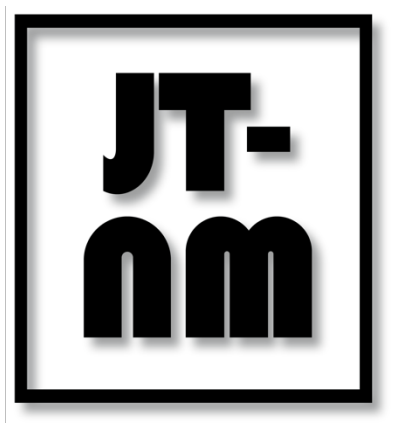




**JT-NM Tested Event
IP Showcase
IBC2019**





“JT-NM Tested Program August 2019” SMPTE ST 2110 Test Plan v.1.3

Changelog to v. 1.2

Post-testing editorial update

- **Tests 2.5, 2.6** - editorial change
- **Tests 2.3, 2.4** were not performed

Changelog to v. 1.1

- **Grouping of the tests by application** - section removed (grouping will be done in the results spreadsheet)
- **General statements and terms** - amended

Changelog to v. 1.0

- **Test 6.2** - amended
- **Test 7.3** - amended

Changelog to “JT-NM Tested March 2019 Program” Test Plan v. 1.3

- **Abstract and motivation behind the program** - Updated
- **PTP configuration used during the event** - Updated
- **Grouping of the tests by application** - section added
- **Tests 1.1 and 1.2** - DHCP testing added
- **Test 3.2** - IS-04 is added
- **Section 4_TX** - UHD added, video formats changed to European (50 Hz)
- **Section 4_RX** - UHD added, video formats changed to European (50 Hz)
- **Test 4.4** - amended
- **Test 5.3** - amended
- **Section 7** - amended



Abstract and motivation behind the program

JT-NM Tested Program returns to the IP Showcase. The JT-NM continues to partner with vendors and users to provide information that aids the transition to IP. As the industry’s use of IP matures, the JT-NM Tested program offers prospective purchasers of IP based equipment greater, more documented insight into how vendor equipment conforms to the SMPTE standards and AMWA NMOS specifications.

Sponsored by the JT-NM and administered by the EBU and IRT, two top European technical bodies, vendors who submit equipment for evaluation will have the opportunity to list that equipment in a JT-NM Tested catalog which will be made publicly available at the IP Showcase booth and on-line. This catalog will provide transparency, describing the test criteria and testing methodology, as well as the hardware and software versions of the products that were tested. This program is not a certification program; rather it is a snapshot in time of how vendor equipment conforms to key parts of SMPTE standards and AMWA NMOS specifications, providing prospective purchasers and users with a reference as they begin their equipment evaluation and qualification process.

Because this is a partnership between the JT-NM and the industry, and because this is a voluntary program, vendors will have the opportunity to decline to have the results for a specific device made public, and/or they may choose to withdraw from the program entirely after seeing test results. Should a company choose to withdraw a product, or should that company decide to withdraw from the testing program completely, JT-NM will not disclose those corresponding results, and participating companies will be legally required to keep the results of other participants confidential.

Acknowledgement

This Test Plan was prepared by an expert group within the Joint Task Force on Networked Media (JT-NM) with key contributions from: Alun Fryer (Ross Video), Andrew Bonney (BBC R&D), Andy Rayner (Nevion), Bill McLaughlin (EEG), Felix Oberhardt (IRT), Ievgen Kostiukevych (EBU), Jack Douglass (PacketStorm Communications, Inc.), Jean Lapierre (Matrox), John Mailhot (Imagine Communications), Leigh Whitcomb (Imagine Communications), Mike Overton (Tektronix/Telestream), Mike Waidson (Tektronix/Telestream), Pedro Ferreira (Bisect), Peter Brightwell (BBC R&D), Robert Welch (Arista Networks), Serge Grondin (Grass Valley), Sonja Langhans (IRT), Thomas Kernen (Mellanox Technologies) and Willem Vermost (EBU).

Applicable Standards and versions

- **SMPTE ST 2059-1:2015** Generation and Alignment of Interface Signals to the SMPTE Epoch
- **SMPTE ST 2059-2:2015** SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications
- **SMPTE ST 2110-10:2017** Professional Media over Managed IP Networks: System Timing and Definitions
- **SMPTE ST 2110-20:2017** Professional Media over Managed IP Networks: Uncompressed Active Video



- **SMPTE ST 2110-21:2017** Professional Media over Managed IP Networks: Traffic Shaping and Delivery Timing for Video
- **SMPTE ST 2110-30:2017** Professional Media over Managed IP Networks: PCM Digital Audio
- **SMPTE ST 2110-40:2018** Professional Media over Managed IP Networks: SMPTE ST 291-1 Ancillary Data
- **SMPTE ST 2022-7:2019** - SMPTE Standard - Seamless Protection Switching of SMPTE ST 2022 IP Datagrams
- Internet Engineering Task Force (IETF) **RFC 3376** Internet Group Management Protocol, Version 3 <https://www.ietf.org/rfc/rfc3376.txt>
- **JT-NM TR-1001-1:2018** http://www.jt-nm.org/documents/JT-NM_TR-1001-1:2018_v1.0.pdf

Equipment used during testing

The following equipment was selected by the JT-NM Test Experts Group to support the “JT-NM Tested” event. In a number of cases, other vendor’s equipment would have worked equally well. To preserve the integrity of the testing environment, the team needed to choose one set of support equipment. The listing of a company below should not be taken to indicate that this is the only equipment that could have performed the tasks required. Note also that support equipment was *not* “JT-NM Tested” unless it is specifically listed in the test results matrix, and that no special status is awarded by the JT-NM to these companies other than to note that the JT-NM appreciates their support.

Test and measurement equipment and software used during the event

- BridgeTech VB440
 - <https://bridgetech.tv/vb440/>
- EBU Live IP Software Toolkit (EBU LIST)
 - <http://list.ebu.io>
 - <https://github.com/ebu/pi-list>
- Meinberg PTP Track Hound
 - <https://www.ptptrackhound.com/>
- Packetstorm CRS, Network Emulator (6XG / 8XG), VIP
 - <https://packetstorm.com/packetstorm-products/>
- SDPoker
 - <https://github.com/Streampunk/sdpoker>
- Tektronix PRISM
 - <https://www.tek.com/prism-media-monitoring-and-analysis-platform>
- Wireshark (with ST 2110 dissectors)
 - <https://github.com/FOXNEOAdvancedTechnology>



Reference senders and receivers used during the event

- DirectOut MONTONE.42
 - <https://www.directout.eu/en/products/montone42/>
- Imagine Communications SNP
 - <https://www.imaginecommunications.com/products/networking-infrastructure/processing/selenio-network-processor>
- Nevia Virtuoso
 - <https://nevia.com/products/nevia-virtuoso/>
- EEG HD492 iCap™ Encoder with Alta™ IP Video Caption Encoder
 - <https://eegent.com/products/UZNIZP3RN7GLM2GC/hd492-icapTM-encoder>
 - <https://eegent.com/products/X6KO3ARIL9X1VEIU/altaTM-ip-video-caption-encoder>
- Matrox X.mio3 IP
 - https://www.matrox.com/video/en/products/developer/hardware/xmio3_ip/
- SDI source(s), SDI monitor(s), SDI DA(s), SDI router(s), audio source(s), audio monitor(s)
TBA

Network switches used during the event

- Arista 7060CX2-32 (EOS Version 4.21.4F)
 - https://www.arista.com/assets/data/pdf/Datasheets/7060X_7260X_DS.pdf
- Arista 7280SR48-YC6 (EOS Version 4.21.4F)
 - <https://www.arista.com/assets/data/pdf/Datasheets/7280R-DataSheet.pdf>
- Arista 7280SR2-48YC6 (EOS Version 4.21.4F)
 - <https://www.arista.com/assets/data/pdf/Datasheets/7280R-DataSheet.pdf>
- Arista 7020TR-48 (EOS Version 4.21.4F)
 - https://www.arista.com/assets/data/pdf/Datasheets/7020R-48_Datasheet.pdf

PTP configuration used during the event

The PTP Grandmaster(s) used during the event - Tektronix **SPG8000A**.

The network switches will be configured in a **Boundary Clock** mode.

Multicast communication mode for all messages will be used (except for management TLV responses).

The PTP profile details will be provided at the time of testing. The parameters provided will be within the values allowed by SMPTE ST 2059-2:2015.



General statements and terms

- When validating the Device Under Test (DuT) against other reference senders and/or receivers, in case of the suspected possibility of a test failure by DuT - multiple tries with different reference devices and with various test and measurement equipment will be attempted before making final conclusions. However, the ability of the team to retest will be limited due to time and resource constraints.
- The execution of the tests will be done with common sense in mind. Ambiguities will be addressed by the test team on a case-by-case basis.
- If the DuT fails any particular test, a Vendor representative will be given an opportunity to explain and discuss the results.
- Vendor representatives will be given the configuration parameters sets at the time of testing.
- Vendor representatives will be expected to configure their equipment themselves.
- An example of IPv4 and PTP configuration that will be given to Vendors on a per-device basis may be provided.
- RTP payload type IDs will be pre-defined and communicated.
- Standard MTU size (1500 octets) will always be expected.
- General Packing Mode (GPM) will be used and expected.
- All baseband signals and/or files required for the testing will be provided.
- Vendors may not change software/firmware once testing has commenced but may adjust settings on their products as necessary during the testing process.
- The Test Plan team reserves the right to update the "JT-NM Tested Program" Test Plan as required.

Description of the tests

1. General Network Interface Tests

Description: This set of Tests is expected to validate the general network-related functionality of a media device.

First steps:

At the time of testing, Testers will provide the Vendor representative with a set of parameters consisting of:

- A unicast host IPv4 address
- A subnet mask from the range from /8 to /30
- A default gateway IPv4 address

Sets of parameters will be provided for essence interface(s) and for management interface(s) (if an out-of-band management interface is present for the DuT). The Vendor representative will be expected to configure the DuT with the given sets of parameters. If the DuT has no out-of-band management interface(s) and uses inband management via essence interface(s), only a set of parameters for essence interface(s) will be provided and the test 1.1. will be skipped.



1.1. Management Network Interface Test*

*Only applied to devices with out-of-band management interface(s). DHCP variant of this test is part of NMOS/TR-1001-1 testing. If a device does not provide means to display the management IP address assigned by the DHCP - it may be assigned a static address.

Description: Tests the ability of DuT to receive the IPv4 address, subnet mask, and default gateway parameters for a management interface via DHCP. Also tests blocking of ICMP messages and TTL values of ICMP replies. The DuT will be pinged from a host in another subnet. DuT is expected to reply to ICMP echo requests (ping) coming from another subnet, while properly utilising a default gateway, and with TTL > 16. This test will not involve a VLAN change and/or IP address change, a demonstration of basic configurability will suffice. Manual configurability of these parameters will also be expected. If the DuT does not support DHCP, or does not participate in the NMOS/TR-1001-1 testing, only the manual configurability of these parameters will be expected. The ICMP ping test will be done twice with 2 payloads: 32 and 56 bytes, the DuT is expected to properly reply to both.

Validation method: Console log from a device sending ICMP echo requests is used for validation.

Pass criteria:

- The DuT assumes the parameters assigned via DHCP (if tested), or manually, can be pinged from a host on another subnet. The TTL value of ICMP echo reply to both payload sizes is > 16.

No pass criteria:

- The DuT does not assume the parameters assigned via DHCP (if tested), or manually, or cannot be pinged from a host on another subnet with one or both payload sizes.

1.2. Media Network Interface(s) Test*

* DHCP variant of this test is part of NMOS/TR-1001-1 testing. If a device has inbound management and does not provide means to display the management IP address assigned by the DHCP - it may be assigned a static address.

Description: Tests the ability of DuT to receive the IPv4 address, subnet mask, and default gateway parameters for a media interface(s) via DHCP. Also tests blocking of ICMP messages and TTL values of ICMP replies. The DuT will be pinged from a host in another subnet. DuT is expected to reply to ICMP echo requests (ping) coming from another subnet, while properly utilising a default gateway, and with TTL > 16. This test will not involve a VLAN change and/or IP address change, a demonstration of basic configurability will suffice. Manual configurability of these parameters will also be expected. If the DuT does not support DHCP, or does not participate in the NMOS/TR-1001-1 testing, only the manual configurability of these parameters will be expected.

If a device has ST 2022-7 multiport capabilities - both ports will be tested. The ICMP ping test will be done twice with 2 payloads: 32 and 56 bytes, the DuT is expected to properly reply to both.

Validation method: Console log from a device sending ICMP echo requests is used for validation.

Pass criteria:

- The DuT assumes the parameters assigned via DHCP (if tested), or manually, can be pinged from a host on another subnet. The TTL value of ICMP echo to both payload sizes reply is > 16.

No pass criteria:



- The DuT does not assume the parameters assigned via DHCP (if tested), or manually, or cannot be pinged from a host on another subnet with one or both payload sizes.

2. Media Network Related Tests

Description: This set of Tests validates the basic behavior of the DuT related to PTP synchronization and multicast addressing capabilities.

First steps:

At the time of testing, Testers will provide to the Vendor representative sets of parameters consisting of:

- A PTP profile compliant to SMPTE 2059-2:2015. Any parameter values allowed by the profile may be used.
- A set of multicast addresses.
- Source-specific multicast (SSM) will not be tested.

The Vendor representative will be expected to configure the DuT with the given sets of parameters.

2.1. Basic PTP Configuration Test

Description: The Test validates the basic PTP behavior of the DuT in slave only mode (defaultDS.slaveOnly set to TRUE). A set of PTP-related tests will be executed to test:

- The DuT that has a dedicated network port for PTP (not management and not an essence port) will be expected to expose the IP address configurability as per test 1.2.
- The ability of the DuT to lock to the (Grand)master with freely assignable PTP Domain number and follow the parameters of the PTP profile communicated by a Grandmaster and Master port to which the DuT is connected to: The PTP profile values may be modified in a (Grand)master, the DuT will be expected to re-lock to it. **Validation method:** DuT visual reporting of PTP lock status, a PTP log of the DuT, and/or Wireshark/PTP Track Hound analysis.
- The ability of the DuT to be set in a slave-only mode: the DuT is expected not to assume a (Grand)master role even if there is no (Grand)master present. **Validation method:** by changing the PTP domain setting on the DuT, the flow of valid PTP announce messages is interrupted, DuT visual reporting of PTP lock status, a PTP log of the DuT, or a Wireshark/PTP Track Hound analysis of a PTP communication from a mirrored port of the switch connected to the DuT is used to analyze the behavior of the DuT.
- The ability of the DuT to maintain proper PTP communication according to the parameters communicated by a (Grand)master: the DuT is expected to keep stable lock to PTP and maintain the messages rate communicated by a (Grand)master. **Validation method:** DuT visual reporting of PTP lock status, or a PTP log of the DuT, a Wireshark/PTP Track Hound analysis of a PTP communication from a mirrored port of the switch connected to the DuT.
- The ability of the DuT not to reply to TLV management messages with multicast acknowledgment. **Validation method:** The PTP Grandmaster will be using the defined PTP profile as per SMPTE ST 2059-2 and will be sending the SMPTE TLV management messages once per second. Wireshark will be used to monitor from a mirrored port of the



switch connected to the DuT and to verify that the BC is sending the TLV to the DuT and that the DuT, while being locked to PTP, is not responding inappropriately.

Pass criteria:

- The DuT’s dedicated PTP port* can be pinged from a host on another subnet. The TTL value of ICMP echo reply is > 16.
*Only applicable to DuT that has a dedicated PTP port
- It is possible to freely assign PTP domain parameters into DuT.
- The DuT can lock to the (Grand)master, can maintain a stable lock and maintains PTP communication according to the parameters communicated by a (Grand)master.
- The DuT does not assume a master role if there is no (Grand)master present.
- The DuT does not reply to TLV management messages with multicast acknowledgment.

No pass criteria:

- The DuT’s dedicated PTP port* cannot be pinged from a host on another subnet.
*Only applicable to DuT that has a dedicated PTP port
- It is not possible to freely assign PTP domain parameters into DuT.
- The DuT cannot lock to the (Grand)master, cannot maintain a stable lock or does not maintain PTP communication according to the parameters communicated by a Grandmaster.
- The DuT assumes a (Grand)master role if there is no (Grand)master present.
- The DuT replies to TLV management messages with multicast acknowledgment.

2.2. Manual PTP Configurability Test*

*As this test may be disruptive and/or may require significant network changes, it may be postponed and performed after the rest of the tests are executed. Given the time and resources limitations, this test may be dropped.

Description: The Test validates the manual PTP configurability of the DuT, with a slave only mode enabled or disabled (defaultDS.slaveOnly set to TRUE, or FALSE). A multicast and/or a hybrid (also referred to as mixed mode) without negotiation communication modes will be tested. A set of PTP-related tests will be executed to test:

- The DuT that has a dedicated network port for PTP (not management and not an essence port) will be expected to expose the IP address configurability as per test 1.2.
- The ability to freely set PTP profile parameters, including PTP domain number, sync and announce message intervals, timeout intervals, delay request/response rates, priorities 1 and 2 and a communication mode in the DuT: a Vendor representative will be expected to set a given set of PTP parameters into DuT. **Validation method:** DuT visual reporting of PTP lock status, a PTP log of the DuT, and/or Wireshark/PTP Track Hound analysis.
- The ability of the DuT to maintain proper PTP communication according to the parameters set: the DuT is expected to remain locked according to the given PTP profile parameters and to send the number of delay requests that matches its configured value. **Validation method:** DuT visual reporting of PTP lock status, or a PTP log of the DuT, a Wireshark/PTP Track Hound analysis of a PTP communication from a mirrored port of the switch connected to the DuT.

Pass criteria:

- The DuT’s dedicated PTP port* can be pinged from a host on another subnet. The TTL value of ICMP echo reply is > 16.



*Only applicable to DuT that has a dedicated PTP port

- It is possible to freely setup PTP profile parameters into DuT.
- The DuT can lock to the (Grand)master, can maintain stable lock and maintains PTP communication according to the parameters set.

No pass criteria:

- The DuT’s dedicated PTP port* cannot be pinged from a host on another subnet.
*Only applicable to DuT that has a dedicated PTP port
- It is not possible to freely assign PTP profile parameters into DuT.
- The DuT cannot lock to (Grand)master, cannot maintain stable lock and does not maintain PTP communication according to the parameters set..

2.3. BMCA Master/Slave test*

*This test is applicable to devices capable of assuming a PTP master role.

As this test may be disruptive and/or may require significant network changes, it may be postponed and performed after the rest of the tests are executed. Given the time and resources limitations, this test may be dropped.

Description: The Test validates the PTP behavior of the DuT with a slave only mode disabled (defaultDS.slaveOnly not set to TRUE): The DuT is expected to follow a BMCA process and assume appropriate Master/Slave role. A PTP domain of the DuT is changed and/or priorities 1 and 2 of the (Grand)master and the DuT are changed to trigger the BMCA process. **Validation mode:** DuT visual reporting of PTP lock status, or a PTP log of the DuT, and/or Wireshark/PTP Track Hound analysis of a PTP communication from a mirrored port of the switch connected to the DuT.

Pass criteria: DuT properly follows a BMCA process and assume appropriate Master/Slave role.

No Pass criteria: DuT does not properly follow a BMCA process and/or does not assume appropriate Master/Slave role.

2.4. One step/two step Master lock test*

*As this test may be disruptive and/or may require significant network changes, it may be postponed and performed after the rest of the tests are executed. Given the time and resources limitations, this test may be dropped.

Description: The Test validates the one step / two step behavior of the DuT.

- The ability of the DuT to lock to the one-step and the two-step (Grand)master: a PTP (Grand)master and/or a switch in BC mode (running as a Master port) will be switched to one-step or two-step clock mode. The DuT is expected to be able to lock to it in both scenarios. **Validation method:** DuT visual reporting of PTP lock status, a PTP log of the DuT, and/or Wireshark/PTP Track Hound analysis.

Pass criteria:

- The DuT can lock to a one-step and two-step (Grand)master.

No Pass criteria:

- The DuT cannot lock to the one-step and two-step (Grand)master.



2.5. Basic Multicast Configuration Test

Description: The Test validates the basic configurability of source and destination multicast IPv4 addresses of the DuT. An ability to independently configure a given set of source and destination multicast IPv4 addresses randomly picked in the 239.0.0.0/8 range is expected. If a device is a sender only (a receiver only), the configuration of a destination (source) multicast IPv4 address only will be expected. This test counts towards NMOS/TR-1001-1 testing, since 239.0.0.0/8 range is mandated in TR-1001-1.

Validation method: Visible acknowledgment of parameters by the DuT without errors.

Pass criteria:

- The DuT allows independent configuration of source and destination multicast addresses* randomly picked as defined in the description.
*If a device is a sender only (a receiver only), the configuration of a destination (source) multicast IPv4 address only will be expected

No pass criteria:

- The DuT does not allow independent configuration of source and destination multicast addresses* randomly picked as defined in the description.
*If a device is a sender only (a receiver only), the configuration of a destination (source) multicast IPv4 address only will be expected

2.6. Extended Multicast Range Configurability Test

Description: The Test validates advanced configurability of source and destination multicast IPv4 addresses of the DuT. An ability to independently configure a given set of randomly picked source and destination multicast IP addresses is checked. The given multicast address will not be in the ranges "224.0.0.0 to 224.0.0.255" and "224.0.1.0 to 224.0.1.255". If a device is a sender only (a receiver only), the configuration of a destination (source) multicast IPv4 address only will be expected.

Validation method: visible acknowledgment of parameters by the DuT without errors.

Pass criteria:

- The DuT allows independent configuration of source and destination multicast addresses* randomly picked as defined in the description.
*If a device is a sender only (a receiver only), the configuration of a destination (source) multicast IPv4 address only will be expected

No pass criteria:

- The DuT does not allow independent configuration of source and destination multicast addresses* randomly picked as defined in the description.
*If a device is a sender only (a receiver only), the configuration of a destination (source) multicast IPv4 address only will be expected

3. ST 2110-10 Tests

Description: This set of Tests validate the basic DuT's conformance to SMPTE ST 2110-10.



First steps: For DuT with receiving capabilities: the Vendor representative is provided with a multicast IPv4 address with an active stream (audio/video depending on DuT capabilities) that is present and active in the network and requested to receive this stream. For DuT with sending capabilities: an SDP verification is done. Ability to decode a stream and/or produce a valid stream is neither verified nor expected at this stage.

3.1. IGMPv3 test for a receiver

Description: The Vendor representative is requested to have their DuT join a given multicast group. IGMPv3 communication is expected between the DuT and a switch. Use of Source-Specific Multicast is not expected. **Validation method:** IGMP communication is monitored with Wireshark from a mirrored port of the switch connected to the DuT.

Pass criteria:

- The DuT maintains IGMPv3 communication with a switch.

No pass criteria:

- The DuT uses another version of IGMP.

3.2. SDP verification for a sender

Description: The Vendor is expected to demonstrate that the DuT has a user-accessible way to expose a valid SDP. This test is performed alongside tests 4_TX, 5_TX and 6_TX. The SDP is checked for the respected essence type (-20, -30 and/or -40) when a stream is initiated. If an SDP is exposed via NMOS IS-04 - this will be accounted towards the NMOS/TR-1001-1 testing.

Validation method: an exposed SDP is checked with SDPoker and/or manually.

Pass criteria:

- The DuT exposes a user-accessible and valid SDP.

No pass criteria:

- The Vendor representative is not able to demonstrate that the DuT supports user-accessible SDP data, or SDP is not valid.

4_TX. ST 2110-20 Tx tests*

*Applicable only to DuT with video transmitting capabilities

Description: This set of tests validate the basic DuT's conformance to SMPTE ST 2110-20.

First steps: The Vendor representative will be provided with a multicast IPv4 address, a port number, and video format parameters (1080i50 and/or 1080p50). DuT is expected to be able to initiate a stream with given parameters. Standard MTU size will always be expected. A separate testing of UHD capabilities (2160p50) will be executed. It will be reflected accordingly in the results spreadsheet (e.g. 4.2-UHD).



4.1. Stream basic test Tx

Description: The Vendor representative is expected to configure the DuT so that it initiates a stream of a given configuration with the given multicast address and port number. Packets of the stream are expected to have a valid source and destination MAC and IPv4 addresses.

Validation method: Stream is analyzed in real time (and/or captured and analyzed offline) via IGMP join and/or from a mirrored port of the switch connected to the DuT. Source and destination MAC and IPv4 address are validated either by a test and measurement equipment or manually using Wireshark.

Pass criteria:

- DuT is capable of initiating a stream with given IPv4 address parameters, and video format parameters.
- Stream uses a valid multicast MAC address.

No pass criteria:

- DuT is not capable of initiating a stream with given IPv4 address parameters, and video format parameters.
- Stream uses an invalid multicast MAC address.

4.2. Stream visual validation Tx

Description: A stream initiated during test 4.1. is received with a reference receiver. A basic subjective visual test is done. The stream is expected to have no obvious visual artifacts of digital nature.

Validation method: A stream is visualized using a reference receiver. If a reference receiver is not capable of decoding the stream - a test and measurement device is used to analyze the stream. The stream will be observed for ~60 seconds.

Pass criteria:

- The stream can be received and decoded by a reference receiver and/or a majority of the test equipment. The video signal is free from artifacts of a digital nature.

No pass criteria:

- The stream cannot be decoded. A Vendor representative will have an opportunity to articulate why this might be ok.

4.3. ST2110-21 profile sender compliance test Tx

Description: A stream generated during test 4.1. is expected to be compliant to SMPTE ST 2110-21 with either N, NL or W profile. A stream will be analyzed with a test and measurement device to validate conformance.

Validation Method: The generated essence stream will be analyzed for good behavior according to the network compatibility model and the virtual receive buffer model. The stream will be analyzed online. It can also be analyzed offline with a network capture. If the SDP file includes the announcement of the Media Type Parameter `TROFFSET`, it will be considered in the VRX results analysis.



Maximum allowable C_{full} and VRX_{full} :

V	H	T	Color	bit	C_{full} N	C_{full} W	VRX_{full} N	VRX_{full} W
1280	720	50	4:2:2	8	4	16	8	720
1280	720	60	4:2:2	8	4	16	8	720
1280	720	50	4:2:2	10	4	16	8	720
1280	720	60	4:2:2	10	4	16	8	720
1920	1080	25	4:2:2	10	4	16	8	720
1920	1080	50	4:2:2	10	4	16	8	720
1920	1080	60	4:2:2	10	5	16	8	726
1920	1080	50	4:2:2	12	5	16	8	726
3840	2160	50	4:2:2	10	17	33	26	2420
3840	2160	60	4:2:2	10	21	40	32	2904
3840	2160	120	4:2:2	10	42	80	64	5808
3840	2160	120	4:4:4	12	75	145	116	10455
3840	2160	120	4:4:4	16	100	193	154	13940

Table 1 - Informative SMPTE ST 2110-21:2017- Jan 25th 2019

Pass criteria:

- The test passes if the maximum level of the network compatibility model does not exceed the maximum as described in the standard for the given type of sender (N, NL, W), the maximum level of the virtual receive buffer does not exceed the value described in the standard and the virtual receive buffer does not underrun.



No pass criteria:

- The measured value exceeds the defined maximum or the virtual receive buffer underruns or If the arrival time of the first packet for each frame or field is drifting (this indicates the sender may not be locked to PTP).

4.4. RTP-Timestamp-Test

Description: A stream initiated during test 4.1. is expected to have a media clock to RTP clock offset equal zero ($a=mediaclock:direct=0$), The relation between the instantaneous RTP timestamp and PTP is expected to remain stable with time.

Validation Method: The instantaneous value of the RTP timestamp is analyzed by a test and measurement device and is related to the current PTP time. The instantaneous value of the RTP timestamp is expected not to be in the future, not to be more than 1 ms in the past (unless there is a clear justification for it to be off, e.g frame synchronization). It is assumed that a stream is originated in the DuT and is not being "processed". Therefore the question of re-timestamping is not considered.

Pass criteria:

- The instantaneous value of the RTP timestamp of the stream is not in the future, not more than 1 ms in the past (unless justified), and preserves a stable relation to the PTP (should not "drift").

No pass criteria:

- The instantaneous value of the RTP timestamp of the stream is in the future, more than 1 ms in the past (unless justified), or "drifts".

4_RX. ST 2110-20 Rx tests*

*Applicable only to DuT with video receiving capabilities

Description: This set of Tests validate basic video receiving capabilities of the DuT.

First steps: The Vendor representative is given a multicast source IPv4 address(es), port number, and video format (1080i50 and/or 1080p50). The streams will be generated by the reference sender. Standard MTU size will always be used. The stream will be a Narrow Gapped stream. A separate testing of UHD capabilities (2160p50) will be executed. It will be reflected accordingly in the results spreadsheet (e.g. 4.6-UHD).

4.5. ST 2110-21 profile receiver compliance test Rx

Description: The Vendor representative is expected to set up the DuT to join a multicast group provided at the time of the test, in order to receive a stream generated by a reference sender.

Validation Method: The reference stream can be received by the DuT. At this given time the reference stream will be of the type: Narrow. Receivers of any type should be able to receive this reference stream.

Pass criteria: The DuT passes the test if it is able to receive and display the stream. Devices which are not intended to display the stream will be allowed to suggest appropriate alternative criteria



No pass criteria: The DuT fails the test if it is not able to receive and display the stream, or suggest an appropriate alternative.

4.6. Stream visual validation Rx

Description: the DuT is expected to be able to receive and to decode reference stream(s). A basic subjective visual test is done. The stream is expected to have no obvious visual artifacts of digital nature.

Validation method: A stream is visualized using the DuT. If the DuT is not capable of reproducing the stream, it is allowed to loopback the stream back into the network and the visual test is done on a reference device. The stream will be observed for 1 minute.

Pass criteria:

- The DuT is capable of receiving a stream according to its capabilities
- The stream can be decoded by the DuT. The video signal is free from artifacts of a digital nature.
- If the stream is looped back into the network - the looped stream can be decoded by a reference receiver. The video signal is free from artifacts of a digital nature.

No pass criteria:

- The stream cannot be decoded or shows visible artifacts. A Vendor representative will have an opportunity to articulate why this might be ok.

5_TX. ST 2110-30 Tx tests*

Description: This set of Tests validate basic audio transmitting capabilities of DuT.

First steps: The Vendor representative is given a multicast destination IPv4 address(es)**, port number, channel configuration**, and audio packetization parameters (packet time)**. The bit depth of the stream is always expected to be 24 bit. Standard MTU size will always be expected.

*Applicable only to DuT with audio transmitting capabilities

**Depending on DuT capabilities (e.g. if a device supports the transmission of up to 64 channels with 1ms or 125 us packet time - a random number, but not more than 64, of channels with either 1ms or 125 us packet time may be selected to be tested.

5.1. Stream - Basic Test

Description: The Vendor representative is expected to configure the DuT such that it initiates a stream of a given configuration and to a given multicast address and port number. Packets of the stream are expected to have a valid source and destination MAC and IPv4 addresses.

Validation method: stream is analyzed in real time (and/or captured and analyzed offline) from a mirrored port of the switch connected to the DuT. Source and destination MAC and IPv4 address are validated either by a test and measurement equipment or manually using Wireshark.

Pass criteria:

- DuT is capable of initiating a stream with given IPv4 address parameters, channel configuration, and audio packetization parameters.



- Stream uses a valid multicast MAC address.

No pass criteria:

- DuT is not capable of initiating a stream with given IP address parameters, channel configuration, and audio packetization parameters.
- Stream uses an invalid multicast MAC address.

5.2. Stream - audible Validation Tx

Description: A stream initiated during test 5.1. is received with a reference receiver. A basic subjective audition test is done. The stream is expected to have no obvious audible artifacts of digital nature (pops, clicks, distortion).

Validation method: A stream is auditioned using headphones connected to a reference receiver for ~60 seconds. If a reference receiver is not capable of decoding the stream - a test and measurement device is used to analyze the stream.

Pass criteria:

- The stream can be received and decoded by a reference receiver and/or a majority of the test equipment. The audio signal is free from artifacts of a digital nature.

No pass criteria:

- The stream cannot be decoded. A Vendor representative will have an opportunity to articulate why this might be ok.

5.3. RTP-Timestamp-test

Description: A stream initiated during test 5.1. is expected to have a media clock to RTP clock offset equal zero ($a=mediack:direct=0$), The relation between the instantaneous RTP timestamp and PTP is expected to remain stable with time.

Validation Method: The instantaneous value of the RTP timestamp is analyzed by a test and measurement device and is related to the current PTP time. The instantaneous value of the RTP timestamp is expected not to be in the future, not to be more than 1 ms in the past (unless there is a clear justification for it to be off, e.g frame synchronization).

Pass criteria:

- The instantaneous value of the RTP timestamp of the stream is not in the future, not more than 1 ms in the past (unless justified), and preserve a stable relation to the PTP (should not "drift").

No pass criteria:

- The instantaneous value of the RTP timestamp of the stream in the future, more than 1 ms in the past (unless justified), or "drifts".

5_RX. ST 2110-30 Rx tests*

Description: This set of Tests validate basic audio receiving capabilities of DuT.

First steps: The Vendor representative is given a multicast source IPv4 address(es)**, port number, channel configuration**, and audio packetization parameters (packet time)**. The streams will be



generated by the reference sender. The bit depth of the stream is always 24 bit. Standard MTU size will always be used.

*Applicable only to DuT with audio receiving capabilities

**Depending on DuT capabilities (e.g. Level A - 8 channels with 1 ms packet time, Level B - 8 channels with 125 us packet time, Level C - 64 channels with 125 us packet time)

5.4. Stream - audible Validation Rx

Description: the DuT is expected to be able to receive and to decode reference stream(s). A basic subjective audition test is done. The stream is expected to have no obvious audible artifacts of digital nature (pops, clicks, distortion). The DuT is not expected to reproduce all channels from the stream if it is not designed to do so (e.g. a stereo-output device will be expected to receive an 8 channel stream, but output at minimum of selected 2 channels).

Validation method: A stream is auditioned using headphones connected to the DuT for ~60 seconds. If a DuT outputs audio embedded in SDI - and SDI analyzer will be used. For receivers which do not provide an audio output, a Vendor representative will be allowed to suggest an alternative method to verify fidelity. The Testing team must approve any alternative methods.

Pass criteria:

- The DuT is capable of receiving a stream according to its capabilities (Level A, B, or C)
- The stream can be decoded by the DuT. The audio signal is free from artifacts of a digital nature.
- If the stream is looped back into the network - the looped stream can be decoded by a reference receiver. The audio signal is free from artifacts of a digital nature.

No pass criteria:

- The stream cannot be decoded. A Vendor representative will have an opportunity to articulate why this might be ok.

6_TX. ST 2110-40 Tx tests*

Description: This set of Tests is expected to validate basic ancillary data transmitting capabilities of the DuT. The actual services used during the tests will be provided at a later stage.

First steps: The Vendor representative is given a multicast destination IPv4 address(es) and a port number. Standard MTU size will always be expected.

*Applicable only to DuT with ancillary data transmitting capabilities

** 1080i50 stream will be used for this test

6.1. Stream -40 validation Tx

Description: The Vendor representative is expected to be able to configure the DuT such that it initiates a valid ancillary data stream with a given multicast address and port number. The Vendor representative will announce the used DID/SDIDs values to the testing team.

Validation Method:

- The ancillary data stream is received by a T&M device to validate the stream.



Pass criteria:

- The stream contains the DID/SDIDs matching prior Vendor representative's description
- The stream uses legal values for all SDI line and sample fields
- The stream uses the 'marker' and 'field' bits correctly for the intended video standard
- The stream payload errors are not detected

No pass criteria:

- The stream DID/SDIDs values do not match prior Vendor representative's description
- The stream does not use legal values for all SDI line and sample fields
- The stream does not use the 'marker' and 'field' bits correctly for the intended video standard
- The stream payload errors are detected

6_RX. ST 2110-40 Rx tests*

Description: This set of Tests validate basic ancillary data receiving capabilities of DuT. The actual services used during the tests will be provided at a later stage.

First steps: A Vendor representative is given a multicast IPv4 address(es) and a port number of a valid ancillary data stream. Standard MTU size will always be used.

*Applicable only to DuT with ancillary data receiving capabilities

** 1080i50 stream will be used for this test

6.2. Stream -40 validation Rx

Description: The Vendor representative is expected to configure the DuT to join a SMPTE ST 2110-40 stream generated by a reference sender. A single source multicast stream will be provided that contains 4302 (OP-47) subtitles with actual text in them, plus at least one other 'surprise' DID/SDID.

Validation Method: the DuT is expected to demonstrate at least one of the following features:

- Display the text of the closed captions on a monitoring terminal or video overlay.
- Output the ANC packets into SDI video where they can be read back correctly by an SDI analyzer such as Tektronix.
- Provide a "packet list" display that at a minimum shows the list of DID/SDIDs found in the multicast and the line number settings for each.

Pass criteria:

- the DuT is capable of receiving and decoding an ancillary data stream with either of features described in the Validation Method.

No pass criteria:

- the DuT is not capable of receiving and decoding an ancillary data stream with either of features described in the Validation Method.

7. ST 2022-7 tests*

Description: This set of tests validate that the DuT is able to properly transmit and receive redundant (Red path and Blue path) video (-20), audio (-30) and/or ancillary (-40) streams according to SMPTE



ST 2022-7. This test will be applied to all devices with respected 2022-7 capabilities alongside the basic essence tests (4_TX, 4_RX, 5_TX, 5_RX and/or 6_TX,6_RX).

First steps: a Vendor representative is given a set of multicast IPv4 addresses and port numbers. The DuT will be expected to initiate or receive a ST 2022-7 compliant redundant stream with a given set of parameters. The essence type will be picked according to the type of tests performed alongside (4_TX, 4_RX, 5_TX, 5_RX or 6_TX,6_RX).

*Applicable only to DuT with -20, -30 and/or -40 capable devices with 2022-7 functionality

7.1. Stream - Basic Test Tx*

Description: This test validates that the DuT is able to properly transmit redundant (Red path and Blue path) video (-20), audio (-30) and/or ANC (-40) ST2022-7 streams. The DuT is expected to be able to initiate a redundant stream with different destination multicast IPv4 and MAC addresses on Red Path and Blue Path. The unicast source IPv4 and MAC addresses of the Red Path and Blue Path are expected to be different.

Validation Method: The Red and Blue streams generated by the DuT will be analyzed with a T&M device and/or received by a reference receiver(s) to determine if both streams are compliant with ST 2110-20, -30 or -40, depending on the essence under test.

Pass criteria:

- The DuT is able to initiate a valid redundant stream with different destination multicast IPv4 and MAC addresses on Red Path and Blue Path.
- The unicast source IPv4 and MAC addresses of the Red Path and Blue Path are different.

No pass criteria:

- The DuT is not able to initiate a valid redundant stream with different destination multicast IPv4 and MAC addresses on Red Path and Blue Path.
- The unicast source IPv4 and MAC addresses of the Red Path and Blue Path are the same.

*Applicable only to DuT with -20, -30 and/or -40 senders with 2022-7 capability

7.2. Stream - Basic Test Rx*

Description: This test validates that the DuT is able to properly receive redundant (Red path and Blue path) video (-20), audio (-30) and/or ANC (-40) ST2022-7 streams with different source, multicast, IPv4 and MAC addresses on Red Path and Blue Path initiated by a reference sender. The unicast source IPv4 and MAC addresses of the Red Path and Blue Path will be different. The DuT is expected to have different unicast IPv4 and MAC addresses on redundant ports.

Validation Method: Visual reporting, video/audio output and/or logging of the DuT will be used to validate proper redundant stream receiving. The MAC address table of a switch is used to validate if redundant ports of the DuT have different MAC addresses.

Pass criteria:

- The DuT Receiver is able to properly receive a redundant (Red Path and Blue Path) video, audio and/or ancillary stream with different host IPv4 addresses and multicast mac address without errors.
- The unicast IPv4 and MAC addresses of redundant ports of the DuT are different.



No pass criteria:

- The DuT Receiver is not able to properly receive a redundant (Red Path and Blue Path) video, audio and/or ancillary stream with different host IPv4 addresses and multicast mac address.
- The unicast IPv4 and MAC addresses of redundant ports of the DuT are the same.

*Applicable only to DuT with -20, -30 and/or -40 receivers with 2022-7 capability

7.3. Redundancy Test

Description: This test validates that the DuT receiver is able to properly receive redundant (Red path and Blue path) video (-20), audio (-30) and ancillary (-40) ST 2022-7 streams with the following impairment tests:

7.3.1 Synchronized Alternating Burst Loss of 25%.

7.3.2 Differential Latency with Synchronized Alternating Burst Loss of 25%.

7.3.3 Differential Latency and Packet Delay Variation (PDV/Jitter) with Synchronized Alternating Burst Loss of 25%.



Network Emulator Setup used:

Test #	Sync Burst Loss (Continuous)	Path 1 RTP Seq Number Pattern	Path 2 RTP Seq Number Pattern	T1	Imp	T2	Imp	T3	Imp	Drop Now (Pkts) Blue Path	Delay (us) Blue Path	PDV (us) Blue Path NRO Peak
7.3.1	25%	XXXX XXXX 00XX XXXX	XXXX XXXX 11XX XXXX	5s	no	10s	dec	10s	no	1000		
7.3.2	25%	XXXX XXXX 00XX XXXX	XXXX XXXX 11XX XXXX	5s	no	10s	dec	10s	no	1000	150	
7.3.3	25%	XXXX XXXX 00XX XXXX	XXXX XXXX 11XX XXXX	5s	no	10s	dec	10s	no	1000	90	60

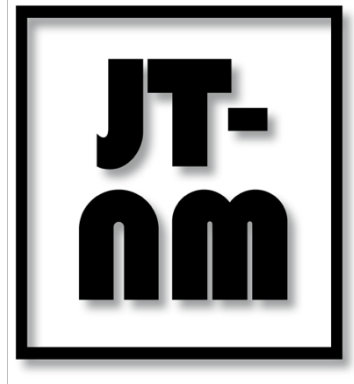
Validation Method: Where available/applicable - video/audio/ancillary output will be observed to validate a proper redundant stream receiving. Visual reporting and/or logging of the DuT may also be used.

Pass criteria:

- The DuT receiver is able to properly receive a redundant stream with test conditions 7.3.1, 7.3.2 and 7.3.3

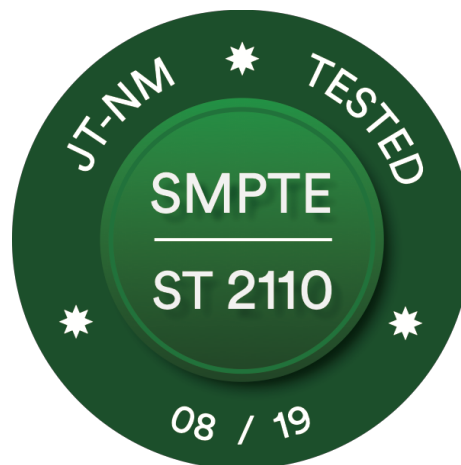
No pass criteria:

- The DuT receiver is not able to properly receive a redundant stream with test conditions 7.3.1, 7.3.2 and 7.3.3 without errors (video artifacts, audio artifacts and/or loss of ancillary data).



Appendix

JT-NM Tested Event August 2019 – SMPTE ST 2110 Results IBC2019



JT-NM Tested Event August 2019 – SMPTE ST 2110 Results

Device Under Test				REPORT		1. General Network Interface Tests				2. Media Network Related Tests						3. ST 2110-10 Tests							
Vendor Name	Model	HW version	SW Version	Video Only, Audio Only, Full	Tx, Rx, Tx/Rx	1.1 Management Network Interface Test	1.1.1 Ping Respons	1.1.2 TTL > 16	1.2 Media Network Interface Test	1.2.1 Ping Respons	1.2.1 TTL > 16	2.1 Basic PTP configuration Test	2.1.1 Set PTP Domain	2.1.2 Lock to PTP	2.1.3 Do Not Become Master	2.1.4 Doesn't Reply to TLV Management Messages	2.2 Manual PTP configuration Test	2.5 Basic Multicast Configuration test	2.6 Extended Multicast Configuration test	3.1 IGMPv3 test for a receiver	3.2 SDP verification for a sender	3.2.1 Tx provides an SDP	3.2.2 SDP is validated with SDPoker and correct
Adeas/Nextera	SDI IP Gateway	V2.2	V2.2	1. Full	1. Tx/Rx																		
Adeas/Nextera	SDI IP Gateway - UHDp50	V2.2	V2.2	1. Full	1. Tx/Rx																		
AJA	KonaIP	v1.0	v15.5	1. Full	1. Tx/Rx																		
AJA	IolIP	v1.0	v15.2	1. Full	1. Tx/Rx																		
Embrionix	emFusion	200	2.5	1. Full	1. Tx/Rx																		
Embrionix	emFusion - UHDp50	200	2.5	1. Full	1. Tx/Rx																		
EVS	XT-VIA	XT-VIA	16.2	1. Full	1. Tx/Rx																		
Grass Valley (Multiviewer)	Kaleido-IP	X320	v11.0	1. Full	1. Tx/Rx																		
Grass Valley (Processors)	XIP-3901 + XIP-3901-UDC-IP	Rev AJ	v0.255	1. Full	1. Tx/Rx																		
Grass Valley (Switcher)	K-FRM X	v14.4.3	v14.4.3	1. Full	1. Tx/Rx																		
Hamronic	Spectrum X	1RU	9	1. Full	1. Tx/Rx																		
Imagine Communications	SNP	A	v1.3.0	1. Full	1. Tx/Rx																		
Imagine Communications	EPIC-MV	A	v1.4.4.5	1. Full	1. Tx/Rx																		
Imagine Communications	SNP - UHDp50	A	v1.3.0	1. Full	1. Tx/Rx																		
Macnica ATD	Media over IP Package	v1.1.2	v1.1.1	1. Full	1. Tx/Rx																		
Matrox	X.mio5 Q25	RevA	10.1.040.24351	1. Full	1. Tx/Rx																		
Matrox	DSX LES D25	RevA	10.1.040.24351	1. Full	1. Tx/Rx																		
Matrox	X.mio3 IP	RevA	10.1.040.24350	1. Full	1. Tx/Rx																		
Matrox	X.mio5 Q25 - UHDp50	RevA	10.1.040.24351	1. Full	1. Tx/Rx																		
Matrox	DSX LES D25 - UHDp50	RevA	10.1.040.24351	1. Full	1. Tx/Rx																		
Nevion	Virtuoso MI	MI V1.0	v1.1.2502	1. Full	1. Tx/Rx																		
Pebble Beach Systems	Dolphin	N/A	v.1.13.2954.1	1. Full	1. Tx/Rx																		
Pebble Beach Systems	Dolphin - UHDp50	N/A	v.1.13.2954.1	1. Full	1. Tx/Rx																		
Riedel Communications	MediorNet MicroN IP	N/A	V6.1	1. Full	1. Tx/Rx																		
Sony	HDCU Series	V2.23	V2.23	1. Full	1. Tx/Rx																		
Sony	HDCU Series - UHDp50	V2.23	V2.23	1. Full	1. Tx/Rx																		
Sumavision	S010	V1.1	V1.0.2	1. Full	1. Tx/Rx																		
TAG V.S.	MCM-9000	N/A	v4.8.5	1. Full	1. Tx/Rx																		
TAG V.S.	MCM-9000 - UHDp50	N/A	v4.8.5	1. Full	1. Tx/Rx																		
Tektronix/Teletream	PRISM MPI2-10	MPI2-10	1.8.2	1. Full	1. Tx/Rx																		
vizrt	VizEngine 3.14	3.14	3.14	1. Full	1. Tx/Rx																		
vizrt	VizEngine 3.14 - UHDp50	3.14	3.14	1. Full	1. Tx/Rx																		
AJA	IPT-10G2-HDMI	v1.0	v2.2	1. Full	2. Tx																		
AJA	IPT-10G2-SDI	v1.0	v2.2	1. Full	2. Tx																		
Embrionix	ST2110 Encapsulator (HD-SDI)	100	3.1	1. Full	2. Tx																		

LEGEND

- Green square = test passed
- Grey square = test failed or not tested
- White square = test not applicable

JT-NM Tested Event August 2019 – SMPTE ST 2110 Results

Device Under Test				REPORT		1. General Network Interface Tests					2. Media Network Related Tests					3. ST 2110-10 Tests								
Vendor Name	Model	HW version	SW Version	Video Only, Audio Only, Full	Tx, Rx, Tx/Rx	1.1 Management Network Interface Test	1.1.1 Ping Respons	1.1.2 TTL > 16	1.2 Media Network Interface Test	1.2.1 Ping Respons	1.2.1 TTL > 16	2.1 Basic PTP configuration Test	2.1.1 Set PTP Domain	2.1.2 Lock to PTP	2.1.3 Do Not Become Master	2.1.4 Doesn't Reply to TLV Management Messages	2.2 Manual PTP configuration Test	2.5 Basic Multicast Configuration test	2.6 Extended Multicast Configuration test	3.1 IGMPv3 test for a receiver	3.2 SDP verification for a sender	3.2.1 Tx provides an SDP	3.2.2 SDP is validated with SDPoker and correct	
MediaKind	Cygnus RX1	N/A	10.6.0.0	1. Full	2. Tx																			
Net Insight	N640-Tx	A1	Gx5.6.0.3	1. Full	2. Tx																			
PHABRIX Ltd.	SxTAG Handheld (Encap)	ID 11.0	v2.0	1. Full	2. Tx																			
AJA	IPR-10G-HDMI	v1.0	v2.2	1. Full	3. Rx																			
AJA	IPR-10G2-HDMI	v1.0	v2.2	1. Full	3. Rx																			
AJA	IPR-10G2-SDI	v1.0	v2.2	1. Full	3. Rx																			
Bridge Technologies	VB440	Rev A	v5.3.6	1. Full	3. Rx																			
EBU - TEST TEST	LIST	v1.4	ba99c18a	1. Full	3. Rx																			
Embrionix	ST2110 Decapsulator (HD-SDI)	100	3.1	1. Full	3. Rx																			
Grass Valley (Multiviewer)	IPVU-UHD	v1.0	v1.0	1. Full	3. Rx																			
Leader Electronics Corp.	LV5600	Rev A	v3.4	1. Full	3. Rx																			
M3L Inc.	vIGSV01_01	v1.0	v1.0	1. Full	3. Rx																			
Net Insight	N640-Rx	A1	Gx5.6.0.3	1. Full	3. Rx																			
PHABRIX Ltd.	Qx	Main 9	v3.4.0.159	1. Full	3. Rx																			
PHABRIX Ltd.	SxTAG Handheld (Decap)	ID 11.0	v2.0	1. Full	3. Rx																			
EEG	HD492 Alta	1.57	8.2.2019	3. ANC Only	1. Tx/Rx																			
Calrec Audio	Type-R Core	v3	v1.1	4. Audio Only	1. Tx/Rx																			
Calrec Audio	Type-R Combo	v3	v1.1	4. Audio Only	1. Tx/Rx																			
Calrec Audio	AolP Box	v1.0	v2.0.5	4. Audio Only	1. Tx/Rx																			
Clear-Com, an HME Company	Eclipse-HX	N/A	V12	4. Audio Only	1. Tx/Rx																			
DirectOut GmbH	MONTONE.42	v4.5	v4.18	4. Audio Only	1. Tx/Rx																			
DirectOut GmbH	PRODIGY.MC	v0.12	v0.12	4. Audio Only	1. Tx/Rx																			
Lawo	Power Core	V1.2	6.2.0.16	4. Audio Only	1. Tx/Rx																			
Lawo	mc² Micro Core	v2.7	v5.18.0	4. Audio Only	1. Tx/Rx																			
Lawo	A_mic8	v2.0	10.0.4.42	4. Audio Only	1. Tx/Rx																			
Lawo	Nova37	v1.5	v5.18.0	4. Audio Only	1. Tx/Rx																			
Riedel Communications	Artist 32/64/128 G2	N/A	V8.0	4. Audio Only	1. Tx/Rx																			
Riedel Communications	NSA-002A	Rev. D	V1.0.1	4. Audio Only	1. Tx/Rx																			
Riedel Communications	Artist UI-C-128	V1	V1.0	4. Audio Only	1. Tx/Rx																			
Solid State Logic	HC Bridge	1.1.1.3	V4.2.0.11	4. Audio Only	1. Tx/Rx																			
Solid State Logic	HC Bridge SRC	1.1.1.3	V4.2.0.11	4. Audio Only	1. Tx/Rx																			
Solid State Logic	MADI Bridge	4.0.2.11	V4.2.0.28	4. Audio Only	1. Tx/Rx																			
Solid State Logic	A32	4.0.2.11	V4.2.0.28	4. Audio Only	1. Tx/Rx																			
Stage Tec	NEXUS XFIP/R/F67	V4.5	V4.18	4. Audio Only	1. Tx/Rx																			
Yamaha	QL1	N/A	V4.2.0.27	4. Audio Only	1. Tx/Rx																			
Riedel Communications	RSP-1232HL	N/A	V1.1	4. Audio Only	3. Rx																			

LEGEND

Green square = test passed

Grey square = test failed or not tested

White square = test not applicable

JT-NM Tested Event August 2019 – SMPTE ST 2110 Results

Device Under Test				REPORT		4. ST 2110-20 Tests																					
Vendor Name	Model	HW version	SW Version	Video Only, Audio Only, Full	Tx, Rx, Tx/Rx	4.1 Stream Basic test Tx	4.1.1 Stream Present?	4.1.2 Multicast Address Correct?	4.1.3 Video Format Correct?	4.2 Stream Visual Validation Tx	4.2.1 Decoded by Reference Rx	4.2.2 No Visible Errors	4.2.3 No errors reported by PRISM	4.3 SMPTE ST 2110-21 profile sender compliance test Tx	4.3.1 Network Compatibility Model (Conax)	4.3.2 Virtual Receiver Buffer (VRB)	4.4 RTP Timestamp test Tx	4.4.1 RTP timestamp between -1ms and 0ms	4.4.2 RTP timestamp is not drifting	4.5 SMPTE ST 2110-21 profile receiver compliance test Rx	4.5.1 Receive Stream	4.5.2 Display Stream	4.6 Stream Visual Validation Rx	4.6.1 Receive Stream	4.6.2 Video is free of artifacts		
Adeas/Nextera	SDI IP Gateway	V2.2	V2.2	1. Full	1. Tx/Rx																						
Adeas/Nextera	SDI IP Gateway - UHDp50	V2.2	V2.2	1. Full	1. Tx/Rx																						
AJA	KonaIP	v1.0	v15.5	1. Full	1. Tx/Rx																						
AJA	IoIP	v1.0	v15.2	1. Full	1. Tx/Rx																						
Embrionix	emFusion	200	2.5	1. Full	1. Tx/Rx																						
Embrionix	emFusion - UHDp50	200	2.5	1. Full	1. Tx/Rx																						
EVS	XT-VIA	XT-VIA	16.2	1. Full	1. Tx/Rx																						
Grass Valley (Multiviewer)	Kaleido-IP	X320	v11.0	1. Full	1. Tx/Rx																						
Grass Valley (Processors)	XIP-3901 + XIP-3901-UDC-IP	Rev AJ	v0.255	1. Full	1. Tx/Rx																						
Grass Valley (Switcher)	K-FRM X	v14.4.3	v14.4.3	1. Full	1. Tx/Rx																						
Hammonic	Spectrum X	1 RU	9	1. Full	1. Tx/Rx																						
Imagine Communications	SNP	A	v1.3.0	1. Full	1. Tx/Rx																						
Imagine Communications	EPIC-MV	A	v1.4.4.5	1. Full	1. Tx/Rx																						
Imagine Communications	SNP - UHDp50	A	v1.3.0	1. Full	1. Tx/Rx																						
Macnica ATD	Media over IP Package	v1.1.2	v1.1.1	1. Full	1. Tx/Rx																						
Matrox	X.mioS Q25	RevA	10.1.040.24351	1. Full	1. Tx/Rx																						
Matrox	DSX LE5 D25	RevA	10.1.040.24351	1. Full	1. Tx/Rx																						
Matrox	X.mio3 IP	RevA	10.1.040.24350	1. Full	1. Tx/Rx																						
Matrox	X.mioS Q25 - UHDp50	RevA	10.1.040.24351	1. Full	1. Tx/Rx																						
Matrox	DSX LE5 D25 - UHDp50	RevA	10.1.040.24351	1. Full	1. Tx/Rx																						
Nevision	Virtuoso MI	MI V1.0	v1.1.2502	1. Full	1. Tx/Rx																						
Pebble Beach Systems	Dolphin	N/A	v.1.13.2954.1	1. Full	1. Tx/Rx																						
Pebble Beach Systems	Dolphin - UHDp50	N/A	v.1.13.2954.1	1. Full	1. Tx/Rx																						
Riedel Communications	MediorNet MicroNIP	N/A	V6.1	1. Full	1. Tx/Rx																						
Sony	HDCU Series	V2.23	V2.23	1. Full	1. Tx/Rx																						
Sony	HDCU Series - UHDp50	V2.23	V2.23	1. Full	1. Tx/Rx																						
Sumavision	S010	V1.1	V1.0.2	1. Full	1. Tx/Rx																						
TAG V.S.	MCM-9000	N/A	v4.8.5	1. Full	1. Tx/Rx																						
TAG V.S.	MCM-9000 -UHDp50	N/A	v4.8.5	1. Full	1. Tx/Rx																						
Tektronix/Teletream	PRISM MPI2-10	MPI2-10	1.8.2	1. Full	1. Tx/Rx																						
vizrt	VizEngine 3.14	3.14	3.14	1. Full	1. Tx/Rx																						
vizrt	VizEngine 3.14 - UHDp50	3.14	3.14	1. Full	1. Tx/Rx																						
AJA	IPT-10G2-HDMI	v1.0	v2.2	1. Full	2. Tx																						
AJA	IPT-10G2-SDI	v1.0	v2.2	1. Full	2. Tx																						
Embrionix	ST2110 Encapsulator (HD-SDI)	100	3.1	1. Full	2. Tx																						

LEGEND

Green square = test passed

Grey square = test failed or not tested

White square = test not applicable

JT-NM Tested Event August 2019 – SMPTE ST 2110 Results

Device Under Test				REPORT		4. ST 2110-20 Tests																				
Vendor Name	Model	HW version	SW Version	Video Only, Audio Only, Full	Tx, Rx, Tx/Rx	4.1 Stream Basic test Tx	4.1.1 Stream Present?	4.1.2 Multicast Address Correct?	4.1.3 Video Format Correct?	4.2 Stream Visual Validation Tx	4.2.1 Decoded by Reference Rx	4.2.2 No visible Errors	4.2.3 No errors reported by PRISM	4.3 SMPTE ST 2110-2.1 profile sender compliance test Tx	4.3.1 Network Compatibility Model (Cmax)	4.3.2 Virtual Receiver Buffer (VRX)	4.4 RTP Timestamp test Tx	4.4.1 RTP timestamp between -1ms and 0ms	4.4.2 RTP timestamp is not drifting	4.5 SMPTE ST 2110-2.1 profile receiver compliance test Rx	4.5.1 Receive Stream	4.5.2 Display Stream	4.6 Stream Visual Validation Rx	4.6.1 Receive Stream	4.6.2 Video is free of artifacts	
MediaKind	Cygnus RX1	N/A	10.6.0.0	1. Full	2. Tx																					
Net Insight	N640-Tx	A1	GxS.6.0.3	1. Full	2. Tx																					
PHABRIX Ltd.	SxTAG Handheld (Encap)	ID 11.0	v2.0	1. Full	2. Tx																					
AJA	IPR-10G-HDMI	v1.0	v2.2	1. Full	3. Rx																					
AJA	IPR-10G2-HDMI	v1.0	v2.2	1. Full	3. Rx																					
AJA	IPR-10G2-SDI	v1.0	v2.2	1. Full	3. Rx																					
Bridge Technologies	VB440	Rev A	v5.3.6	1. Full	3. Rx																					
EBU - TEST TEST	LIST	v1.4	ba99c18a	1. Full	3. Rx																					
Embrionix	ST2110 Decapsulator (HD-SDI)	100	3.1	1. Full	3. Rx																					
Grass Valley (Multiviewer)	IPVU-UHD	v1.0	v1.0	1. Full	3. Rx																					
Leader Electronics Corp.	LV5600	Rev A	v3.4	1. Full	3. Rx																					
M3L Inc.	vIGSV01_01	v1.0	v1.0	1. Full	3. Rx																					
Net Insight	N640-Rx	A1	GxS.6.0.3	1. Full	3. Rx																					
PHABRIX Ltd.	Ox	Main 9	v3.4.0.159	1. Full	3. Rx																					
PHABRIX Ltd.	SxTAG Handheld (Decap)	ID 11.0	v2.0	1. Full	3. Rx																					
EEG	HD492 Alta	1.57	8.2.2019	3. ANC Only	1. Tx/Rx																					
Calrec Audio	Type-R Core	v3	v1.1	4. Audio Only	1. Tx/Rx																					
Calrec Audio	Type-R Combo	v3	v1.1	4. Audio Only	1. Tx/Rx																					
Calrec Audio	AoIP Box	v1.0	v2.0.5	4. Audio Only	1. Tx/Rx																					
Clear-Com, an HME Company	Eclipse-HX	N/A	V12	4. Audio Only	1. Tx/Rx																					
DirectOut GmbH	MONOTONE.42	v4.5	v4.18	4. Audio Only	1. Tx/Rx																					
DirectOut GmbH	PRODIGY.MC	v0.12	v0.12	4. Audio Only	1. Tx/Rx																					
Lawo	Power Core	V1.2	6.2.0.16	4. Audio Only	1. Tx/Rx																					
Lawo	mic² Micro Core	v2.7	v5.18.0	4. Audio Only	1. Tx/Rx																					
Lawo	A_mic8	v2.0	10.0.4.42	4. Audio Only	1. Tx/Rx																					
Lawo	Nova37	v1.5	v5.18.0	4. Audio Only	1. Tx/Rx																					
Riedel Communications	Artist 32/64/128 G2	N/A	V8.0	4. Audio Only	1. Tx/Rx																					
Riedel Communications	NSA-002A	Rev. D	V1.0.1	4. Audio Only	1. Tx/Rx																					
Riedel Communications	Artist UIC-128	V1	V1.0	4. Audio Only	1. Tx/Rx																					
Solid State Logic	HC Bridge	1.1.1.3	V4.2.0.11	4. Audio Only	1. Tx/Rx																					
Solid State Logic	HC Bridge SRC	1.1.1.3	V4.2.0.11	4. Audio Only	1. Tx/Rx																					
Solid State Logic	MADI Bridge	4.0.2.11	V4.2.0.28	4. Audio Only	1. Tx/Rx																					
Solid State Logic	A32	4.0.2.11	V4.2.0.28	4. Audio Only	1. Tx/Rx																					
Stage Tec	NEXUS XF1P/RIF67	V4.5	V4.18	4. Audio Only	1. Tx/Rx																					
Yamaha	QL1	N/A	V4.2.0.27	4. Audio Only	1. Tx/Rx																					
Riedel Communications	RSP-1232HL	N/A	V1.1	4. Audio Only	3. Rx																					

LEGEND
 Green square = test passed
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 White square = test not applicable

JT-NM Tested Event August 2019 – SMPTE ST 2110 Results

Device Under Test				REPORT		5. ST 2110-30 Tests										6. ST 2110-40 Tests						7. ST 2022-7 Tests																	
Vendor Name	Model	HW version	SW Version	Video Only, Audio Only, Full	Rx, Tx, Rx, Tx/Rx	5.1 Stream Basic Test Tx	5.1.1 Stream Present	5.1.2 Multicast Address is correct	5.2 Stream Audible Validation Tx	5.3 RTP Timestamp Test Tx	5.3.1 RTP timestamp is between -1ms and 0ms	5.3.2 RTP timestamp is not drifting	5.4 Stream Audible Validation Rx	5.4.1 Receive Stream Level A	5.4.2 Receive Stream Level B	5.4.3 Receive Stream Level C	5.4.4 No audible artifacts on headphones	6.1 Stream -40 Validation Tx	6.1.1 DID/SDI match expectations	6.1.2 Legal Values for SDI line and sample fields	6.1.3 Marker and Field bits correct for format	6.1.4 No Stream Payload Errors	6.2 Stream -40 Validation Rx	6.2.1 Display Closed Caption Text	6.2.2 Output AK into SDI and read on Test Equipment	6.2.3 Provide a packet list with at least DID/SDID and line numbers	7.1 Stream Basic Test Tx	7.1.1 Inhibit Redundant Stream	7.1.2 Read and Blue on different MAC and IP Addresses	7.2 Stream Basic Test Rx	7.2.1 Receive stream without artifacts	7.2.2 Read and Blue on different MAC and IP Addresses	7.3 Redundancy Test	7.3.1 Receive w/ 25% error alternating between ports	7.3.2 Diff latency with synchronized alternating burst loss 25%	7.3.3 Diff latency and PDV w synchronized latency of 25%			
Adesa/Nextera	SDI IP Gateway	V2.2	V2.2	1, Full	1, Tx/Rx																																		
Adesa/Nextera	SDI IP Gateway - UHDp50	V2.2	V2.2	1, Full	1, Tx/Rx																																		
AJA	KonaIP	v1.0	v15.5	1, Full	1, Tx/Rx																																		
AJA	totP	v1.0	v15.2	1, Full	1, Tx/Rx																																		
Embrionix	emFusion	200	2.5	1, Full	1, Tx/Rx																																		
Embrionix	emFusion - UHDp50	200	2.5	1, Full	1, Tx/Rx																																		
EVS	XT-VIA	16.2	1, Full	1, Full	1, Tx/Rx																																		
Grass Valley Multiviewer	Kaleido-IP	X320	v11.0	1, Full	1, Tx/Rx																																		
Grass Valley Processors	XIP-3901 + XIP-3901-UDC-IP	Rev AJ	v0.255	1, Full	1, Tx/Rx																																		
Grass Valley Switcher	K-FRM X	v14.4.3	v14.4.3	1, Full	1, Tx/Rx																																		
Harmonic	Spectrum X	1 RU	9	1, Full	1, Tx/Rx																																		
Imagine Communications	SNP	A	v1.3.0	1, Full	1, Tx/Rx																																		
Imagine Communications	EPIC-MV	A	v1.4.4.5	1, Full	1, Tx/Rx																																		
Imagine Communications	SNP - UHDp50	A	v1.3.0	1, Full	1, Tx/Rx																																		
Macnica ATD	Media over IP Package	v1.1.2	v1.1.1	1, Full	1, Tx/Rx																																		
Matrox	X.mio5 Q25	RevA	10.1.040.24351	1, Full	1, Tx/Rx																																		
Matrox	DSX LES D25	RevA	10.1.040.24351	1, Full	1, Tx/Rx																																		
Matrox	X.mio3 IP	RevA	10.1.040.24350	1, Full	1, Tx/Rx																																		
Matrox	X.mio5 Q25 - UHDp50	RevA	10.1.040.24351	1, Full	1, Tx/Rx																																		
Matrox	DSX LES D25 - UHDp50	RevA	10.1.040.24351	1, Full	1, Tx/Rx																																		
Nevion	Virtuoso MI	MI V1.0	v1.1.2502	1, Full	1, Tx/Rx																																		
Pebble Beach Systems	Dolphin	N/A	v.1.13.2954.1	1, Full	1, Tx/Rx																																		
Pebble Beach Systems	Dolphin - UHDp50	N/A	v.1.13.2954.1	1, Full	1, Tx/Rx																																		
Riedel Communications	MediorNet MicroN IP	N/A	V6.1	1, Full	1, Tx/Rx																																		
Sony	HDCU Series	V2.23	V2.23	1, Full	1, Tx/Rx																																		
Sony	HDCU Series - UHDp50	V2.23	V2.23	1, Full	1, Tx/Rx																																		
Sumavision	SO10	V1.1	V1.0.2	1, Full	1, Tx/Rx																																		
TAG V.S.	MCM-9000	N/A	v4.8.5	1, Full	1, Tx/Rx																																		
TAG V.S.	MCM-9000 - UHDp50	N/A	v4.8.5	1, Full	1, Tx/Rx																																		
Tektronix/Telestream	PRISM MPI2-10	1.8.2	1, Full	1, Full	1, Tx/Rx																																		
vizrt	VizEngine 3.14	3.14	3.14	1, Full	1, Tx/Rx																																		
vizrt	VizEngine 3.14 - UHDp50	3.14	3.14	1, Full	1, Tx/Rx																																		
AJA	IPF-10G2-HDMI	v1.0	v2.2	1, Full	2, Tx																																		
AJA	IPF-10G2-SDI	v1.0	v2.2	1, Full	2, Tx																																		
Embrionix	ST2110 Encapsulator (HD-SDI)	200	3.1	1, Full	2, Tx																																		

LEGEND

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JT-NM Tested Event August 2019 – SMPTE ST 2110 Results

Device Under Test				REPORT		5. ST 2110-30 Tests										6. ST 2110-40 Tests						7. ST 2022-7 Tests															
Vendor Name	Model	HW Version	SW Version	Video Only, Audio Only, Full	Rx, Tx, Rx/Tx/Rx	5.1 Stream Basic Test Tx	5.1.1 Stream Present	5.1.2 Multicast Address is correct	5.2 Stream Audible Validation Tx	5.3 RTP Timestamp Test Tx	5.3.1 RTP timestamp is between -1ms and 0ms	5.3.2 RTP timestamp is not drifting	5.4 Stream Audible Validation Rx	5.4.1 Receive Stream Level A	5.4.2 Receive Stream Level B	5.4.3 Receive Stream Level C	5.4.4 No audible artifacts on headphones	6.1 Stream -40 Validation Tx	6.1.1 DIO/SDI match expectations	6.1.2 Legal Values for SDI line and sample fields	6.1.3 Marker and Field bits correct for format	6.1.4 No Stream Payload Errors	6.2 Stream -40 Validation Rx	6.2.1 Display Closed Caption Text	6.2.2 Output ACK into SDI and read on Test Equipment	6.2.3 Provide a packet list with at least DIO/SDI and line numbers	7.1 Stream Basic Test Tx	7.1.1 Inhibit Redundant Stream	7.1.2 Read and Blue on different MAC and IP Addresses	7.2 Stream Basic Test Rx	7.2.1 Receive stream without artifacts	7.2.2 Read and Blue on different MAC and IP Addresses	7.3 Redundancy Test	7.3.1 Receive w/ 25% error alternating between ports	7.3.2 Diff latency with synchronized alternating burst loss 25%	7.3.3 Diff latency and PDV w synchronized latency of 25%	
MediaKind	Cygnus RX1	N/A	10.6.0.0	1. Full	2. Tx																																
Net Insight	N640-Tx	A1	Gx5.6.0.3	1. Full	2. Tx																																
PHABRIX Ltd.	SxTAG Handheld (Encap)	ID 11.0	v2.0	1. Full	2. Tx																																
AJA	IPR-10G-HDMI	v1.0	v2.2	1. Full	3. Rx																																
AJA	IPR-10G2-HDMI	v1.0	v2.2	1. Full	3. Rx																																
AJA	IPR-10G2-SDI	v1.0	v2.2	1. Full	3. Rx																																
Bridge Technologies	VB440	Rev A	v5.3.6	1. Full	3. Rx																																
EBU - TEST TEST	L1ST	v1.4	ba99c18a	1. Full	3. Rx																																
Embrionx	ST2110 Decapsulator (HD-SDI)	100	3.1	1. Full	3. Rx																																
Grass Valley Multiviewer	IPVU-LHD	v1.0	v1.0	1. Full	3. Rx																																
Leader Electronics Corp.	LV5600	Rev A	v3.4	1. Full	3. Rx																																
M3L Inc.	vIGSV01_01	v1.0	v1.0	1. Full	3. Rx																																
Net Insight	N640-Rx	A1	Gx5.6.0.3	1. Full	3. Rx																																
PHABRIX Ltd.	Gx	Main 9	v3.4.0.159	1. Full	3. Rx																																
PHABRIX Ltd.	SxTAG Handheld (Decap)	ID 11.0	v2.0	1. Full	3. Rx																																
EEG	HD492-Atlas	1.57	8.2.2019	3. ANC Only	1. Tx/Rx																																
Calrec Audio	Type-R Core	v3	v1.1	4. Audio Only	1. Tx/Rx																																
Calrec Audio	Type-R Combo	v3	v1.1	4. Audio Only	1. Tx/Rx																																
Calrec Audio	AcIP Box	v1.0	v2.0.5	4. Audio Only	1. Tx/Rx																																
Clear-Com, an HME Company	Eclipse-HX	N/A	V12	4. Audio Only	1. Tx/Rx																																
DirectOut GmbH	NONTONE.42	v4.5	v4.18	4. Audio Only	1. Tx/Rx																																
DirectOut GmbH	PRODIGY_MC	v0.12	v0.12	4. Audio Only	1. Tx/Rx																																
Lawo	Power Core	V1.2	6.2.0.16	4. Audio Only	1. Tx/Rx																																
Lawo	mic ⁴ Micro Core	v2.7	v5.18.0	4. Audio Only	1. Tx/Rx																																
Lawo	A_mic8	v2.0	10.0.4.42	4. Audio Only	1. Tx/Rx																																
Lawo	Nova37	v1.5	v5.18.0	4. Audio Only	1. Tx/Rx																																
Riedel Communications	Artist 32/64/128 G2	N/A	V8.0	4. Audio Only	1. Tx/Rx																																
Riedel Communications	NSA-002A	Rev. D	V1.0.1	4. Audio Only	1. Tx/Rx																																
Riedel Communications	Artist UIC-128	V1	V1.0	4. Audio Only	1. Tx/Rx																																
Solid State Logic	HC Bridge	1.1.1.3	V4.2.0.11	4. Audio Only	1. Tx/Rx																																
Solid State Logic	HC Bridge SRC	1.1.1.3	V4.2.0.11	4. Audio Only	1. Tx/Rx																																
Solid State Logic	NIADI Bridge	4.0.2.11	V4.2.0.28	4. Audio Only	1. Tx/Rx																																
Solid State Logic	A32	4.0.2.11	V4.2.0.28	4. Audio Only	1. Tx/Rx																																
Stage Tec	NEXUS XF1P/RF67	N/A	V4.18	4. Audio Only	1. Tx/Rx																																
Yamaha	QL1	N/A	V4.2.0.27	4. Audio Only	1. Tx/Rx																																
Riedel Communications	RSP-1232HL	N/A	V1.1	4. Audio Only	3. Rx																																

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