

## HV COMPONENTS FOR TOV ON EXTRUDED HVDC CABLE SYSTEMS

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### ABSTRACT

According to the CIGRE technical brochure TB 852 special temporary overvoltage tests (TOV) need to be performed on HVDC cable systems additional to the type tests. These special tests consist of a very slow front temporary overvoltage (TOV) test, a very slow front chopped temporary overvoltage (chopped TOV) test and a zero crossing damped temporary overvoltage test. The paper describes how the superimposed TOV can be generated and what might be the limitations. A new multiple chopping gap design will be introduced, which allows the chopping of the superimposed TOV waveshape and the chopping of the DC voltage to generate the zero crossing damped temporary overvoltage. Besides the components to generate the voltage waveshape (wave shaping resistors, blocking diode, inductance for the oscillations), a suitable high voltage measuring system with appropriate evaluation software and suitable coupling and protection components (coupling capacitor, protection resistor) are required. The required parameters for the recording and evaluation system will be discussed and the necessary circuit component such as coupling capacitor, wave shaping resistors, blocking diode and protection resistor will be described.

### KEYWORDS

HVDC; Extruded Cable; Superimposed; Testing; TOV; Chopped TOV; Zero Crossing Damped TOV;

### INTRODUCTION

Prequalification and type testing ensures the development of reliable cable and cable systems for the increasing demand of the energy market. With an increasing number of installed cable systems, operating experience has grown and previously unexpected stresses were noticed in cable systems, especially under fault conditions. The behavior of a cable system under fault condition is not only depending on the configuration and design of the electrical grid, but also on operation manners. Therefore, these investigated stresses may only occur very rarely and under very specific conditions [1].

The CIGRE WG B1.62 released the Technical Brochure 852, in which special overvoltage tests are proposed for development and research of cable systems. Although it is clearly mentioned that normal PQ and type testing is considered sufficient for ensuring the quality of a cable system, the demand for these special tests in the market is increasing. These new tests introduce some very specific wave shapes, which pose new requirements on the test equipment and the measurement equipment. The newly proposed tests are:

### TEMPORARY OVERVOLTAGES

#### VERY SLOW FRONT TOV

This test setup is very similar to a regular superimposed test on a cable system. However, the times for rising and falling of the impulse are significantly longer than for a standard switching impulse. Although TB 852 allows for both common setups with coupling capacitor and coupling spark gap, a setup with a conventional multistage Marx impulse voltage generator and a spark gap may not give satisfactory results. Fig. 1 and 2 show the proposed test setup with a coupling capacitor for the impulse generator and the anticipated wave shape.  $R_{da}$  and SG are considered for the shaping of the tail time. Depending on the generator setup, they may not be necessary. Care must be taken in dimensioning. Quenching of the spark gap SG is mandatory if the impulses are to be executed in a consecutive and repeatable order without turning off the DC source.

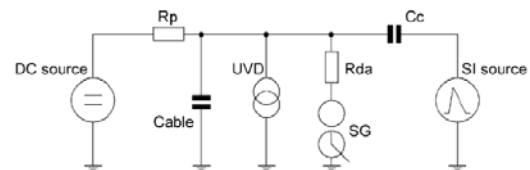


Fig. 1: Possible test setup for TOV

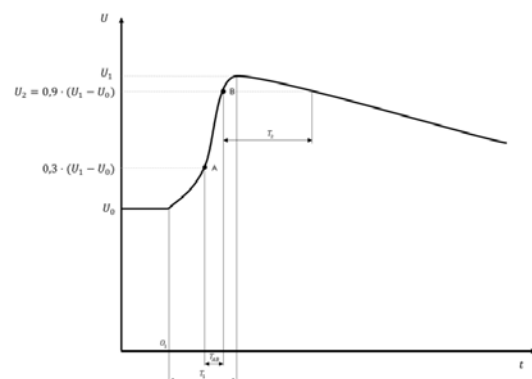


Fig. 2: Wave shape for TOV

#### VERY SLOW FRONT CHOPPED TOV

This test is very similar to the TOV impulse, only a chopping spark gap SG2 is added to the circuit, see Fig. 3 and 4 for the and required wave shape.

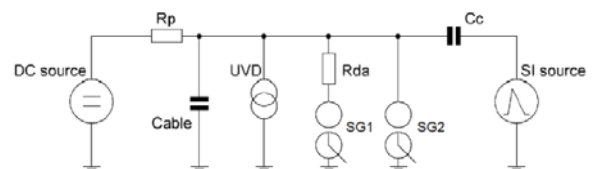


Fig. 3: Possible setup for chopped TOV