"MMC Multi-terminal HVDC" Lecture Report

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2nd of July, 2014

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The modular multilevel converter topology offers great potential to a broad range of applications HVDC Transmission, FACTS, to motor drives due to lower switching losses compared to 2 level VSC topologies. Its mathematical model is continually being developed and, basically, operates as three independent single-phase ac/dc converters. Each of them is composed by a series connection of cells (also called submodules which are composed by an half bridge converter in parallel with a capacitor) with an inductor, as shown in figure 1a.

The operation of MMC is based on applying modulating signal m_U(t) to the upper arm and m_L(t)to the lower arm of each phase in the form of:

$$m_U(t) = \frac{1}{2} - \frac{U_{ref}}{U_{DC}} cos(\omega t + \delta) \tag{1}$$

$$m_L(t) = \frac{1}{2} + \frac{U_{ref}}{U_{DC}} cos(\omega t + \delta) \tag{2}$$

Applying these modulating signals to the correspondent arm's cells connects/bypasses a ratio of N capacitors as illustrated in figure 1b.

$$n_U(t) = N\left[\frac{1}{2} - \frac{U_{ref}}{U_{DC}} cos(\omega t + \delta)\right] \tag{3}$$

$$n_L(t) = N\left[\frac{1}{2} + \frac{U_{ref}}{U_{DC}} cos(\omega t + \delta)\right] \tag{4}$$

Summing (3) and (4) is clear that in each phase unit N cells are all the time connected.
The cell's status and their capacitor's voltages [1] over the time determines the converter upper- $u_U(t)$ and lower- $u_L(t)$ arm voltages.

$$u_U(t) = n_U(t) U_{cap}(t) \tag{5}$$

$$u_L(t) = n_L(t) U_{cap}(t) \tag{6}$$

The converter arm voltages are managed in order to achieve some goals as: the active/reactive power flow, the DC link voltage control, converter dynamics, etc.

[1] Considering that all the capacitors in the same arm balanced and equal to U_{cap}

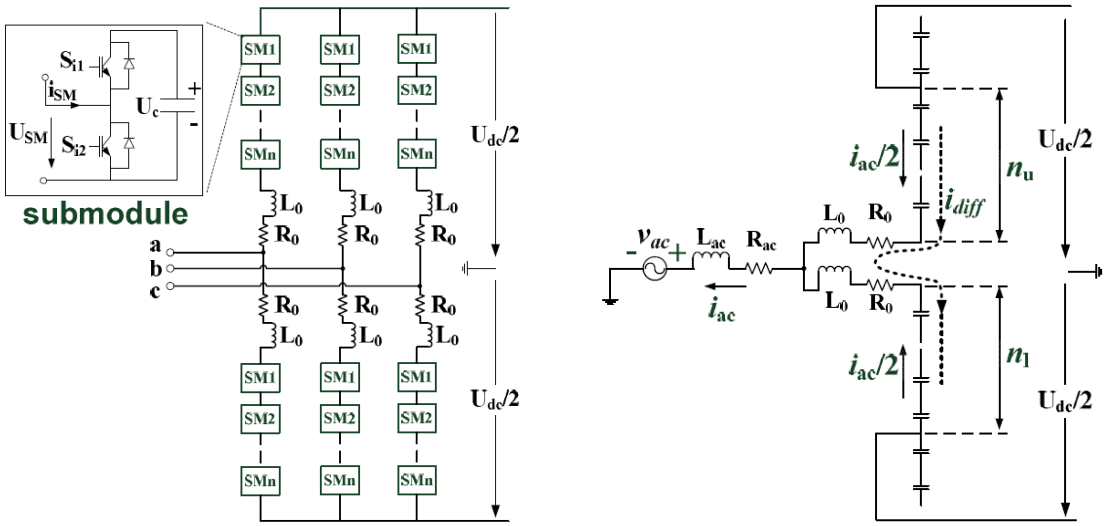

Figure 1: Three-phase MMC: (a) structure and (b) model

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