White Paper | BNC

Return loss measurements on connectors for high-resolution video signals

NEUTRIK®

Content

White Paper – BNC
Title: NWP06

1 ABSTRACT

Currently, data transport of high definition serial digital interface (HD-SDI) signals at 3 Gb/s is state of the art and standardized by the Society of Motion Picture & Television Engineers (SMPTE). For return loss and voltage standing wave ratio (VSWR) measurements, suitable equipment is available. With upcoming ultra high definition (UHD) signals and related high frequencies, the discrepancies between available 50 Ω measuring equipment and defined 75 Ω video standards increase.

This paper explains the influence and importance of return loss in a video system and shows a suitable test method which Neutrik believes is the best for high frequencies. Further return loss measurements compare Neutrik`s new rearTWIST UHD BNC connector, which is specifically designed for high frequencies, with UHD optimized connectors from common manufacturers up to 18 GHz (ST 2082-1).

THEORY

2 RETURN LOSS

2.1 What is return loss?

Return loss is signal attenuation caused by im-pedance variations in the structure of a cable or associated connection parts like Bayonet Neill–Concelman (BNC) connectors. These variations cause some part of the signal to reflect (return) back to the source. At lower frequencies, return loss is a minor effect; at frequencies above 50 MHz it can have a significant impact on the signal performance and the transmitted distance. For signals with high bandwidth (e.g. UHD) and resulting high frequencies, it can be a critical factor. In addition also the VSWR is a function of the reflection coefficient, which describes the power reflected from the end of the system and is another representation of the return loss.

2.2 About return loss

With the transition to UHD signals, including 4K and 8K signals with their higher data rates up to 24 Gb/s (ST 2083-1 pending) and related in-creased clock frequencies, the impedance of BNC connectors becomes more important than ever. Every impedance deviation has a negative influence on the return loss and VSWR values.

In order to maintain the square waveform of digital signals harmonics (table 1) up to the 5th order should be considered. Taking the 3rd harmonic as a limit represents a reasonable compromise between signal waveform and reliable test results.

DATA RATE	3rd HARMONICS	APPLICATION
3.0 Gb/s	4.5 GHz	HD acc. ST 424
6.0 Gb/s	9.0 GHz	4K acc. ST 2081-1
12.0 Gb/s	18.0 GHz	4K acc. ST 2082-1

table 1

3 HOW TO MEASURE RETURN LOSS UP TO 18 GHZ

3.1 Challenges

As mentioned, for high definition signals (HD) up to 3 GHz, there are suitable return loss and VSWR measuring devices available. For 4K and 8K signals with related high frequencies (table 1), there is only some dedicated 75 Ω return loss measure-ment equipment and related calibration kits avail-able, but with limited frequency range (see refer-ences No 2.). 50 Ω based test instru-ment systems have to be used to carry out measurements in the required extended fre-quency range. The Time Domain Gating (TDG) method can be used as an alternative to the conventional S11 (ST2081-1 & ST2082-1) measurement procedure on frequency domain in order to avoid calibration uncertainties due to components (e.g. adapters, matching pad, etc.) which are not specified for higher frequen-cies. The major advantage of TDG is an easier visu-alization and localisation of impedance deviations.

3.2 Principle - Time Domain Gating (TDG)

a) The device under test (DUT) is connected to the network analyser via a short adapter cable. This increases the distance between the test port, any existing adapters and the DUT, which enhances the distinct identification from impedance deviations.

b) The measured signal is transformed from fre-quency to time domain (figure 1 & 2). Similar to a conventional Time Domain Reflectometer (TDR), all impedance deviations from DUT components (e.g. BNC connector, cable, etc.) can be clearly identified.

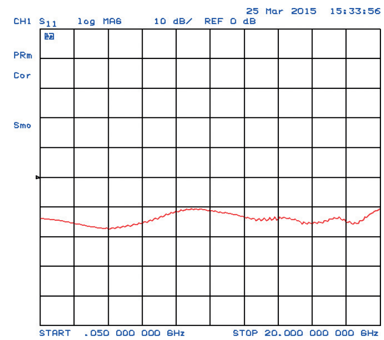

figure 1

c) A gate (figure 2) with defined start and end points is positioned on the DUT component (e.g. BNC connector, cable, etc.) which has to be measured.

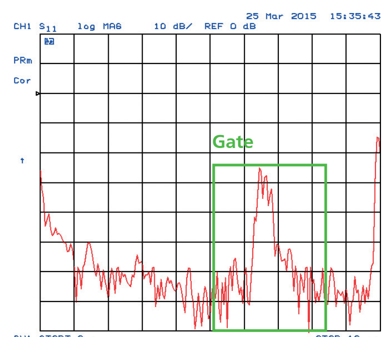

figure 2

d) Current return loss values inside the gate are transformed back from the time domain to the frequency domain (figure 3), representing the return loss from a defined position within the DUT.

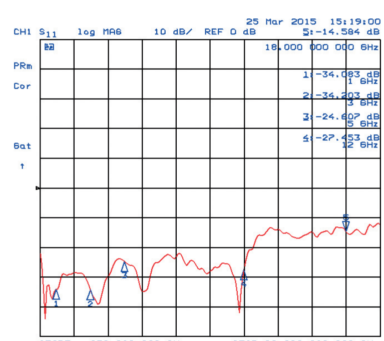

figure 3

MEASUREMENT – TDG METHOD

4 RETURN LOSS MEASUREMENT UP TO 18 GHZ

The following return loss measurement demon-strates the functionality of the TDG method by an ex-ample and compares the performance of Neutrik`s new rearTWIST UHD BNC with well-known connectors from US and French manufac-turers, offering UHD-optimized BNC connectors, in order to provide a verifiable reference of com-monly used products in the professional broadcast industry.

4.1 Measurement setup & condition

Figure 4 and table 2 show the measuring setup including network analyzer, adapter cable, DUT and a 75 Ω load for the return loss measurement via TDG method.

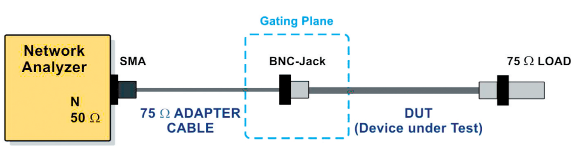

figure 4

ITEM	TYPE
Network Analyser	HP 8722D
Adapter cable	SMA terminated with Belden 1694A (0.8 m length) and a BNC female jack on the other side
COAX cable DUT	Belden 1694A (8 m)
BNC connectors I	Neutrik rearTWIST UHD BNC NBNC75BTU11X
BNC connectors II	Common French manufacturer
BNC connectors III	Common US manufacturer

table 2

4.2 Measurement results "non-gated" in frequency and time domain

The measured return loss values are transformed from the frequency domain to the time domain. The gate (figure 5) is manually positioned (table 3 lists used gate parameters) to measure the BNC con-nector and blend out the impedance of the cable, analyser, etc.

PARAMETER	VALUE
Spam	5 ns
Zero point	5,5 ns
End point	8 ns

table 3

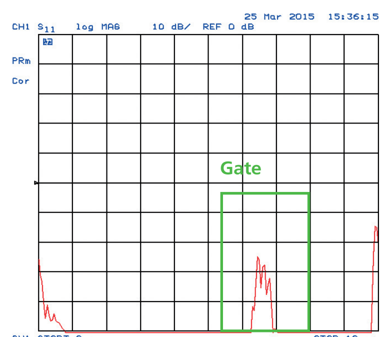

figure 5

4.3 Conclusion & Results

The goal was to receive verifiable return loss characteristics of BNC connectors, measured with a suitable test method for high frequencies up to 18 GHz (ST 2083-1). Due to limited calibration kits for 75 Ω systems for high frequencies the TDG method (section 3.2) has been chosen to measure the return loss of the connector only, suppressing the impedance deviations of the cable and adapters.

To compare the new rearTWIST UHD BNC, specifically UHD optimized connectors from common manufacturers were used as reference.

All BNC connectors indicate low return loss values and sufficient headroom to the required UHD limit (figure 6) over the entire frequency range up to 18 GHz (ST8083-1). Therefore all 3 connector types are suitable for high resolution video signal transmission.

Figure 6 represents the optimum measuring setup with minimum connection points to avoid additional adulteration from the return loss values. In reality, real broadcast installations contain multiple BNC connection points which have significant influence on the return loss performance. Therefore sufficient distance (headroom) to the UHD limit is essential to guarantee appropriate signal transmission.

Neutrik's new rearTWIST UHD BNC achieves increased headroom compared to the connectors from the US or French manufacturers and offers additional return loss reserve for potential impedance de-viations resulting from cable bending, incorrect connector assembly or faulty connection interfaces without signal interruption.

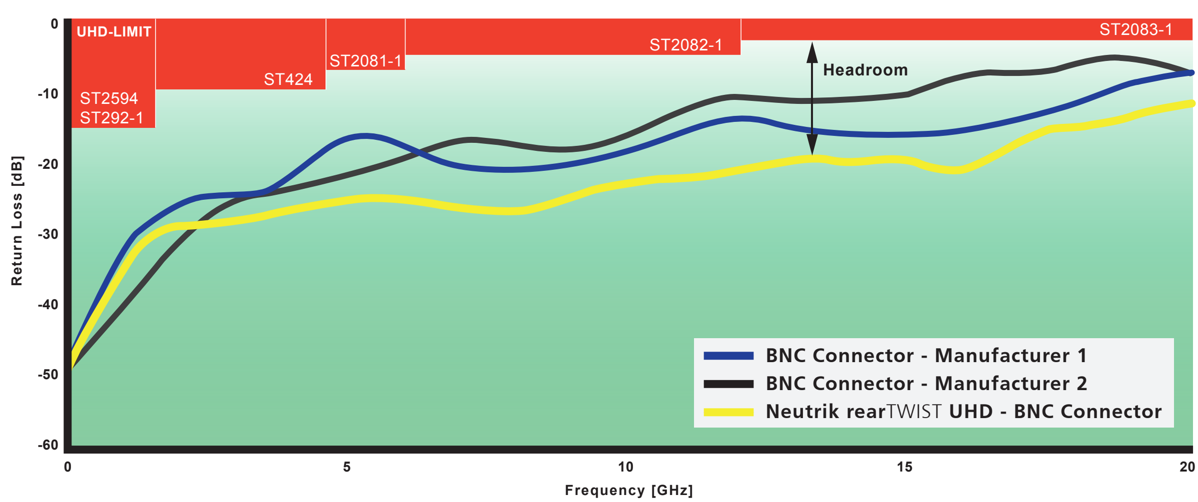

figure 6

References / Literature

1 Neutrik BNC White Paper “Optimum Performance of Neutrik rearTWIST 75 Ω BNC-Connectors in HD 1080p applications”
2 Samtec “Characterizing Non-Standard Impedance Channels with 50 Ohm Instruments”
3 Belden “High-Definition Cabeling and Retrun Loss”
4 Axon “Adventures In Return Loss”

Liechtenstein (Headquarters)
NEUTRIK AG, Im alten Riet 143, 9494 Schaan
T +423 237 24 24, F +423 232 53 93, neutrik@neutrik.com

Germany / Netherlands / Denmark / Austria
Neutrik Vertriebs GmbH, Felix-Wankel-Strasse 1, 85221 Dachau, Germany
T +49 8131 28 08 90, info@neutrik.de

Great Britain
Neutrik (UK) Ltd., Westridge Business Park, Cothey Way
Ryde, Isle of Wight PO33 1 QT
T +44 1983 811 441, sales@neutrik.co.uk

France
Neutrik France SARL, Rue du Parchamp 13, 92100 Boulogne-Billancourt
T +33 1 41 31 67 50, info@neutrik.fr

USA
Neutrik USA Inc., 4115 Taggart Creek Road, Charlotte, North Carolina, 28208
T +1 704 972 30 50, info@neutrikusa.com

Japan
Neutrik Limited, Yusen-Higashinihonbashi-Ekimae Bldg., 3-7-19
Higashinihonbashi, Chuo-ku, Tokyo 103
T +81 3 3663 47 33, mail@neutrik.co.jp

Hong Kong
Neutrik Hong Kong LTD., Suite 18, 7th Floor Shatin Galleria
Fotan, Shatin
T +852 2687 6055, neutrik@neutrik.com.hk

China
Ningbo Neutrik Trading Co., Ltd., Shiqi Street, Yinxian Road West
Fengjia Villiage, Yinzhou Area, Ningbo, Zhejiang, 315153
T +86 574 88250488 800, neutrik@neutrik.com.cn

India
Neutrik India Pvt. Ltd., Level 3, Neo Vikram, New Link Road,
Above Audi Show Room, Andheri West, Mumbai, 400058
T +91 982 05 43 424, anklesaria@neutrik.com

Associated companies

Contrik AG
Steinackerstrasse 35, 8902 Urdorf, Switzerland
T +41 44 736 50 10, contrik@contrik.ch

H. Adam GmbH
Felix-Wankel-Straße 1, 85221 Dachau, Germany
T +49 08131 28 08-0, info@adam-gmbh.de

www.neutrik.com

BNC WHITE PAPER