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Improved DC Fault Current Limiting Characteristics of DC Flux-Lock Type SFCL with Parallel Connection btween Two Coils

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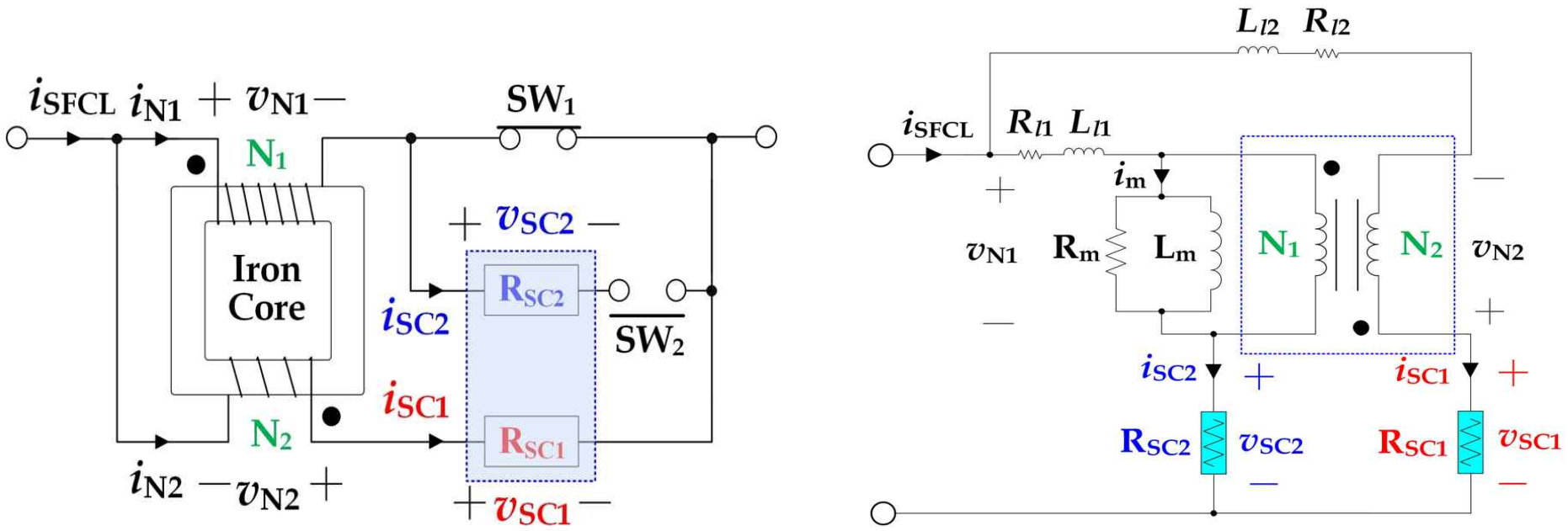
Introduction

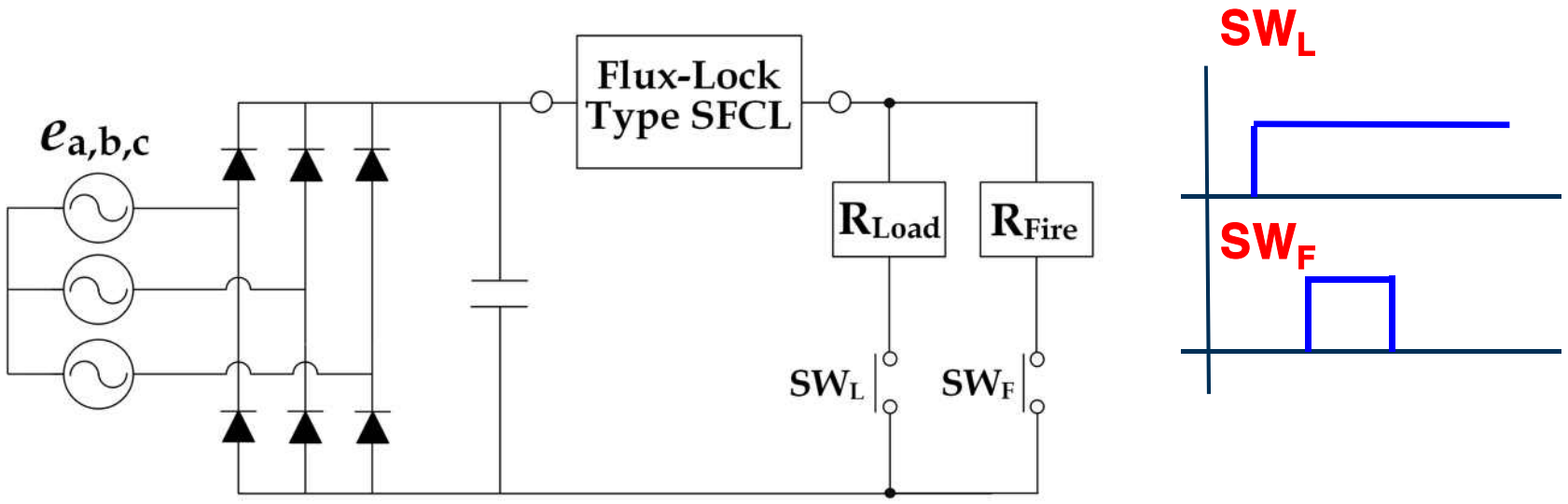
In this paper, DC fault current limiting characteristics of DC flux-lock type superconducting fault current limiter (SFCL) with parallel connection between two coils were analyzed. DC flux-lock type SFCL with parallel connection between two coils was com-posed of two windings connected in parallel and two supercon-ducting modules (SMs), which were connected in series with each secondary winding. DC flux-lock type SFCLs with a parallel connection between two coils and one SM with one secondary winding in series was thought to perform fault current limiting operation as in AC system. However, since the transient period after resistance generation in SM approaches into the constant value, unlike the AC system, there is a DC current limiting tran-sient period. Therefore, the DC current limiting effect disappears in the DC system and the recovery characteristic after the fault is removed also disappears. To analyze the DC fault current limit-ing and recovery characteristics, a DC short-circuit test was per-formed, and the various behaviors of flux-locked type SFCLs in DC systems were investigated from the test results.

Configuration



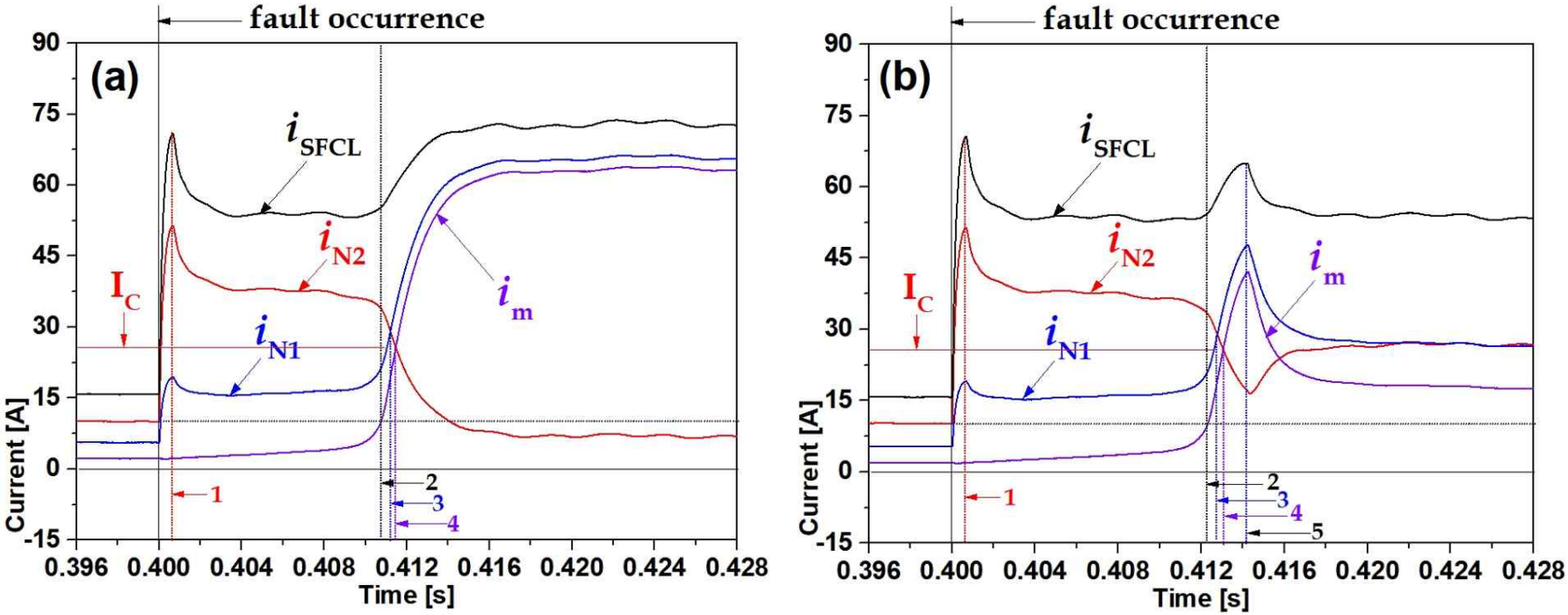
Schematic diagram of DC flux-lock type SFCL with parallel connection between two coils. (a) Structure (b) Equivalent circuit.

Experimental Circuit



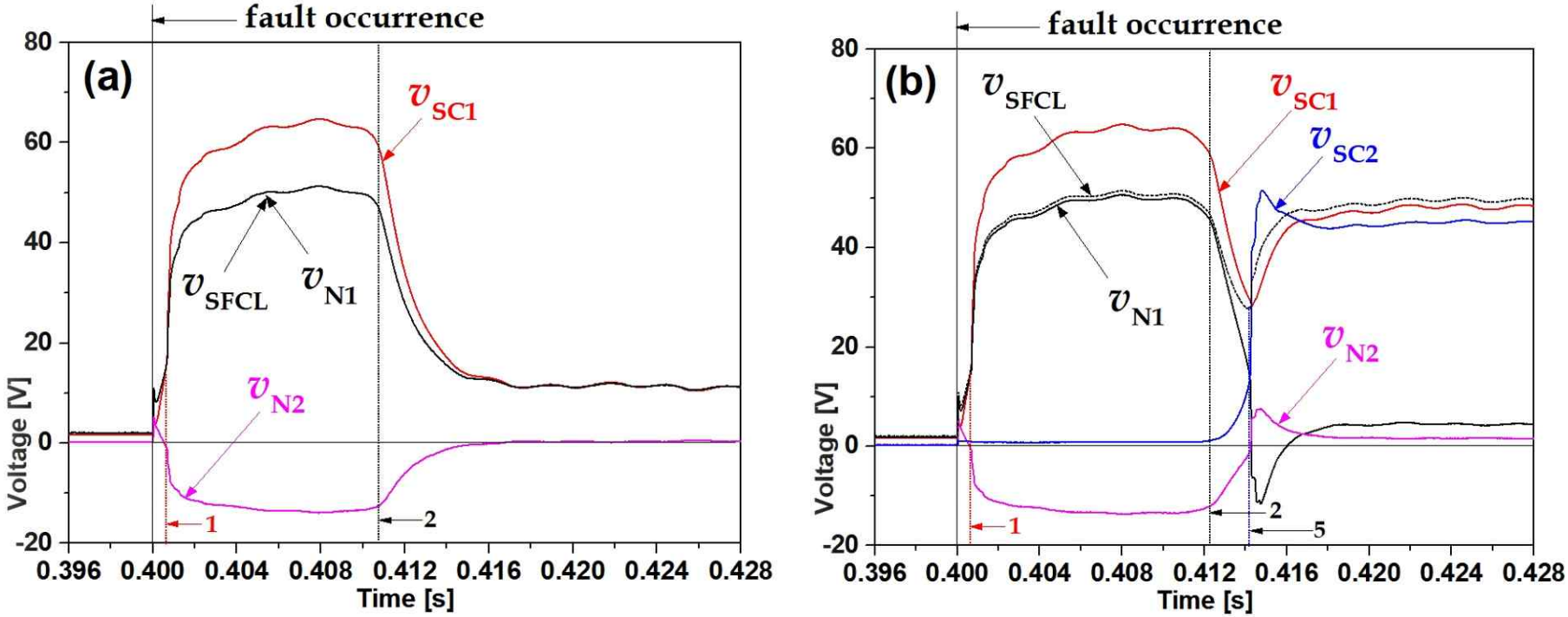
Experimental circuit diagram for DC fault current limiting test of flux-lock type SFCL with parallel connecting between two coils

Experimental Results and Analysis



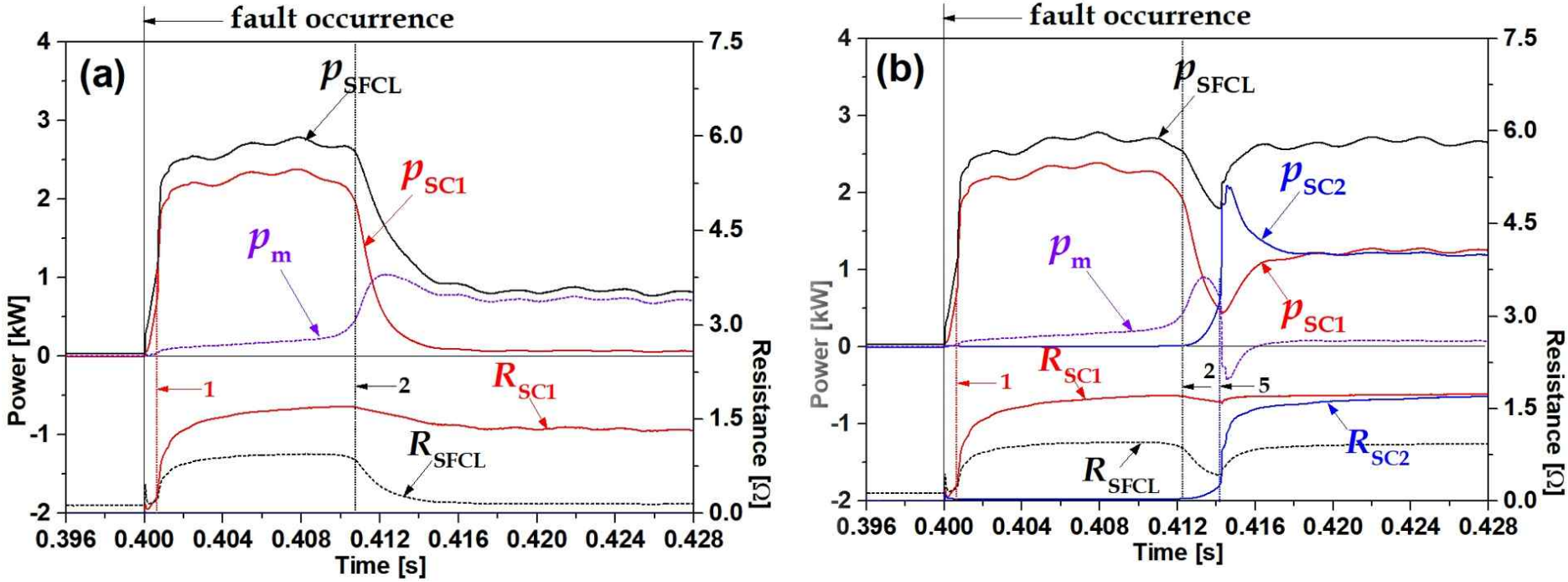
DC current waveforms depending on the number of superconducting modules of flux-locked type SFCL with subtractive polarity winding and parallel connection between two coils. (a) When one superconducting module (R_{sc1}) is operating due to SW_1 ON and SW_2 OFF. (b) When two superconducting modules (R_{sc1}, R_{sc2}) are operating due to SW_1 OFF and SW_2 ON.

Experimental Results and Analysis



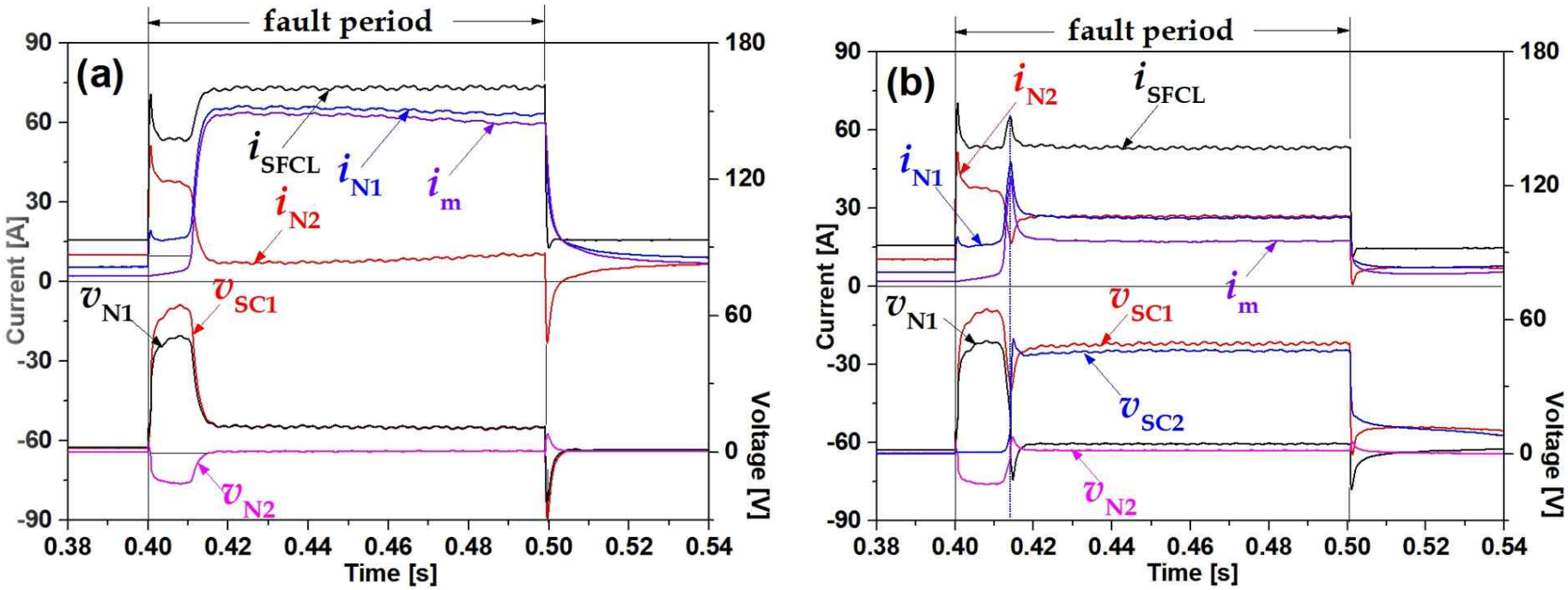
DC voltage waveforms depending on the number of superconducting modules (SMs) of flux-locked type SFCL with subtractive polarity winding and parallel connection between two coils. (a) When one superconducting module (R_{sc1}) is operating due to SW_1 ON and SW_2 OFF. (b) When two superconducting modules (R_{sc1}, R_{sc2}) are operating due to SW_1 OFF and SW_2 ON.

Experimental Results and Analysis



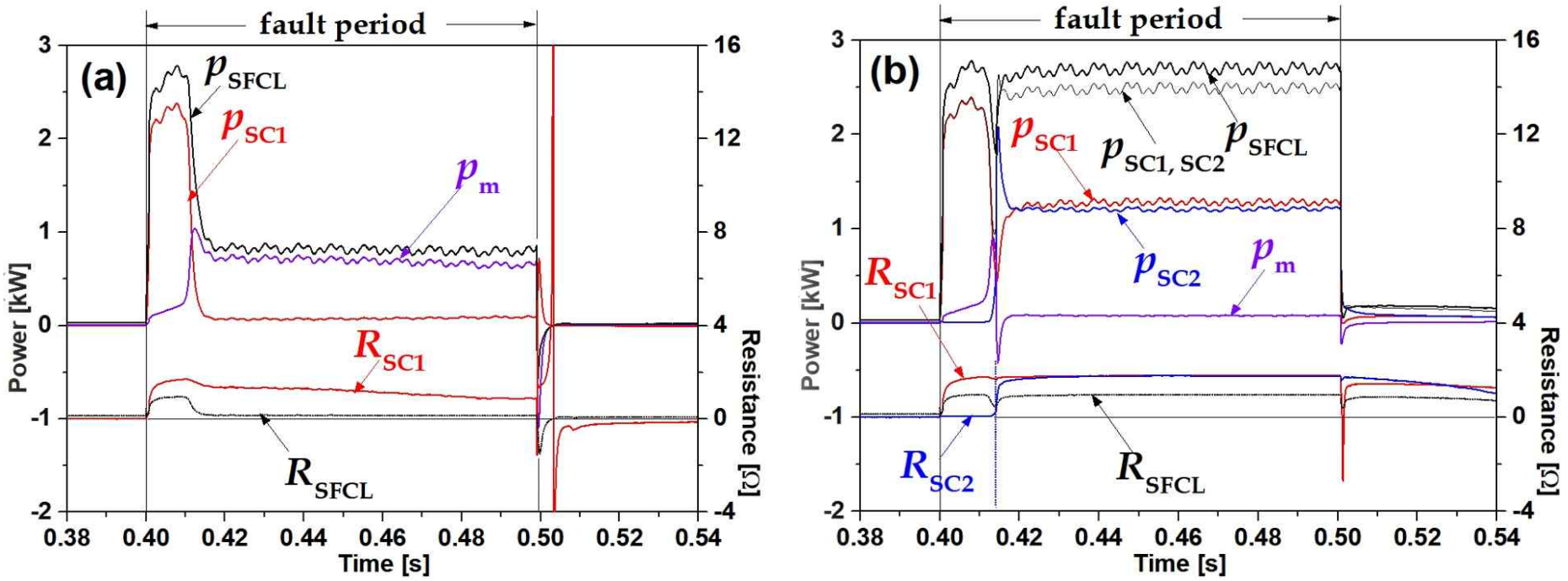
Instantaneous power and resistance relationship curves depending on the number of superconducting modules (SMs) of flux-locked type SFCL with subtractive polarity winding and parallel connection between two coils. (a) When one superconducting module (R_{sc1}) is operating due to SW_1 ON and SW_2 OFF. (b) When two superconducting modules (R_{sc1}, R_{sc2}) are operating due to SW_1 OFF and SW_2 ON.

Experimental Results and Analysis



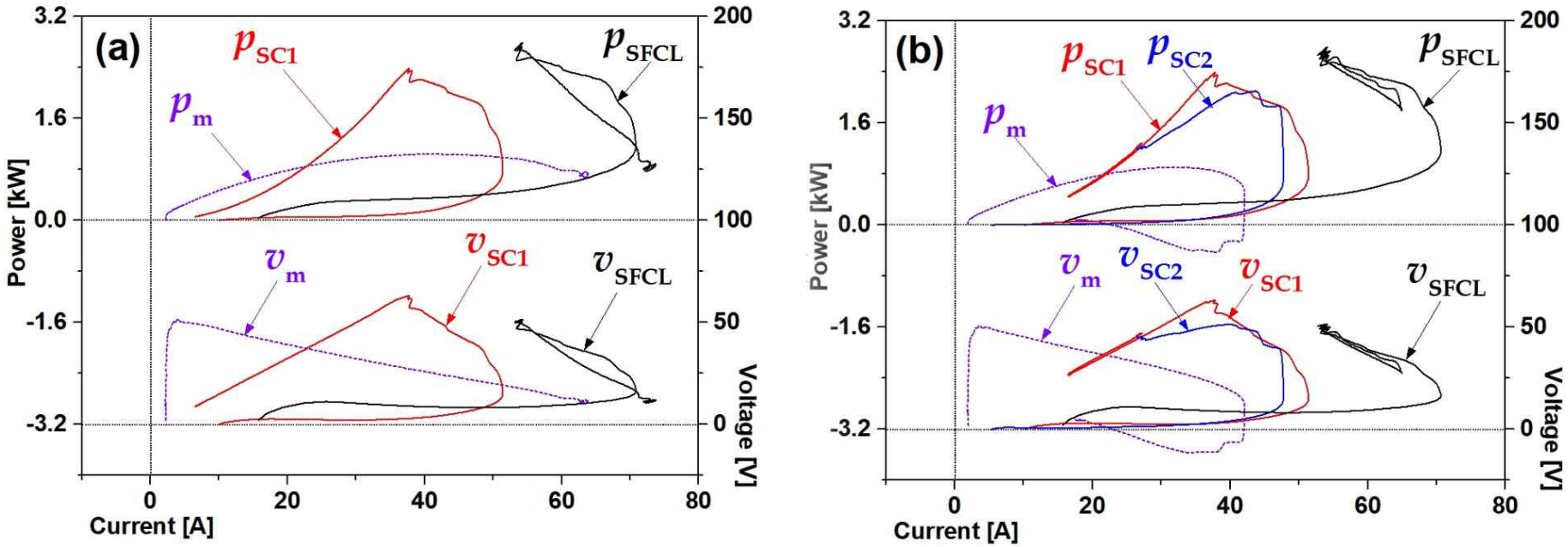
Voltage and DC fault current limiting relationship curves depending on the number of superconducting modules (SMs) of flux-locked type SFCL with subtractive polarity winding and parallel connection between two coils. (a) When one superconducting module (R_{sc1}) is operating due to SW_1 ON and SW_2 OFF. (b) When two superconducting modules (R_{sc1}, R_{sc2}) are operating due to SW_1 OFF and SW_2 ON.

Experimental Results and Analysis



Power consumption of each devices including SMs and resistances relationship curves depending on the number of superconducting modules (SMs) of flux-locked type SFCL with subtractive polarity winding and parallel connection between two coils. (a) When one superconducting module (R_{sc1}) is operating due to SW_1 ON and SW_2 OFF. (b) When two superconducting modules (R_{sc1}, R_{sc2}) are operating due to SW_1 OFF and SW_2 ON.

Experimental Results and Analysis



Tracks of instantaneous powers (p_{SFCL}, p_{SC}, p_m) and DC voltages relationship curves depending on the number of superconducting modules (SMs) of flux-locked type SFCL during DC fault current limiting and recovery operation. (a) When one superconducting module (R_{sc1}) is operating due to SW_1 ON and SW_2 OFF. (b) When two superconducting modules (R_{sc1}, R_{sc2}) are operating due to SW_1 OFF and SW_2 ON.

Conclusion

Improved DC Fault Current Limiting Characteristics of DC Flux-Lock Type SFCL with Parallel Connection btween Two Coils

In this paper, to analyze its DC fault current limiting and recovery operation, DC short circuit tests were performed and the different operations of the flux-lock type SFCL in DC system were investigated from the test results.

Through the analysis on the test results, it was shown that the case of using two superconducting modules for the primary and secondary windings of a single iron core can limit the fault current more effectively with less magnetizing current than the case of using one superconducting module.