IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Computer aided power system analysis

AC- DC Load Flow

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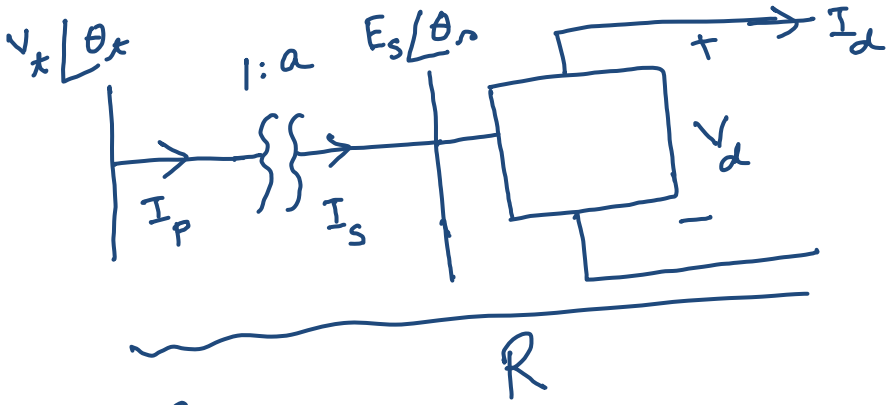


LCC - HVDC

Thyristor based HVDC

$\overline{X}_{DC}$

Rectifier terminal

'α' → firing angle

Inverter terminal

'γ' → extinction angle

Power-factor at both Rectifier and inverter.

Equations for the HVDC link.

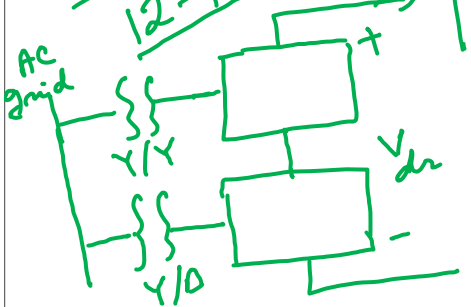
Rectifier

Inverter

DC-link

LCC-HVDC

12-pulse



Rectifier

$$V_{dr} = \frac{3\sqrt{2}}{\pi} N_r a_r E_{tr} \cos\phi_r = V_{dor} \cos\phi_r \quad \text{--- (1)}$$

(V_{dor})

$N_r = 2$ (For 12-pulse converter)

$$V_{dr} = V_{dor} \cos\alpha - \frac{3}{\pi} X_{cr} N_r I_d \quad \text{--- (2)}$$

Inverter side

$$V_{di} = \frac{3\sqrt{2}}{\pi} N_i a_i E_{ti} \cos\phi_i = V_{doi} \cos\phi_i \quad \text{--- (3)}$$

(V_{doi})

$$V_{di} = V_{doi} \cos\gamma - \frac{3}{\pi} X_{ci} N_i I_d \quad \text{--- (4)}$$

$N_r (N_i)$ → number of 6-pulse converters connected in series at rectifier (inverter) side

$a_r (a_i)$ → transformer tap ratio at rectifier (inverter)

$E_{tr} (E_{ti})$ → AC terminal voltage at rectifier (inverter)

$X_{cr} (X_{ci})$ → Individual transformer leakage impedance at rectifier (inverter)

$\phi_r (\phi_i)$ → Power factor angle at rectifier (inverter)

HVDC link.

$$I_d = \frac{V_{dr} - V_{di}}{R_{dc}} \quad \text{--(5)}$$

R_{dc} → DC link resistance

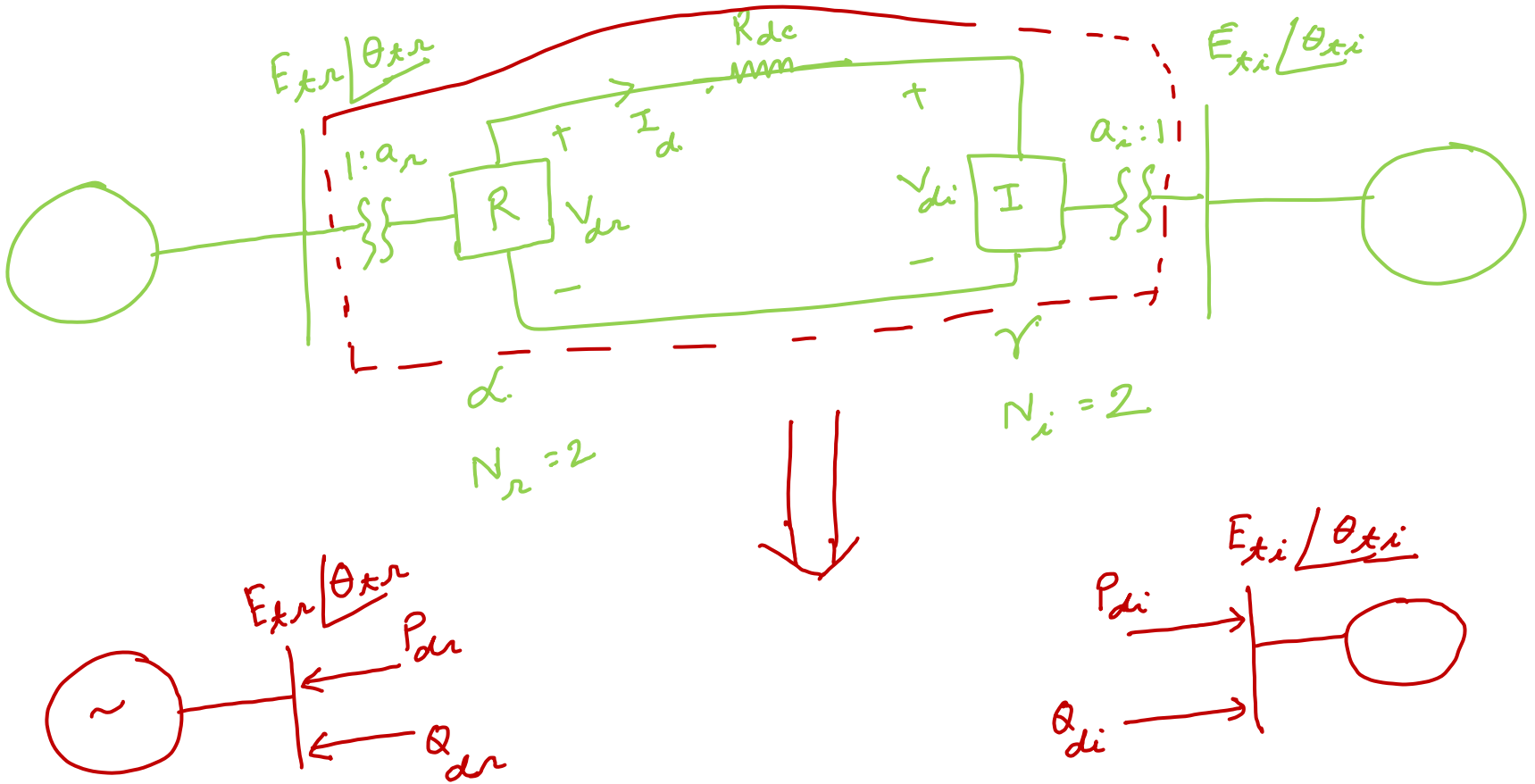
At each side, the unknowns are chosen as:

$[V_{dr} \quad I_d \quad a_r \quad \cos\alpha \quad \phi_r]$ → At rectifier

$[V_{di} \quad I_d \quad a_i \quad \cos\gamma \quad \phi_i]$ → At inverter

Total unknowns

$[V_{dr} \quad V_{di} \quad I_d \quad a_r \quad a_i \quad \cos\alpha \quad \cos\gamma \quad \phi_r \quad \phi_i]$ → total 9 unknown quantities.


$E_{tr}\angle\theta_{tr}$
R_{dc}
$E_{ti}\angle\theta_{ti}$
$1:a_r$
R
V_{dr}
I_d
V_{di}
I
$a_i:1$
α
γ
$N_r = 2$
$N_i = 2$
$E_{tr}\angle\theta_{tr}$
P_{dr}
Q_{dr}
$E_{ti}\angle\theta_{ti}$
P_{di}
Q_{di}