TITLE **Solution for Noise Injection and calibration of their level**

PROJECTS ADSL (and SDSL and VDSL)

AUTHOR: Rob F. M. van den Brink, tel +31 70 4462389
KPN Research fax: +31 70 4463477
P.O. Box 421 e-mail: R.F.M.vandenBrink@kpn.com
2260 AK Leidschendam ***the above numbers and e-mail address are***
The Netherlands ***changed since 9 feb 2001!***

STATUS for decision

ABSTRACT This WD discusses and describes means for how to provide a more accurate description of how the noise are to be injected in the testloops during xDSL performance testing, and how their levels are to be calibrated.

There is consensus about the fact that (differential mode) noise injection method shall be current injection in nature (see WD15 from the previouse neeting in Gent). This approach is perfectly in line with how noise injectors are commonly constructed.
This document describes (a) an equivalent circuit diagram of the noise injector, (b) a setup for checking/calibrating the defined noise levels, and (c) the interpretation of these noise levels in case the noise injector is terminated by other impedances then when used during calibration.

This difference between this propoasl and the one in WD15 from the previous meeting (in Gent), is that this proposal also solves the problems raised in TD15 (from this meeting) about PSD variations at lower frequencies in a very elegant and fundamental way.

Common mode noise injection is not covered here, and remains for further study.

<<<<<<<<<<<<<< ***BEGIN OF TEXT PROPOSAL*** >>>>>>>>>>>>>>>***:***

0.1. Noise injection Network

The adding network in figure 3 facilitates the injection of the differential mode and common mode noise from the impairment generator into the test cable.

0.1.1. Differential mode noise injection

The noise injector for differential mode noise is a two-port network in nature, and may have additional ports connected to the impairment generator. The Norton equivalent circuit diagram is shown in figure [x]. The current source I_x is controlled by the impairment generator. The parasitic shunt impedance Z_x shall have a value of $|Z_x|>4k\Omega$ in the frequency range from 100 Hz to 2 MHz.

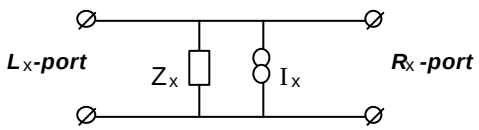

Figure [x] Norton equivalent circuit diagram of the differential mode noise injector.

The noise levels, as specified in sub clause [*], hold under calibration conditions in which no testloop is used (the "null-loop") and while both sides of the differential mode noise injector are terminated with passive well-defined impedance, as illustrated in figure [y].

- The R_x side of the noise injector, is terminated during calibration by the design impedance $\mathbf{R_V}$ of the modem under test, (100Ω for ADSL and 135Ω for SDSL and VDSL).

- The Lx side of the noise injectoris terminated during calibration by a frequency dependent impedance that equals the design impedance $\mathbf{R_V}$ at high frequencies and increases in impedance when the frequency decreases. The values are specified in table [q] (for further study).).
  EDITORIAL NOTE. The values are for further study, but can possibly be copied from previous standards dealing with ISDN, POTS and or hybrids.

The noise level during calibration is specified in terms of power $\mathbf{P_x}$ at the port that will be connected to the input of the victim modem under test. $\mathbf{R_v}$=100Ω for ADSL (and 135Ω for SDSL and VDSL). The rms voltage $\mathbf{U_x}$ (in figure [y]) across the load impedance $\mathbf{R_v}$ is therefore equal to $\mathbf{U_x} = \sqrt{(\mathbf{P_x} / \mathbf{R_v})}$.

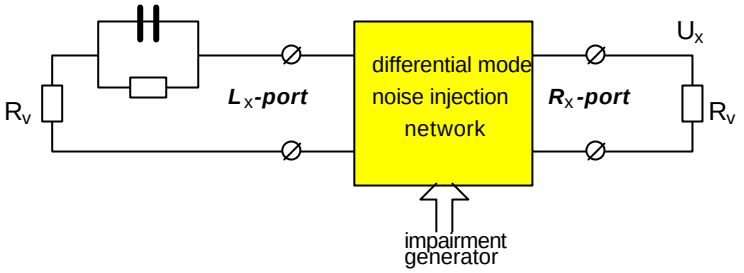

Figure [y] for which the noise level is defined, and applicable for calibration purposes.

EDITORIAL NOTE: A first order network is shown here to demonstrate the rationale of the approach, but higher order networks may give better results. This is for further study.

During performance testing the noise injector will be part of the circuit diagram in figure [z]. In this configuration the termination impedances at both ports of the differential mode noise injector can be different from the values $\mathbf{R_v}$ used in figure [y] since the cable impedance and the actual impedances of the xDSL modem under test will be a slightly different from the design impedance $\mathbf{R_v}$. As a result the noise voltage $\mathbf{U'_x}$ during performance testing (as shown in figure [z]) can be a slightly different from the noise voltage $\mathbf{U_x}$ during calibration (as shown in figure [y]).

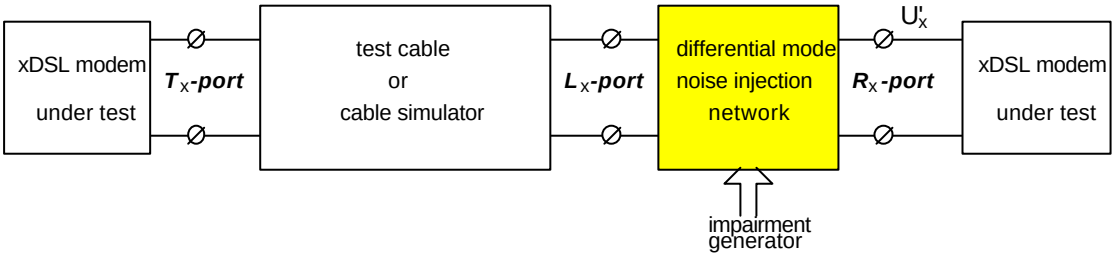

Figure [z] Usage of the noise injector during performance testing.

0.1.2. Common mode noise injection

<for further study>