VideoQ, Inc.

VQDM-100

AV Test Pattern Generator
AV Delay & AV Sync Analyzer

Training Presentation

June 2019

www.videoq.com

VQDM-100 Training Agenda

- VQDM Concept and Test Setup
  - VQDM Test Pattern ⇨ VQDM Generator HDMI output ⇨ System Under Test HDMI input ⇨ *optional Reference Display*
  - System Under Test DVI/HDMI/Screen output ⇨ VQDM Sensor ⇨ VQDM input ⇨ Host PC USB ⇨ VQDM SW ⇨ Report
- VQDM Features and Specifications
  - Main Features
  - Target Applications
  - Hardware Specification
  - Software Specification
- VQDM Software - multi-channel AV Delay & AV Sync SW Analyzer
  - Examples of usage for different systems
- Q&A
- *Optional (separate presentation):*
  VQL - Comprehensive library of sophisticated static and dynamic test patterns and live sequences
  - Main Features
  - Key Test Patterns examples

VQDM-100 Features and Parameters

Features:

- Combination of **Test Generator** and **Delay Analyzer** to measure AV latency and AV sync errors
- **Self-contained hardware/software solution** allows measurement in **normal work conditions** without any interference into the **System Under Test**
- **Windows SW Application** with multi-channel GUI, revealing
  AV delay time profiles, **AV sync errors** and **AV delay statistics** in real time
- Two reporting modes:
  a) **Machine-readable .txt** or **.csv** file for test automation QA/QC applications
  b) **Windows GUI** and detailed multi-page **PDF** document print-out for engineers
- Provides for **calibration and prequalification** of System Under Test using built-in subset of **VQL** - VideoQ Test Patterns Library

Components:

- **VQDM-100** – Main Video Generator, Capture and Conversion Unit
- **VQDM Executable** (Windows Application) – AV Delay Analyzer SW
- **Saleas Logic** (Windows Application) – Preview, Capture and Scope Utility
- **VQHD-420** – *Optional* HDMI to BluSync™ Pulse Adapter

What is in the box 1

What is in the box 2

- **VQDM-100 Main Unit:**

  Contains Test Generator (Reference Source), loaded with special set of test patterns and built-in multi-channel (4+4) AV capture device with USB connectivity to Host PC

- **Video Sensors with vacuum caps (Display Light Sensors): x4**

- **Mini-jack Cables: x4**

- **USB Cable:**

  Connects VQDM-100 Main Unit to Host PC

- **Software:**

  Includes VQDM.EXE - AV Delay Analyzer Application for Windows, User Manual, VQDM Test Patterns source files and Utilities SW

- ***Optional* HDMI to AV Reference BluSync™ Pulse Converter VQHD-420**

VQDM-100 Hardware Specifications

- Weight: 0.3 kg
- Dimensions (D x W x H): 95 mm x 155 mm x 50 mm (3.75" x 6" x 2")
- Two internal modules: **TPG** (Test Pattern Generator) and **DAM** (Digital Acquisition Module)
- TPG video outputs: **HDMI** (with embedded audio), **YPrPb**
- TPG Audio outputs: **Analog L&R**, **SPDIF**
- DAM Video Sensor (Light Sensor) Inputs: **x4, mini-jack**
- DAM Audio Inputs: **x4, mini-jack**, mono or stereo, high impedance
- Audio input level: from 0.5 Vpp to 4 Vpp
- USB Port: **Type B USB Port** for connection to Host PC
- External PSU: Input 100-240 V, 50-60 Hz, DC Output 12 V, 1.5 A, center = positive

VQDM Software Specifications

- System Requirements:
  - Windows XP, 7, 8, 10 - 32 bit or 64 bit versions
  - About 2 MB of disk space
- Test Session Duration:
  - min 10 s
  - max 10,000 s
- Analysis Results:
  - Average Delay, ms
  - Minimal Delay, ms
  - Maximal Delay, ms
  - Delay Variance (Standard Deviation), ms
  - Delay Trend, ms/s
  - Average AV Sync Error, ms
- Measurable Ranges:
  - Video Delay vs. Video Reference Input: -49 ms to +949 ms
  - Video Delay vs. any other Video Input: -499 ms to +499 ms
  - Audio Delay vs. Audio Reference Input: -49 ms to +949 ms
  - Audio Delay vs. any other Audio Input: -499 ms to +499 ms
  - AV Sync Errors: -499 ms to +499 ms

VQDM Test Patterns

VQDM dynamic AV test patterns are designed to be compatible with a majority of video cameras, software or hardware codecs and media players.

VQDM test patterns contain only relatively large components, so they remain suitable for accurate measurements even after low bitrate coding and severe position and/or scaling errors, e.g. zoom-out down to 25% or overscan up to 110%.

Large Light Sensor Areas on the Test Patterns are flashing white every second for the duration of **two video frames** *(one frame for 25 fps variants).* These flashes are read for analysis purposes by VQDM Light Sensors attached to the display screen by vacuum caps.

Audio delays are measured by connecting relevant test points to the corresponding VQDM outputs and inputs. There is no need for special audio sensors, VQDM TPG Module produces and VQDM Data Acquisition Module reads **standard audio line signals**.

VQDM1, VQDM2, VQDM3 Test Patterns

VQDM Analyzer can work with either one of 3 test patterns – **VQDM1, VQDM2, VQDM3**:

- **VQDM1** and **VQDM3** general purpose test patterns are suitable for automatic testing of **source-to-glass** and **glass-to-glass** systems, e.g. video distribution or video conference systems
- **VQDM2** advanced test pattern is more suitable for **signal-to-signal** systems, such as video links using frame buffers or **signal-to-glass** systems, such as displays.

Mainly monochrome **VQDM1** and **VQDM3** tests contain large white flashing circular white areas on dark background.

Mainly dark **VQDM2** test contains flashing blue stripes and flashing circular yellow areas

Audio components of all VQDM test patterns are the same (identical)

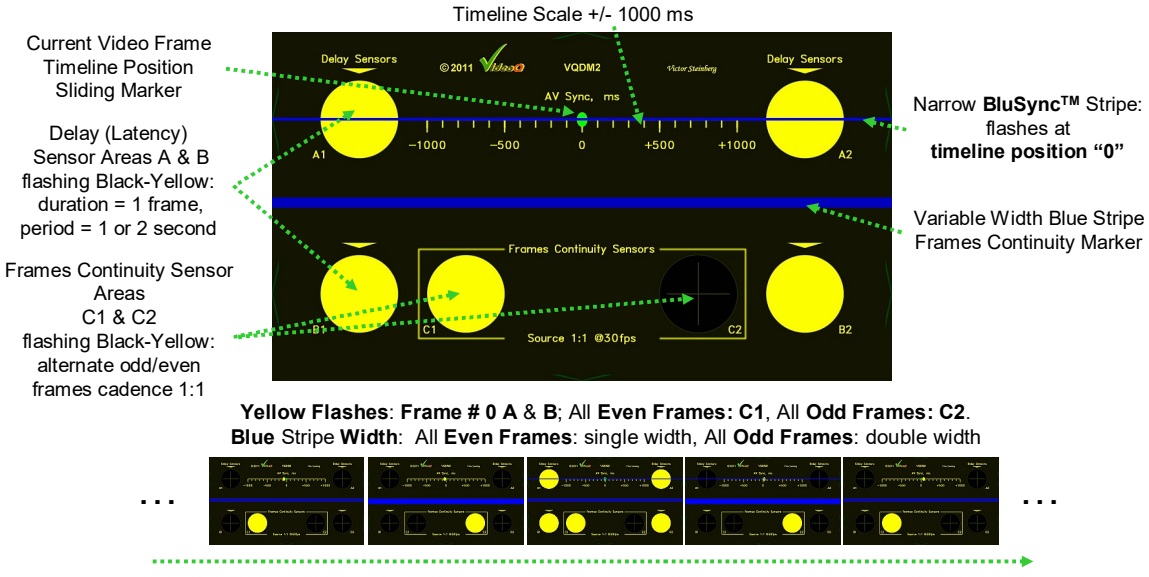
VQDM1 General Purpose Test Pattern – Composition

VQDM1 Test Pattern Details

Dynamic AV test pattern consisting of:

1. Highly visible **Time Stamps** (frame numbers) in the central area
2. Synchronously rotating white dot (clock dial) serving to check frame sequence continuity
3. Two circular **Light Sensor Areas** flashing White on Black at the beginning of Video Frame # 00
4. Sliding white ellipse marker indicating current frame position within the +/- 500 ms timeline scale; position “0” marks ***the center*** of **Audio Burst**

VQDM2 Advanced Test Pattern – Composition

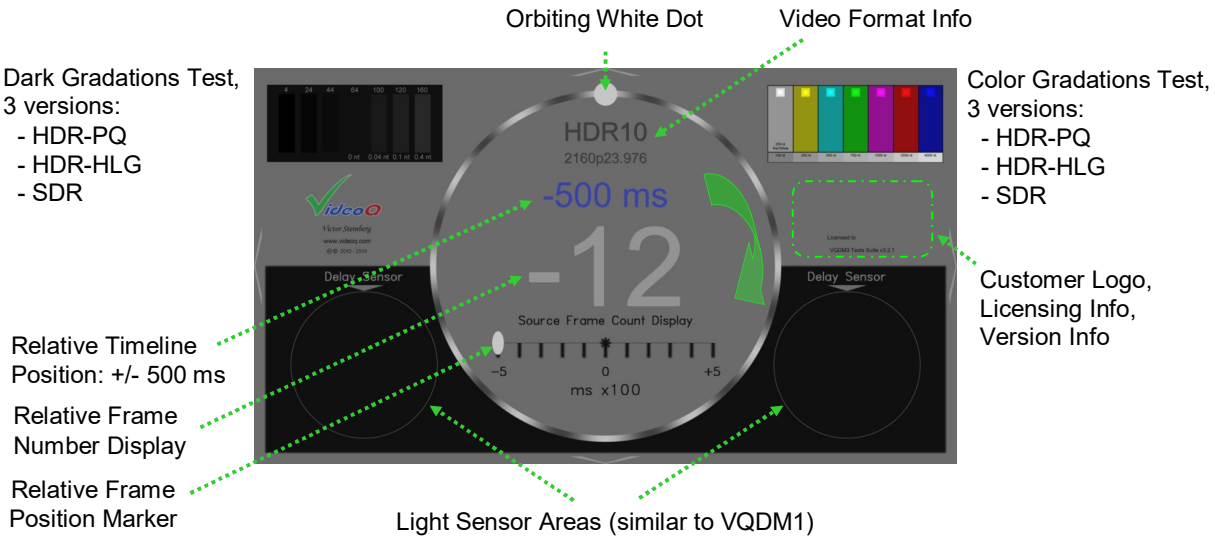


VQDM2 Test Pattern Details

Dynamic AV test pattern consisting of:

1. Dark yellow background with yellow texts and markers, producing 0% signal in Blue channel
2. Three sets of circular **Light Sensor Areas** flashing Yellow on Black
3. Sensor Areas **A & B** flashing on Video Frame # 0 serve for measurement of signal-to-glass Display Latency (B - A for vertical latency profile), glass-to-glass System Latency, and AV Sync errors
4. Sensor Areas **C1 & C2** serve for measurement of Frames Continuity: cadences and drops/freezes
5. Flashing **BluSync™** stripes via optional HDMI-to-Sync adapter provide electric pulses: Narrow Blue Stripe is co-timed with A1/A2 Areas, Alternating Width Blue Stripes are co-timed with C1/C2 Areas
6. Sliding yellow ellipse **Time Marker** indicates current frame position within the +/- 1000 ms timeline scale; position “0” (green asterisk) marks the center of **Audio Burst**

VQDM3 Multi-format Test Pattern



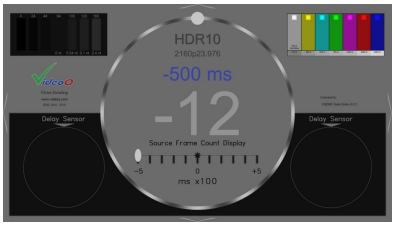
VQDM3 Test Pattern Details

Set of test pattern video files:

- Dynamic Range Format: HDR10 (HDR-PQ), HDR-HLG, SDR
- Duration: N x 1s long cycles (1000 ms or 1001 ms)
- AV format: YUV 422p Video, 10 bit, PCM 2.0 Audio, 48 kHz, 24 bit
- 2 frame sizes, various frame rates:
  - 1920x1080p (HD 16:9):
    23.976, 24.0, 25.0, 29.97, 30.0, 50.0, 59.94, and 60.0 fps
  - 3840x2160p (UHD 16:9):
    23.976, 24.0, 25.0, 29.97, 30.0, 50.0, 59.94, and 60.0 fps

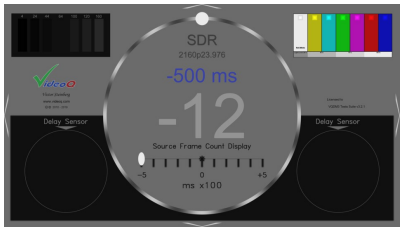
VQDM3 Test Pattern Variants

HDR10 (HDR-PQ)



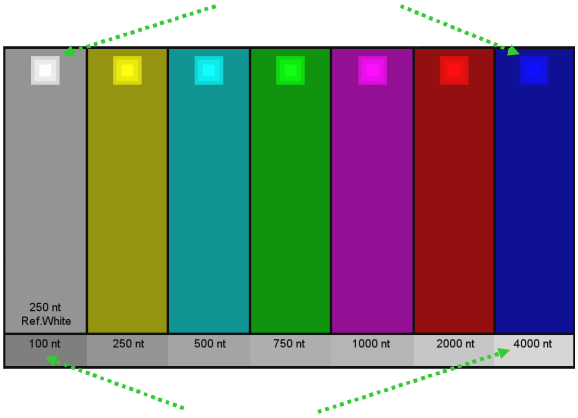
HDR-HLG

SDR



VQDM3 Color Gradations Test Details and Usage Examples

7 **White PLUGE** components (nested squares)

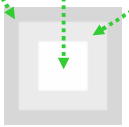


The special **HDR-PQ Grayscale**
features critical **Light Levels** up to **4000 nt**

White PLUGE 10 bit levels:

860 **1016** = upper limit of **"Full"** 10 bit video data range

940 = upper limit of regular **"Narrow"** 10 bit video data range



Case 1:
The HDR display renders the full 10 bit video data range **without clipping** at the level 940; this is **not allowed by any HDR standard** (PQ or HLG)

Case 2:
Clipping at 10 bit value of 940 as required by HDR standard:
- It is **normal** for all **HLG** displays,
- It is also normal for the **PQ** displays capable of rendering the full valid range, i.e. if **TDMB = 10,000 nit**

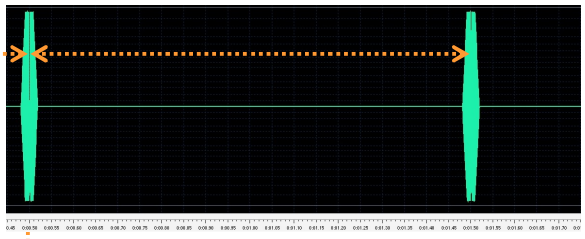
Case 3:
The display is not rendering full valid range;
the **clipping** is at a video level **much lower than 940**:
- It is **not normal** for any **HLG** display,
- It is **normal** for the **PQ** displays with a **TDMB < 10,000 nit**

VQDM Test Patterns Audio Component

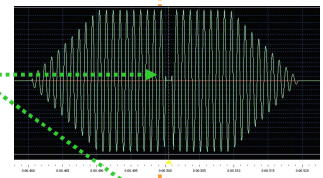
Audio Burst Period:

VQDM1 and VQDM3: **1000 ms**
(**1001 ms** for 29.97 and 23.976 fps)

VQDM2-2: **2000 ms**
(**2002 ms** for 29.97 and 23.976 fps)



H Zoom x10



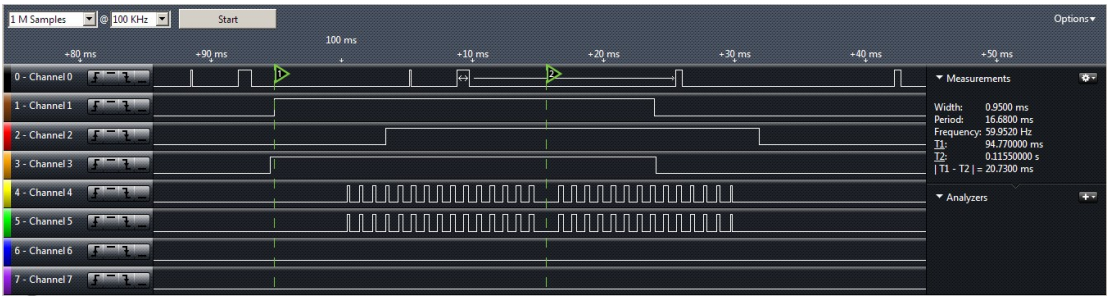
Audio Burst Parameters

Frequency:	1 kHz
Peak Level:	-3 dBfs
Half-amplitude Duration:	25 ms
Central Gap Duration:	1 ms

Burst Center Position:
Video Frame # 0

Video Frames Timeline

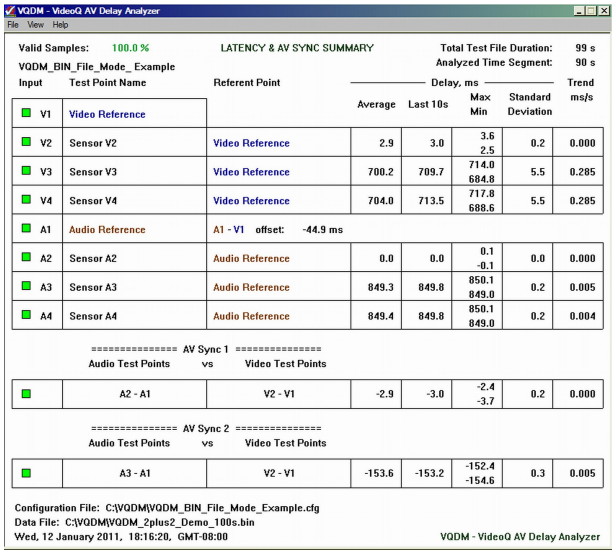
Example of VQDM Pulse Preview Windows GUI

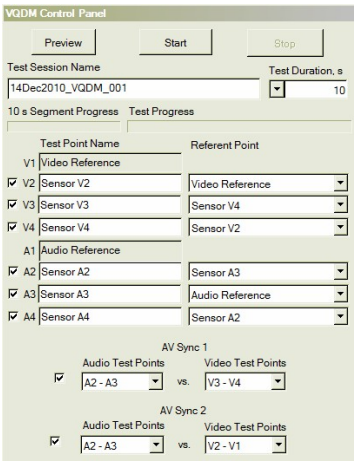


8-channels pulse display (4 video and 4 audio):

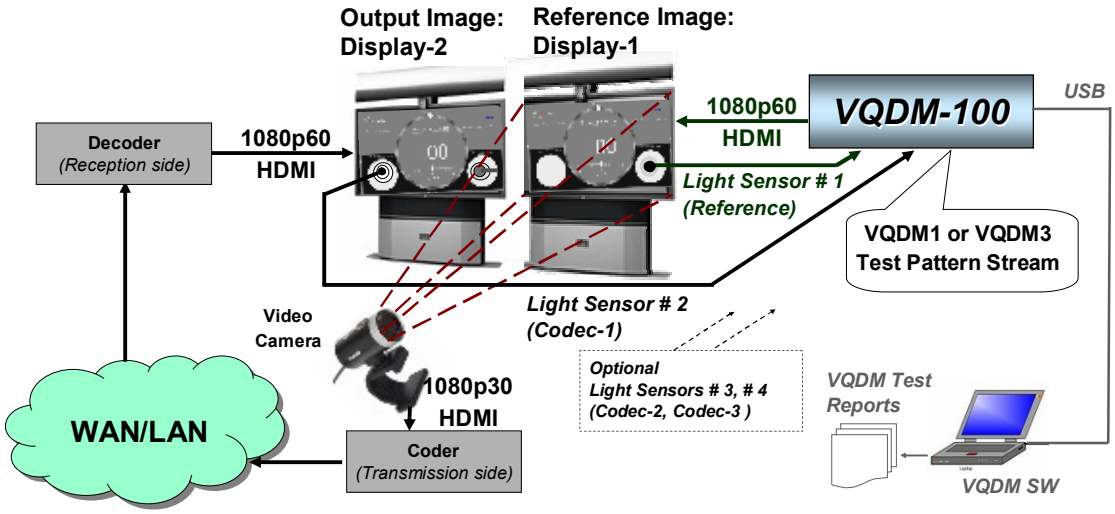
- Wide range of sampling rates and captured data time intervals
- Timeline zooming with intuitive wheel mouse controls
- Two adjustable timeline markers
- Automatic period and frequency calculation
- Captured data can be stored in a Test Session File and retrieved later for off-line analysis

Example of VQDM-100 Windows GUI Page



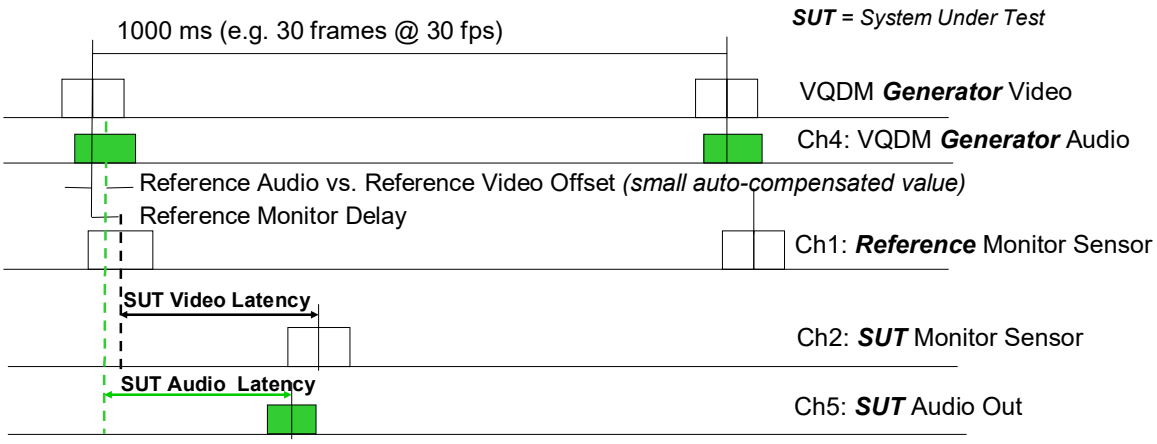


Setup Example 1 – Teleconference System Video Latency



Glass-to-Glass Latency Measurement: Camera + Coder + Network + Decoder + Display-2

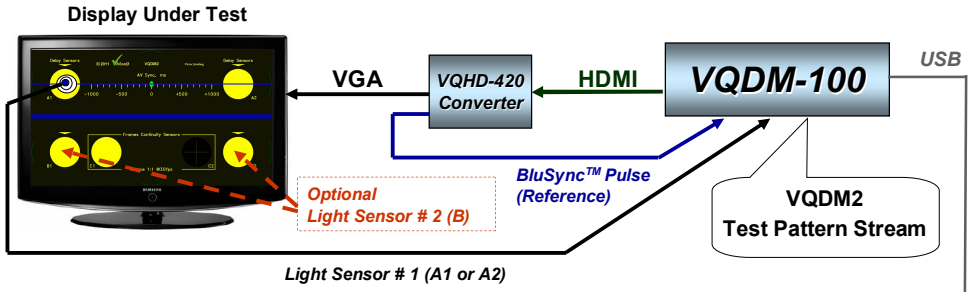
Example of Timing Diagram – Latency & AV Sync



A/V Sync Error* = *Video Latency* – *Audio Latency

VQDM methodology allows correct measurement of AV Sync errors even if A & V components are not perfectly co-timed at source

Setup Example 2 – Gaming Display Video Latency

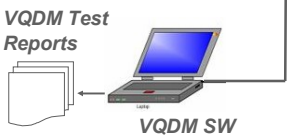


VQDM methodology allows measurement of display latency spatial (horizontal and vertical) profile by comparison of:

*Display Latency at screen top (areas **A1** and/or **A2**)*

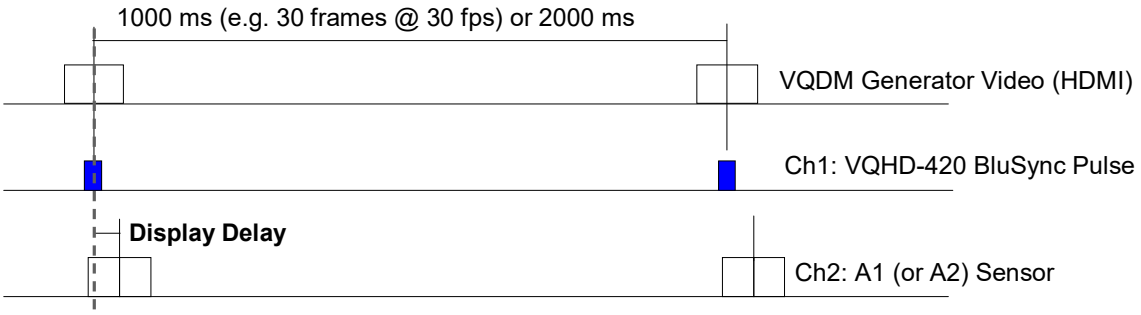
vs.

*Display Latency at screen bottom (areas **B1** and/or **B2**)*



Display Latency = Sensor Pulse Timeline Position – Reference Sync Pulse Position

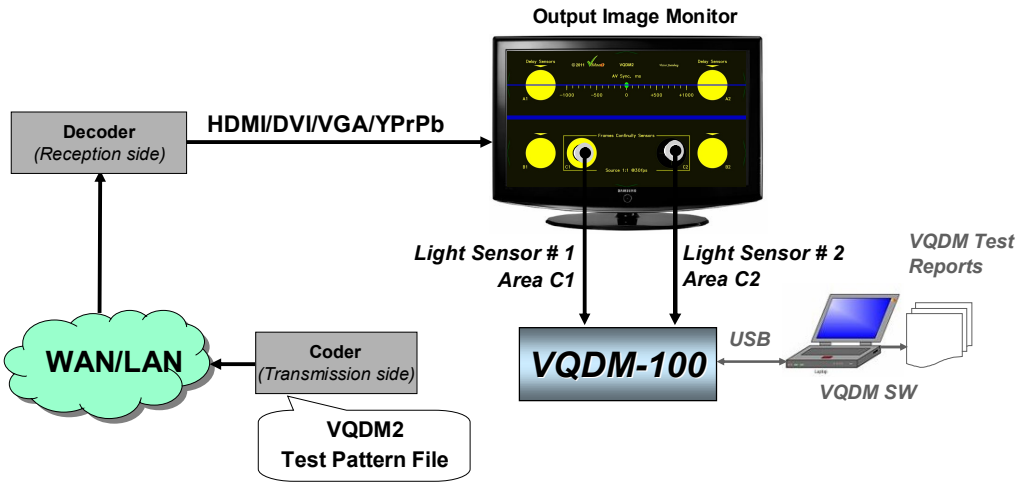
Example of Timing Diagram – Display Latency



Display Latency = Light Sensor Pulse Time Position – Reference Sync Pulse Position

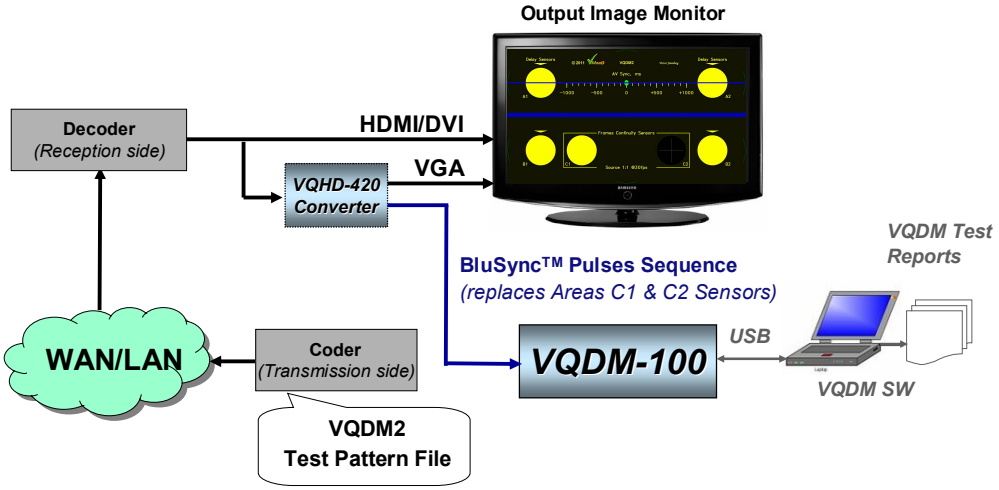
BluSync Pulse is derived by optional VQHD-420 adapter from Blue Flash component of VQDM2 test pattern

Setup Example 3 – Frames Continuity Test



Source-to-Destination Frames Continuity Measurement: Coder + Network + Decoder + Display

Setup Example 4 – Frames Continuity Test using VQHD-420



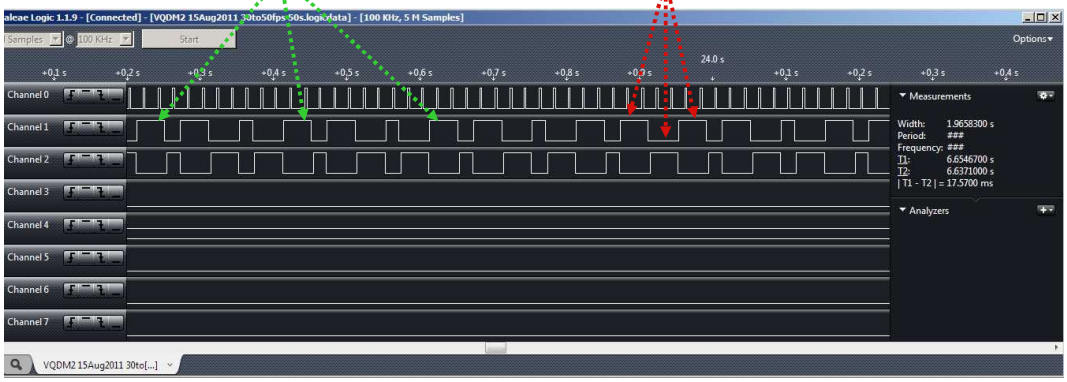
Latency Continuity and Frame Continuity Measurement: Coder + Network + Decoder

Example 1 of VQDM2 Frames Continuity Test Results

1080p30 stream played out as 720p50, displayed as 1080p50

Regular 2:1:2 cadence: 30 Hz to 50 Hz conversion

Cadence Error: 2:2:2 fragment

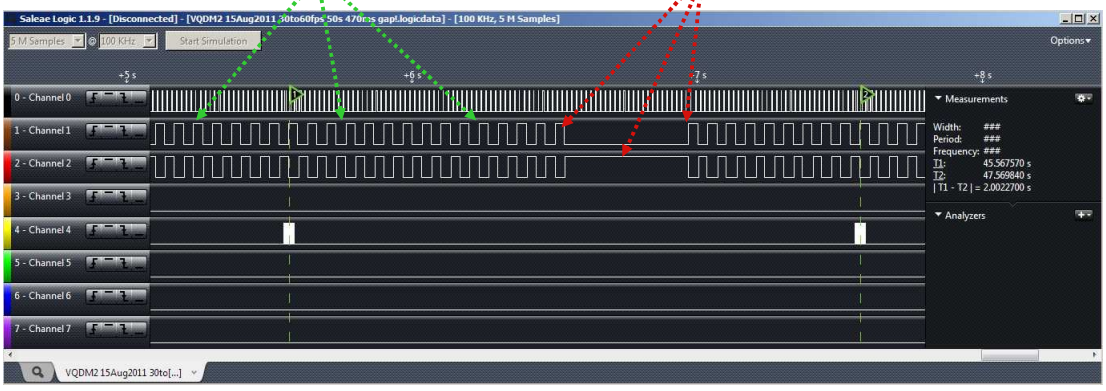


Example 2 of VQDM2 Frames Continuity Test Results

1080p30 stream played out and displayed as 1080p60

Regular 2:2:2 cadence: 30 Hz to 60 Hz conversion

Freeze: 26 frames @1080p60



Example of machine-readable VQDM Report File

```
; VideoQ Inc. Copyright [c] 2010
; VQDM v1.1 Report
TEST_REPORT_TIME, Tue, 11 January 2011,  00:41:46,  GMT-08:00
;
TEST_START_TIME, Tue, 11 January 2011,  00:41:16,  GMT-08:00
TEST_END_TIME, Tue, 11 January 2011,  00:41:29,  GMT-08:00
;
TEST_SESSION_NAME, 11Jan2011_VQDM_001
;
CONFIGURATION_FILE, N/A
;
VQDM_MODE, ONLINE
TEST_SESSION_END_MODE, PARTIAL DURATION
REQUESTED_TIME_INTERVAL_S, 100
ACTUAL_TIME_INTERVAL_S, 10
;
;
VALID_SAMPLES_PERCENT, 100.0
V1_VIDEO_REFERENCE_STATUS1, ACTIVE
V1_VIDEO_REFERENCE_STATUS2, VALID
;
V2_STATUS1, ACTIVE
V2_STATUS2, VALID
V2_TEST_POINT_NAME, Sensor V2
V2_REFERENT_POINT_NAME, Video Reference
V2_AVERAGE_DELAY_MS,  3.0
V2_MAX_DELAY_MS,  3.1
V2_MIN_DELAY_MS,  3.0
V2_DELAY_STD_DEV_MS,  0.0
V2_DELAY_TREND_MS_PER_S, 0.000
;
```


Things to remember

1. LCD displays often use pulse-width modulation technique to control back-light intensity. It is highly recommended to use **maximal display brightness**, thus minimizing the detrimental effect of back-light modulation
2. VQDM automatically adjusts slicing level - separately for each light sensor, so it can work within very wide range of screen luminosities
3. Black level is of smaller importance, but better keep it dark enough. Black areas brightness values between 0% and 20% are acceptable
4. Compression coding artefacts (blockiness) may deteriorate sensor function, but only if the artefact contrast is very high - more than 25%
5. It is highly recommended to clean sensor vacuum cap and the screen target area with wet LCD cleaning wipe - before each sensor installation.

About VideoQ

Company History

- Founded in 2005
- Formed by an Engineering Awards winning team sharing between them decades of global video technology.
- VideoQ is a renown player in calibration and benchmarking of Video Processors, Transcoders and Displays, providing tools and technologies instantly revealing artifacts, problems and deficiencies, thus raising the bar in productivity and video quality experience.
- VideoQ products and services cover all aspects of video processing and quality assurance - from visual picture quality estimation and quality control to fully automated processing, utilizing advanced VideoQ algorithms and robotic video quality analyzers, including latest UHD and HDR developments.

Operations

- Headquarters in CA, USA
- Software developers in Silicon Valley and worldwide
- Distributors and partners in several countries
- Sales & support offices in USA, UK