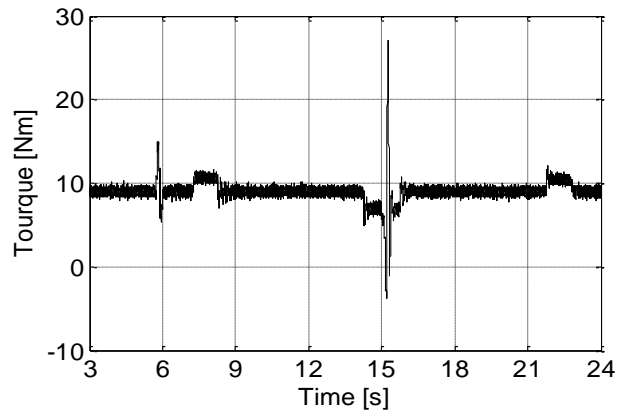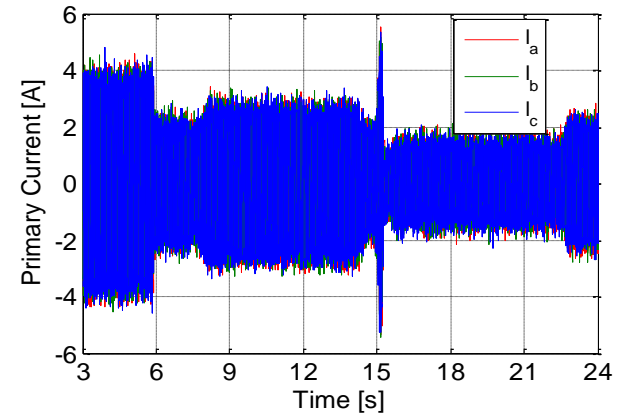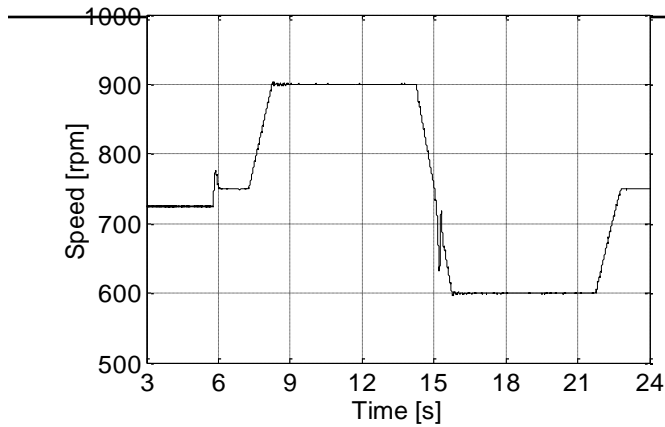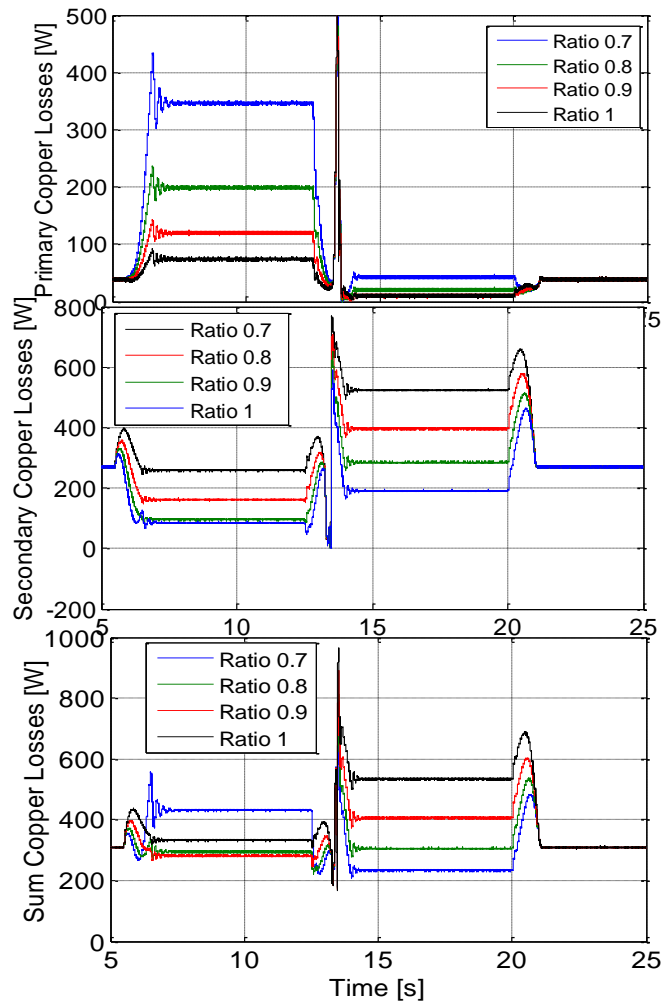
Boost voltage

fbase

Frequency(HZ)
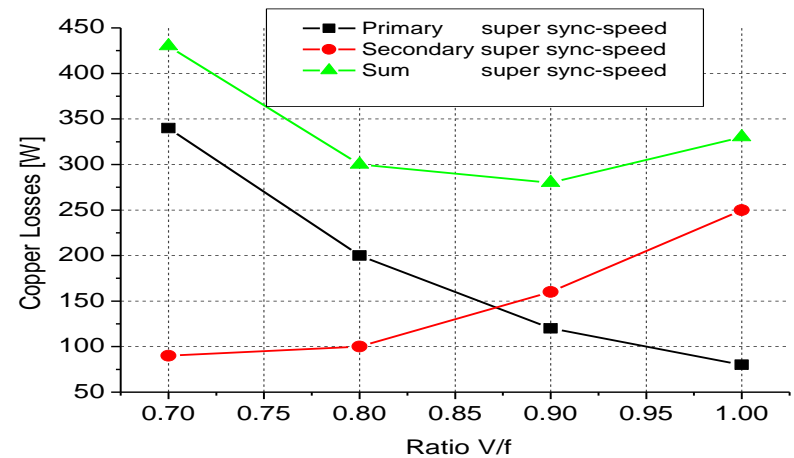
# Boost voltage with rated voltage suplayment

The results：

`Losses behaviors in motoring mode

Ratio	Primary Super-synch	Secondary Super-synch	Total losses Super-synch	Primary Sub-synch	Secondary Sub-synch	Total losses Sub-synch
0.7	340	90	430	40	185	225
0.8	200	100	300	25	280	305
0.9	120	160	280	10	400	410
1	80	250	330	20	500	520

Actual performance of BDFRM based dSPACE application
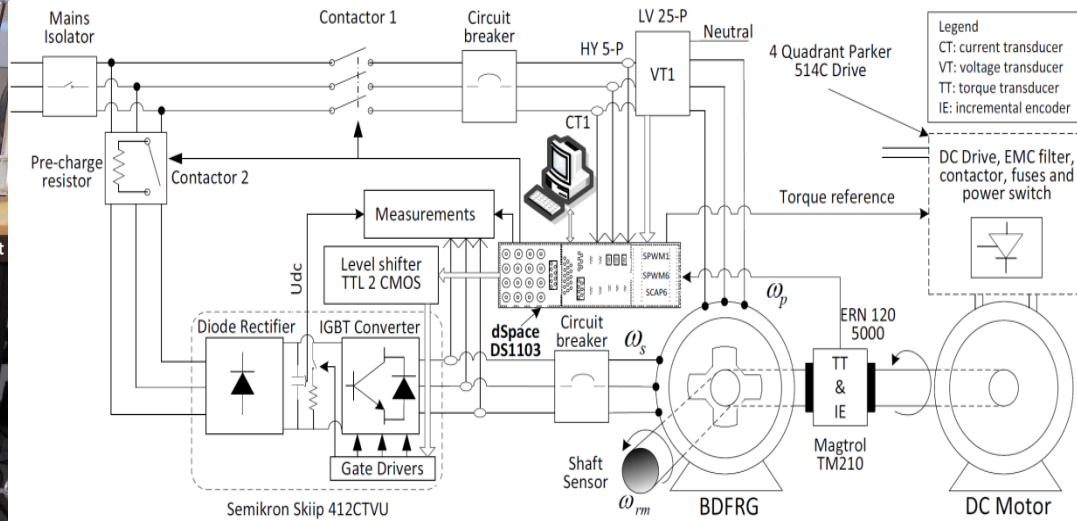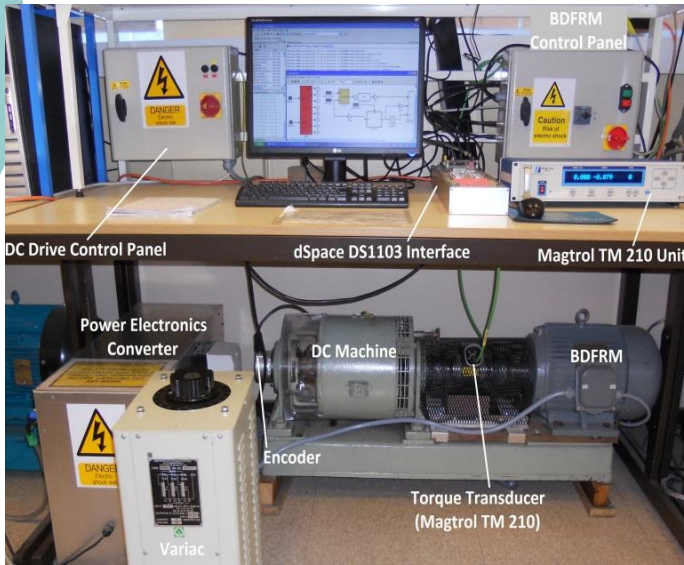
Conclusion and feature work

○ Evaluating control algorithms v/f prove the basic control algorithm can provide the real behaviour of power flow between the primary and secondary sides

○ The effect of **MTPAI** to achieve the control side stable under sudden change, by Enabling reactive   current I_{sq} to have big role in torque production when I_{sd} minimizing to zero.

○ The most important feature for the **BDFRM** machine simple dealing partially with the converter and good .

○ The compatibility of **dSPACE** Application to provide the suitable and accuracy result in practice.

Thank you for your attention!