ClearView
A/V Analyzers

Video Clarity
Tools for Video Analysis
ClearView is a state-of-the-art test & measurement analyzer for video quality, subjective viewing, recording and playing high definition and standard definition uncompressed sequences*. The product line consists of the widest choice of product capabilities and model platforms available.

With the convergence of voice, TV and data there is a drive toward multiple resolutions and processing methods to all screens - TV, PC and mobile. Therefore, the requirements of digital content distribution have increased dramatically. Evolving compression schemes from MPEG-2 to MPEG-4 AVC and now HEVC and mJPEG have increased the need for tools that can properly analyze and track results.

Digital media can be reproduced at any resolution, assuming that one has the storage space and the bandwidth (the number of bits per second that can be sent through a given medium, such as fiber optic cable or the air). At some point, the level of resolution achieved by digitizing a signal will become so good that it is indistinguishable, given the limitations of our perception, from the source.

The most decisive task for product developers and broadcasters is to create a product or service that can fit as many programs as possible into the available bandwidth before the quality becomes objectionable.

To this end, human perceptual video and audio quality analysis must be done.

Two ways exist to do this analysis:
- Perform in-depth analysis on problematic/difficult streams and judge the perceived A/V quality
- Perform long-duration tests searching for drops/degradation in A/V quality over a 24/48 hour test run

In depth A/V quality analysis is a subjective notion. The most precise way to measure quality is to collect human observers and to ask them to judge the quality. This is an expensive and potentially inconsistent approach as human observers need to be judged to make sure that they can be trusted - i.e. their sight is good, they are not too tired or they are not color blind, etc. In the end, a mean opinion score (MOS) is computed for each test. Details for setting up a subjective test can be found in Recommendation ITU-R BT.500-12 - Methodology for the subjective assessment of the quality of television pictures.

A number of algorithms have been developed to estimate perceived quality in a precise way. The results of these algorithms are then correlated against correctly produced subjective data under ITU-R BT.500.12. The result is a perceptual measure of subjective quality.

The algorithms are divided into three general types:
- Full reference algorithms compare the processed and reference sequences
- No reference algorithms analyze only the processed
- Reduced reference algorithms extract specific information from the reference stream and use it when analyzing the processed stream

The ClearView Analyzer product line features four full reference scoring methods or scales:
- MOVIE: MOtion-based Video Integrity Evaluation index which is able to provide one of the most accurate perceptual video quality measurements
- MS-SSIM/DMOS: Multi-Scale Structural Similarity Image Quality Assessment on both MS-SSIM and DMOS scales, where DMOS is the difference between the mean opinion scores of the reference and processed video
- JND: The number of human observers that must be gathered to end up with at least one person who believes that the processed video is at least as good as the reference (just noticeable differences)
- PEAQ: Perceptual Evaluation of Audio Quality with two scales produced from a computerized model of the human ear, BS.1387 and BS.1118

The ClearView Analyzer product line includes four no-reference scoring methods:
- APEAK: True-peak audio measurement per channel according to ITU-R BS.1770-3
- LKFS: Audio loudness measurement per program according to ITU-R BS.1770-3
- Spatial: Calculates the activity power of a video frame, a higher number indicates more changes in the frame
- Temporal: Calculates the changes between successive video frames, a zero indicates a frozen frame

ClearView provides various tools for assessing perceptual video and audio quality and the performance of video and audio. To start, we will explore the various subjective tools (page 3) and then move to the perceptual and performance tools (page 4 and 5).

* A sequence can be video with audio and VANC of any duration.
One of the easiest ways to subjectively analyze two different sequences is to look at them on the same display. Using two different displays, even of the same type, requires vigilant calibration. Therefore, ClearView has many viewing modes that show the two sequences. In side-by-side and split-mirror modes the sequences can be panned as only half of the image is showing. In seamless split part of the image is from the reference and the rest of the image is from processed (the combined image forms a full screen). ClearView allows the split point to be arbitrary (not just the middle/center).

ClearView can, of course, send the two sequences to two different displays. This is done using the multiple output viewing mode command. Further, this can be perfectly synchronized for 3D playback.

**Side-By-Side Viewing**

Using the ClearView GUI, the command line interface (CLI), or play lists, two sequences can be displayed in a variety of ways:
- Side-by-Side (or over-under)
- Seamless Split
- Split Mirror (butterfly)
- A minus B (with threshold and color addback)
- Full Screen (each sequence to a different display or one at a time to the same display)

Video sequences can be further analyzed as follows:
- Playing individual fields
- Zooming into any picture area up to 16x
- Panning within the picture during zoom or split screen
- Identifying pixel values via mouse click

ClearView A-B: An easy way to view pixel intensity differences between two images. Below a straight subtraction shows one pixel level intensity which may not be possible with some displays. ClearView includes A minus B with Threshold and Addback allowing users to see differences that are greater than a threshold as a color. Edge differences also stand out in this mode.

A minus B with Threshold = 20 Viewing Modes

**Colors green A>B; yellow B>A**

These views are simultaneously fed to the ClearView user interface and to each of ClearView’s full resolution video outputs providing a versatile subjective viewing solution.
PSNR: The most widely used metrics are PSNR (Peak Signal-to-Noise Ratio) or MSE (Mean Squared Error). Both measure the mean error between input and output. PSNR expresses its result as a ratio of the peak signal expressed in dB. PSNR and MSE, while not performing a human perceptual video quality prediction, do serve an important role. PSNR is the objective metric included in all ClearView systems. It measures the absolute difference between two signals, which is completely quantifiable. This is very important in QA and device performance testing where the perceived quality has already been measured in the laboratory environment and what is needed is a PASS/FAIL indicator.

Video Perceptual Quality Measurements

MOVIE: The ClearView 8.2 version system provides a new video quality measurement, MOVIE, the MOtion-based Video Integrity Evaluation index which is able to provide an improved perceptual video quality prediction as an addition to others offered in ClearView systems up to this point. Additionally, MOVIE provides an incrementally accurate correlation to standards-based human subjective quality assessments versus other measurements by implementing an advanced method of defining and measuring spatial and temporal motion distortion in a localized multiscale framework. Therefore, MOVIE provides a leap forward by defining the time-space element and its effects on human perception of video quality as it applies to a full-reference measurement method. In ClearView the overall MOVIE index is provided and selections for Temporal MOVIE or Spatial MOVIE indices are included.

MS-SSIM and DMOS: The structural similarity approach provides an alternative and complementary way to accurately measure human perceptual video quality. It is based on a top-down assumption that the HVS is highly adapted for extracting structural information from a scene, and therefore a measure of structural similarity is an excellent approximation of perceived image quality. The idea is that the eye can recognize a shape even if part of it is missing. It has been shown that a simple implementation of structural similarity (SSIM) outperforms other perceptual image quality metrics. However, the SSIM index achieves the best performance when applied at an appropriate scale (i.e. viewer distance/screen height). Therefore, multi-scale structure similarity (MS-SSIM) has been defined. In MS-SSIM, the picture is evaluated at various resolutions and the result is an average of these calibrated steps and MS-SSIM out-performs simple SSIM even when the SSIM is correctly calibrated to the environment and data set.

ClearView includes the algorithm developed by the University of Texas known as MS-SSIM and provides it on both DMOS (Differential Mean Opinion Score) and MS-SSIM scales. The measurements may be performed on luma (Y) and a combined score is provided for color difference channels (Cb, Cr).

ClearView System Option - Sarnoff JND: A well accepted perceptual video quality index method which simulates the functionality of the human visual system (HVS) components.

The method involves video/audio alignment, low pass filtering (to simulate the eye – video only), calculating the differences that affect the human eye/ear, blockiness, blurriness, noise, lack of dynamic range, loss of high frequencies, classifying the types of distortions, and generating a perceived quality number per frame. ClearView analyzers are optionally licensed with the algorithm developed by Sarnoff Corporation known as Picture Quality Ratio (PQR) and place it on the JND (Just Noticeable Differences) scale.
Audio Perceptual Quality Measurement

The ITU-R PEAQ (Perceptual Evaluation of Audio Quality) model is an “electronic ear” which performs an objective measurement of perceived quality of wide band (up to 20 kHz) audio signals using a computerized model of the human ear. This well accepted perceptual audio quality measurement method was developed jointly by experts from eight leading research laboratories and is an international ITU-R standard. It is ITU-R Recommendation BS.1387, “Method for objective measurement of perceived audio quality”.

The PEAQ model processes two audio signals to be compared (namely the original reference signal and the test version to be evaluated) and calculates a quality score similar to the mean opinion score that would be obtained from a formal subjective test. In this sense, the PEAQ model is considered as an “average listener”.

The perceptual rating generated by the PEAQ model represents the overall severity of the impairments in the test signal as compared to the reference. The ClearView system provides the user with two rating scales as shown on the right.

The ClearView analyzer features a full implementation of the ITU-R PEAQ model which has been certified by the Communications Research Centre Canada, one of the laboratories that developed the ITU-R PEAQ method.

The PEAQ measurement is included with all fully licensed ClearView system models delivered with ClearView 7.0 or later versions. It is an optional upgrade for ClearView systems delivered under previous ClearView versions or new ClearView QA systems.

Audio Performance Measurements

Audio Frequency Metric - AFREQ - A comparison of audio versus a reference to find gross audio errors.
- Audio Alignment (lip-sync), a millisecond accurate measurement, is included in AFREQ.

Audio Peak Metric and Loudness Measurement - APEAK measures the true-peak amplitude and gives a value for each frame and separate value for each channel. Within the APEAK there is a selection for LKFS, Loudness K-weighted relative to Full Scale. LKFS metric gives a measurement that will take the peak loudness over a one second period over all audio channels in a given program and respond with one value over that period. The values returned are based on a logarithmic scale with 0 being the maximum value and -60 being close to silence.
- The LKFS measurement in ClearView is based on recommendation ITU-R BS.1770-3.
**Equipment Manufacturers** want to accelerate the development of their processing algorithms. ClearView allows developers to compare performance of algorithms, quantitatively or subjectively judge them, and get detailed reports.

**ClearView**
- Imports many compressed or uncompressed file formats (video and audio file types listed on page 10)
- Records video and audio using standard baseband inputs like HD/SD/3G SDI, HDMI, Component, Composite or S-Video as well as digital or analog audio on XLR and embedded SDI
- Captures live from an IP network and demultiplexes the targeted stream for decoding and testing

Regardless of whether the sequence is imported as a file or recorded, a file is stored as YUV 4:2:2 or RGB 4:4:4.

ClearView can then:
- Automatically align the two sequences spatially and temporally
- Provide a subjective comparison of the two sequences using any of the viewing modes previously shown
- Score the video and audio quality on a perceptual scale using the MOVIE, DMOS, JND and PEAQ methods
- Objectively measure using PSNR

The perceptual scores and objective measurements can be saved to a log file, which contains all of the information about the sequences. The log file can be imported into Excel so as to be combined with other data and it can be dropped onto the ClearView GUI (shown on page 10) to restore the test session.

**Ways to use ClearView:**
1) Send a sequence via HDSDI or IP to ClearView or from ClearView to the processing unit. Simultaneously record the transmitted output from a hardware decoder or from an IP network directly.

2) Send a known sequence via SDI to the processing unit, record the output from a hardware decoder and compare this to a pre-recorded result - generating pass fail to a ClearView log file or CLI script.
Content originators and entertainment service providers want to determine the optimal parameters to fit as many channels or streams into the delivery network as possible and reach an acceptable quality level. They also want to check the quality of the material after it has been compressed and packaged in a transport or program stream. To do this the ClearView analyzer will play a reference sequence to the processing unit and simultaneously record the decoder output.

ClearView then provides multiple comparison measurements of the processor output to the original content.

ClearView
- Plays an uncompressed sequence through HD/SD/3G SDI, HDMI or analog outputs to the processing unit
- Records, simultaneously, from the IP network or from a decoder through HD/SD/3G SDI, HDMI or analog inputs
- Aligns spatially & temporally
- Judges the quality using MOVIE, DMOS, JND and PEAQ
- Produces log files with the results (log files are text that can be examined as is or automatically exported to Excel)
- Drag and drop logs for recalling any test along with its synchronized side by side audio/video comparison

Another application for manufacturers, broadcasters or any entertainment service provider is using RTM to monitor quality and record performance faults in on-air or IP network quality of service from a long duration test. The RTM system can detect content specific, continuous or intermittent effects on audio or video quality.

RTM - a full reference A/V quality monitor *
- Inputs source “reference” and downstream “processed” AV signals through HDSDI, IP or File
- Measures the audio and video quality as PSNR or DMOS in real-time on live sources
- Measures the audio and video delay (lip-sync) in real-time
- Measures the audio loudness according to ITU-R BS.1770-3
- Measures each VANC line’s data line integrity with each line individually selectable
- Continuously reports min, max and average A/V quality and A/V delay to log files
- Records the failed portions of the A/V sequences, sends an SNMP trap or alarm if any of the above have fallen below a user set degradation threshold
- RTM is optionally combined with ClearView in the same system to provide both test applications

*See RTM data sheet for full feature description
Perceptual Quality Metrics
- MOVIE: MOTion-based Video Integrity Evaluation index with separately selectable Temporal MOVIE and Spatial MOVIE indices
- MS-SSIM: Provided on DMOS and MS-SSIM scales
- Sarnoff JND*: On the Just Noticable Differences scale
- PEAQ: ITU-R BS.1387 method on BS.1387 or BS.1116 scales for audio quality

Objective Metrics
- PSNR: Peak Signal to Noise differences in video
- aFREQ: Audio Frequency conformance measurement to find gross errors in audio performance versus a reference, provides lip-sync measurement in milliseconds

No Reference (Reduced Reference) Metrics
- APEAK: True-peak audio measurement per channel according to ITU-R BS.1770-3
- LKFS: Audio loudness measurement per program according to ITU-R BS.1770-3
- Spatial: Calculates the activity power of a frame, a higher number indicates more changes within the frame
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Subjective Viewing Modes on Video Output
- Numerous side-by-side, over-under viewing modes to assess quality at full resolution
- Interactive Picture Zoom and Pan, Field/Frame play modes, Pixel Value tools and more

* JND metric license is an option on all ClearView models, item CV-JND.

ClearView Graphical User Interface

Control
- ClearView GUI
- Play list commands
- Load list commands
- Batch file commands
- Using CLI interface

Operation
- Record from AV inputs
- 3G HDSDI, HDMI or analog
- Input from IP Network
- Both a source and test stream
- Real-time demux/decode
- Import files
- Demultiplex MPTS files
- Scale/Crop
- Decode many file types
- Review On HDSDI or HDMI
- Side-by-side
- Over-under
- Split mirror
- A-B with addback/threshold
- Field-only play
- Zoom & pan
- Pixel values

Perceptual Metrics
- MOVIE
- MS-SSIM with DMOS scale
- JND (option)
- PEAQ

Other
- APEAK true-peak amplitude
- LKFS loudness test
- aFREQ impairment test
- Lip-sync +/- measurement
- PSNR
- Spatial (Activity)
- Temporal (Change)

Off-line Analysis
- Log files contain the scores and information about the test setup
- Export into Excel
- Import back to ClearView to restore sessions
There are several ways to record live AV sequences into ClearView. All ClearView systems provide a combination of digital video/audio inputs as well as IP input capabilities. Digital input interfaces are HDSDI with embedded audio and IP network inputs. IP inputs provide several options for capturing one or two IP streams as outlined below. ClearView also provides the very useful ability to record a side by side sequence from the system’s output into a file for export to standard file formats.

**Broadcast Inputs**

ClearView systems hold several options for HDSDI, HDMI or analog source recording. The broadcast record tab allows a selection of single input, dual input or input/output modes and the configuration menu options are tailored to the input interfaces installed in your ClearView model.

ClearView systems automatically detect the input format for record operations. Sequences are stored as unmodified, fully uncompressed audio and video which is saved for instant recall and playback operations from a user designated ClearView library file folder and sequence name.

**IP Inputs**

Record 1 IP Input - A single input mode that records a video sequence as sensed at the IP multicast address and port specified within the IP configuration menu as pictured to the right.

Record 2 Inputs - Dual IP or IP with SDI input modes record sequences from two separate inputs or mix of inputs. Each input selection is provided with individual menus to set up SDI or IP input parameters. Each IP menu contains transformation settings for scale, crop, de-interlace, rate change and position for matching of source content to the IP network delivered sequence format for testing.

Record While Playing - In this mode the HDSDI output will play a sequence loaded into Viewport A for processing by the IP network processor or device under test with IP output. The ClearView IP input can then simultaneously record from an IP stream.

**From ClearView**

The ClearView Output tab provides the unique ability to record any sequence or combination of two sequences that are set into any View Mode. As an example a side by side view of two synchronized sequences, each with an identifying overlay window is created as a single file in a ClearView library. This AV sequence can then be exported in YUV, AVI or QuickTime format for delivery and playback review by most of today’s computer desktop graphics outputs. This mode also allows a snapshot recording so that representative stills can be inserted as reference material to presentations.
ClearView File Importer is the latest addition for importing files into ClearView. It is a stand-alone application provided with ClearView systems allowing complete control and thumbnail viewing of imported sequences that are automatically formatted into a ClearView library for use within a ClearView test routine.

ClearView File Importer GUI

User configurable file adjustments:
- Decoded or imported frame size, rate
- First/last frames to import
- 3:2 pull down insertion or removal
- Bit depth conversion (8 to 10 or 10 to 8)
- Crop source with input values or interactive box
- Scale video resolution up or down to x, y / w, h
- Color space convert YUV to/from RGB
- Import audio
- Variable image and canvas resolution
- Truncate to legal broadcast values (yes/no)

Imported File Formats (partial list)
- Accom YUV CCIR 601 8-bit
- ARI Raw Bayer Pattern
- Avid AVR, DS HD/SD, DV (*.gen)
- Avid Meridian, Y’CbCr, OMFI (*.omf, *.omfi)
- AVR, JFIF, JPEG, Meridian, RGB, Y’CbCr
- Cineon (*.cin), CineWave
- DPX RGB 8, RGB 10, Y’CbCr 4:2:2
- DV (*.dv, *.dif), Digital Negative (*.dng)
- DVS Direct File Format (*.dvs)
- DVSD, DV25, DV50, MPEG-I, mJPEG, DigiSuite
- D261, H.264, H.265, HDV
- Headerless/Raw (*.hdr, *.yuv, *.rgb, *.raw)
- HiCon SLB32 RFB format (*.slb)
- Image (*.gif, *.jpg, *.png), Jaleo Direct Format (*.js)
- JPEG, JPEG2000, Media 100 MJPEG
- Microsoft AVI (*.avi), BMP, DIB Files (*.dps)
- MJPEG, MPEG 1 4:2:0 (*.mpeg, *.mpeg)
- MPEG-2 Elem. Stream, (4:2:0/4:2:2), MPEG2 (*.m2v)
- MPEG-2 Program Stream, (4:2:0/4:2:2)
- MPEG-2 in Transport Stream, (4:2:0/4:2:2)
- MPEG-2.4 in MPTS (4:2:0, 4:2:2), MPEG4 (*.m4v)
- MPEG-4 AVC Elementary Stream 4:2:0/4:2:2, (*.h264)
- MPEG-H HEVC/H.265 4:2:0 Main Profile (*.h265)
- MXF Format (DV, VCPro50, MPEG, IMX)
- Newtek Video Toaster (*.rtv)
- Phantom Support (*.cine), Photoshop FilmStrip (*.flm)
- Photo CD, PhotoShop, Portable anymap PNM
- Portable Bitmap Format PBM DPS
- Portable graymap PGM
- Portable pixmap PPM
- Profile GXF Format/SMPTE-360 (*.gxf)
- QuickTime Movies (*.mov)
- QuickTime formats w/proper codec, ProRes, etc...
- RealVideo (*.ra, *.rm, *.ram), Red Camera Stream (*.r3d)
- Run-Length encoding (rl)
- SGI Movie Format (*.mv), SGI RGB
- Silicon Image Bayer (*.siv), Sun Raster (*.ras)
- Targa TGA, ICB, VDA, VST, Targa 3000, TIFF, TIF
- v210 Y’CbCr 10 Bit, VC-1 Pro, Viewstore (*.vcr)
- Windows Media (/*.asf, *.wmv), Y’CrCb (*.vsr)
- Y’CbCr 8/10, Y’CbCr, RGB, YCrCb 8/RGB

Audio Import Formats
- Dolby Digital Plus Professional Decoder (option)
- MPEG-2 Layer 1 (*mp1)
- MPEG-2 Layer 3 (*mp3)
- Waveform Audio (*wav)
- Adaptive Multi-rate (*amr)
- Audio Interchange File Format (*.aiff)
- Windows Media Audio (*.wma)
- Advanced Audio Coding (*.aac)

Exported File Formats
- QuickTime with up to 8 audio channels
- Microsoft AVI (*.avi), BMP
- Headerless/Raw (*.yuv, *.rgb, *.raw)
### Product Feature Matrix

<table>
<thead>
<tr>
<th>Features</th>
<th>Products</th>
<th>ClearView Extreme 4K10</th>
<th>CV-Extreme 4K10 + RTM</th>
<th>ClearView Shuttle 4K</th>
<th>ClearView Shuttle HD</th>
<th>CV-Shuttle HD + RTM</th>
<th>ClearView QA</th>
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<tr>
<td>PSNR, aFreq, aPeak, Lip-sync metrics</td>
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<td>3RU Kit</td>
<td>3RU Kit</td>
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**ClearView**
- Records two live inputs, imports compressed and uncompressed files
- Stores input items as YUV 4:2:2 or RGB 4:4:4 files
- Automatically aligns reference and comparator file spatially and temporally
- Performs video perceptual measurements with MOVIE, DMOS/MS-SSIM, and JND*
- Performs audio perceptual measurements with PEAQ on BS.1387 or BS.1116 scales
- Facilitates subjective testing by allowing the user to view and hear the sequences via HDSDI or HDMI output
- Provides audio conformance (aFreq), lip-sync, true-peak, loudness and full VANC data integrity measurements on recorded or imported files
- Includes many royalty free test sequences used for encoding research

**RTM Option for ClearView Systems**
- Measures the audio and video quality in real-time
- Performs either DMOS or PSNR calculation in real-time
- Measures the A/V offset/delay (lip-sync)
- Measures audio loudness according to ITU-R BS.1770-3
- Measures the VANC data accuracy by line
- Alarms and records the A/V sequences if any of the above are below the defined threshold
- Creates time based logs for recorded failures and continuous min, max, average log at user set interval

* JND license is an option on all ClearView models

**See RTM data sheet for full feature description**
ClearView Product Models and Specifications

ClearView Extreme 4K Systems

ClearView Extreme 4K-10: Model # CV-S8084-4K-10
A/V Interfaces: CV-SDI-I-O-4K2 (2)
Accessories: 3 RU rack kit, keyboard, mouse, mirror boot drive, manual, AV cables (2)
Play/Record Duration Examples:
Digital Video Standard
3840x2160@60p, 10-bit, 4:2:2: 132 min.
1920x1080@60p, 10-bit, 4:2:2: 528 min.

ClearView Extreme 4K-RTM: Model # CV-S8084-4K-10-RTM
A/V Interfaces and Accessories:
- Same as model CV-S8084-4K-10
- RTM license with RTM-3G function included

ClearView Shuttle Systems

ClearView Shuttle 4K: Model # CV-S2044
A/V Interface: CV-SDI-I-O-4K2 (1)
Accessories: Hard travel case, keyboard, mouse, OS recovery disk, printed manual, cable kit, rack ears
Play/Record Duration Examples: Video Standard
3840x2160@60p, 10-bit, 4:2:2: 28 min.
1920x1080@60p, 10-bit, 4:2:2: 113 min.

ClearView Shuttle Dual HD: Model # CV-S2042
A/V Interface: CV-SDI-I-O-CVD22 (1)
Accessories: Hard travel case, keyboard, mouse, OS recovery disk, printed manual, BNC kit, rack ears
Play/Record Duration Examples:
Digital Video Standard
1280x720@60p, 8-bit, 4:2:2: 194 min.
1920x1080@60, 8-bit, 4:2:2: 173 min.

ClearView QA

Model # CV-S2041-QA
A/V Interface: CV-SDI-I-O-LHI (1)
Accessories: Hard travel case, keyboard, mouse, OS recovery disk, printed manual, cable kit, rack ears
Play/Record Duration Examples:
Video Standard
1920x1080@60, 8-bit, 4:2:2: 224 min.
3840x2160@60p, 10-bit, 4:2:2: 66 min.

ClearView Product A/V Interface Specifications

CV-SDI-I-O-4K2:
- Digital Video: 4 BNC input/output programmable - 3G HD-SDI or SD-SDI compliant
- Supports 8 or 10 bits for SMPTE 259, 292, 296, 424, 425a/b and 4K/QuadHD
- Digital Embedded Audio: 8 channels - SDI embedded input and output
- Digital AES/EBU Audio: 8 channels on 4 BNC input, 8 channels on 4 BNC output
- Analog Video: 3 BNC in, 3 BNC out - Component (Y, Pr, Pb), Composite or S-Video
- Reference Input: 1 BNC - Tri-level HD sync (on analog A/V breakout cable supplied)
- Options:
  - CV-JND - JND metric
  - VC-DDP - Dolby® Digital Plus
  - CV-DDP - Dolby® Digital Plus Professional Input Decoder

CV-SDI-I-O-CVD22:
- Digital Video: 2 BNC input, 2 BNC output - Single 3G or Dual SMTE-292 compliant
- Supports ITU-601, SMPTE 259, 292, 296, 424, 425 (Level A or B-Dual Stream)
- Digital Audio I/O and Format: 8 channels - SDI embedded, 24bit, 48KHz PCM
- Reference Input: 1 BNC - Tri-level sync

CV-SDI-I-O-LHI:
- Digital Video: 1 BNC input, 1 BNC output - 3G HD-SDI or SD-SDI compliant
- Supports 8 or 10 bits for SMPTE 259, 292, 296, 424, 425a/b
- Digital Audio I/O: 8 channels - SDI embedded or 2 channels - AES/EBU on 1 XLR
- HDMI 1.3a: 1 input, 1 output on HDMI mini connectors (2 converter cables supplied)
- Analog Video: 3 BNC in, 3 BNC out - Component (Y, Pr, Pb), Composite or S-Video
- Analog Audio I/O: 2 channels on 2 XLR (Analog A/V cable breakout supplied)
- Reference Input: 1 BNC - Tri-level sync

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