Picture Quality Analysis System

PQA600A Datasheet

Features & Benefits

- Fast, Accurate, Repeatable, and Objective Picture Quality Measurement (Option BAS)

- Predicts DMOS (Differential Mean Opinion Score) based on Human Vision System Model (Option BAS)

- SD/HD/3G SDI, HDMI compliant with HDCP interface and IP interface supporting IGMP for Simultaneous Generation and Capture, 2-channel Capture and 2-channel Generation with Swap-channel / Side by Side / Wipe display

- Real time Up / Down conversion at generation / capture with SDI/HDMI interface for testing the instrument with Up / down conversion process.

- IP Interface with simultaneous 2–channel generation / capture with IGMP support for multicast streams (Option IP)

- Picture Quality Measurements can be made on a Variety of HD Video Formats (1080p, 1080i, 720p) and SD Video Formats (525i or 625i) (Option BAS)

- User-configurable Viewing Condition and Display Models for Reference and Comparison (Option ADV)

- Attention/Artifact Weighted Measurement (Option ADV)

- Region Of Interest (ROI) on Measurement Execution and Review (Option BAS)

- Automatic Temporal and Spatial Alignment (Option BAS)

- Embedded Reference Decoder (Option BAS)

- Easy Regression Testing and Automation using XML Scripting with "Export/Import" File from GUI (Option ADV)

- Multiple Results View Options (Option BAS)

- Preinstalled Sample Reference and Test Sequences

Applications

- CODEC Design, Optimization, and Verification

- Conformance Testing, Transmission Equipment, and System Evaluation

- Digital Video Mastering

- Video Compression Services

- Digital Consumer Product Development and Manufacturing

Picture Quality Analysis System

The PQA600A is the latest-generation Picture Quality Analyzer built on the Emmy Award winning Tektronix PQA200/300. Based on the concepts of the human vision system, the PQA600A provides a suite of repeatable, objective quality measurements that closely correspond with subjective human visual assessment. These measurements provide valuable information to engineers working to optimize video compression and recovery, and maintaining a level of common carrier and distribution transmission service to clients and viewers.

Tektronix®
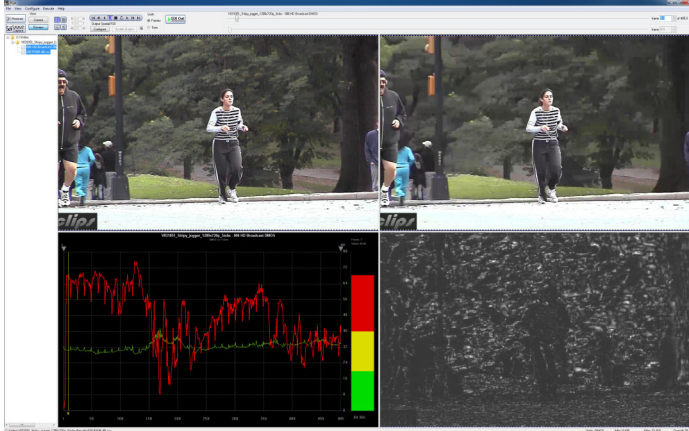
User Interface of PQA600A. Showing reference, test sequences, with difference map and statistical graph.

Compressed Video Requires New Test Methods

The true measure of any television system is viewer satisfaction. While the quality of analog and full-bandwidth digital video can be characterized indirectly by measuring the distortions of static test signals, compressed television systems pose a far more difficult challenge. Picture quality in a compressed system can change dynamically based on a combination of data rate, picture complexity, and the encoding algorithm employed. The static nature of test signals does not provide true characterization of picture quality.

Human viewer testing has been traditionally conducted as described in ITU-R Rec. BT.500-11. A test scene with natural content and motion is displayed in a tightly controlled environment, with human viewers expressing their opinion of picture quality to create a Differential Mean Opinion Score, or DMOS. Extensive testing using this method can be refined to yield a consistent subjective rating. However, this method of evaluating the capabilities of a compressed video system can be inefficient, taking several weeks to months to perform the experiments. This test methodology can be extremely expensive to complete, and often the results are not repeatable. Thus, subjective DMOS testing with human viewers is impractical for the CODEC design phase, and inefficient for ongoing operational quality evaluation. The PQA600A provides a fast, practical, repeatable, and objective measurement alternative to subjective DMOS evaluation of picture quality.

System Evaluation

The PQA600A can be used for installation, verification, and troubleshooting of each block of the video system because it is video technology agnostic: any visible differences between video input and output from processing components in the system chain can be quantified and assessed for video quality degradation. Not only can CODEC technologies be assessed in a system, but any process that has potential for visible differences can also be assessed. For example, digital transmission errors, format conversion (i.e. 1080i to 480p in set-top box conversions), analog transmission degradation, data errors, slow display response times, frame rate reduction (for mobile transmission and videophone teleconferencing), and more can all be evaluated.

How It Works

The PQA600A takes two video files as inputs: a reference video sequence and a compressed, impaired, or processed version of the reference. First, the PQA600A performs a spatial and temporal alignment between the two sequences, without the need for a calibration stripe embedded within the video sequence. Then the PQA600A analyzes the quality of the test video, using measurements based on the human vision system and attention models, and then outputs quality measurements that are highly correlated with subjective assessments. The results include overall quality summary metrics, frame-by-frame measurement metrics, and an impairment map for each frame. The PQA600A also provides traditional picture quality measures such as PSNR (Peak Signal-to-Noise Ratio) as an industry benchmark impairment diagnosis tool for measuring typical video impairments and detecting artifacts.

Each reference video sequence and test clip can have different resolutions and frame rates. This capability supports a variety of repurposing applications such as format conversion, DVD authoring, IP broadcasting, and semiconductor design. The PQA600A can also support measurement clips with long sequence duration, allowing a video clip to be quantified for picture quality through various conversion processes.

## Prediction of Human Vision Perception

PQA600A measurements are developed from the human vision system model and additional algorithms have been added to improve upon the model used in the PQA200/300. This new extended technology allows legacy PQR measurements for SD while enabling predictions of subjective quality rating of video for a variety of video formats (HD, SD, CIF, etc.). It takes into consideration different display types used to view the video (for example, interlaced or progressive and CRT or LCD) and different viewing conditions (for example, room lighting and viewing distance).
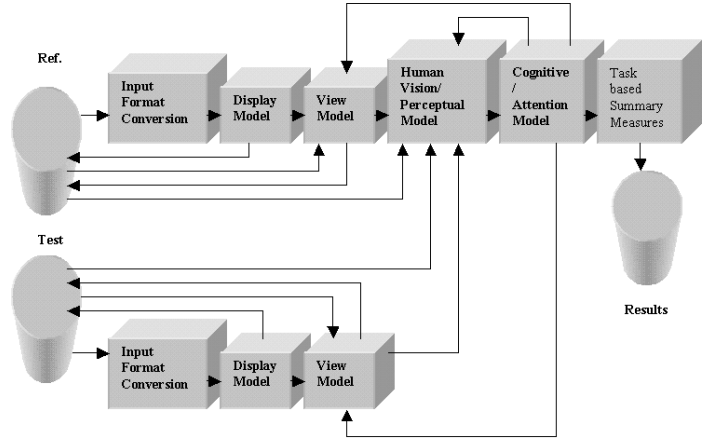

Picture Quality Analysis System

A model of the human vision system has been developed to predict the response to light stimulus with respect to the following parameters:

- Contrast including Supra-threshold
- Mean Luminance
- Spatial Frequency
- Temporal Frequency
- Angular Extent
- Temporal Extent
- Surround
- Eccentricity
- Orientation
- Adaptation Effects
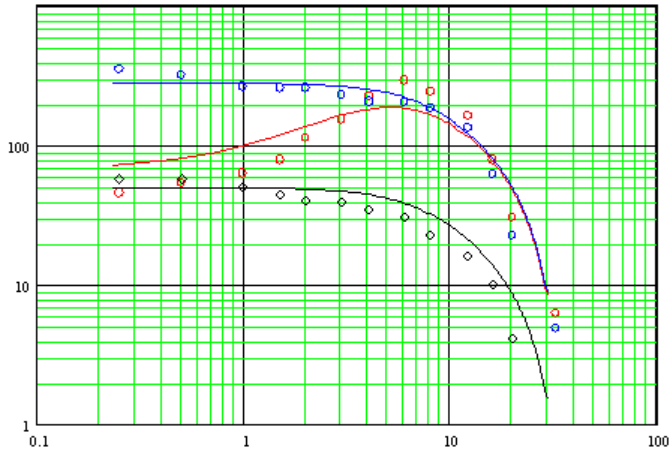
A: Modulation Sensitivity vs. Temporal Frequency
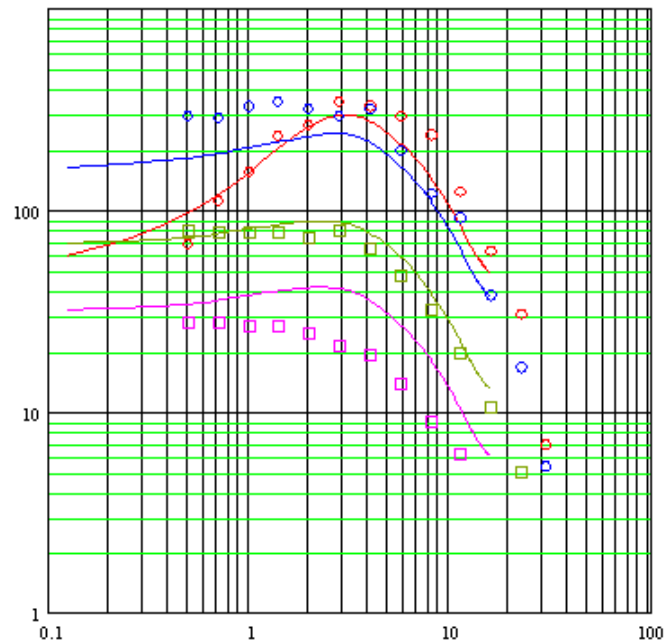
B: Modulation Sensitivity vs. Spatial Frequency

This model has been calibrated, over the appropriate combinations of ranges for these parameters, with reference stimulus-response data from vision science research. As a result of this calibration, the model provides a highly accurate prediction.

C: Reference Picture

D: Perceptual Contrast Map

The graphs above are examples of scientific data regarding human vision characteristics used to calibrate the human vision system model in the PQA600A. Graph (A) shows modulation sensitivity vs. temporal frequency, and graph (B) shows modulation sensitivity vs. spatial frequency. The use of over 1400 calibration points supports high-accuracy measurement results.

Picture (C) is a single frame from the reference sequence of a moving sequence, and picture (D) is the perceptual contrast map calculated by the PQA600A. The perceptual contrast map shows how the viewer perceives the reference sequence. The blurring on the background is caused by temporal masking due to camera panning and the black area around the jogger shows the masking effect due to the high contrast between the background and the jogger. The PQA600A creates the perceptual map for both reference and test sequences, then creates a perceptual difference map for use in making perceptually based, full-reference picture quality measurements.

E: Reference

**G**: PSNR Map
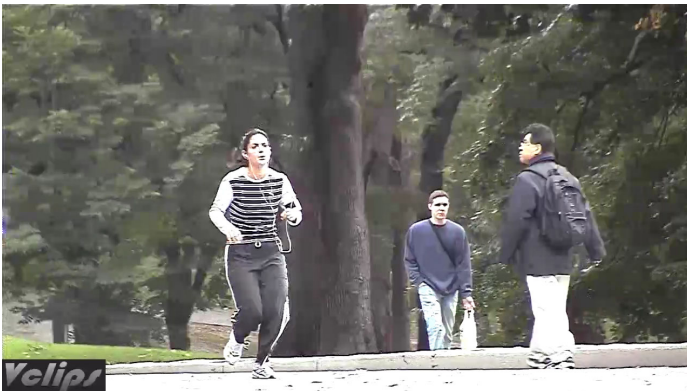
F: Test

H: Perceptual Difference Map for DMOS

Comparison of Predicted DMOS with PSNR

In the example above, Reference (**E**) is a scene from one of the VClips library files. The image Test (**F**), has been passed through a compression system which has degraded the resultant image. In this case the background of the jogger in Test (**F**) is blurred compared to the Reference image (**E**). A PSNR measurement is made on the PQA600A of the difference between the Reference and Test clip and the highlighted white areas of PSNR Map (**G**) shows the areas of greatest difference between the original and degraded image. Another measurement is then made by the PQA600A, this time using the Predicted DMOS algorithm and the resultant Perceptual Difference Map for DMOS (**H**) image is shown. Whiter regions in this Perceptual Contrast Difference map indicate greater perceptual contrast differences between the reference and test images. In creating the Perceptual Contrast Difference map, the PQA600A uses a human vision system model to determine the differences a viewer would perceive when watching the video.

The Predicted DMOS measurement uses the Perceptual Contrast Difference Map (**H**) to measure picture quality. This DMOS measurement would correctly recognize the viewers perceive the jogger as less degraded than the trees in the background. The PSNR measurement uses the difference map (G) and would incorrectly include differences that viewers do not see.
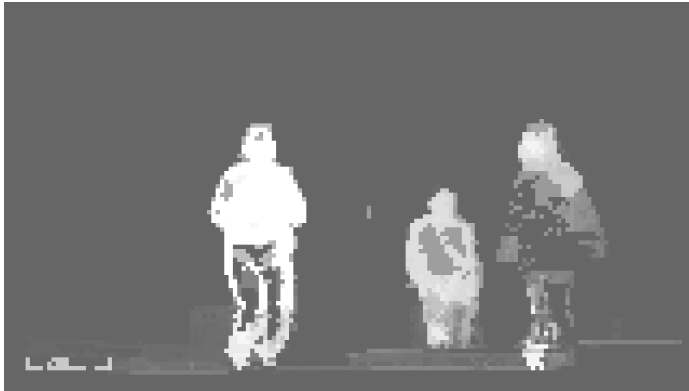
Attention Map Example: The jogger is highlighted

Attention Model

The PQA600A Opt. BAS and Opt. ADV or PQASW Opt. ADV, also incorporate an Attention Model that predicts focus of attention. This model considers:

- Motion of Objects
- Skin Coloration (to identify people)
- Location
- Contrast
- Shape
- Size
- Viewer Distraction due to Noticeable Quality Artifacts

These attention parameters can be customized to give greater or less importance to each characteristic. This allows each measurement using an attention model to be user-configurable. The model is especially useful to evaluate the video process tuned to the specific application. For example, if the content is sports programming, the viewer is expected to have higher attention in limited regional areas of the scene. Highlighted areas within the attention image map will show the areas of the image drawing the eye's attention.

Artifact Detection

Artifact Detection reports a variety of different changes to the edges of the image:

- Loss of Edges or Blurring
- Addition of Edges or Ringing/Mosquito Noise
- Rotation of Edges to Vertical and Horizontal or Edge Blockiness
- Loss of Edges within an Image Block or DC Blockiness

They work as weighting parameters for subjective and objective measurements with any combination. The results of these different
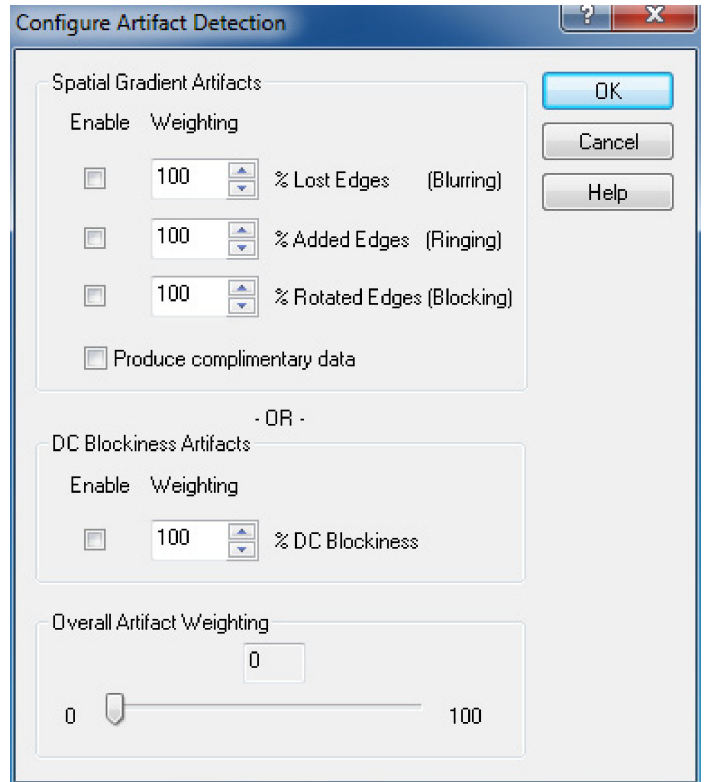
Artifact Detection Settings

measurement combinations can help to improve picture quality through the system.

For example, artifact detection can help answer questions such as: "Will the DMOS be improved with more de-blocking filtering?" or, "Should less prefiltering be used?"

If edge-blocking weighted DMOS is much greater than blurring-weighted DMOS, the edge-blocking is the dominant artifact, and perhaps more de-blocking filtering should be considered.

In some applications, it may be known that added edges, such as ringing and mosquito noise, are more objectionable than the other artifacts. These weightings can be customized by the user and configured for the application to reflect this viewer preference, thus improving DMOS prediction.

Likewise, PSNR can be measured with these artifact weightings to determine how much of the error contributing to the PSNR measurement comes from each artifact.

The Attention Model and Artifact Detection can also be used in conjunction with any combination of picture quality measurements. This allows, for example, evaluation of how much of a particular noticeable artifact will be seen where a viewer is most likely to look.
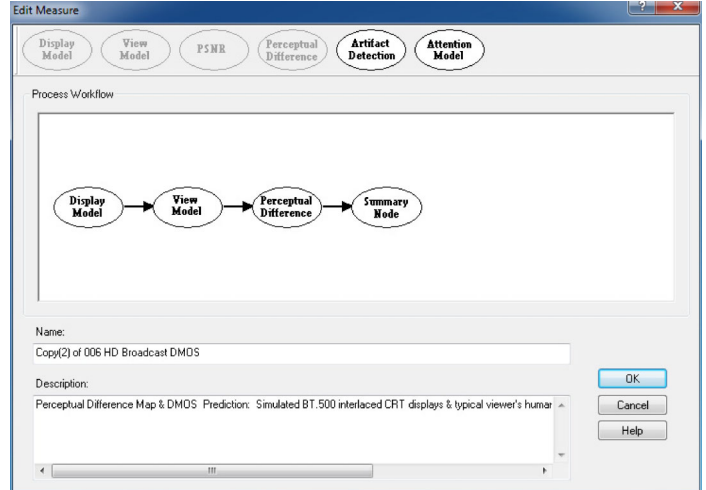
Configure Measure Dialog
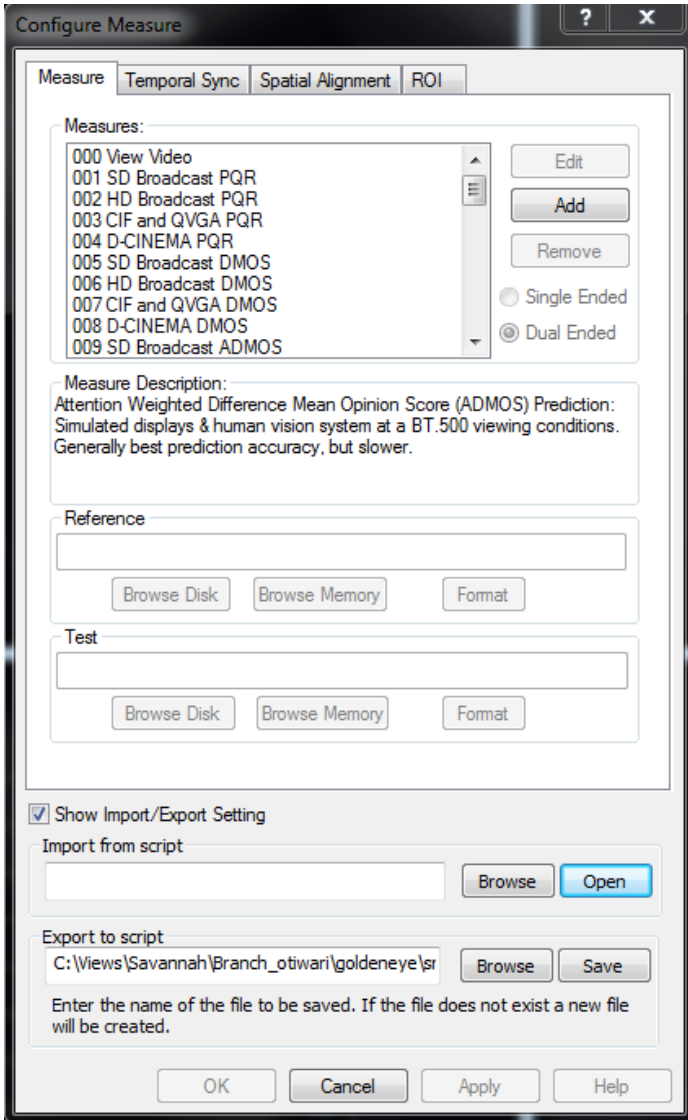
Edit Measure Dialog

Comprehensive Picture Quality Analysis

The PQA600A provides Full Reference (FR) picture quality measurements that compare the luminance signal of reference and test videos. It also offers some No Reference (NR) measurements on the luminance signal of the test video only. Reduced Reference (RR) measurements can be made manually from differences in No Reference measurements. The suite of measurements includes:

- Critical Viewing (Human Vision System Model-based, Full Reference) Picture Quality

- Casual Viewing (Attention Weighted, Full Reference, or No Reference) Picture Quality

- Peak Signal-to-Noise Ratio (PSNR, Full Reference)

- Focus of Attention (Applied to both Full Reference and No Reference Measurements)

- Artifact Detection (Full Reference, except for DC Blockiness)

- DC Blockiness (Full Reference and No Reference)

The PQA600A supports these measurements through preset and user-defined combinations of display type, viewing conditions, human vision response (demographic), focus of attention, and artifact detection, in addition to the default ITU BT-500 conditions. The ability to configure measurement conditions helps CODEC designers evaluate design trade-offs as they optimize for different applications, and helps any user investigate how different viewing conditions affect picture quality measurement results. A user-defined measurement is created by modifying a preconfigured measurement or creating a new one, then saving and recalling the user-defined measurement from the Configure Measure dialog menu.

Easy-to-Use Interface

The PQA600A has two modes: Measurement and Review. The Measurement mode is used to execute the measurement selected in the Configure Dialog. During measurement execution, the summary data and map results are displayed on-screen and saved to the system hard disk. The Review mode is used to view previously saved summary results and maps created either with the measurement mode or XML script execution. The user can choose multiple results in this mode and compare each result side by side using the synchronous display in Tile mode. Comparing multiple results maps made with the different CODEC parameters and/or different measurement configurations enables easy investigation of the root cause of any difference.
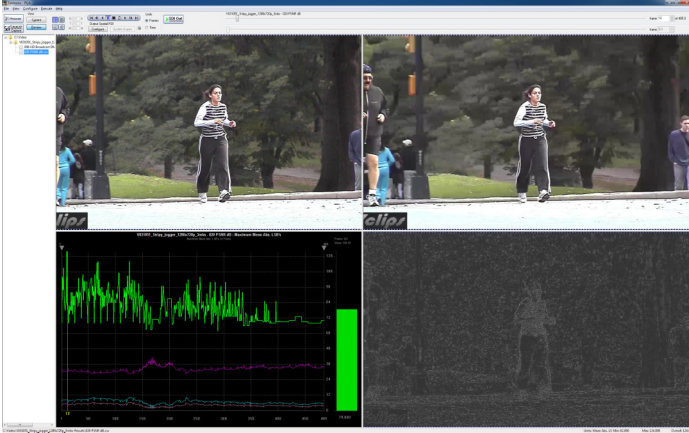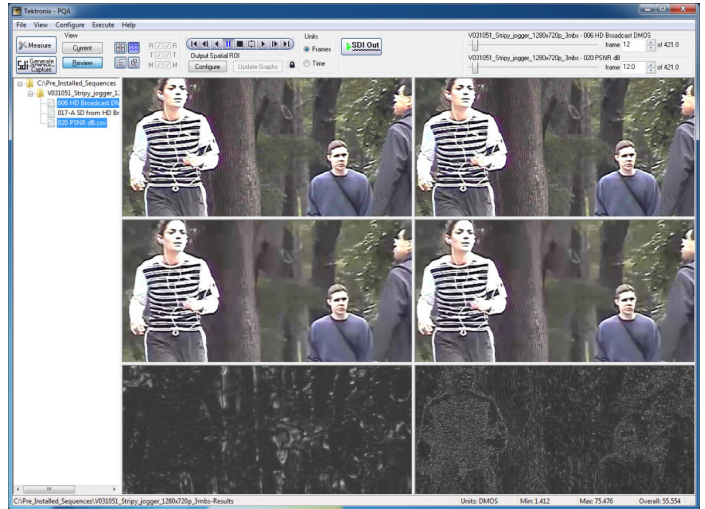
Summary Graph

Graph display with time shift

Six-tiled display

Overlay display, Reference and Map

Multiple Result Display

Resultant maps can be displayed synchronously with the reference and test video in a Summary, Six-tiled, or Overlaid display.

In Summary display, the user can see the multiple measurement graphs with a barchart along with the reference video, test video, and difference map during video playback. The user also can select two measurement results on a graph with auto time shifting that absorbs the timing difference at the content capture tom compare two measurement results intuitively. Summary measures of standard parameters and perceptual summation metrics for each frame and overall video sequence are provided.

In Six-tiled display, the user can display the 2 measurement results side by side. Each consists of a reference video, test video, and difference map to compare to each other.
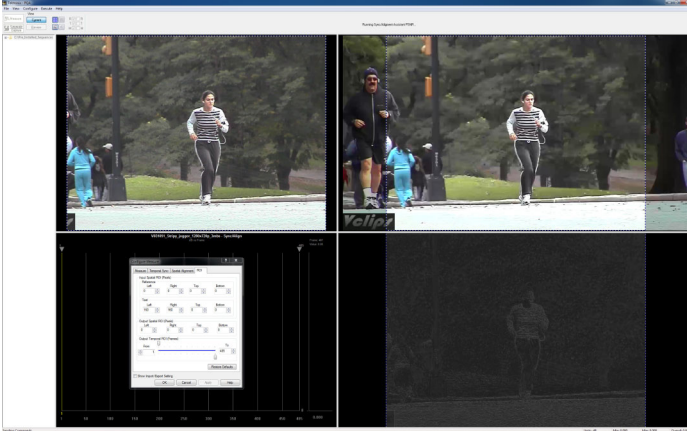
In Overlay display, the user can control the mixing ratio with the fader bar, enabling co-location of difference map, reference, and impairments in test videos.

Error logging and alarms are available to help users efficiently track down the cause of video quality problems.

All results, data, and graphs can be recalled to the display for examination.

Auto spatial alignment execution with spatial region of interest selected

## Automatic Temporal/Spatial Alignment

The PQA600A supports automatic temporal and spatial alignment, as well as manual alignment.

The automatic spatial alignment with spatial region of interest in Measure mode selected independently of the spatial alignment function can measure the cropping, scale, and shift in each dimension, even across different resolutions and aspect ratios (for example, when aligning SD to HD video). If extra blanking is present within the standard active region, it is measured as cropping when this function is enabled.

The automatic spatial and temporal alignment allows picture quality measurement between reference and test videos of different resolutions and frame rates.

Region of Interest

There are two types of spatial/temporal Region of Interest (ROI): Input and Output. Input ROIs are used to eliminate spatial or temporal regions from the measurement which are not of interest to the user. For example, Input
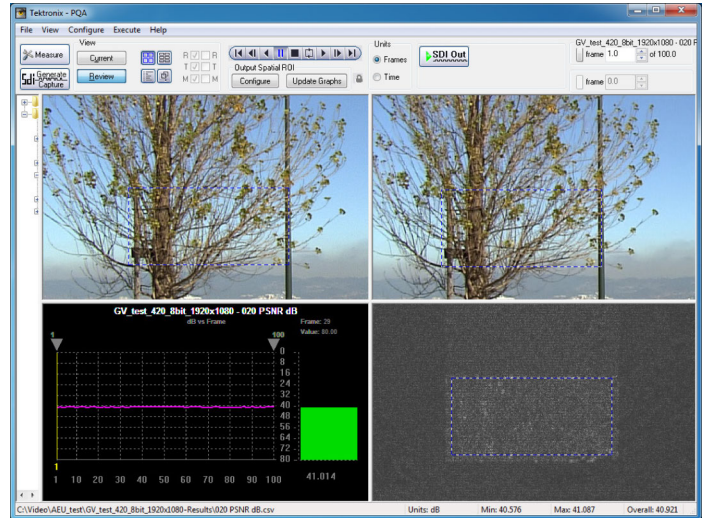
Output Spatial ROI on Review mode for in-depth investigation

Spatial ROI is used when running measurements for reference and test videos which have different aspect ratios. Input Temporal ROI, also known as temporal sync, is used to execute measurements just for selected frames and minimize the measurement execution time.

Output ROIs can be used to review precalculated measurement results for only a subregion or temporal duration. Output Spatial ROI is instantly selected by mouse operation and gives a score for just the selected spatial area. It's an effective way to investigate a specific spatial region in the difference map for certain impairments. Output Temporal ROI is set by marker operation on the graph and allows users to get a result for just a particular scene when the video stream has multiple scenes. It also allows users to provide a result without any influence from initial transients in the human vision model. Each parameter can be embedded in a measurement for the recursive operation.

Script Sample

Import/Export Script in Configure Measure Dialog

Result File Sample

Automated Testing with XML Scripting

In the CODEC debugging/optimizing process, the designer may want to repeat several measurement routines as CODEC parameters are revised. Automated regression testing using XML scripting can ease the restrictions of manual operation by allowing the user to write a series of measurement sequences within an XML script. The script file can be exported from or imported to the measurement configuration menu to create and manage the script files easily. Measurement results of the script operation can be viewed by using either the PQA600A user interface or any spreadsheet application
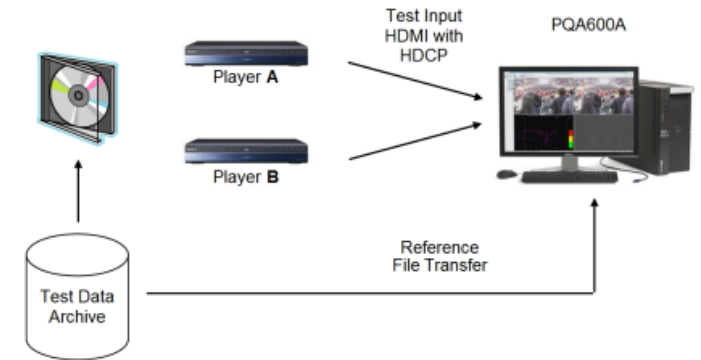
HDMI compliant with HDCP support: Comparing Blu-ray disk players
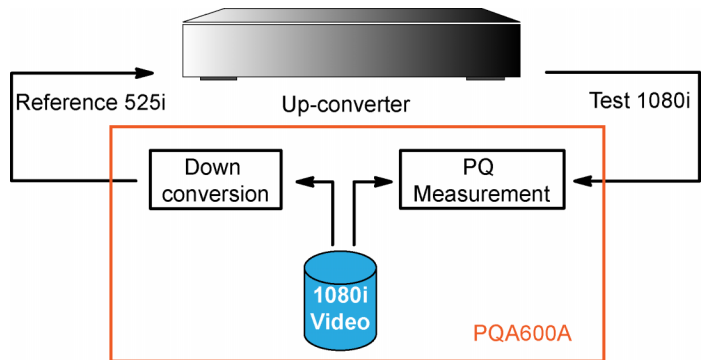
Simultaneous generation/capture: Measuring the picture quality of Up-converter device

that can read the created .csv file format as a summary. Multiple scripts can be executed simultaneously for faster measurement results.

SD/HD/3G SDI, HDMI compliant with HDCP interface and IP interface

An SD/HD SDI interface and IP interface enable both generation and capture of SDI video and IP video. The HDMI compliant with HDCP support allows the user to directly capture the HDCP encrypted contents from the consumer instruments such as Blu-ray player and Set Top Box without hassle. This is beneficial for comparing the performance in multiple units/models or monitoring the picture quality of end to end broadcast chain including the STB output at home.

There are three modes of simultaneous generation capture operation: generation and capture, 2-channel capture, and 2-channel generation.

Simultaneous generation and capture

Simultaneous generation and capture lets the user playout the reference video clips directly from the PQA600A into the device under test. The test output from the device can then be simultaneously captured by the PQA600A. The real time up / down converter could be inserted in the video signal path at generation or capture operation to evaluate an instrument with up / down conversion process.
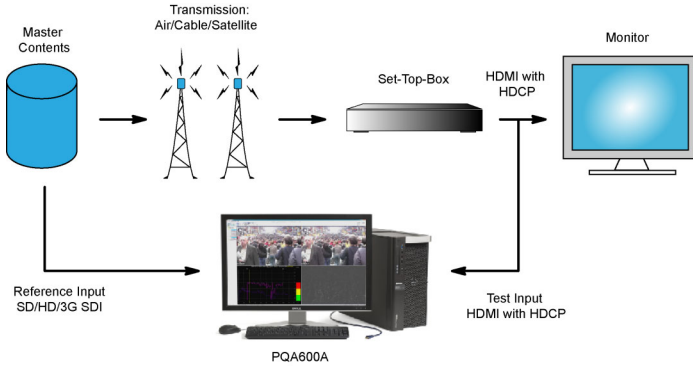
Simultaneous 2-channel capture: Evaluating the performance of a set-top box
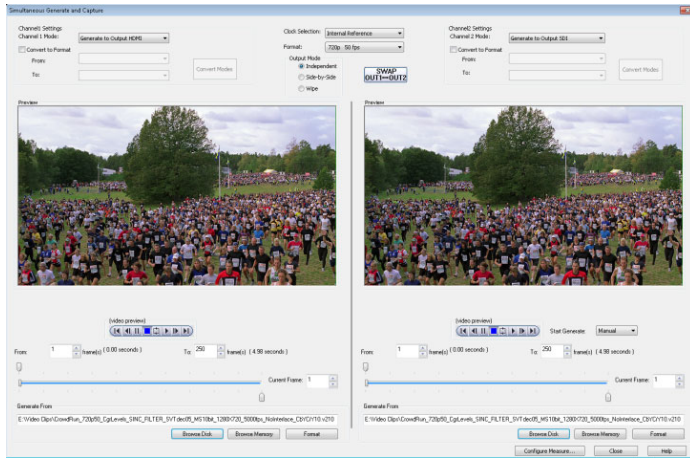
Simultaneous 2-channel generation: Swapping output channels 1 and 2

Simultaneous 2-channel capture

Simultaneous 2-channel capture lets the user capture two live signals to use as reference and test videos in evaluating the device under test in operation. To accommodate equipment processing delay that may be present in the system, the user can use the Delay Start function when capturing video. Using Delayed Start minimizes the number of unused overhead frames in the test file and enables faster execution of the auto temporal alignment in the measurement.

Simultaneous 2-channel generation

Simultaneous 2-channel generation capability, available only in SDI/HDMI interface selection, supports three types of subjective testing with one display. Swap-channel capability will exchange reference and test video

Simultaneous 2-channel generation: Side-by-side display
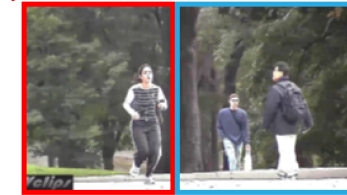
Simultaneous 2-channel generation: Wipe display

sources in a frame to help the user to figure out the difference without moving his/her eye's focus point.

Side-by-side display arranges the video output from the regions in the reference and test video lining up in a row. The Wipe display takes the left region of reference video and the right region of the test video and merges them into a single video output seamlessly.
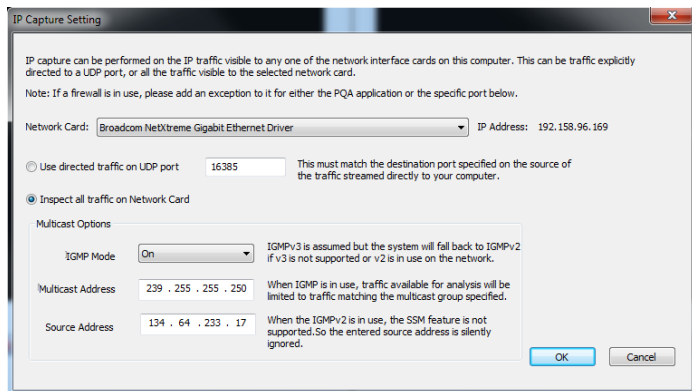
IGMP user interface

IGMP support

In any modes, the user can select the Cross Interface configuration such as generating from SDI/HDMI and capturing from IP or vice versa. IGMP support in IP capture will make stream selection simple at multicast streaming. The compressed video file captured through IP will be converted to an uncompressed file by an internal embedded decoder.

Supported File Formats for SD/HD/3G SDI, HDMI compliant with HDCP Interface

The SD/HD SDI video option can generate SDI video from files in the following formats (8 bit unless otherwise stated):

- .yuv (UYVY, YUY2)
- .v210 (10 bit, UYVY, 3 components in 32 bits)
- .rgb (BGR24)
- .avi (uncompressed, BGR32 (discard alpha channel) / BGR24 / UYVY / YUY2 / v210)
- .vcap (created by PQA600A SDI video capture)
- .vcap10 (10 bit, created by PQA600A video capture)

Frame Geometry	Format	Frame format
720 x 486	525i	29.97
720 x 576	625i	25
1280 x 720	720p	50, 59.94, 60
1920 x 1080	1080i	25, 29.97, 30
	1080psF	23.98, 24, 25, 29.97, 30
	1080p	23.98, 24, 25, 29.97, 30
	1080p (Level A,B)	50, 59.97, 60

Supported File Formats for IP Interface

The IP interface option can generate and capture compressed files using TS support over UDP in compliance with ISO/IEC 13818-1.

Supported formats for up / down conversion

Supported formats for up / down conversion. The output video from format converter will stay in the same colorimetry in the original video.

Input format	Output format
525i 29.97	720p 59.94, 1080i 29.97
625i 25	720p 50, 1080i 25
720p 50	625i 25, 1080i 25
720p 59.94	525i 29.97, 1080i 29.97
720p 60	1080i 30
1080psf 23.98	525i 29.97
1080i 25	625i 25, 720p 50
1080i 29.97	525i 29.97, 720p 59.94
1080i 30	720p 60

Supported File Formats for Measurement

All formats support 8 bit unless otherwise stated:

- .yuv (UYVY, YUY2, YUV4:4:4, YUV4:2:0_planar)
- .v210 (10 bit, UYVY, 3 components in 32 bits)
- .rgb (BGR24, GBR24)
- .avi (uncompressed, BGR32 (discard alpha channel) / BGR24 / UYVY / YUY2 / v210)
- ARIB ITE format (4:2:0 planar with 3 separate files (.yyy, .bbb, .rrr))
- .vcap (created by PQA600A SDI video capture)
- .vcap10 (10 bit, created by PQA600A video capture)

The following compressed files are internally converted to an uncompressed file before measurement execution. The format support listed here is available in software version 4.0 and later.

Decoder Format

Format	ES	ASF	MP4	3GPP	Quicktime	MP2 PES	MP2 PS	MP2 TS	MXF	GXF	AVI	LXF
H263	✓		✓	✓	✓						✓	
MP2	✓				✓	✓	✓	✓	✓	✓	✓	✓
MP4	✓		✓	✓	✓						✓	
H264/AVC	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
DV	✓				✓				✓	✓	✓	✓
VC-1	✓	✓									✓	
ProRes					✓							
Quicktime			✓	✓	✓							
JPEG2000	✓		✓	✓	✓				✓			
VC3/DNxHD	✓		✓	✓	✓				✓			
Raw	✓										✓	✓

Preinstalled Video Sequences

Sequence	Resolution	Formats	Clips
Vclips	1920×1088	YUV4:2:0 planar	V031202_Eigth_Ave, V031255_TimeSquare, V031251_Stripy_jogger
	1920×1080	UYVY	V031251_Stripy_jogger
	1280×720	UYVY, YUV4:2:0 planar	V031002_Eigth_Ave, V031055_TimeSquare, V031051_Stripy_jogger with 3/10/26 Mb/s
	864×486	YUV4:2:0 planar	Converted V031051_Stripy_jogger with 2/4/7 Mb/s
	320×180	YUV4:2:0 planar	Converted V031051_Stripy_jogger with 1000/1780/2850 Kb/s
PQA300 without Trigger	720×486	UYVY	Ferris, Flower, Tennis, Cheer with 2 Mb/s_25 fps
	720×576	UYVY	Auto, BBC, Ski, Soccer
PQA300 with Trigger	720×486	UYVY	Mobile with 3/6/9 Mb/s
	720×576	UYVY	Mobile with 3/6/9 Mb/s

Performance You Can Count On

Depend on Tektronix to provide you with performance you can count on. In addition to industry-leading service and support, this product comes backed by a one-year warranty as standard.

Characteristics (Option BAS)

Some measurements are available only with Option ADV.

Preconfigured Measurement Set

Measurement Class	Measurement Name	Required option	Configuration Nodes						
			Display Model	View Model	PSNR	Perceptual Difference	Artifact Detection	Attention Model	Summary Node
View Video with No Measurement	"000 View Video"	BAS	NA	NA	NA	NA	NA	NA	NA
Subjective Prediction: Full Reference									
Noticeable Differences									
SD Display and Viewing	"001 SD Broadcast PQR"	BAS	SD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	NA	PQR Units
HD Display and Viewing	"002 HD Broadcast PQR"	BAS	HD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	NA	PQR Units
CIF Display and Viewing	"003 CIF and QVGA PQR"	BAS	CIF/QVGA LCD	7 scrn heights, 20 cd/m^2	NA	Typical	NA	NA	PQR Units
D-CINEMA Projector and Viewing	"004 D-CINEMA PQR"	BAS	DMD Projector	3 scrn heights, .1 cd/m^2	NA	Typical	NA	NA	PQR Units
Subjective Rating Predictions									
SD Display and Viewing	"005 SD Broadcast DMOS"	BAS	SD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	NA	DMOS Units Re: BT.500 Training
HD Display and Viewing	"006 HD Broadcast DMOS"	BAS	HD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	NA	DMOS Units Re: BT.500 Training
CIF Display and Viewing	"007 CIF and QVGA DMOS"	BAS	CIF/QVGA LCD	7 scrn heights, 20 cd/m^2	NA	Typical	NA	NA	DMOS Units Re: BT.500 Training
D-CINEMA Projector and Viewing	"008 D-CINEMA DMOS"	BAS	DMD Projector	3 scrn heights, .1 cd/m^2	NA	Typical	NA	NA	DMOS Units Re: BT.500 Training
Attention Biased Subjective Rating Predictions									
SD Display and Viewing	"009 SD Broadcast ADMOS"	BAS, ADV	SD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	Default Weightings	DMOS Units Re: BT.500 Training
HD Display and Viewing	"010 HD Broadcast ADMOS"	BAS, ADV	HD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	Default Weightings	DMOS Units Re: BT.500 Training
CIF Display and Viewing	"011 CIF and QVGA ADMOS"	BAS, ADV	CIF/QVGA LCD	7 scrn heights, 20 cd/m^2	NA	Typical	NA	Default Weightings	DMOS Units Re: BT.500 Training
SD Sports	"012 SD Sports Broadcast ADMOS"	BAS, ADV	SD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	Motion and Foreground Dominant	DMOS Units Re: BT.500 Training
HD Sports	"013 HD Sports Broadcast ADMOS"	BAS, ADV	HD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	Motion and Foreground Dominant	DMOS Units Re: BT.500 Training
SD Talking Head	"014 SD Talking Head Broadcast ADMOS"	BAS, ADV	SD Broadcast CRT	(ITU-R BT.500)	NA	Typical	NA	Skin and Foreground Dominant	DMOS Units Re: BT.500 Training

Measurement Class	Measurement Name	Required option	Configuration Nodes						
			Display Model	View Model	PSNR	Perceptual Difference	Artifact Detection	Attention Model	Summary Node
Repurposing: Reference and Test are Independent. Use Any Combination Display Model and Viewing Conditions with Each Measurement									
Above									
Format Conversion: Cinema to SD DVD	"015 SD DVD from D-Cinema DMOS"	BAS	DMD Projector and SD CRT	7 scrn heights, 20 cd/m^2 and (ITU-R BT.500)	NA	Expert	NA	NA	DMOS Units Re: BT.500 Training
Format Conversion: SD to CIF	"016 CIF from SD Broadcast DMOS"	BAS	LCD and SD Broadcast CRT	(ITU-R BT.500) and 7 scrn heights, 20 cd/m^2	NA	Expert	NA	NA	DMOS Units Re: BT.500 Training
Format Conversion: HD to SD	"017 SD from HD Broadcast DMOS"	BAS	SD and HD Broadcast CRT	(ITU-R BT.500)	NA	Expert	NA	NA	DMOS Units Re: BT.500 Training
Format Conversion: SD to HD	"017-A SD from HD Broadcast DMOS"	BAS	SD and HD Progressive CRT	(ITU-R BT.500)	NA	Expert	NA	NA	DMOS Units Re: BT.500 Training
Format Conversion: CIF to QCIF	"018 QCIF from CIF and QVGA DMOS"	BAS	QCIF and CIF/QVGA LCD	7 scrn heights, 20 cd/m^2	NA	Expert	NA	NA	DMOS Units Re: BT.500 Training
Attention									
Attention	"019 Stand-alone Attention Model"	BAS, ADV	NA	NA	NA	NA	NA	Default Weightings	Map units: % Probability of focus of attention
Objective Measurements: Full Reference									
General Difference									
PSNR	"020 PSNR dB"	BAS	NA	Auto-align spatial	Selected	NA	NA	NA	dB units
Artifact Measurement									
Removed Edges	"021 Removed Edges Percent"	BAS, ADV	NA	Auto-align spatial	NA	NA	Blurring	NA	%
Added Edges	"022 Added Edges Percent"	BAS, ADV	NA	Auto-align spatial	NA	NA	Ringing / Mosquito Noise	NA	%
Rotated Edges	"023 Rotated Edges Percent"	BAS, ADV	NA	Auto-align spatial	NA	NA	Edge Blockiness	NA	%
% of Original Deviation from Block DC	"024 DC Blocking Percent"	BAS, ADV	NA	Auto-align spatial	NA	NA	DC Blockiness	NA	%
Artifact Classified (Filtered) PSNR									
Removed Edges	"025 Removed Edges Weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	Blurring	NA	dB units
Added Edges	"026 Added Edges Weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	Ringing / Mosquito Noise	NA	dB units
Rotated Edges	"027 Rotated Edges Weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	Edge Blockiness	NA	dB units
% of Original Deviation from Block DC	"028 DC Blocking Weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	DC Blockiness	NA	dB units
Artifact Annoyance Weighted (Filtered) PSNR									
PSNR w/ Default Artifact Annoyance Weights	"029 Artifact Annoyance Weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	All artifacts selected	NA	dB units

Measurement Class	Measurement Name	Required option	Configuration Nodes						
			Display Model	View Model	PSNR	Perceptual Difference	Artifact Detection	Attention Model	Summary Node
Repurposing: Use View Model to Resample, Shift, and Crop Test to Map to Reference									
Format Conversion: Cinema to SD DVD	"030 SD DVD from D-Cinema Artifact weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	All artifacts selected	NA	dB units
Format Conversion: SD to CIF	"031 CIF from SD Broadcast Artifact weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	All artifacts selected	NA	dB units
Format Conversion: HD to SD	"032 SD from HD Broadcast Artifact weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	All artifacts selected	NA	dB units
Format Conversion: CIF to QCIF	"033 QCIF from CIF and QVGA Artifact weighted PSNR dB"	BAS, ADV	NA	Auto-align spatial	Selected	NA	All artifacts selected	NA	dB units
Attention-weighted Objective Measurements									
General Difference									
PSNR	"034 Attention Weighted PSNR dB"	BAS, ADV	NA	NA	Selected	NA	NA	Default Weightings	dB units
Objective Measurements: No Reference									
Artifact									
DC Blockiness	"035 No Reference DC Blockiness Percent"	BAS, ADV	NA	NA	NA	NA	No-reference DC Block	NA	% DC Blockiness
Subjective Prediction Calibrated by Subjective Rating Conducted in 2009 with 1080i29 Video Contents and H.264 CODEC									
(Refer to application note, 28W_24876_0.pdf)									
	036 HD PQR ITU-BT500 with Interlaced CRT	BAS	Custom HD CRT	3 scrn heights	NA	Custom	NA	NA	PQR Units
	037 HD DMOS ITU-BT500 with Interlaced CRT	BAS	Custom HD CRT	3 scrn heights	NA	Custom	NA	NA	DMOS Units Re:BT.500 Training
	038 HD ADMOS ITU-BT500 with Interlaced CRT	BAS, ADV	Custom HD CRT	3 scrn heights	NA	Custom	NA	Typical	DMOS Units Re:BT.500 Training

Nodes

Node Name	Configurable Parameter
Display Model	Display Technology: CRT/LCD/DMD each with preset and user-configurable parameters (Interlace/Progressive, Gamma, Response Time, etc). Reference Display and Test Display can be set independently
View Model	Viewing distance, Ambient Luminance for Reference and Test independently, image cropping and registration: automatic or manual control of image cropping and test image contrast (ac gain), brightness (dc offset), horizontal and vertical scale and shift
PSNR	No configurable parameters
Perceptual Difference	The viewer characteristics (acuity, sensitivity to changes in average brightness, response speed to the moving object, sensitivity to photosensitive epilepsy triggers, etc)
Attention Model	Overall attention weighting for measures, Temporal (Motion), Spatial (Center, People (Skin), Foreground, Contrast, Color, Shape, Size), Distractions (Differences)
Artifact Detect	Added Edges (Blurring), Removed Edges (Ringing/Mosquito Noise), Rotated Edges (Edge Blockiness), and DC Blockiness (Removed detail within a block)
Summary Node	Measurement Units (Subjective: Predicted DMOS, PQR or % Perceptual Contrast. Objective: Mean Abs LSB, dB)., Map type: Signed on gray or unsigned on black. Worst-case Training Sequence for ITU-R BT.500 Training (Default or User-application Tuned: Determined by Worst Case Video % Perceptual Contrast), Error Log Threshold, Save Mode

Computer System and Peripherals

Component	Description
Operating System	Windows 7 Professional 64-bit
CPU	Intel® Xeon® Processor E5-2630 2.3 GHz
Hard Disk Drive	0.5TB (OS), 2.5TB (Video)
CD/DVD Drive	8X DVD+/-RW drive

Input/Output Ports

Port	Description
Power	100-240 V, 50/60 Hz (115 V/230 V, 6 A/3 A)
Keyboard Port	PS-2 compatible
Mouse Port	PS-2 compatible
USB Ports	8x USB 2.0, 2x USB 3.0
LAN Port	Two RJ-45 connector, 10/100/1000BASE-T
Graphics Port	Dual Link DVI-I (HDCP), Display port (HDCP), Up to 2560×1600 60 Hz
SDI/HDMI IO Port	1 SDI input, 1 SDI output , 1 HDMI input (Type C, HDCP) *1, 1 HDMI output (Type C)

*1 There are restrictions to be compliant with the HDCP license. Please consult your local Tektronix sales representative for more information.

Physical Characteristics

Benchtop Configuration

Dimensions	mm	in.
Height	433.4	16.95
Width	216.0	8.5
Depth	525.0	20.7
Weight	**kg**	**lb.**
Net	16.9	37.3

Ordering Information

PQA600A

Picture Quality Analysis System

PC Monitor Requirement

Note: PQA600A does not include a PC monitor. An external monitor meeting the following requirements is to be provided by the user:

- HDCP compliant Dual Link DVI port

- Display resolution:
  2560×1600 optimum/preferred
  1920×1080 minimum

Included Accessories – One-year warranty, plus the following:

Order Number	Description
PQA600A Picture Quality Analysis System Documentation	
071-3119-xx	Quick Start User Manual
077-0787-xx	Release Notes
071-3120-xx	User Technical Reference
077-0789-xx	Specification and Performance Verification Manual in PDF format on Documentation CD
077-0788-xx	PQA600A Declassification and Security Instructions in PDF format on Documentation CD
077-0790-xx	PQA600A Configuration Guide Technical Reference in PDF format on Documentation CD
063-4488-xx	Documentation CD, containing PDF files of the documentation set
Other	
020-3130-xx	Application Recovery Disk
020-3053-xx	Video Sequences Recovery Media
-	USB keyboard
-	USB mouse
-	Software key dongle
174-6308-xx	HDMI cable, Type A to Type C (2.0 m)

Options

Option	Description
BAS	Base measurement package
ADV	Advanced measurement package (Script operation, Measurement configurability, Weighting measurements)
IP	IP generation / capture
LUD	Add permissions to existing hardware key.

Note: Need to purchase Option BAS for basic picture quality measurement. Option ADV requires Option BAS.

International Power Plugs

Option	Description
A0	North America power
A1	Universal Euro power
A2	United Kingdom power
A3	Australia power
A4	240 V North America power
A5	Switzerland power
A6	Japan power
A10	China power
A11	India power
A12	Brazil power
A99	No power cord or AC adapter

Service

Option	Description
CA1	Single Calibration or Functional Verification
C3	Calibration Service 3 Years
R3	Repair Service 3 Years
IF	Upgrade Installation Service

Post-sale Upgrade

Option	Description
PQA6AUP	Field Upgrade Kit for PQA600A. Choose from the following options.
BAS	Base measurement package
ADV	Advanced measurement package (Script operation, Measurement configurability, Weighting measurement) IP generation / capture
IP	IP Generation / Capture
PQA6UP	Field Upgrade Kit for PQA600
VID	SDI/HDMI card

Product Selection

Feature	PQASW	PQA600A
PSNR, PQR, DMOS Preconfigured Measurements	Yes	Option BAS
Multi-resolution/Frame-rate Support	Yes	Option BAS
Multi-results View Options	Yes	Option BAS
Embedded Reference Decoder	Yes	Option BAS
Automatic Temporal and Spatial Alignment	Yes	Option BAS
IP Generation/Capture	Opt. IP	Opt. IP
User-configurable Measurements	Opt. ADV	Opt. ADV
Attention/Artifact Weighted Measurements	Opt. ADV	Opt. ADV
XML scripting with Export/Import files	Opt. ADV	Opt. ADV
SD/HD/3G SDI Generation and Capture	No	Yes
HDMI without HDCP Generation and Capture	No	Yes
HDMI with HDCP Generation & Capture	No	Opt. BAS
Video format conversion	No	Yes
Side by Side, Wipe display at Generation	No	Yes

Additional Information

Please contact your local Service Manager for information regarding our products and services, or contact us at: www.tektronix.com/serviceandsupportcontactus

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Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

Picture Quality Analysis System — PQA600A

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

11 Dec 2012   25W-28639-0

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