



**JT-NM TESTED PROGRAM
AT IP SHOWCASE
2019 NAB SHOW**





JT-NM Tested Program Catalog for NAB 2019

Introduction: the motivation behind the program

New to the IP Showcase this year is the JT-NM Tested program. 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 ST 2110 and SMPTE ST 2059 standards.

Sponsored by the JT-NM and administered by the EBU and IRT, two top European technical bodies, vendors who submitted equipment for evaluation during the week of March 18th, 2019 at the Fox Networks facility in the Woodlands, Texas were given the opportunity to list that equipment in this JT-NM Tested catalog, which is being made publicly available at the IP Showcase booth and on-line. This catalog provides 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, providing prospective purchasers and users with a reference as they begin their equipment evaluation and qualification process.

Acknowledgements

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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 2022-7:2013** - 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>

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, 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
 - <https://github.com/FOXNEOAdvancedTechnology/smp2110-40-dissector/blob/master/ST2110-40.lua>

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.

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.



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).

Description: Tests the basic configuration of the IPv4 address, subnet mask, default gateway, TTL and blocking of ICMP messages. The DuT will be pinged from a host in another subnet. DuT is expected to reply to the ICMP echo request (ping) coming from another subnet, while properly utilizing 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.

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

Pass criteria:

- The DuT can be pinged from a host on another subnet. The TTL value of ICMP echo reply is > 16.

No pass criteria:

- The DuT cannot be pinged from a host on another subnet.

1.2. Media Network Interface Test

Description: Tests the basic configuration of the IPv4 address, subnet mask, default gateway, TTL and blocking of ICMP messages. The DuT will be pinged from a host in another subnet. DuT is expected to



reply to the ICMP echo request (ping) coming from another subnet, while properly addressing a default gateway, and with TTL > 16.

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

Pass criteria:

- The DuT can be pinged from a host on another subnet. The TTL value of ICMP echo reply is > 16.

No pass criteria:

- The DuT cannot be pinged from a host on another subnet.

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*

* Note: As this test can be disruptive and/or may require significant network changes, for this first test event the JT-NM elected to drop this test from the week of March 18th, 2019 test event. The JT-NM sees this as a valid test for consideration at future test events.

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*

* Note: As this test can be disruptive and/or may require significant network changes, for this first test event the JT-NM elected to drop this test from the week of March 18th, 2019 test event. The JT-NM sees this as a valid test for consideration at future test events.

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*

* Note: As this test can be disruptive and/or may require significant network changes, for this first test event the JT-NM elected to drop this test from the week of March 18th, 2019 test event. The JT-NM sees this as a valid test for consideration



at future test events.

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. 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

2.6. Extended Multicast Range Configurability Test*

*Note: Due to time constraints this first test event the JT-NM elected to drop this test from the week of March 18th, 2019 test event. The JT-NM sees this as a valid test for consideration at future test events

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 source and destination multicast IP addresses randomly picked 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 of 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. **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*

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 (1080i59.94 and/or 1080p50). DuT is expected to be able to initiate a stream with given parameters. Standard MTU size will always be expected.

*Applicable only to DuT with video transmitting capabilities

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 as well as offline with a network capture of 10 seconds. The SDP file will be checked for Media Type Parameter TROFF.

Maximum allowable C_{full} and V_{RXfull} :

V	H	T	Color	bit	Cfull N	Cfull W	VRXfull N	VRXfull 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 TROffset 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=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 500ms in the past.

Pass criteria:

- The instantaneous value of the RTP timestamp of the stream is not in the future, not more than 500ms in the past, 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 500ms in the past, or “drifts”.

4_RX. ST 2110-20 Rx Tests

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 (1080i59.94 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.

*Applicable only to DuT with video receiving capabilities

4.5. ST2110-21 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 500ms in the past.

Pass criteria:

- The instantaneous value of the RTP timestamp of the stream is not in the future, not more than 500ms in the past, 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 500ms in the past, 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).

Validation method: A stream is auditioned using headphones connected to the DuT for ~60 seconds. If a DuT outputs audio embedded in SDI - an 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.

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

** 1080i59.94 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.

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

** 1080i59.94 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 6101 closed captions 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 Synchronized Alternating Burst Loss of 25%.

Network Emulator Setup used:

% loss	Sync Brst Loss	Path 1			Path 2			T1	Imp	T2	Imp	T3	Imp	Repeat			
		RTP	Seq	Number	RTP	Seq	Number										
25%	Yes	XXXX	XXXX	00XX	XXXX	XXXX	XXXX	XXXX	11XX	XXXX	5s	no	10s	dec	10s	no	Continuous (15)

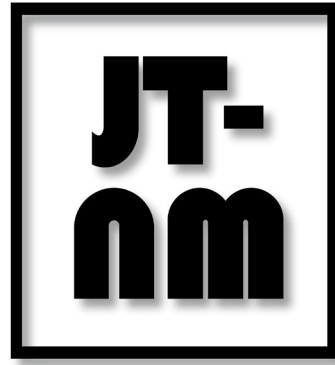
Validation Method: Where available/applicable - video/audio output will be observed to validate a proper redundant stream receiving. Visual reporting and/or logging of the DuT may also be used.

Pass criteria:

- The DuT receiver is able to properly receive a redundant stream with synchronized alternating burst loss (25% packet loss) without errors.

No pass criteria:

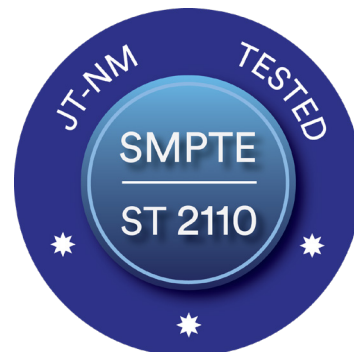
- The DuT receiver is not able to properly receive a redundant stream with synchronized alternating burst loss (25% packet loss) without errors (video or audio artifacts, loss of ancillary data).



Appendix

Results, JT-NM Tested Program

2019 NAB Show



03/30/19			General Tests										ST 2110-20 Video Tests															
Test			1.1 Management	1.1 Management	1.2 Media Interface	1.2 Media Interface	2.1 Basic PTP	2.1 Basic PTP	2.1 Basic PTP	2.5 Multicast config	3.1 IGMP V3	3.2 SDP	3.2 SDP	3.2 SDP	4.1 Basic Tx Video	4.1 Basic Tx Video	4.1 Basic Tx Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.3 ST 2110-21 buffer measurements Video	4.3 ST 2110-21 buffer measurements Video	4.4 RTP - TS Test Video	4.4 RTP - TS Test Video	4.5 Rx Basic Video	4.5 Rx Basic Video	4.6 Rx Fidelity Video	4.6 Rx Fidelity Video
Subtest			Ping	TTL>16	Ping	TTL>16	Set Domain	Lock	Not Master	Independent settings for Tx and Rx	Use IGMP V3	Tx provide an SDP	SDP is valid with SDPoker	SDP is valid with SDPoker	Stream present	Multicast Addr correct	Format correct	Decode by Reference Rx	No Visible Errors	Prism No errors	Cmax Network Compatibility	VRx Buffer virtual Rx	RTP is 0.1-500ms rel to receive	RTP not drifting	Receive Stream	Display Stream	Receive Stream	Video is free of artifacts
Adeas/Nextera	SDI - IP gateway	FW 2.0 / HW 2.0																										
AJA	IPR-10G-HDMI	FW 2.0.2.0d / HW R1																										
AJA	IPR-10G2-HDMI Rx	FW 2.1.0.0d / HW R0																										
AJA	IPR-10G2-SDI Rx	FW 2.1.0.1 / HW R0																										
AJA	IPT-10G2-HDMI Tx	FW 2.1.0.0d / HW R0																										
AJA	IPT-10G2-SDI Tx	FW 2.1.0.13d / HW R0																										
AJA	KONA IP	FW 15.2.0/																										
AJA	io IP	SW 15.2.0 / HW																										
Bridge Technologies	VB440	FW 5.3.5-1 / HW Rev. A																										
Calrec	AoIP Box	Calrec Hydra Software: 2.0.4 OEM Hardware/Software: Product Name: BACH AES67 Firmware Version: v.3.2.0-b0																										
Cobalt	BBG-SDI-TO-IP	SW 1.2.6																										
Cobalt	BBG-IP-TO-SDI	SW 1.2.6																										
Dalet	Brio	Brio 3.14																										
DirectOut GmbH	MONTONE.42	AoIP Module: SW 4.1.4 / HW 4.3, Mainframe: SW 1.92 / HW 2.3																										
EEG	HD492 with Alta 2110 Module	SW Build 4.2.2019-nmos / HW v1.55x5																										
EVS	XT-VIA	SW 16.02.5 HW 6.0																										
Embrionix	emSFP-GATEWAY ST2110 Dual Encapsulator	SW 2.3																										
Embrionix	emSFP-GATEWAY ST2110 Dual De-Encapsulator	SW 2.3																										
Gefei	NXIO 9102IPgate	FPGA 19.3.20.0 // ARM: 19.320 G																										
Grass Valley	LDX86N + UXF XCU	Headunig v15/ XCU v8 /LDX86N /UXF																										
Grass Valley	K-FRM-1005X-I	SW 14.4.0d77 HW ??																										
Grass Valley	MV-820-IP	SW 11.75.76 SW 2.17alpha.62 / HW MV-820-IP																										
Grass Valley	Kaleido-IP	SW 10.80 / HW X320																										
Grass Valley	iTX	SW 3.212.8.768 HW:GVSP2																										
Grass Valley	IQUCP25	SW 11.73.76 / HW RMIX1251																										

General Tests and ST2110-20 Video Tests continue on following pages. For ST 2110-30 Audio Tests, ST 2110-40 ANC Tests, and ST 2022-7 Tests see pages 3-6.

Legend

Green square indicates the device passed the test.

Blank (white) square denotes one of the following:

1. The test does not apply to the device (example: "SMPTE ST 2110-20 tests do not apply to an audio only product", or "multiviewer product does not have a SMPTE ST 2110-20 sender").
2. The device did not pass the test.

03/30/19		General Tests											ST 2110-20 Video Tests															
Test		1.1 Management	1.1 Management	1.2 Media Interface	1.2 Media Interface	2.1 Basic PTP	2.1 Basic PTP	2.1 Basic PTP	2.5 Multicast config for Tx and Rx	3.1 IGMP V3	3.2 SDP	3.2 SDP	4.1 Basic Tx Video	4.1 Basic Tx Video	4.1 Basic Tx Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.3 ST 2110-21 buffer measurements Video	4.3 ST 2110-21 buffer measurements Video	4.4 RTP - TS Test Video	4.4 RTP - TS Test Video	4.5 Rx Basic Video	4.5 Rx Basic Video	4.6 Rx Fidelity Video	4.6 Rx Fidelity Video	
Subtest		Ping	TTL>16	Ping	TTL>16	Set Domain	Lock	Not Master	Independent settings for Tx and Rx	Use IGMP V3	Tx provide an SDP	SDP is valid with SDP/Port	Stream present	Multicast Addr correct	Format correct	Decode by Reference Rx	No Visible Errors	Prism No errors	Cmax Network Compatibility	Rx Buffer virtual Rx	RTP is 0.1-500ms lat to receive	RTP not drifting	Receive Stream	Display Stream	Receive Stream	Video is free of artifacts		
Harmonic	Spectrum X	SW 8.5.1.0.41 / HW v1																										
Imagine Communications	SNP	SW 1.2.0.18 / HW RevA																										
Imagine Communications	EPIC-MV	SW 1.3. / HW RevA																										
Imagine Communications	VERSIO	SW 4.1.1																										
Leader Electronics Corp	LV5600	SW 2.9 / HW RevA																										
Macnica Technology	VIPA10-L (Judge)	SW 1.6.1 / HW R6310																										
Macnica Technology	VIPA10 (Flair)	SW 1.6.2 / HW R6329																										
Macnica ATD	ST2110 10G Tx IP Package	FPGA Design ver. 0.8.11 / SDK ver. 0.3.0																										
Macnica ATD	ST2110 10G Rx IP Package	FPGA Design ver. 0.8.11 / SDK ver. 0.3.0																										
Matrox Rev	X.mio3 IP	HW RevA / SW 10.0.101.23776																										
Matrox Rev	DSX LE5 Q25	HW RevA / SW 10.0.101.23895																										
Matrox Rev	X.mio5 Q25	HW RevA / SW 10.0.101.23895																										
MediaKind	MK Content Processing	SW 10.5.0.2 / FW 1.1.0.28																										
Mellanox	Rivermax 1.0	SW v. 0.5.44																										
Nevion	Virtuoso	SW 2.9.1600 / HW B1																										
Net Insight	Nimbra 600	HW A1 / SW GX.5.6.0.3																										
Pesa	Secura IP	FW 104 SW 2.30																										
Phabrix	Ox (Decap)	s/w v 3.0.0.																										
Phabrix	Sx TAG (Encap)	s/w 1.07.15177; Embrixion sfp: f/w 2.3																										
Phabrix	Sx TAG (Decap)	s/w 1.07.15177; Embrixion sfp: f/w 2.3																										
Riedel	AES67-108 G2	SW 6.0.0 / HW 12.05																										
Riedel	MicroN IP	SW 7.50 / HW G2																										

General Tests and ST2110-20 Video Tests continue on following page. For ST 2110-30 Audio Tests, ST 2110-40 ANC Tests, and ST 2022-7 Tests see pages 3-6.

Legend

Green square indicates the device passed the test.

Blank (white) square denotes one of the following:

1. The test does not apply to the device (example: "SMPTE ST 2110-20 tests do not apply to an audio only product", or "multiviewer product does not have a SMPTE ST 2110-20 sender").
2. The device did not pass the test.

03/30/19		General Tests										ST 2110-20 Video Tests															
Test		1.1 Management	1.1 Management	1.2 Media Interface	1.2 Media Interface	2.1 Basic PTP	2.1 Basic PTP	2.1 Basic PTP	2.5 Multicast config	3.1 IGMP V3	3.2 SDP	3.2 SDP	4.1 Basic Tx Video	4.1 Basic Tx Video	4.1 Basic Tx Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.2 Stream Validation Video	4.3 ST 2110-21 buffer measurements Video	4.3 ST 2110-21 buffer measurements Video	4.4 RTP - TS Test Video	4.4 RTP - TS Test Video	4.5 Rx Basic Video	4.5 Rx Basic Video	4.6 Rx Fidelity Video	4.6 Rx Fidelity Video	
Subtest		Ping	TTL > 16	Ping	TTL > 16	Set Domain	Lock	Not Master	Independent settings for Tx and Rx	Use IGMP V3	Tx provide an SDP	SDP is valid with SDPoker	Stream present	Multicast Addr correct	Format correct	Decode by Reference Rx	No Visible Errors	Prism No errors	Cmax Network Compatibility	VRx Buffer virtual Rx	RTP is 0.1-500ms lat to receive	RTP not drifting	Receive Stream	Display Stream	Receive Stream	Video is free of artifacts	
Ross Video	XPN-4RU-IP2-M7	SW 8.7.build 4768 / HW 10.0.100.23768																									
Ross Video	NEWT-IPX-PKG	Firmware: v.2.20.0-b34 Software: 2.0-331 Hardware: v.1.1.0-b31																									
Ross Video	RPTR-EDGE	Firmware: v.1.3.200-b9 Software: 1.0-92-gcc6693d Hardware: v.2.1.0-b78																									
Ross Video	IGGY-MADI	FW 1.0.0-b43 / SW 2.0-327 / HW 1.0.0-b52																									
Ross Video	Minuet	FW 3.2.0-b0 / HW 1.8.4-b10																									
Ross Video	Bach openModule	FW 2.3.0-b103 / HW 0.6.1-b2																									
Ross Video	Bach Liberty	FW 2.3.0-b103 / HW 0.6.1-b1																									
Sony	NXLK-IP series	v0.24																									
Stage Tec	NEXUS XFIP/RIF67	AoIP Module: SW 4.1.4 / HW 4.3																									
Studio Technologies	Model 5512-02	SW 1.00 / HW RevA																									
Studio Technologies	Model 5518	SW 1.00 / HW RevA																									
Sumavision	S010	HW v.1.1 / SW v. 1.0.2																									
TAG	MCM-9000	v4.7.2002																									
Tektronix, Inc	PRISM	SW 1.7.1																									
The Telos Alliance	Axia iQx AoIP console	HW r1 / SW r1																									
The Telos Alliance	Telos Infinity IP Intercom Master Panel	HW r1 / 1.0.6																									
The Telos Alliance	Telos Infinity IP Intercom Beltpack	HW r1 / 1.0.6																									
The Telos Alliance	Mixed Signal xNode	HW r1 / 2.1.2d																									
The Telos Alliance	AES/EBU xNode	HW r1 / 2.1.2d																									
The Telos Alliance	Mic xNode	HW r1 / 2.1.2d																									
The Telos Alliance	Analog xNode	HW r1 / 2.1.2d																									
Vizrt	Viz Engine	Viz Engine/Viz Artist 3.13.0																									
Ward-Beck Systems	preMO-221 + GPIO	HW v2.0 / FW v2.28/190																									
Ward-Beck Systems	32ME-N	HW v2.0 / FW v050001/4078																									
Ward-Beck Systems	AMS8-1AN	HW v1.0, FW v0200/4078																									

For ST 2110-30 Audio Tests, ST 2110-40 ANC Tests, and ST 2022-7 Tests see pages 3-6.

Legend

Green square indicates the device passed the test.

Blank (white) square denotes one of the following:

1. The test does not apply to the device (example: "SMPTE ST 2110-20 tests do not apply to an audio only product", or "multiviewer product does not have a SMPTE ST 2110-20 sender").
2. The device did not pass the test.

03/30/19		ST 2110-30 Audio Tests											ST 2110-40 ANC Tests				ST 2022-7 Tests											
Test		5.1 Basic Tx Audio	5.1 Basic Tx Audio	5.2 Stream Validation Tx Audio	5.3 RTP-TS Test Audio	5.3 RTP-TS Test Audio	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	6.1 Tx Stream Validation ANC	6.1 Tx Stream Validation ANC	6.1 Tx Stream Validation ANC	6.1 Tx Stream Validation ANC	6.2 Rx Validation ANC	6.2 Rx Validation ANC	6.2 Rx Validation ANC	6.2 Rx Validation ANC	7.1 ANC Tx Dual	7.1 ANC Tx Dual	7.1 Audio Tx, Dual (ST 2022-7)	7.1 Audio Tx, Dual (ST 2022-7)	7.1 Video Tx, Dual (ST 2022-7)	7.1 Video Tx, Dual (ST 2022-7)	7.3 Dual ANC Rx with Errors (ST 2022-7)	7.3 Dual audio Rx with Errors (ST 2022-7)	7.3 Dual video Rx with Errors (ST 2022-7)
Subtest		Stream present	Multicast Addr correct	Decode by Reference Rx	RTP is 0.1 - 500ms rel to receive	RTP not drifting	Receive Stream - A	Receive Stream - B	Receive Stream - C	No Audible artifacts on Headphones	DID/SDID match expectation	Legal values for SDI line and sample fields	Marker and Field bits correct for format	No Stream payload errors	Display Closed Caption Text	Output ANC into SDI and read on Test Equipment	Provide packet list with at least DID/SDID and line numbers	Initiate Redundant Stream	Red and Blue on different IPV4 and MAC addr	Initiate Redundant Stream	Red and Blue on different IPV4 addr	Initiate Redundant Stream	Red and Blue on different IPV4 addr	Red and Blue on different IPV4 addr	Receive w/ 25% error alternating between ports	Receive w/ 25% error alternating between ports	Receive w/ 25% error alternating between ports	
Adeas/Nextera	SDI - IP gateway	FW 2.0 / HW 2.0																										
AJA	IPR-10G-HDMI	FW 2.0.2.0d / HW R1																										
AJA	IPR-10G2-HDMI Rx	FW 2.1.0.0d / HW R0																										
AJA	IPR-10G2-SDI Rx	FW 2.1.0.1 / HW R0																										
AJA	IPT-10G2-HDMI Tx	FW 2.1.0.0d / HW R0																										
AJA	IPT-10G2-SDI Tx	FW 2.1.0.13d / HW R0																										
AJA	KONA IP	FW 15.2.0/																										
AJA	io IP	SW 15.2.0 / HW																										
Bridge Technologies	VB440	FW 5.3.5-1 / HW Rev. A																										
Calrec	AoIP Box	Calrec Hydra Software: 2.0.4 OEM Hardware/Software: Product Name: BACH AES67 Firmware Version: v.3.2.0-b0																										
Cobalt	BBG-SDI-TO-IP	SW 1.2.6																										
Cobalt	BBG-IP-TO-SDI	SW 1.2.6																										
Dalet	Brio	Brio 3.14																										
DirectOut GmbH	MONTONE.42	AoIP Module: SW 4.1.4 / HW 4.3, Mainframe: SW 1.92 / HW 2.3																										
EEG	HD492 with Alta 2110 Module	SW Build 4.2.2019-nmos / HW v1.55x5																										
EVS	XT-VIA	SW 16.02.5 HW 6.0																										
Embrionix	emSFP-GATEWAY ST2110 Dual Encapsulator	SW 2.3																										
Embrionix	emSFP-GATEWAY ST2110 Dual De-Encapsulator	SW 2.3																										
Gefei	NXIO 9102IPgate	FPGA 19.3.20.0 // ARM: 19.320 G																										
Grass Valley	LDX86N + UXF XCU	Headunig v15/ XCU v8 /LDX86N /UXF																										
Grass Valley	K-FRM-100SX-I	SW 14.4.0d77 HW ??																										
Grass Valley	MV-820-IP	SW 11.75.76 SW 2.17alpha.62 / HW MV-820-IP																										
Grass Valley	Kaleido-IP	SW 10.80 / HW X320																										
Grass Valley	iTX	SW 3.212.8.768 HW:GVSP2																										
Grass Valley	IQU/CP25	SW 11.73.76 / HW RMIX1251																										

ST 2110-30 Audio Tests, ST 2110-40 ANC Tests, and ST 2022-7 Tests continue on following pages.

Legend

Green square indicates the device passed the test.

Blank (white) square denotes one of the following:

1. The test does not apply to the device (example: "SMPT E ST 2110-20 tests do not apply to an audio only product", or "multiviewer product does not have a SMPT E ST 2110-20 sender").
2. The device did not pass the test.

03/30/19			ST 2110-30 Audio Tests													ST 2110-40 ANC Tests				ST 2022-7 Tests															
		Test	5.1 Basic Tx Audio	5.1 Basic Tx Audio	5.2 Stream Validation Tx Audio	5.3 RTP-TS Test Audio	5.3 RTP-TS Test Audio	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	5.4 Rx Audible Validation	6.1 Tx Stream Validation ANC	6.1 Tx Stream Validation ANC	6.1 Tx Stream Validation ANC	6.1 Tx Stream Validation ANC	6.2 Rx Validation ANC	6.2 Rx Validation ANC	6.2 Rx Validation ANC	6.2 Rx Validation ANC	7.1 ANC Tx Dual	7.1 ANC Tx Dual	7.1 Audio Tx Dual (ST 2022-7)	7.1 Audio Tx Dual (ST 2022-7)	7.1 Video Tx Dual (ST 2022-7)	7.1 Video Tx Dual (ST 2022-7)	7.3 Dual ANC Rx with Errors (ST 2022-7)	7.3 Dual audio Rx with Errors (ST 2022-7)	7.3 Dual video Rx with Errors (ST 2022-7)				
		Subtest	Stream present	Multicast Addr correct	Decode by Reference Rx	RTP is 01-500ms rel to receive	RTP not drifting	Receive Stream-A	Receive Stream-B	Receive Stream-C	No Audible artifacts on Headphones	DID/SDID match expectation	Legal values for SDI line and sample fields	Marker and Field bits correct for format	No Stream payload errors	Display Closed Caption Text	Output ANC into SDI and read on Test Equipment	Provide packet list with at least DID/SDID and line numbers	Initiate Redundant Stream	Red and Blue on different IPV4 and MAC addr	Initiate Redundant Stream	Red and Blue on different IPV4 addr	Initiate Redundant Stream	Red and Blue on different IPV4 addr	Initiate Redundant Stream	Red and Blue on different IPV4 addr	Initiate Redundant Stream	Red and Blue on different IPV4 addr	Receive w/ 25% error alternating between ports	Receive w/ 25% error alternating between ports	Receive w/ 25% error alternating between ports				
Harmonic	Spectrum X	SW 8.5.1.0.41 / HW v1																																	
Imagine Communications	SNP	SW 1.2.0.18 / HW RevA																																	
Imagine Communications	EPIC-MV	SW 1.3. / HW RevA																																	
Imagine Communications	VERSIO	SW 4.1.1																																	
Leader Electronics Corp	LV5600	SW 2.9 / HW RevA																																	
Macnica Technology	VIPA10-L (Judge)	SW 1.6.1 / HW R6310																																	
Macnica Technology	VIPA10 (Flair)	SW 1.6.2 / HW R6329																																	
Macnica ATD	ST2110 10G Tx IP Package	FPGA Design ver. 0.8.11 / SDK ver. 0.3.0																																	
Macnica ATD	ST2110 10G Rx IP Package	FPGA Design ver. 0.8.11 / SDK ver. 0.3.0																																	
Matrox Rev	X.mio3 IP	HW RevA / SW 10.0.101.23776																																	
Matrox Rev	DSX LE5 Q25	HW RevA / SW 10.0.101.23895																																	
Matrox Rev	X.mio5 Q25	HW RevA / SW 10.0.101.23895																																	
MediaKind	MK Content Processing	SW 10.5.0.2 / FW 1.1.0.28																																	
Mellanox	Rivermax 1.0	SW v. 0.5.44																																	
Neveon	Virtuoso	SW 2.9.1600 / HW B1																																	
Net Insight	Nimbra 600	HW A1 / SW GX.5.6.0.3																																	
Pesa	Secura IP	FW 104 SW 2.30																																	
Phabrix	Qx (Decap)	s/w v 3.0.0.																																	
Phabrix	Sx TAG (Encap)	s/w 1.07.15177; Embrixonix sfp: f/w 2.3																																	
Phabrix	Sx TAG (Decap)	s/w 1.07.15177; Embrixonix sfp: f/w 2.3																																	
Riedel	AES67-108 G2	SW 6.0.0 / HW 12.05																																	
Riedel	MicroN IP	SW 7.50 / HW G2																																	

ST 2110-30 Audio Tests, ST 2110-40 ANC Tests, and ST 2022-7 Tests continue on page 6.

Legend

Green square indicates the device passed the test.

Blank (white) square denotes one of the following:

1. The test does not apply to the device (example: "SMPTTE ST 2110-20 tests do not apply to an audio only product", or "multiviewer product does not have a SMPTTE ST 2110-20 sender").
2. The device did not pass the test.

