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Question: 4/15

SOURCE[1]: Ericsson AB, TNO

TITLE: G.fast: Proposed change of admittance in current G.fast cable model

ABSTRACT

This contribution proposes a modification of the cable model for G.fast. The change involves adding a parameter that allows better fit for cables with high-loss dielectrics (e.g. PVC).

1. Introduction

In the agreed and provisionally agreed cable model from TNO [1][2][3], the series impedance Z_s has 4 (or more) parameters to match an impedance while the shunt impedance Y_p has only 2 essential parameters to match an admittance. Therefore its flexibility is limited compared to Z_s. Contribution 2012-05-4A-045 has shown that the use of an additional parameter in Y_p is needed for matching cables where the loss tangent is not constant and the dielectric losses are of significance.

2. Proposed modification of the admittance model

The admittance Y_p in the accepted (old model) described in TNO [1] in combination with the shaping function $Q_{y,1}$ which is also described in [1] can be written as:

$$Y_p(jw) = jw \cdot C_{p0} \times \left[Q_Y\left(\frac{jw}{w_d}\right)\right]^f ,$$

or

$$Y_p(jw) = jw \cdot C_{p0} \times \left(1 + \frac{jw}{w_d}\right)^{-2\cdot f/p} \text{, for } Q_Y(jw) = \left(\frac{1}{1+jw}\right)^{2/p}$$

This is also the expression that is currently agreed and provisionally agreed to in TNO [2][3]

This contribution proposes to change the model by introducing a third "scaling parameter" q_c as motivated in contribution 2012-05-4A-045. Expressing Y_p via this third scaling parameter, q_c, introduces the required additional degree of freedom and also has the advantage that q_c can be viewed as for refining purposes. If $q_c = 0$, the result is the original TNO model. If $q_c \neq 0$, it can match cables where the dielectric losses cannot be ignored. The new model

[1] Contact:
Per-Erik Eriksson, Ericsson, T: +46 10 719 8721, E: per-erik.s.eriksson@ericsson.com
Miguel Berg, Ericsson, T: +46 10 714 6273, E: miguel.berg@ericsson.com
Daniel Cederholm, Ericsson, T: +46 10 717 2464, E: daniel.cederholm@ericsson.com
Rob F.M. van den Brink, TNO, T: +31.8886.67059, E: Rob.vandenBrink@tno.nl

proposed is written as:

$$Y_p(jw) = jw \cdot C_{p0} \times (1-q_c) \times \left[Q_Y\left(\frac{jw}{w_d}\right)\right]^f + jw \cdot C_{p0} \times q_c$$

or

$$Y_p(jw) = jw \cdot C_{p0} \times (1-q_c) \times \left(1+\frac{jw}{w_d}\right)^{-2\cdot f/p} + jw \cdot C_{p0} \times q_c \quad \text{for } Q_Y(jw) = \left(\frac{1}{1+jw}\right)^{2/p}$$

If we apply these modified expressions for admittance to the full model descriptions in [2] and [3], that are currently agreed and provisionally agreed, we obtain the following new model:

Simple model, with square root function, 7+1 parameters:

$[Z_s, Y_p]$ = Model_01 ($Z_{0\mu}, \eta_{VF}, R_{s0}, q_L, q_H, q_c, f, f_d$)
$Z_s(jw) = jw \cdot L_{s\infty} + R_{s0} \times \left(1 - q_s + sqrt\left(q_s^2 + 2 \cdot \frac{jw}{w_s}\right)\right)$
$Y_p(jw) = jw \cdot C_{p0} \times (1-q_c) \times \left(1+\frac{jw}{w_d}\right)^{-2\cdot f/p} + jw \cdot C_{p0} \times q_c$

More advanced model, with square root of rational function, 9+1 parameters:

$[Z_s, Y_p]$ = Model_02 ($Z_{0\mu}, \eta_{VF}, R_{s0}, q_L, q_H, q_x, q_y, q_c, f, f_d$)
$Z_s(jw) = jw \cdot L_{s\infty} + R_{s0} \times \left(1 - q_s \cdot q_x + sqrt\left(q_s^2 \cdot q_x^2 + 2 \cdot \frac{jw}{w_s} \cdot \left(\frac{q_s^2 + jw/w_s \cdot q_y}{q_s^2/q_x + jw/w_s \cdot q_y}\right)\right)\right)$
$Y_p(jw) = jw \cdot C_{p0} \times (1-q_c) \times \left(1+\frac{jw}{w_d}\right)^{-2\cdot f/p} + jw \cdot C_{p0} \times q_c$

3. Summary

This contribution should be presented under G.fast. The contribution proposes a modification to the existing shunt admittance part of the G.fast cable model in order to more accurately model cables with non-constant loss tangent and high dielectric loss.

It is proposed to agree to the following issue:

5.1.x	Agreed	That the cable model for G.fast agreed in issue 5.1.1.1 and provisionally agreed in issue 4.7.2.1.7 is modified according to this contribution, including a third parameter q_c.	This contribution

4. Acknowledgements

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5. References

[1] TNO: "G.fast: Wideband modeling of twisted pair cables as two-ports", Contribution ITU-T SG15/Q4a 11GS3-028, Geneva, Switzerland, Sept 2011

[2] TNO: "G.fast: Parametric cable models for specifying reference loops", Contribution ITU-T SG15/Q4a 11GS3-029, Geneva, Switzerland, Sept 2011

[3] TNO: "G.fast: Specification of reference loops and wire pair models", Contribution ITU-T Sg15/Q4a 2012-02-4A-030, Paris, France March 2012