The 4th International Symposium on Smart Grid — Methods, Tools, and Technologies
Jinan, Shandong, CHINA Oct.29-30, 2021

Calculation of AC Short-Circuit Current at MMC-HVDC Converter Station

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Introduction

In recent years, Modular Multilevel Converter based High Voltage Direct Current (MMC-HVDC) transmission system has gradually developed, and the AC short-circuit current contributed by both the converter and AC system needs to be solved urgently. However the accurate calculation of the fault transient current is the most direct method to realize the effective evaluation of the transient process current, so providing a reference for the selection of AC side current-limiting equipment through the accurate calculation of the short-circuit current.

Method

Fault current is divided into two parts according to the blocking time of converter station.

1) Equivalent model and current path before blocking

Due to **symmetric bipolar structure,** it can be seen that **all** sub-modules are involved in the discharge process. The current path and equivalent circuit of each phase is shown in Fig. 1.

Therefore, based on the principle that the energy storage capacity of the capacitor is unvaried and the second-order zero-input formula, the fault current can be obtained:

$$i = e^{-\delta t}\left[U_{dc}\sqrt{\frac{C_{eq}}{L_{eq}}}sin(\omega t)+I_0 cos(\omega t)\right]$$

2) Equivalent model and current path after blocking

Due to the bridge arm inductance, the **inductance discharge** constitutes the DC component of the bridge arm current and **the AC system** still injects short-circuit current to the short-circuit point.

The total current of A-phase after blocking is as follows:

$$I_a\ s = I_{a1}\ s + I_{a2}\ s = \frac{U\ s + L_s i_{a\_}0 + \frac{L_0}{2}\ i_{p\_}0 + i_{n\_}0}{R_s + sL_s + \frac{R_{loss}}{4} + \frac{sL_0}{2}}$$

After simplification, the phase a current can be rewritten:

$$I_a\ s = \frac{U\ s + \left(L_s + \frac{L_0}{2}\right) i_{a\_}0}{R_s + \frac{R_{loss}}{4} + s\left(\frac{L_0}{2} + L_s\right)}$$

This paper builds the MMC-HVDC two-terminal 38-level power transmission system in PSCAD. Then **the total fault current of AC side** should be verified. The simulation results are shown in Fig. 3.

Equivalent model and current path

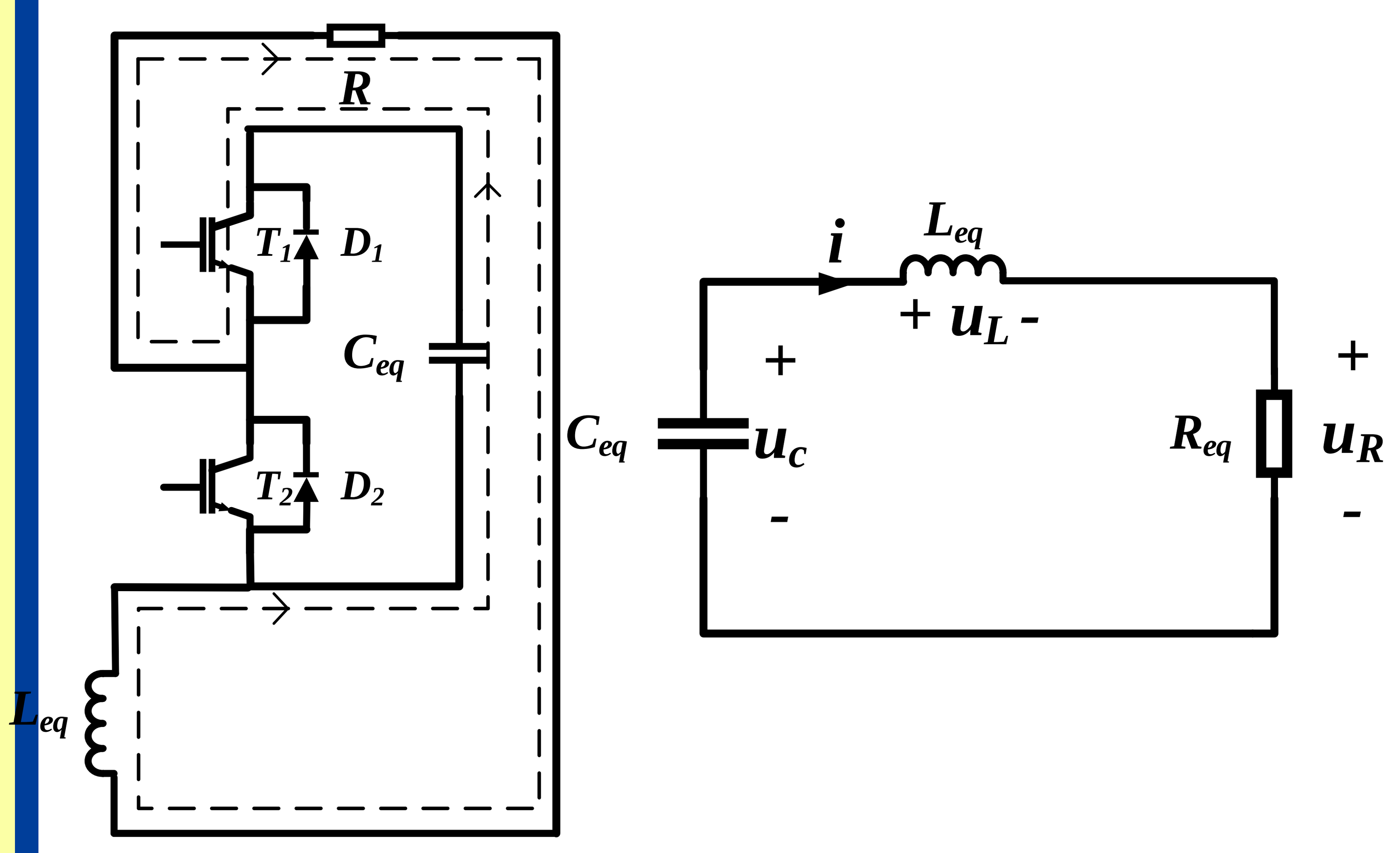

Fig.1 Current flow path and Equivalent circuit

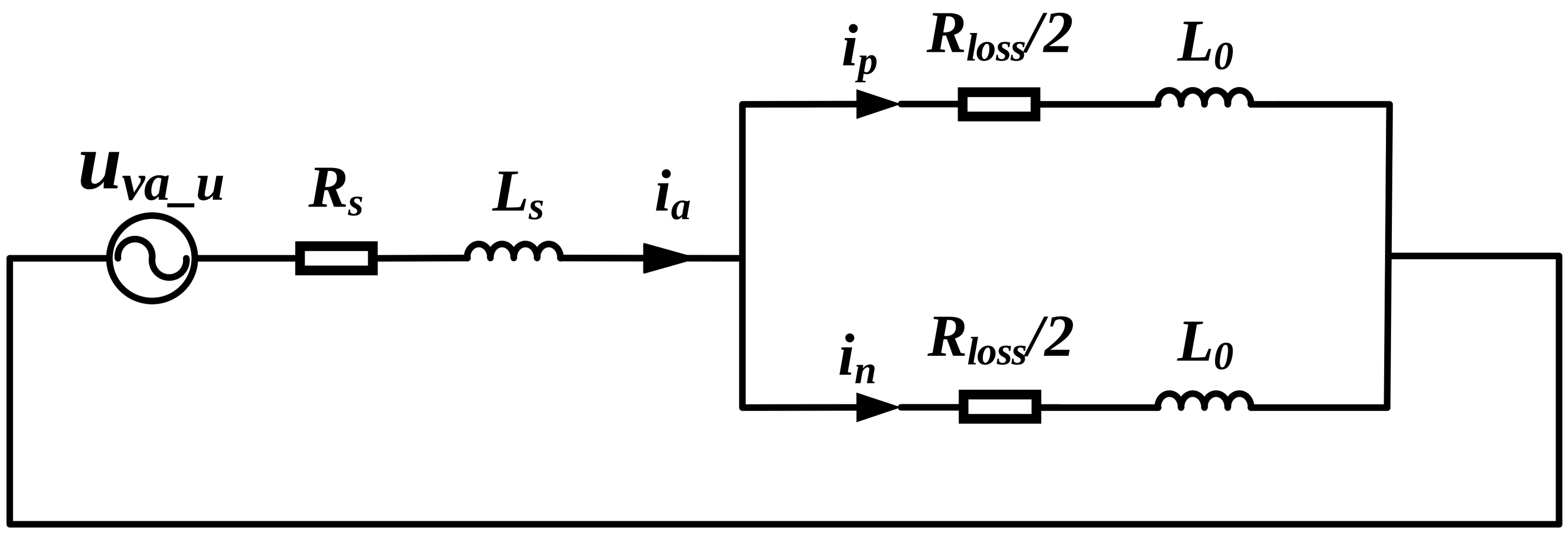

Fig.2 Equivalent model of single-phase current path

Simulation results

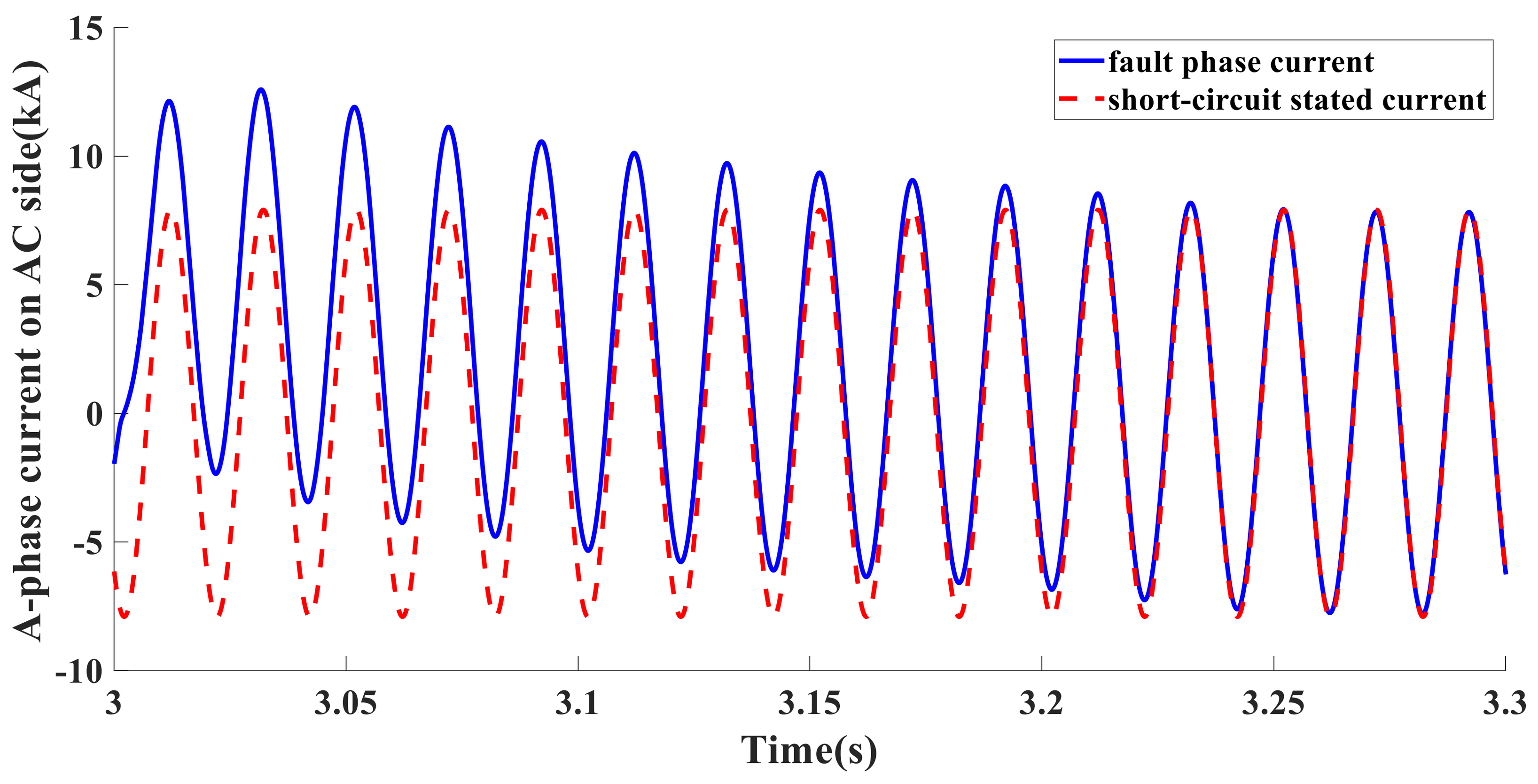

Fig.3 Comparison of a-phase current simulation calculation

Conclusions

1) **The current path before unipolar ground fault blocking, and the short-circuit current path on the AC side after blocking.**
2) **Clarified the fault mechanism and calculation equations of the AC side short-circuit current**
3) **The calculation method is verified by the two-terminal simulation model built in PSCAD.**

References

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