ITU - Telecommunication Standardization Sector Temporary Document: 2013-03-Q4-025

STUDY GROUP 15 Original: English

Red Bank, New Jersey, 18 – 22 March, 2013

Question: 4/15

SOURCE(*): TNO.

TITLE: G.fast: Release of measured transfer characteristics of the 104m KPN access cable

Abstract

Having available adequate data on the transfer characteristics is important to be able to perform simulations of channel estimation and vectoring performance in G.fast. For this purpose TNO releases the measured transmission and forward crosstalk data of the 104m long KPN access cable (6x4x0.5) to the parties involved in the G.fast standardization. The data provided represents the complete forward transfer matrix containing the transmission and FEXT (thus the transfer functions for all 12x12 wire pair combinations). This contribution is for information only.

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1 Introduction

At the ITU-T Q4/15 January 2013 meeting the need was expressed to obtain additional cable characteristics which can be used for simulation of channel estimation and vectoring performance in the development of the G.fast standard. As a response to the call for papers, recorded in the 'Updated Issues List for G.fast' (2013-01-Q4-U20R1), TNO provides to Q4 measurement data for the 104m long KPN access cable. The data consists of the transmission and FEXT for all 12 wire pairs, thus the complete forward transfer matrix. As such this data provides the characterization of this 104m KPN cable for which some partial measurement results have been presented in earlier contributions ([5], [6]). The measurement data can be used by interested parties for simulations and G.fast performance analysis.

2 Description of the cable

The provided data represents measurements that were performed on the 104m long KPN access cable (see Figure 1) that has been described in chapter 7 of report [1]. This is one of the cable types that is widely used by KPN in the access network within the Netherlands. This type of cable is applied both underground as well as in multi dwelling buildings. For the transmission properties of this cable the cable model "T05u" has been derived, which is described in Appendix I of the current draft of the G.fast standard [2].

This particular cable has the dimensions "(6×4×0.5)": it consists of six quads, each quad consisting of two twisted wire pairs of 0.5 mm PE-insulated wire. The four wires in the quad are twisted together as a whole, which means that the two wire pairs in a quad have the same twist length. Wire pairs in different quads are expected to have different twist length, to reduce crosstalk even further. The cable has a common metallic shielding.

Figure 1: The 6x4x0.5 KPN Access cable for which the transfer characteristics were measured.

More information regarding the transmission and the FEXT in this cable can be found in [1]. Details about the measurement method can be found in [3]. A discussion about the dual-slope effect of the FEXT in this cable (and in other cables) can be found in [4].

3 Provided measurement data

The measurement data that is provided represents the complete forward transfer matrix for the 104m KPN cable. The data is provided in the file 'T05u_Transfer_Ipol.mat' as a Matlab data structure[1] which contains:

- *Freq* : a row vector defining the frequency grid (in kHz);
- *H* : the 3-dimensional array containing the interpolated measurement data;
- *Leg* : a matrix (cell array) of strings representing a legend with the measurement data .

H(f,i,j) represents the measured forward transfer function from wire pair *j* to wire pair *i*. Thus *H* contains 12x12 complex transfer functions with a linear frequency grid that corresponds to the center frequencies of the carriers defined in G.fast (in the range from 0 – 212 MHz).

The complex values are all obtained via a cubic spline interpolation from the original measurements at the desired frequency grid. This interpolation was done directly on the original measured complex values (linear).

As such the provided data contains the differential mode transmissions and FEXT couplings for all wire pairs in the cable in one direction[2]. All measurements are normalized to a reference impedance of 100Ω.

5 Summary

This paper is relevant for G.fast and is for information only. It is a response to the call for papers to provide input on 'FEXT and noise models above 30 MHz, up to no more 250 MHz' and relates to the agreed goal described in the following item of the G.fast issues list:

6.2.10.3.4	Agreed 20-Sept-12	that simulation conditions and environment to conclude on performance advantages/disadvantages for any proposed channel estimation scheme and its relationship to vectoring should be provided by the November 2012 Q4a/15 meeting, and that simulations should be provided no later than the January 2013 Q4a/15 meeting, with a goal to make a decision at that meeting.

The provided measurement data is intended to be used by the interested parties for simulations of channel estimation and vectoring performance.

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] Associate Rapporteur for G.fast: "*Updated draft text for G.fast – version 4.0*", Contribution ITU-T SG15/Q4a, 2013-03-Q4-R20, Red Bank, USA, March 2013

[3] TNO: *"G.fast: Wideband transfer and crosstalk measurements on twisted pair cables"*, Contribution ITU-T SG15/Q4a 11BM-021, Conference Call, 18 April 2011

[4] TNO: *"G.fast: Dual slope behaviour of EL-FEXT"*, Contribution ITU-T SG15/Q4a 2012-

[1] Upon request the measurement data can be provided in ASCII format

[2] The FEXT and transmission in the reverse direction were also measured. Because of reciprocity, these measurements are highly comparable to the measurements in forward direction, and are therefore not provided.

02-4A-038, Paris, France, February 2011

[5] TNO: *"G.fast: Release of TNO cable measurements for use in simulations"*, Contribution ITU-T SG15/Q4a, TD2012-11-4A-TC-TNO, Conference call 4 oct 2012.

[6] TNO: *"G.fast: release of interpolated TNO cable measurements"*, Contribution ITU-T SG15/Q4a 2012-11-4A-022, Chengdu, China, November 2012