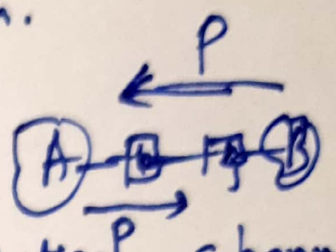
HVDC Light / Plus:

Tradename: ABB / Siemens

Main problems with classical HVDC Technology

i) It is mostly used for long distance, point-to-point transmission.



ii) It requires fast communication channels between two converting stations.

iii) It requires large reactive power support at both converting stations.

$$\text{As } \alpha \uparrow, \text{ pf} \downarrow \Rightarrow Q_c \uparrow$$

iv) They introduce both characteristic and uncharacteristic harmonics, thus, requiring costly and bulky harmonics filters.

v) Line-commutated converters using Thyristor valves are employed → PWM technique is not used. → Size of magnetics (L & C) is very large.

HVDC Light / Plus:

- Replaces CSCs by VSCs
- Thyristor valves are replaced by modern self-commutating power semi-conducting devices like IGBTs, IGCTs, GTOs, etc.

IGBTs → fast switching operation
→ 20KHz

VSC – HVDC Technology

Advantages of HVDC Light / Plus:

i) It is economical even in low power range over short distances;

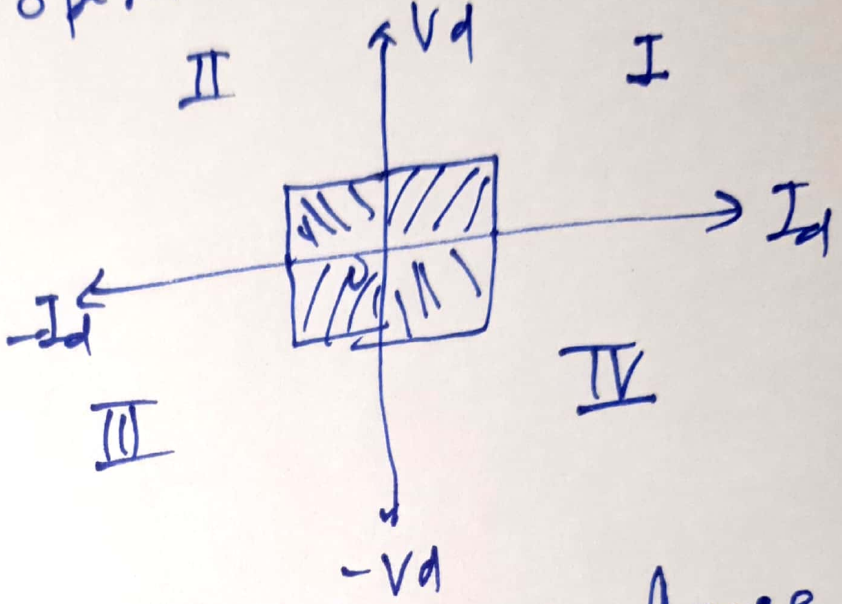
ii) Real and reactive power is controlled independently in two HVDC light converters

iii) It controls AC voltage rapidly

iv) No contribution to short circuit current (due to very fast control action)

v) No need to have fast communication channels between two converter stations (both stations can be controlled independently).

vi) It operates in all four quadrants (4-Q operation).



vii) Opportunity to transmit large amount of power over long distances via U.G. cables

viii) PWM scheme is used.

→ High switching freq. of converters

→ size of magnetics (L & C) is drastically reduced.

→ nearly upf operation

↓

No need for Q compensation

– Harmonic content in line current ↓ → No need of costly Harmonic filters

ix) Small and compact
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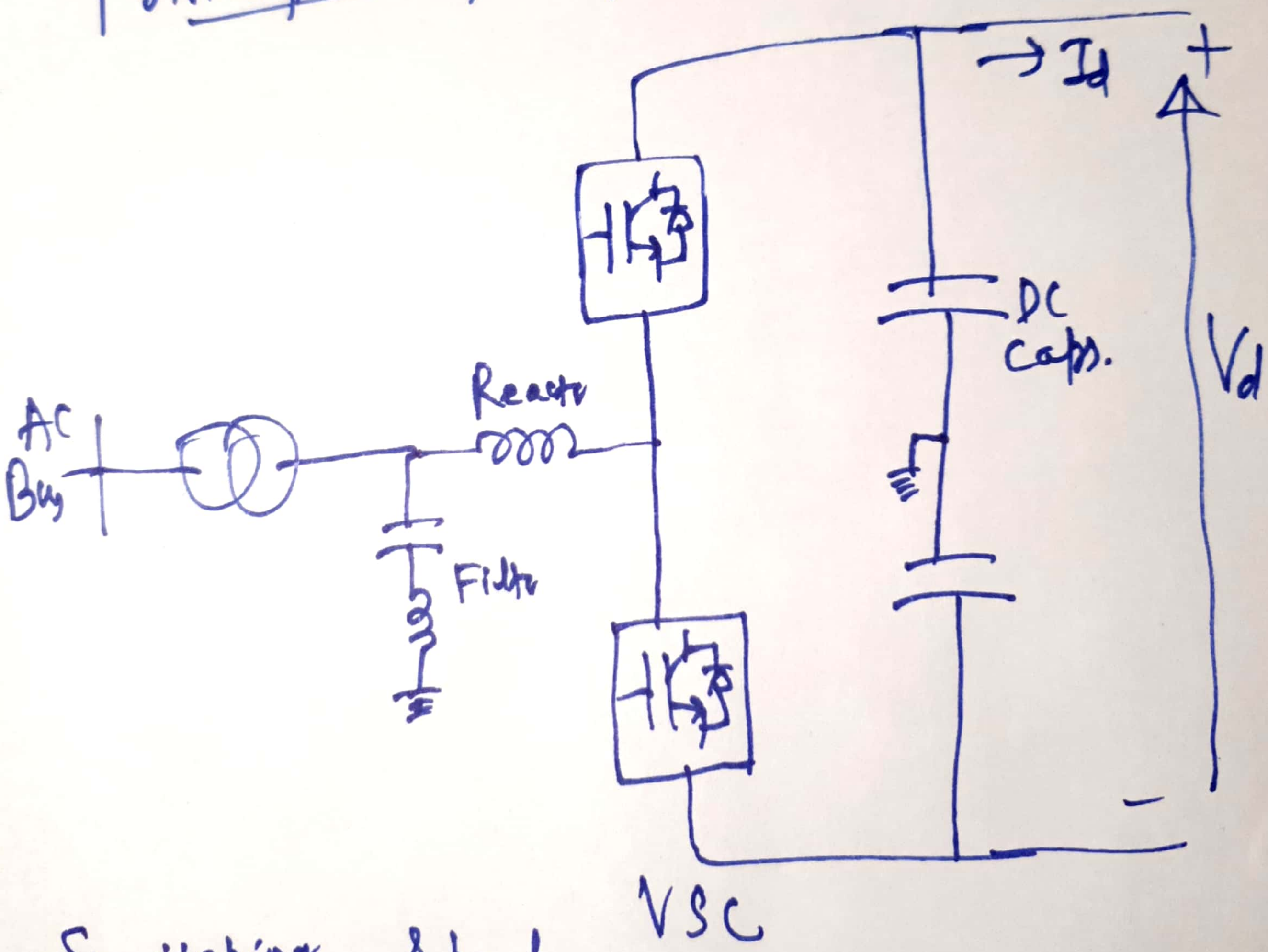
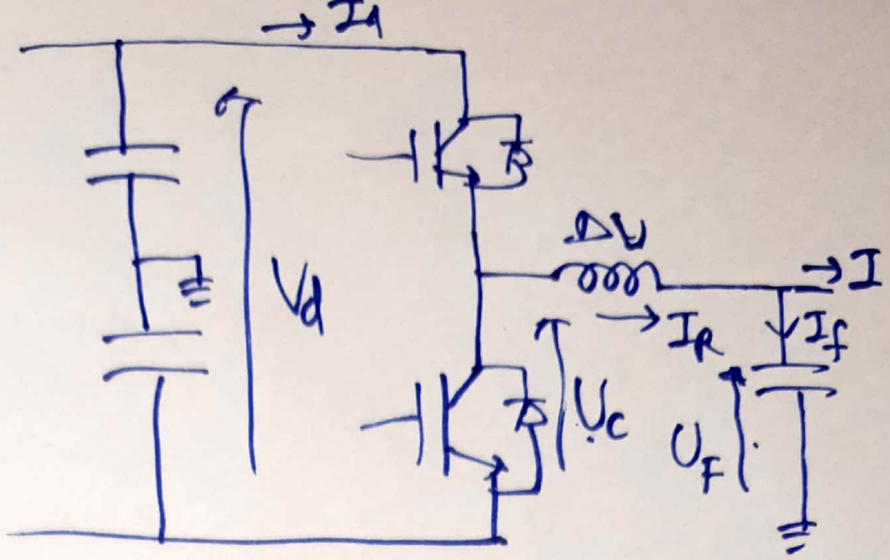
That is why it is called HVDC Light.

x) Useful in windmills

Principle of Operation:



Switching Speed is 27 times faster than classical HVDC system.



Power transmitted by HVDC Light is,

$$S_b = P + jQ = \sqrt{3}\, U_F I_R^*$$

$$\boxed{S_b = \sqrt{3}\, U_F \frac{(U_c - U_F)^*}{Z_R^*}} \quad \text{— (1)}$$

Active and reactive powers are given by,

$$P = \frac{U_F U_c \sin\delta}{\omega L} \quad \text{— (2)}$$

$$Q = \frac{U_F (U_F - U_c \cos\delta)}{\omega L} \quad \text{— (3)}$$

where 'δ' is phase-difference bet. U_F & U_c

'L' is equiv. reactance

$\omega = 2\pi f \rightarrow$ rad/sec.

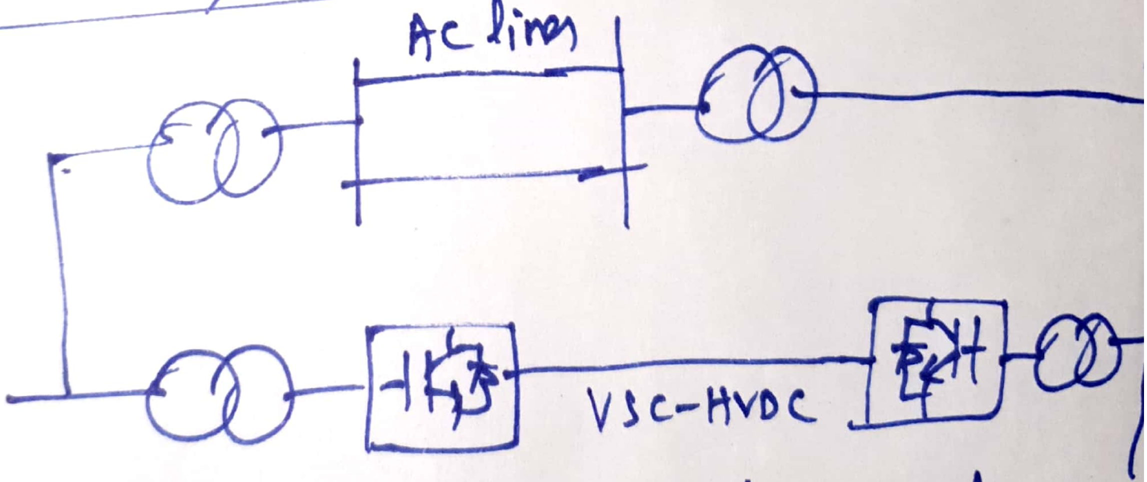
For $\delta > 0$, U_F is leading U_C and the active power is transferred from AC to DC and converter acts as a rectifier.

For $U_F > U_C \cos\delta$, the converter generates reactive power and if $U_F < U_C \cos\delta$, it absorbs Q.

Applications:

i) VSC-HVDC (HVDC Light/Plus) in

ii) AC/DC Hybrid Transmission:



i) Using VSC-HVDC, its ability of regulating the DC power can help to damp the oscillations when the system has fault.

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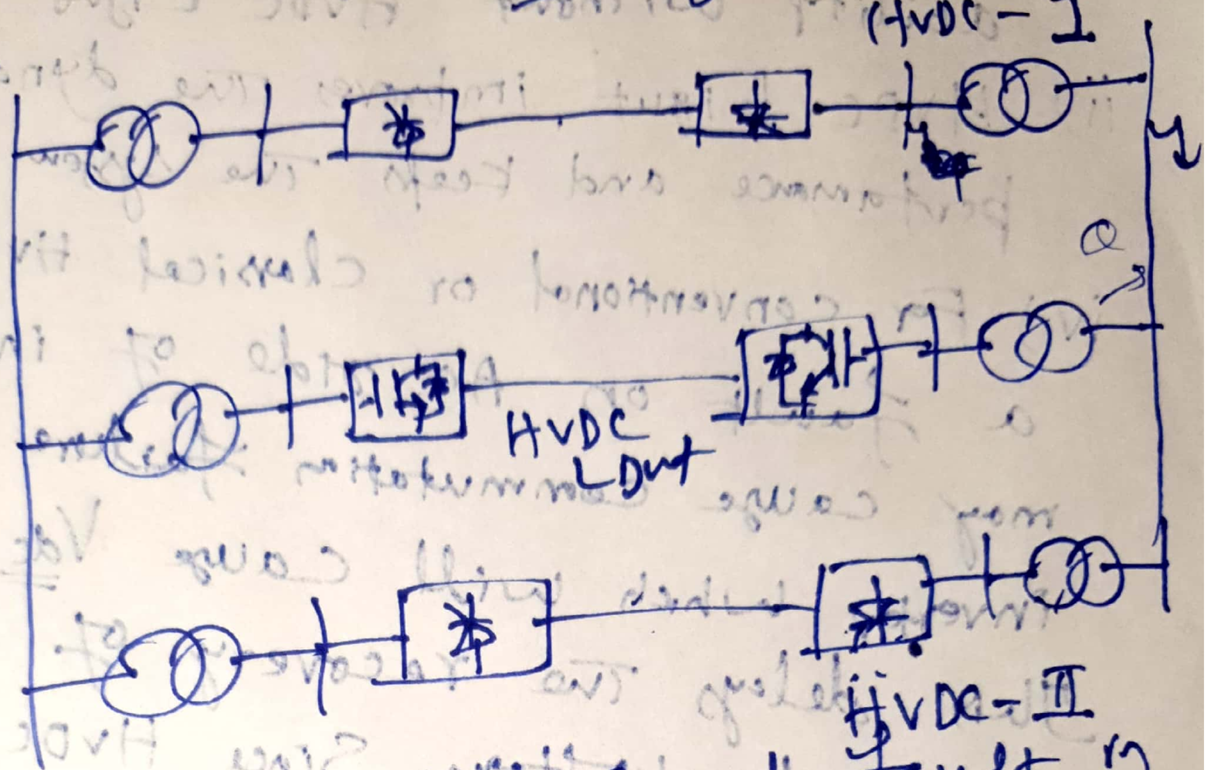
ii) If power demand of receiver system increases, the system will lose it's ability without HVDC Light.

iii) HVDC Light improves the dynamic performance and keeps the system stable.

iv) For conventional or classical HVDC system, a fault on AC side of inverter may cause commutation failure in inverter which will cause $V_{dc} = 0$. This delays the recovery of DC and AC side voltage. Since HVDC Light doesnot has commutation failure, it recovery AC voltage quickly by providing reactive power support on AC side.

ii) HVDC Light in Multi-infeed HVDC System:



Suppose Single phase - ground fault in inverter set at AC bus of HVDC-I, inception of fault at 4 sec. & duration is 0.1 sec. (5 cycle).

- Commutation failure of both HVDC-I & HVDC-II inverters

- With HVDC Light, Q will be supplied & voltage support is provided.

⇒ AC bus voltage is not let go down deep and This results in quick recovery of DC-side and AC-side voltages of HVDC-I & HVDC-II.