NAME : Kazuyuki HYODO   GROUP REF. : SC B5
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Application of improved ROCOF in Japan

1. Introduction

The introduction of renewable energy sources is expanding, and if a large-scale power outage occurs, the frequency will reduce significantly, and wide area instability may occur, which may lead to a collapse of the whole power system. To provide stable power supply in such an increasingly complicated power system, it is an urgent task to ensure frequency stability.

Under frequency relay(UFR) and ROCOF relay are applied to prevent frequency drop. There are cases where it is difficult to detect power outage at an early stage with UFR that operate sequentially when the frequency drops below a certain frequency. In addition, since there was an event that the conventional ROCOF relay could not operate depending on the timing when the generator dropped out, an improved ROCOF was developed.

2. Comparison of conventional type and improved type

The conventional ROCOF relay calculates the frequency change rate(df/dt) for a certain period. However, this method may not operate in the case where the power outage occurs in multiple times.

Therefore, the improved ROCOF relay is a method that can deal with multiple frequency drops by integrating the number of operations with "dt" as a small fixed value of several samples.
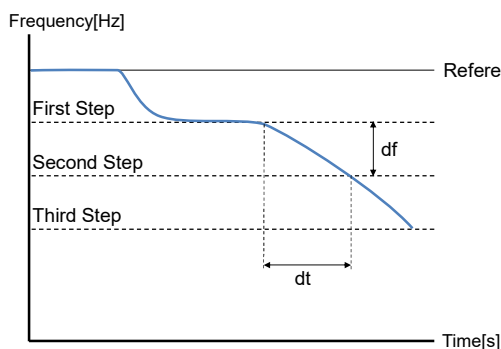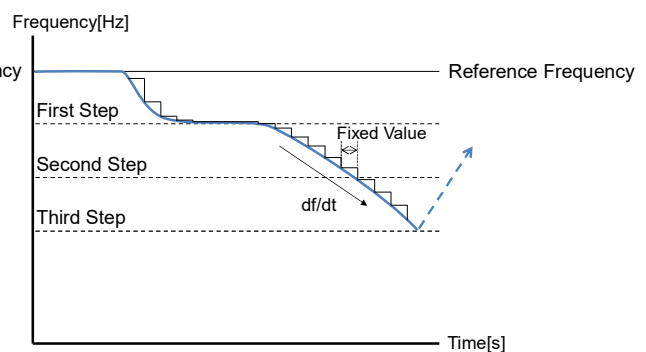
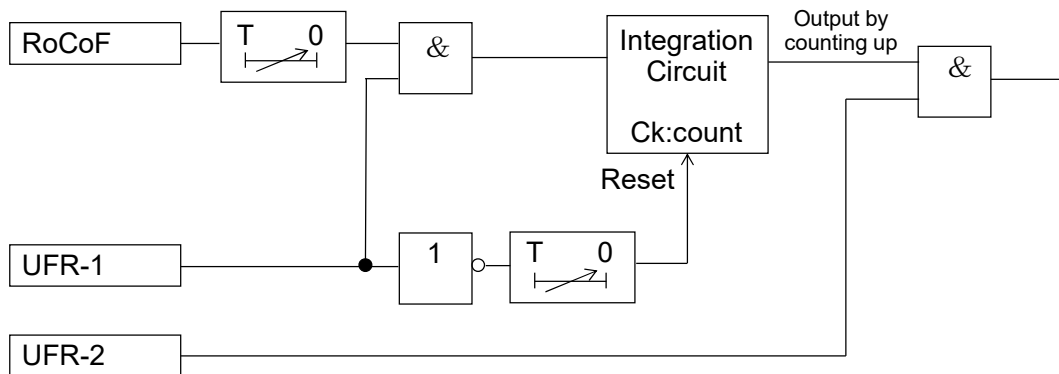
Conventional ROCOF Relay   Improved ROCOF Relay
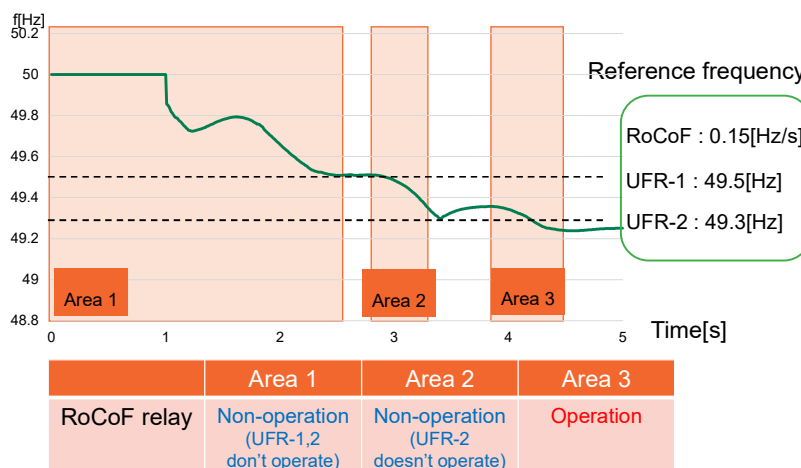
3. Logic of improved ROCOF

This relay is mainly composed of ROCOF, two under frequency relays and integration circuit.
- Integration circuit : Outputs a signal when number of ROCOF operations reaches Ck
- UFR-1 : Reset integration if below operating level
- UFR-2 : Block output if below operating level

4. Test result

The ROCOF relay operation when the frequency fluctuates as shown in the figure below is shown. It operated correctly in "Area 3" where the frequency was below a setting value and the integration of operations reaches Ck.

	Area 1	Area 2	Area 3
RoCoF relay	Non-operation (UFR-1,2 don't operate)	Non-operation (UFR-2 doesn't operate)	Operation

5. Conclusion

By defining the operating requirements of the improved ROCOF relay and setting value of the UFR and frequency reduction rate, it is possible to prevent the ROCOF relay from malfunctioning.