Stepped or ramped transitions

1 Introduction

The time-domain simulation of a control system consists in successive solutions of the corresponding system of equations at discrete instants. Various assumptions can be made as to the value of a signal between these visited instants.

In power (electrical circuits) systems, it is useful to consider that a current or voltage changes linearly between two successive instants of the simulation. Value transitions between successive instants *t1* and *t2* are calculated and plotted as straight lines or "ramps".

In control systems, a variety of signals are used, often representing the occurrence of events, or having values of a logical nature (true or false) or that are part of a set of discrete values (for example, indexing signals). For these signals, it is not correct to assume that numerical (as opposed to expressly modeled) value transitions are linear. Instead, we need a bi-level or multi-level representation of the signal value, with vertical or "stepped" (see Figure 1) transitions between levels, calculated and plotted at the instant when they occur.

The EMTP control solver can accommodate both types of signals. Any control element can be specified as having either ramped transitions or stepped transitions between the discrete instants of the simulation.
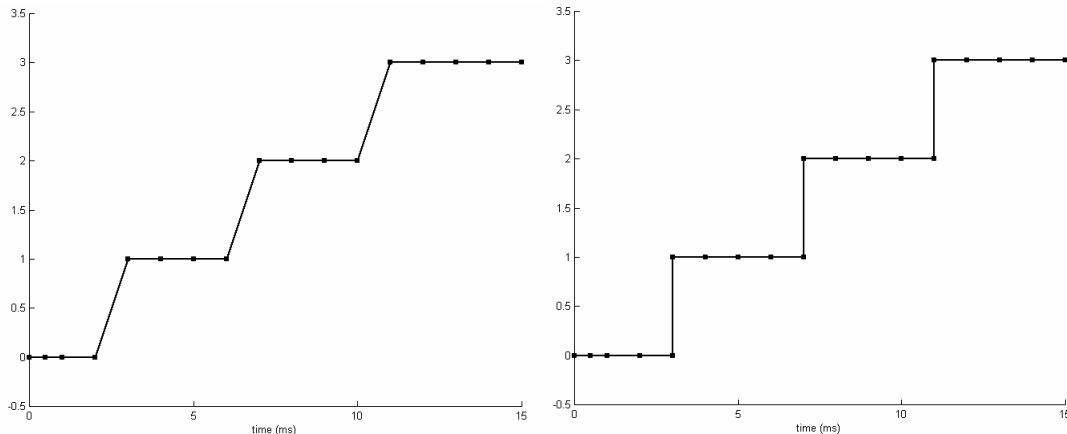

Figure 1 Ramp and step value transitions between simulation instants

2 Plotting stepped transitions or not

When no signals have been specified as having stepped transitions (see the above section), it is useless to request that both pre-transition and post-transition values of the control signals be plotted at each instant t_i of the simulation, as the two values will always be identical.

Even in the case when some signals are specified as stepped, it may not be necessary to increase the size of the plotted data. Plotting stepped transitions requires one additional point for each control signal at each simulation instant. It may be sufficient to know that the value transitions of these signals are calculated correctly, and accept the false ramps when plotting, especially when the time step and, consequently, the width of the incorrectly-plotted ramp are small relative to the duration of a step or level.

In the remaining cases, it may be desirable to correctly plot the vertical transitions of the stepped signal values. This can be done by selecting the option "Show step mode signals" under menu item "EMTP> Simulation options" Output tab. This setting is global and applies to all control diagrams contained in a simulation.