Variable Frequency Operation of Hydro Generators Connected Through Full-power Converters
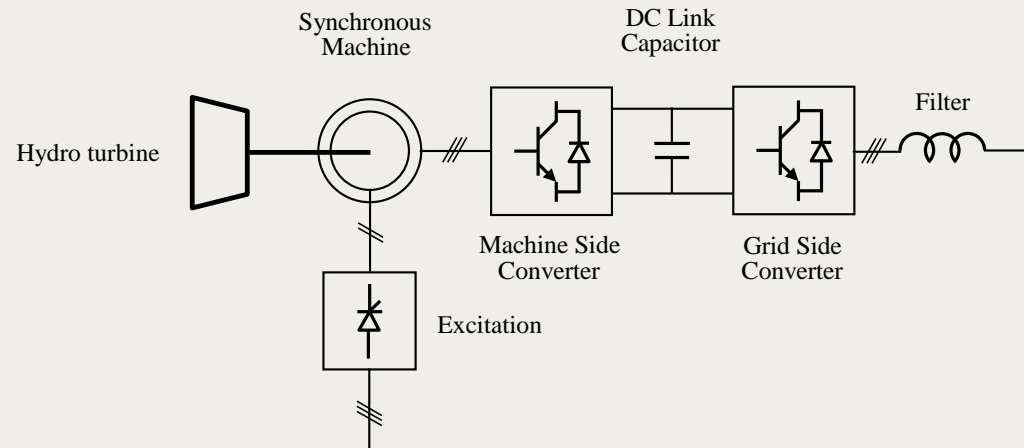
SC A1 Rotating Machines
PS3> DEVELOPMENTS OF ROTATING ELECTRICAL MACHINES AND OPERATIONAL EXPERIENCE

Q-306>What would be the concerns to be overcome regarding the operability of the plant in the variable frequency domain?

Luis Rouco, Spain

Flux and field current

- Field current is determined to operate at nominal flux

Synchronous Machine

DC Link Capacitor

Filter

Hydro turbine

Machine Side Converter

Grid Side Converter

Excitation

Assuming

$$i_{sd} = 0$$

Given the torque and the flux
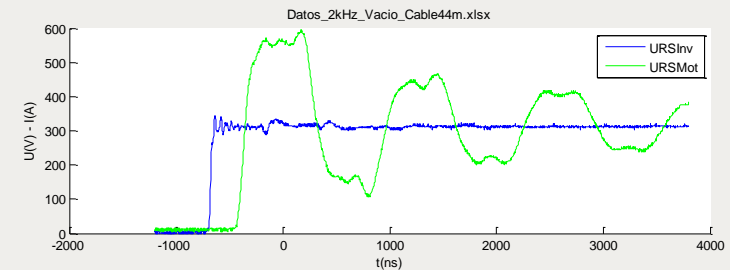
$$t_e = \psi_{sd} i_{sq}$$
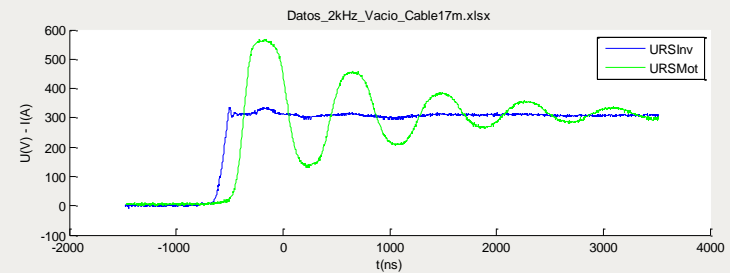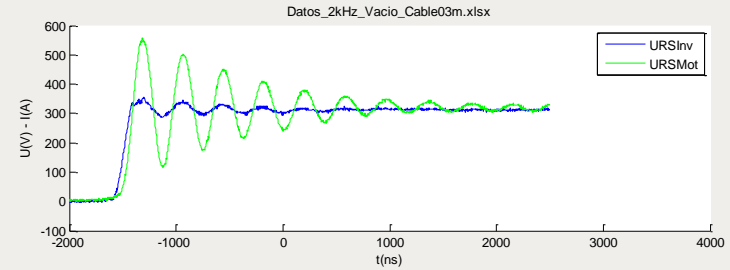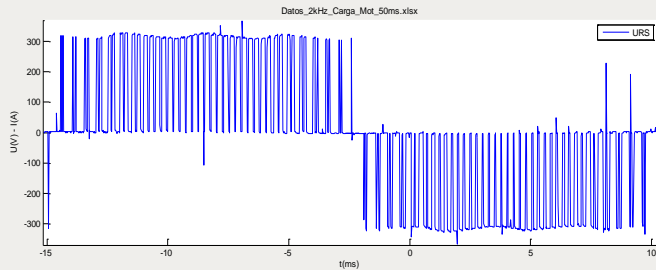
$$\psi_{sq} = L_q i_{sq}$$

$$\psi_s^2 = \psi_{sd}^2 + \psi_{sq}^2 = \psi_{sd}^2 + \left(L_q \frac{t_e}{\psi_{sd}} \right)^2$$

The excitation current is calculated

$$i_{rd} = \frac{\psi_{sd}}{l_{md}}$$

Voltage requirements

- Insulation stresses due to PWM inverter + cable

Voltage requirements

- Extra voltage requirements

Converter rated voltage	6.6+/-10% kV
Machine rated voltage	U_n=6.4 kV
Machine standard rated lightning impulse withstand voltage	U_p=1.7(U_n+5)=53 kV
Machine 0.2us impulse withstand voltage	U_p'=0.65U_p=34 kV
Machine standard rated short-duration power frequency withstand voltage	(2U_n+1)=14 kV
dv/dt	3kV/us
Maximum line-to-line voltage	13.75 kV
Maximum line-to-ground voltage	10 kV

Group Discussion Meeting