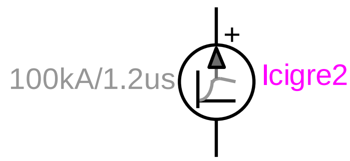
CIGRE current source device



Jean Mahseredjian, 12/29/2013 12:41 AM

1 Description

This device accepts only 1-phase signals.

This device is used to model the current shape of a lightning stroke. It is used for accurate calculations of the lightning performance of equipment. A complete description of this source and the reasoning behind the provided analytical representation of the current shape, can be found in [1]. The current waveform picture is shown on the first data tab of this device.

1.1 Parameters

The model parameters are:

- t_{start} start time, if $t < t_{start}$ the source is an open-circuit.
- I_{max} maximum current
- t_f from time
- S_m maximum steepness
- t_h time to half value
- t_{stop} stop time, if $t > t_{stop}$ the source is an open-circuit. The stop time must be greater than the start time

1.2 The current front

The following equations are taken from [1].
The current front of the first strokes can be expressed as:

$$I = At + Bt^n \quad (1)$$

The basic assumption is that the current shape reaches the instant of maximum steepness (90% of amplitude) at a time t_n dependent on the exponent n. The two variables are approximated by:

$$n = 1 + 2(s_N - 1)\left(2 + \frac{1}{s_N}\right) \quad (2)$$

$$t_n = 0.6 t_f \left(\frac{3 s_N^2}{1 + s_N^2}\right) \quad (3)$$

where

$$s_N = S_m \frac{t_f}{I_{max}} \quad (4)$$

The constants of equation (1) then are given by:

$$A = \frac{1}{n-1}\left(0.9 n \frac{I_{max}}{t_n} - S_m\right) \quad (5)$$

$$B = \frac{1}{t_n^n (n-1)}\left(S_m t_n - 0.9 I_{max}\right) \quad (6)$$

1.3 The current tail

The following equations are taken from [1].
The current tail equation is:

$$I = I_1 e^{\frac{-(t - t_n)}{t_1}} - I_2 e^{\frac{-(t - t_n)}{t_2}} \quad (7)$$

Where the time constants and current constants are found from:

$$t_1 = \frac{(t_h - t_n)}{\ln(2)} \quad (8)$$

$$t_2 = 0.1 \frac{I_{max}}{S_m} \quad (9)$$

$$I_1 = \frac{t_1 t_2}{t_1 - t_2}\left(S_m + 0.9 \frac{I_{max}}{t_2}\right) \quad (10)$$

$$I_2 = \frac{t_1 t_2}{t_1 - t_2}\left(S_m + 0.9 \frac{I_{max}}{t_1}\right) \quad (11)$$

Equation (7) is used when EMTP enters the tail zone at $t \geq t_n + t_{start}$.

1.4 Netlist format

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_Icigre;Icigre1;2;2;s1,s2,
0,100kA,1.2us,150,50us,100us,?v,?i,?p,
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Field	Description
_Icigre	Part name
Icigre1	Instance name, any name.
2	Total number of pins
2	Number of pins given in this data section
s1	Signal name connected to k-pin
s2	Signal name connected to m-pin
t_{start}	Start time
I_{max}	Maximum current

t_f	Front time
s_m	Maximum steepness
t_h	Time to have value
t_{stop}	Stop time
?v	Request for voltage scope, sent to scope group vb (branch voltages), optional
?i	Request for current scope, sent to scope group ib (branch currents), optional
?p	Request for power scope, sent to scope group p (branch power), optional

None of the device pins can be deleted.

2 Steady-state model

The steady-state model of this device is an open-circuit.

3 Frequency Scan model

The frequency scan model of this device is an open-circuit.

4 Time-domain model

The device is evaluated at each simulation time-point according to equations (1) and (7). The source is active (not an open-circuit) for $t_{start} \le t \le t_{stop}$. Equation (7) is used when $t \ge t_n + t_{start}$.

5 REFERENCES

[1] "Guide to procedures for estimating the lightning performance of transmission lines", Working Group 01 (Lightning) of Study Committee 33 (Overvoltages and Insulation Co-ordination), October 1991, CIGRÉ.