Technical Paper | mediaCON® USB-C Cable

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Content

Technical Paper – mediaCON **USB-C Cable**
Title: NTP10

Subject:

This technical paper covers the general NEUTRIK USB 3.1 Type-C cable requirements of mechanical, electrical, environmental and performance characteristics.

This documentation describes the results of the test series conducted at Neutrik AG and USB-C cable manufacturer.

The tests were carried out in accordance with the following Standard regulations:
- ANSI/EIA 364-C
Electrical Connector/Socket Test Procedures Including Environmental Classifications, approved 1994. Available in hard copy – reference search site http://www.nssn.org/information.html
- EIA-364-1000.01
Environmental Test Methodology for Assessing the Performance of Electrical Connectors and Sockets Used in Business Office Applications
- USB 2.0
Universal Serial Bus Specification, Revision 2.0. This specification is available on the World Wide Web site http://www.usb.org
- USB 3.1
Universal Serial Bus Specification, revision 3.1. This specification is available on the World Wide Web site http://www.usb.org.
- USB Type-C
Universal Serial Bus Type-C Cable Specification, Revision 1.1 (also referred to as the USB Type-C Specification). This specification is available on the World Wide Web site http://www.usb.org.

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1 Mechanical

1.1 Durability Test

Test Conditions	Performance Requirement
EIA 364-09 The durability test shall be done at a maximum rate of 200 cycles per hour and no physical damage to any part of the connector and cable assembly shall occur.	For all cable assembly : USB Type-C: 10'000 cycles • Insertion Force: 20 N Max. • Extraction Force: 6 N to 20 N

1.2 Cable Flexing Test

Test Conditions	Performance Requirement
EIA 364-41, Condition 1 Dimension X= 3.7 times cable diameter and 100 cycles in each of two planes 120 degree arc.	1. No physical damage. 2. No discontinuity over 1 microsecond during flexing.

1.3 Cable Pull-Out Test

Test Conditions	Performance Requirement
EIA 364-38, Test Condition A The cable assembly shall be subjected to a 40 N axial load for a minimum of 1 minute.	1. No physical damage. 2. No electrical discontinuity over 1 microsecond to the cable assembly.

1.4 4-Axis Continuity Test

Test Conditions	Performance Requirement
The USB Type-C connector family shall be tested for continuity under stress using the test configurations shown below	Test in 4 different directions (left, right, up, down) Fixture device at 90 degree angle 8 N tensile force shall be applied to the cable in a downward direction, perpendicular to the axis of insertion, for a period of at least 10 seconds.

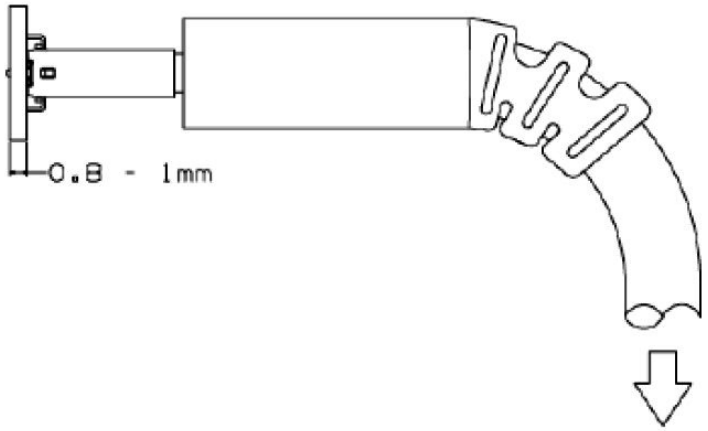

figure 1: Axis Continuity Test

2 Electrical

2.1 SuperSpeed Pair Raw Cable Differential Impedance

Test Conditions	Performance Requirement
The SuperSpeed pair impedance is measured at the rise time to be 200 ps (10%-90%) entering the reference plane.	For all cable assembly: • 85 Ω to 95 Ω for Gen.2 application • 83 Ω to 97 Ω for Gen.1 application

2.2 SuperSpeed Pair Mated Connector Differential Impedance

Test Conditions	Performance Requirement
The differential impedance is measured at the defined rise time entering the reference plane. The definition of rise time: 40ps (20%-80%) for Gen.2 speed 50ps (20%-80%) for Gen.1 speed	For all cable assembly : USB Type-C: 85 Ω ± 9 Ω

2.3 Insertion Loss Fit at Nyquist Frequency: ILfitatNq

Test Conditions	Performance Requirement
Normalized with mated connector 85±9 Ω and raw cable 90±5 Ω differential impedance.	Type-C to Type-C: • For all USB 3.1 Gen.2 pairs: ≥ –4 dB at 2.5 GHz ≥ –6 dB at 5 GHz ≥ –11 dB at 10 GHz • For USB 3.1 Gen.1 cable assembly: ≥–7 dB at 2.5 GHz ≥ –12 dB at 5 GHz • Type-C to Legacy Cable: ≥-4 dB at 2.5GHz, ≥-6 dB at 5GHz, • Type-C to Legacy Adaptor: ≥-4 dB at 2.5 GHz ≥-3.5 dB at 5 GHz

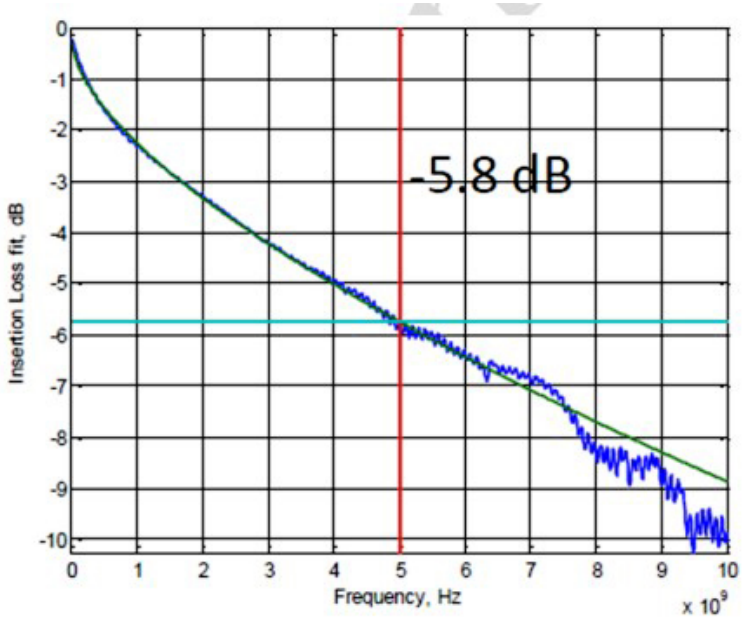

figure 2: Illustration of Insertion Loss

2.4 Integrated Multi-Reflection: IMR

Test Conditions	Performance Requirement
It measures the ripple of the insertion loss, caused by multiple reflections inside the cable assembly (mated with the fixture). Vin(f) is the input trapezoidal pulse spectrum with Tb=Unit interval= 100 ps, Tr= 0 to 100% rise time= 0.4*Tb	The IMR limit is specified as a function of ILfitatNq: • Type-C to Type-C: IMR ≤ 0.126*ILfitatNq^2+3.024*ILfitat Nq-23.392 in dB. • Type-C to Legacy: IMR ≤ 0.126*ILfitatNq^2+3.024*ILfitat Nq-21.392 in dB. • Type-C to Legacy Adaptor: IMR ≤ -34 dB for Tb=200 ps and ≤ -27 dB for Tb=100 ps.

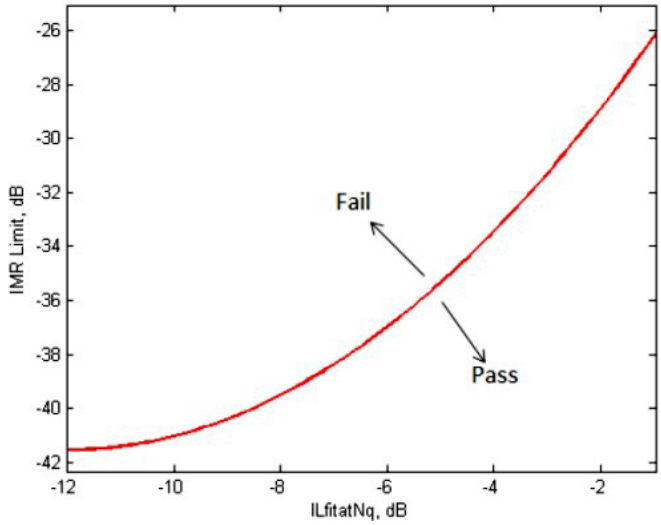

figure 3: IMR Limit as Function of IlfitatNq

2.5 Integrated Crosstalk on SS pairs: INEXT and ISSXT

Test Conditions	Performance Requirement
The integration shall be done for each NEXT and FEXT between USB SuperSpeed pairs.	The IMR limit is specified as a function of ILfitatNq: • Type-C to Type-C: INEXT ≤ -40 dB to 12.5 GHz IFEXT ≤ -40 dB to 12.5 GHz • Type-C to Legacy: ISSXT ≤ -38 dB • Type-C to Legacy Adaptor: ISSXT ≤ -37 dB

2.6 Integrated Crosstalk on SS pairs and D+/D- pairs: IDDXT_1NEXT+FEXT and IDDXT_2NEXT

Test Conditions	Performance Requirement
The integration shall be done for each NEXT and FEXT between USB SuperSpeed pairs.	• Type-C to Type-C: IDDXT_1NEXT+FEXT ≤ -34.5 dB IDDXT_2NEXT ≤ -33 dB For all SuperSpeed pairs.

2.7 Integrated Differential Crosstalk D+/D- pairs: IDDXT

Test Conditions	Performance Requirement
The integration shall be done for each NEXT and FEXT between USB HighSpeed pairs.	• Type-C to Legacy Adapter: ≤ -23 dB

2.8 Integrated Return Loss: IRL

Test Conditions	Performance Requirement
The integrated return loss manages the reflection between the cable assembly and the rest of the system (host and device).	The IRL limit is specified as a function of ILfitatNq : • Type-C to Type-C: IRL ≤ 0.046*ILfitatNq^2+1.812*ILfitat Nq-10.784 in dB. • Type-C to Legacy: IRL ≤ 0.046*ILfitatNq^2+1.812*ILfitat Nq-9.784 in dB. • Type-C to Legacy Adaptor: IRL ≤ -14.5 dB for Tb=200 ps and ≤ -12 dB for Tb=100 ps.

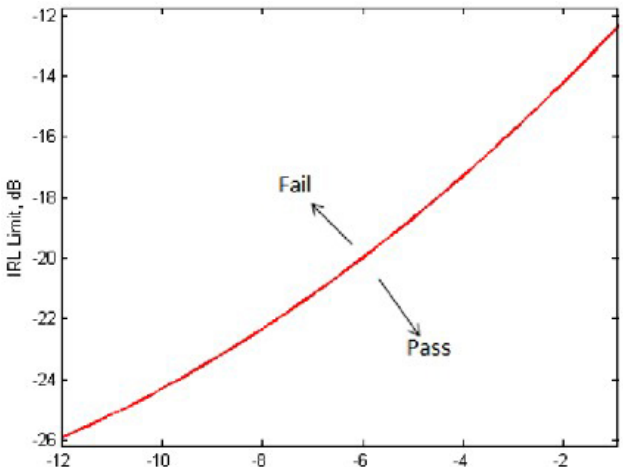

figure 4: IRL Limit at Function of ILfitNq

2.9 Differential-to-Common Mode Conversion (SCD12/SCD21)

Test Conditions	Performance Requirement
Normalized with mated connector 85±9 Ω and raw cable 90±5 Ω differential impedance.	• Type-C to Type-C: SCD12 ≤ -20 dB from 100 MHz to 10 GHz • Type-C to Legacy: SCD12 ≤ -20 dB from 100 MHz to 10 GHz • Type-C to Legacy Adaptor: SCD12 ≤ -15 dB from 100 MHz to 7.5 GHz

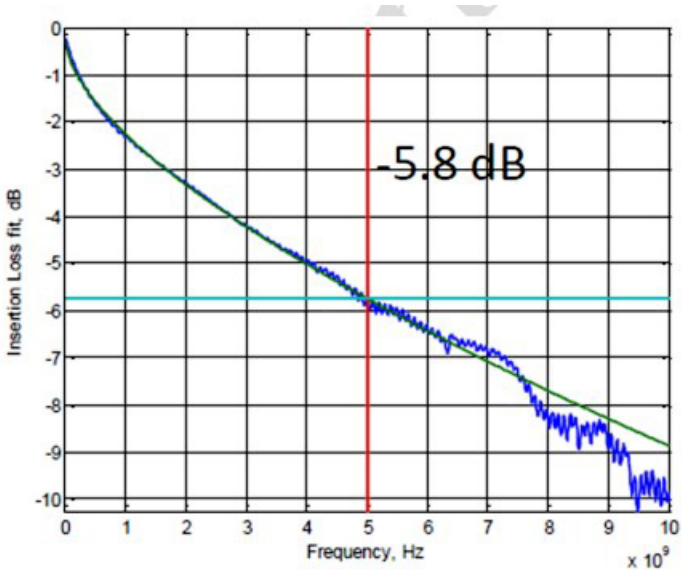

figure 5: Differential-to-Common Mode Conversion Requirement

2.10 D+/D- Pair Attenuation

Test Conditions	Performance Requirement
EIA 364-101 The measured frequency range should be from 50 MHz to 400 MHz with a frequency step of 10 MHz.	• Type-C to Type-C: ≥ -1.02 dB at 50 MHz ≥ -1.43 dB at 100 MHz ≥ -2.4 dB at 200 MHz ≥ -4.35 dB at 400 MHz • Type-C to Legacy: ≥ -1.02 dB at 50 MHz ≥ -1.43 dB at 100 MHz ≥ -2.4 dB at 200 MHz ≥ -4.35 dB at 400 MHz • Type-C to Legacy Adaptor: ≥ -0.7 dB at 400 MHz

2.11 D+/D- Pair Differential Impedance

Test Conditions	Performance Requirement
The D+/D- pair impedance is measured at the rise time to be 400 ps (20%-80%) entering the reference plane.	75 Ω to 105 Ω

2.12 D+/D- Pair Propagation Delay

Test Conditions	Performance Requirement
EIA 364-103 The D+/D- pair propagation delay is measured at the rise time to be 400 ps (20%-80%) entering the reference plane. The propagation delay is measured at the 50% voltage crossing of the received step response.	• Type-C to Type-C: 20 ns max

2.13 D+/D- Intra-Pair Skew

Test Conditions	Performance Requirement
EIA 364-103 The D+/D- pair propagation delay is measured at the rise time to be 400 ps (20%-80%) entering the reference plane. The intra-pair skew is measured at the 50% voltage crossing of the received step response.	• Type-C to Type-C: 100 ps max • Type-C to Legacy: 100 ps max • Type-C to Legacy Adaptor: 20 ps max

2.14 Coupling between CC and differential USB D+/D-

Test Conditions	Performance Requirement
EIA 364-90 The frequency range is from 300 KHz to 100 MHz. All the measured S-parameters are single-ended with a 50 Ω reference impedance.	• Type-C to Type-C: ≤ -60.5 dB at 0.3 MHz ≤ -50 dB at 1 MHz ≤ -26 dB at 16 MHz ≤ -26 dB at 100 MHz

2.15 Coupling between VBUS and differential USB D+/D-

Test Conditions	Performance Requirement
EIA 364-90 The frequency range is from 300 KHz to 100 MHz. All the measured S-parameters are single-ended with a 50 Ω reference impedance.	• Type-C to Type-C: ≤ -40 dB for 0.3 MHz < f ≤ 30 MHz, and ≤ 19.12 log10(f/30)-40 (in dB) for 30 MHz <f ≤ 100 MHz

2.16 Single ended Coupling between SBU_A and CC,SBU_B and CC

Test Conditions	Performance Requirement
EIA 364-90 The frequency range is from 300 KHz to 100 MHz. All the measured S-parameters are single-ended with a 50 Ω reference impedance.	• Type-C to Type-C: ≤ -65 dB at 0.3 MHz ≤ -55 dB at 1 MHz ≤ -30 dB at 18 MHz ≤ -30 dB at 100 MHz

2.17 Single-ended Coupling between CC and D-

Test Conditions	Performance Requirement
EIA 364-90 The frequency range is from 300 KHz to 100 MHz. All the measured S-parameters are single-ended with a 50 Ω reference impedance.	• For USB 2.0 Type-C to Type-C: ≤ -65 dB at 0.3 MHz ≤ -55 dB at 1 MHz ≤ -30 dB at 18 MHz ≤ -30 dB at 100 MHz • For USB Full-Featured Type-C to Type-C ≤ -58 dB at 0.3 MHz ≤ -27.5 dB at 10 MHz ≤ -26 dB at 11.8 MHz ≤ -26 dB at 100 MHz

2.18 Single-ended Coupling between SBU_A and SBU_B

Test Conditions	Performance Requirement
EIA 364-90 The frequency range is from 300 KHz to 100 MHz. All the measured S-parameters are single-ended with a 50 Ω reference impedance.	• For Type-C to Type-C: ≤ -56.5 dB at 0.3 MHz ≤ -46 dB at 1 MHz ≤ -26 dB at 10 MHz ≤ -25 dB at 11.2 MHz ≤ -25 dB at 100 MHz

2.19 Coupling between SBU_A / SBU_B and differential USB D+/D-

Test Conditions	Performance Requirement
EIA 364-90 The frequency range is from 300 KHz to 100 MHz. All the measured S-parameters are single-ended with a 50 Ω reference impedance.	• For Type-C to Type-C: ≤ -80 dB at 0.3 MHz ≤ -40 dB at 30 MHz ≤ -40 dB at 100 MHz

2.20 Voltage Drop Test

Test Conditions	Performance Requirement
The maximum rated VBUS current of the cable assembly shall be used. The measurement includes receptacles at both ends of the cable assembly, mounted on test fixtures.	250 mV max for GND and 500 mV max for VBUS.

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