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INVESTIGATION INTO HARMONICS OF LVDC POWER DISTRIBUTION NETWORK USING EMTDC/PSCAD SOFTWARE

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Abstract. The paper focuses on the investigation of low voltage direct current (LVDC) power distribution network harmonic content. For investigation electromagnetic transient simulation environment PSCAD/EMTDC is used. In the paper, the frequency content of voltages and currents in the LVDC network is presented. Dependence on the power quality of the feeding medium voltage (MV) network of the LVDC network configuration is shown and discussed. In addition, impact of distribution of load across bipolar DC network load on MV network power quality is considered. Model of the LVDC power distribution network is created in PSCAD/EMTDC environment to carry out the above mentioned analyses.

Keywords
LVDC, dc power system, PSCAD, harmonic content, power quality

Introduction

The LVDC power distribution network concept is presented in Fig. 1. The main objectives behind the development of the LVDC network have been to; (1) improve the power quality and supply security experienced by the electricity end-users, (2) improve the economy of the power distribution, (3) provide flexible and robust coupling point for small scale generation, and (4) develop infrastructure for interactive and intelligent distribution network [1], [2]. The development of the LVDC network was started 2005 in Finland. DC solutions with somewhat similar properties and sharing some of the same objectives have been introduced also in [3], [4], [5], [6].

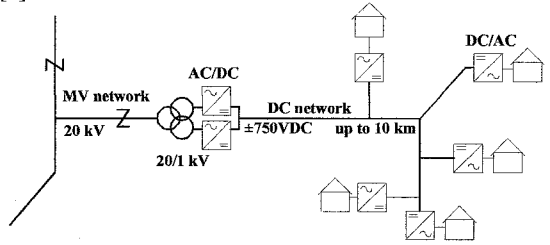

Figure 1. LVDC power distribution network

Roughly speaking the basic ideas of the LVDC network considered in this paper are to reduce the length and complexity of MV networks by increasing the transmission capacity of the low voltage networks, to use power electronics for local power flow and quality control and enable sophisticated network protection and management methods based on ICT solutions integrated into the converters of the LVDC network [7].

Power quality of MV network relates continuous state distortions and power system harmonics are continuous state problem. Power electronic load of LVDC power distribution network create harmonic pollution in DC network. In details customer inverters pollute DC network and LVDC network front-end rectifier pollute MV network. The DC network harmonic pollution is mitigating to MV network affecting MV network power quality and creates additional losses in transformer and in MV distribution network.

In the LVDC distribution network the dc network is powered by a frond-end rectifier. In simplest configuration with directional power flow, the front-end rectifier consists of two six pulse thyristor bridges connected to bipolar dc power distribution network with common zero potential. Thyristor bridges powered by phase shifting transformer with 2 secondary windings form then a 12-pulse rectifier. The customer-end inverters loading the dc system are powered from the bipolar dc power distribution network. Both one and three phase inverters can be used to energise end-customer's ac network. Inverters are mainly connected between the zero pole and plus or minus dc pole due to high ±750 VDC voltage used in the LVDC network. According to the basic LVDC concept, the whole LVDC network is owned by the local distribution company and the connection point of customers is at ac side of the inverter devices. In some special cases the customer's coupling point can also be located in dc side, but that situation will not be considered in the proposed paper.

The converters of the LVDC network generate versatile harmonic currents and voltages to distribution system. The distortion of voltages and currents cause extra losses in system components. The voltage distortion in MV ac network may also cause disturbance for customers connected directly to the ac system (on traditional way) and electromagnetic interferences disturbing distribution