A New Interface for Lightning Induced Overvoltages Calculation Between EMTP and LIOV code

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Summary

For evaluating the lightning performance of distribution lines it is crucial the availability of a tool for the calculation of lightning-induced voltages. Such a tool can be a) a simple analytical formula (as for instance the Rusck one [1], adopted in the IEEE Std 1410 [2]), b) a computer code (as for instance the LIOV code [3,4], adopted in [5]). An analytical formula presents the main advantage of short computational times; on the other hand its application is often limited to cases which tend to be unrealistic [5]. A computer code instead, can potentially allow for the treatment of more realistic cases; the main disadvantage in this case, is the inherent complexity of such one approach. This contribution deals indeed with a computer code, and in particular, on the interface that has been recently realized between the LIOV code and the EMTP96 with the aim of extending the simulation capabilities of the LIOV code to realistic configurations of distribution systems.

In the LIOV code [3-7] the Agrawal et al. field-to-transmission line coupling model [8] has been implemented for dealing with the case of multi-conductor lines closed on resistive terminations. In principle, the LIOV code could be suitably modified case by case in order to take into account the presence of the specific type of termination, as well as of the line-discontinuities (e.g. surge arresters across the line insulators along the line) and of complex system topologies. This procedure requires that the boundary conditions for the transmission-line coupling equations be properly re-written case by case, as discussed in [9].

However, it has been found more convenient to link the LIOV code with the EMTP [9,10]. With these LIOV-EMTP codes it is possible to analyze the response of a realistic distribution systems (see Fig. 1). The LIOV code has the task of calculating the response of the various lines connecting the two-ports (see Fig. 1); the EMTP has the task of solving the boundary condition and the advantage of making available a large library of power components. The philosophy used in [9] for interfacing the two codes (LIOV on the one hand and EMTP on the other hand), namely the exchange of information between them, is different the one used in [10] (see the two papers for the details).

In this paper we present a new interface between the LIOV code and the EMTP96. The difference with the previous ones is that it does not require any modification of the source code. This new interface, a beta-version of which has been presented in [11,12], is described in Fig. 2. The induced voltages at the terminal nodes computed by the LIOV code are input to the EMTP via current controlled generators, and the voltages and currents calculated by the EMTP are input to the LIOV code via current and voltage sources. Also in this new version of the LIOV-EMTP code, each LIOV line is described by the Agrawal coupling model but the partial differential equation are now solved using an improved FDTD 2^{nd} order scheme [12] in order to increase the numerical stability when non-linear phenomena are considered. Compared to [9] and [10], the advantages of this new interfaced LIOV-EMTP96 code are that I) it relies on a more up to dated version of the EMTP code and that II) it allows for the treatment of corona effect respectively.

Fig. 3 shows a complex distribution system used in the experimental test performed in [13]. The voltage calculated at several observation points of the system shown in Fig. 3 are reported in Figs. 4a,b.

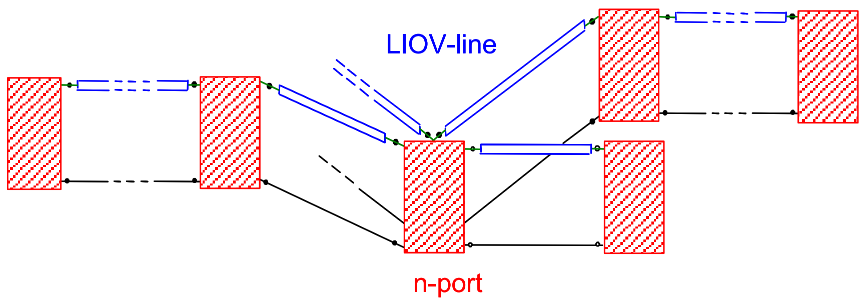


Fig. 1 – Interface scheme between LIOV code and EMTP M39 [9]

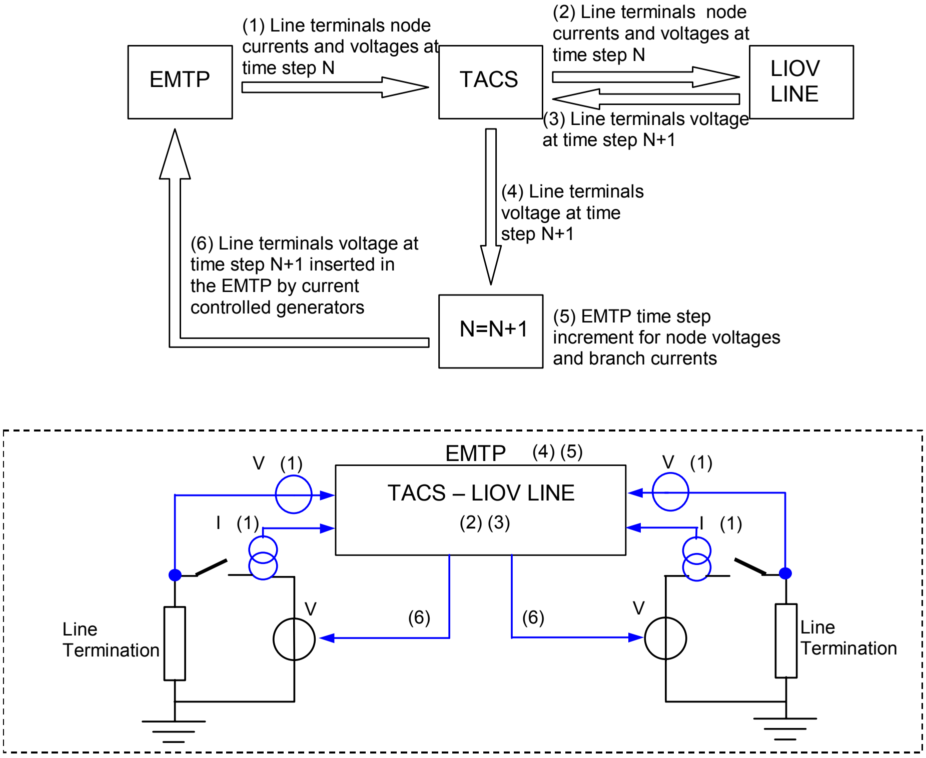


Fig. 2 - Interface between LIOV2 and EMTP96

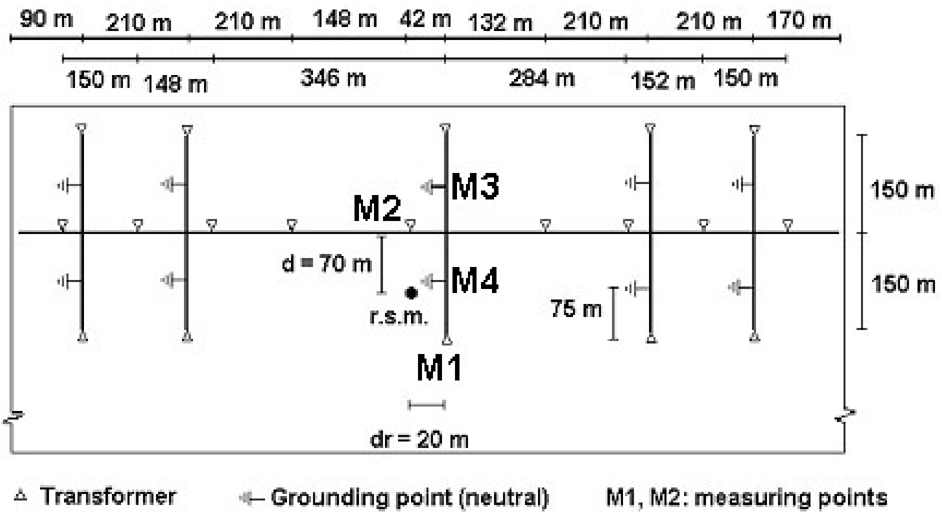
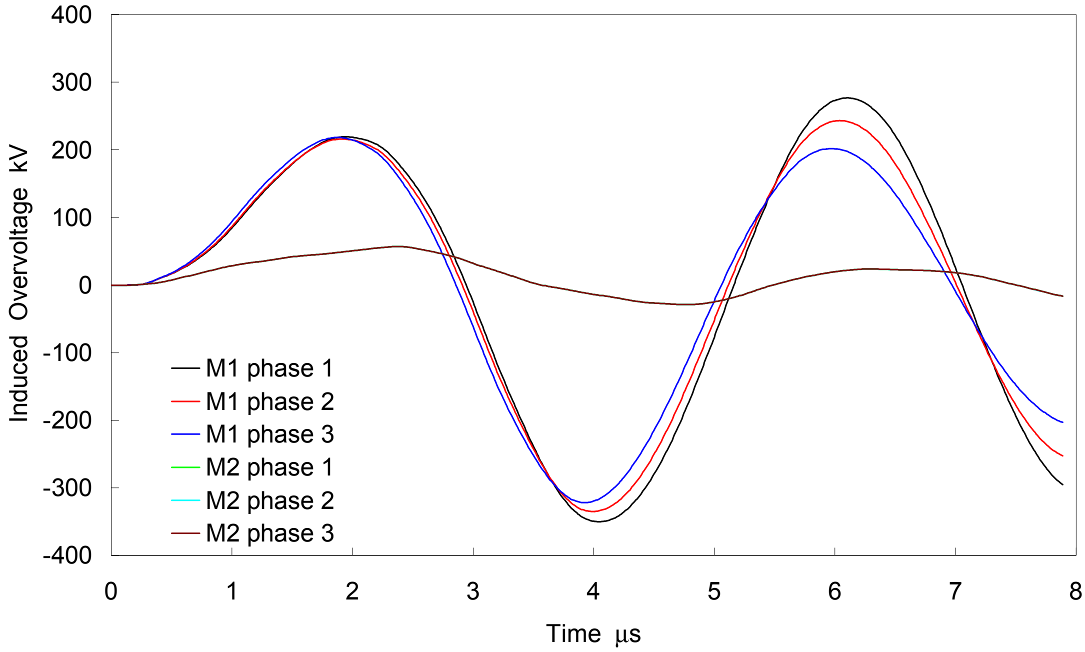
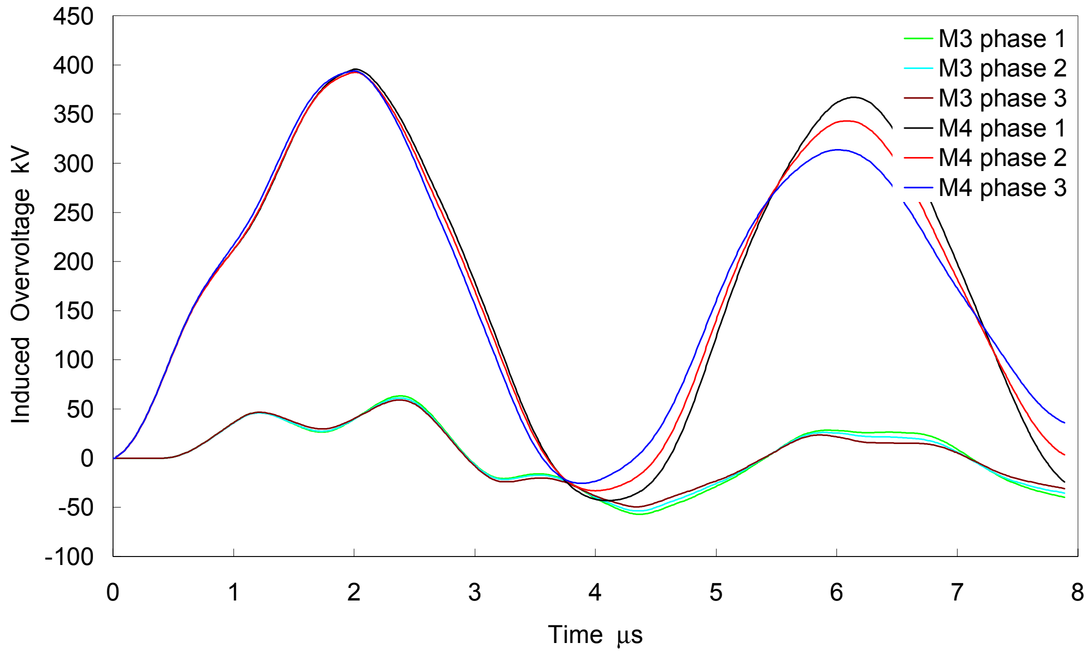


Fig. 3 – Distribution system used in [13].
Lightning current with peak value of 34 kA, maximum time derivative of 17 kA/µs
r.s.m. stands for stroke location



a)



b)

Fig. 4 – Induced overvoltages calculated using LIOV-EMTP96 at points M1 and M2 (4.a), and M3 and M4 (4.b)

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