Multimedia Test

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Multimedia Test

- End of Line Testing & Prototype testing for Multimedia devices

- Test for performance

- Audio & Video Testing

- Analog & Digital Formats
Set top box / Blu-ray player testing

- Automate video measurements
- Test HDCP-encrypted HDMI and mobile HD content
- Test multiple interfaces and formats
Automotive Multimedia – Infotainment Testing

- Test LVDS, HDMI, or NTSC signals
- Automate multi-screen infotainment system test
- Ensure camera performance
HDTV Main-board & Display Testing

- Automate HDMI video generation and LVDS analysis
- Measure picture quality of interpolation or scaling algorithms
- Find tools for validation or production
Medical & Defense – Subsystem test

- Test HD digital audio and video of subsystems
- Automate picture quality analysis
- Integrate into full test system
Types of AV Signals

• Analog media signals
  • Audio
    o Direct waveform
  • Video
    o NTSC
    o PAL
    o VGA etc.

• Digital media signals
  • Audio
    o S/PDIF
    o HDMI
  • Video
    o HDMI
    o DVI
Analog Audio & Video
Analog Audio Measurement & Test
Audio Signal Acquisition

- High quality PC based audio acquisition hardware
  - 8 simultaneously-sampled Analog Inputs
  - 24-bit resolution
  - 120 dB dynamic range AC/DC coupling
- Dynamic Signal Acquisition Modules
  - PXI 4461
  - PXI 4498
The Challenge of Acoustical Test

More than just data acquisition
- IEPE Microphone Excitation
- Amplifiers and Signal Conditioning
- Calibration

Acoustic Measurements
- Sound Pressure & Power
- Possibly Psychoacoustic
Psychoacoustic Measurements

- Loudness (Stationary, time-varying)
- Sharpness (relative high frequency content)
- Roughness (fast modulations)
- Fluctuation Strength (slow modulations)
- Tonality (relative proportion of tonal energy)
Electrical Audio Measurements

- Frequency Response (Phase and Amplitude)
  - Discrete tone excitation (sweep or multi-tone)
- Distortion
  - Total Harmonic Distortion (THD, THD +N)
  - Signal In Noise And Distortion (SINAD)
  - Intermodulation Distortion (IMD)
- Other
  - Impedance
  - Step Response (Attack/Release)
  - DC
  - Crosstalk
Types of Stimulus Signals

- Single Tone
- Amplitude Sweep
- Coherent Sweep & Chirp
- Multiple Pure Tones, or Stepped Frequency
- Multi-tone
- Step Response
- White Noise
NI Solutions for Audio Test

Hardware

PXI-4461 (2 inputs/2 outputs) & PXI-4462 (4 inputs)
- 204.8 kS/s audio analyzer
- IEPE excitation for microphone pre-amp power
- 118 dB dynamic range
- -107 THD
- +/- 0.1 dB amplitude flatness (DC-92kHz)
- Simultaneous acquisition on multiple boards

PXI-7813R for Digital Audio Test
- Up to 4 in/4 out or 8 inputs
- Support for S/PDIF and AES3
NI Solutions for Audio Test

Software

NI AudioMASTER for Analog and Digital Audio Test
- Configuration-based development
- Ideal for automated measurements & EOL Test
- Built-in excitation signals with dozens of measurements
- Custom test steps within NI TestStand

NI Sound and Vibration Software
- Fully Customizable, LabVIEW API for audio measurements
- Higher-level development tools available
- Built-in psychoacoustic measurements
Analog Video Signal

- Intensity Signal (Luma Signal / Y Signal)

Color Signal (Chroma Signal / C Signal)
Composite Signal – CVBS (Color Video Blank Sync)

- Combination of Y Signal, C Signal, blank & sync signals
Types of Analog Video Signals: 
Composite, S-Video & Component

- Component: Hsync and Vsync can be separate or embedded
- Composite and S-Video: Embedded timing
- Standards specify relationship between gray scale or luma (Y) and chrominance or color information (U,V) for encoding and decoding purposes (for eg. 4:2:2)
  - NTSC (National TV System Committee)
  - PAL (Phase Alternation Line)
  - SECAM (Sequential Couleur Avec Memory or Sequential Color with Memory)
Composite Video Displays (CVBS)
Video Measurements

- Timing
- Levels
- Linearity
Sync Testing

- Picture quality is bad when H-Sync & V-Sync are incorrect
Video Measurements

- **Timing**
  - Sync, Burst, Channel Delay
  - Frequency Response

- **Levels**
  - Luma, Chroma, Channel Levels
  - Noise Levels

- **Linearity**
  - Channel Linearity
  - Differential Gain and Phase
Signal Timing

Timing

- Sync, Burst, Channel Delay
- Frequency Response

Sweep

<table>
<thead>
<tr>
<th>Channel Delays:</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y to L/Pb</td>
<td>-25.08 ns</td>
</tr>
<tr>
<td>Y to V/Pr</td>
<td>-27.30 ns</td>
</tr>
<tr>
<td>L/Pb to V/Pr</td>
<td>-2.22 ns</td>
</tr>
<tr>
<td>Signal Period</td>
<td>200.0 ns</td>
</tr>
<tr>
<td>Window Centre</td>
<td>14.2 us</td>
</tr>
<tr>
<td>Window Width</td>
<td>3.1 us</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sync Amplitude</td>
<td>290.6 mV</td>
</tr>
<tr>
<td>Sync Rise Time</td>
<td>201 ns</td>
</tr>
<tr>
<td>Sync Width (RS-170A)</td>
<td>4.70 us</td>
</tr>
<tr>
<td>Burst Amplitude</td>
<td>306.0 mV</td>
</tr>
<tr>
<td>Burst Amplitude Error</td>
<td>0.1 %</td>
</tr>
<tr>
<td>Rise</td>
<td>0.9 us</td>
</tr>
<tr>
<td>TIA</td>
<td>0.9 cycles</td>
</tr>
<tr>
<td>Burst Width</td>
<td>2.49 us</td>
</tr>
<tr>
<td>Burst Delay</td>
<td>6.51 us</td>
</tr>
<tr>
<td>Burst Frequency</td>
<td>19.0 cycles</td>
</tr>
<tr>
<td>SCL-Phase</td>
<td>2.5 Reg</td>
</tr>
<tr>
<td>DC Offset</td>
<td>16.5 mV</td>
</tr>
<tr>
<td>Damping factor (RS-170A)</td>
<td>0.62 vs</td>
</tr>
<tr>
<td>Blank Start (RS-170A)</td>
<td>-1.71 vs</td>
</tr>
<tr>
<td>Blank End (RS-170A)</td>
<td>0.32 vs</td>
</tr>
<tr>
<td>Blank Width (RS-170A)</td>
<td>11.04 vs</td>
</tr>
<tr>
<td>Front Porch</td>
<td>1.71 vs</td>
</tr>
<tr>
<td>Back Porch</td>
<td>4.63 vs</td>
</tr>
</tbody>
</table>

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Frequency Response

Timing
- Sync, Burst, Channel Delay
- Frequency Response

Sin(X)/X

Multiburst

| Measurement | Measurement 1 | 0.0 dB |
| Measurement 2 | -0.0 dB |
| Measurement 3 | -0.1 dB |
| Measurement 4 | -0.1 dB |
| Measurement 5 | -0.6 dB |
| Measurement 6 | -2.0 dB |
| Measurement 7 | -5.0 dB |

Group Delay
- Measurement 1: 0 ns
- Measurement 2: 0 ns
- Measurement 3: 1 ns
- Measurement 4: 2 ns
- Measurement 5: 14 ns
- Measurement 6: 30 ns
- Measurement 7: 457 ns

Frequency
- Measurement 1: 0.5 MHz
- Measurement 2: 1.0 MHz
- Measurement 3: 2.0 MHz
- Measurement 4: 3.0 MHz
- Measurement 5: 4.0 MHz
- Measurement 6: 4.3 MHz
- Measurement 7: 4.8 MHz

Burst 1
- Absolute Amplitudes:
  - Burst 1: 429.1 mV
  - Burst 2: 428.8 mV
  - Burst 3: 429.0 mV
  - Burst 4: 427.7 mV
  - Burst 5: 427.9 mV
  - Burst 6: 427.5 mV

  - Max. Difference: 1.9 mV

Burst Frequencies:
- Burst 1: 0.5 MHz
- Burst 2: 1.3 MHz
- Burst 3: 2.0 MHz
- Burst 4: 3.0 MHz
- Burst 5: 3.6 MHz
- Burst 6: 4.1 MHz

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Channel Levels

- **Timing**
  - Sync, Burst, Channel Delay
  - Frequency Response

- **Levels**
  - Luma, Chroma, Channel Levels
  - Noise Levels

- **Linearity**
  - Channel Linearity
  - Differential Gain and Phase

- **Noe Levels**
  - Luminance Amplitude
  - Chrominance Amplitude
  - Chrominance Phase

- **Timing Levels**

- **Levels**
  - Luma, Chroma, Channel Levels
  - Noise Levels

- **Linearity**
  - Channel Linearity
  - Differential Gain and Phase

- **Noe Levels**
  - Luminance Amplitude
  - Chrominance Amplitude
  - Chrominance Phase

<table>
<thead>
<tr>
<th>Channel</th>
<th>Amplitude</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>713.6 mV</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>499.5 mV</td>
<td></td>
</tr>
<tr>
<td>Cyan</td>
<td>398.3 mV</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>242.3 mV</td>
<td></td>
</tr>
<tr>
<td>Magenta</td>
<td>256.5 mV</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>200.0 mV</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>109.0 mV</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>62.0 mV</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channel</th>
<th>Amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>451.3 mV</td>
</tr>
<tr>
<td>Cyan</td>
<td>637.7 mV</td>
</tr>
<tr>
<td>Green</td>
<td>596.1 mV</td>
</tr>
<tr>
<td>Magenta</td>
<td>595.3 mV</td>
</tr>
<tr>
<td>Red</td>
<td>637.8 mV</td>
</tr>
<tr>
<td>Blue</td>
<td>481.0 mV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channel</th>
<th>Phase (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>167.9 Deg</td>
</tr>
<tr>
<td>Cyan</td>
<td>283.8 Deg</td>
</tr>
<tr>
<td>Green</td>
<td>240.8 Deg</td>
</tr>
<tr>
<td>Magenta</td>
<td>60.8 Deg</td>
</tr>
<tr>
<td>Red</td>
<td>103.8 Deg</td>
</tr>
<tr>
<td>Blue</td>
<td>347.9 Deg</td>
</tr>
</tbody>
</table>
Noise Levels

- Luma, Chroma, Channel Levels
- Noise Levels

---

**Noise Spectrum**

- Chrominance AM/PM Noise

---

**Table:**

<table>
<thead>
<tr>
<th>Noise Level</th>
<th>-71.8 dB rms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.16 nV rms</td>
</tr>
<tr>
<td>Peak Noise Level</td>
<td>-78.5 dB p-p</td>
</tr>
<tr>
<td>Peak Noise Frequency</td>
<td>1.09 MHz</td>
</tr>
<tr>
<td>Noise Band Start</td>
<td>100 kHz</td>
</tr>
<tr>
<td>Noise Band Stop</td>
<td>6.0 MHz</td>
</tr>
</tbody>
</table>

**Chrominance Ref. (0 dB):** 663.1 nV p-p

**Noise Levels:**
- AM Noise: -85.1 dB rms
- PM Noise: -76.1 dB rms
Channel Linearity

- Channel Linearity
- Differential Gain and Phase

**Luminance Nonlinearity**

<table>
<thead>
<tr>
<th>Luminance Non-Linearity</th>
<th>0.6 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Step 2</td>
<td>0.5 %</td>
</tr>
<tr>
<td>Step 3</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Step 4</td>
<td>0.4 %</td>
</tr>
<tr>
<td>Step 5</td>
<td>0.1 %</td>
</tr>
</tbody>
</table>

**Chrominance Nonlinearity**

- Non-Linear Gain:
  - Packet 1: 0.0 %
  - Packet 2: 0.0 %
  - Packet 3: 0.1 %

- Non-Linear Phase:
  - Packet 1: 0.1 Deg
  - Packet 2: 0.0 Deg
  - Packet 3: 0.1 Deg

- Intermodulation:
  - Packet 1: -0.2 %
  - Packet 2: -0.0 %
  - Packet 3: -0.0 %

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Differential Gain and Phase

Timing
- Sync, Burst, Channel Delay
- Frequency Response

Levels
- Luma, Chroma, Channel Levels
- Noise Levels

Linearity
- Channel Linearity
- Differential Gain and Phase

Differential Gain/Phase

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff Gain Min</td>
<td>0.34 %</td>
</tr>
<tr>
<td>Diff Gain Max</td>
<td>1.17 %</td>
</tr>
<tr>
<td>Diff Gain Pk-Pk</td>
<td>1.12 %</td>
</tr>
<tr>
<td>Packet 1 Gain</td>
<td>0.98 %</td>
</tr>
<tr>
<td>Packet 2 Gain</td>
<td>0.99 %</td>
</tr>
<tr>
<td>Packet 3 Gain</td>
<td>0.15 %</td>
</tr>
<tr>
<td>Packet 4 Gain</td>
<td>0.04 %</td>
</tr>
<tr>
<td>Packet 5 Gain</td>
<td>1.17 %</td>
</tr>
<tr>
<td>Diff Phase Min</td>
<td>-0.00 Deg</td>
</tr>
<tr>
<td>Diff Phase Max</td>
<td>0.12 Deg</td>
</tr>
<tr>
<td>Diff Phase Pk-Pk</td>
<td>0.20 Deg</td>
</tr>
<tr>
<td>Packet 1 Phase</td>
<td>0.04 Deg</td>
</tr>
<tr>
<td>Packet 2 Phase</td>
<td>0.01 Deg</td>
</tr>
<tr>
<td>Packet 3 Phase</td>
<td>0.12 Deg</td>
</tr>
<tr>
<td>Packet 4 Phase</td>
<td>0.04 Deg</td>
</tr>
<tr>
<td>Packet 5 Phase</td>
<td>-0.06 Deg</td>
</tr>
<tr>
<td>Relative Burst Gain</td>
<td>0.10 %</td>
</tr>
<tr>
<td>Relative Burst Phase</td>
<td>-0.01 Deg</td>
</tr>
</tbody>
</table>

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Components of Analog AV Testing

- High Speed Digitizer (~ 100MS/s)
- High Quality Audio Acquisition
- Audio Analyzer Software
- Video Analyzer Software
Components of Analog AV Testing

- High Speed Digitizer (~ 100MS/s) - NI PXI 5122
- High Quality Audio Acquisition - NI PXI 4461
- Audio Analyzer Software - NI Audio Master
- Video Analyzer Software - NI VMS
Analog Video: Digitizer Performance Is Important

- Typical oscilloscopes are not well suited for analog video measurements
NI Solutions for Audio-Video Test

**NI Analog Video Analyzers**
CVBS, S-Video, CAV, VGA
- PXI-512x + VideoMUX

**NI Analog Audio Analyzers**
- PXI-4461
- PXI 4498

**NI/Alfamation Video Generator**
CVBS, S-Video, CAV, VGA, HDMI 1.4
NI Video Measurement Suite (VMS)

- Digital video analysis*
  - DVI & HDMI with HDCP encryption 1080p 60Hz
  - Static and Streaming Analysis
  - HDMI 1.4 analysis

- Digital video generation:
  - DVI & HDMI up to 1080p 60Hz

- Analog video analysis*: Analog video analysis*: Analog video analysis*: Analog video analysis*:
  - Composite & S-Video (NTSC & PAL)
  - Component (YPbPr & RGB)
  - Computer VGA

- Analog video generation: Analog video generation: Analog video generation: Analog video generation:
  - Composite (NTSC, PAL & SECAM)
  - S-video & Component

* New Feature Impact

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NI VMS Software

TestStand Steps

Standalone or Soft Front Panel

LabVIEW API

C API

Video Image

Video Waveform

Measurement Results

Vector Scope Display
Video Master

- High Speed Digitizer (for Video)
- Video Measurement Suite (VMS)
- Audio Acquisition Card
- Audio Master Software
- Modular PXI platform
- RAID Drive (Optional)
Benefits of NI PXI Platform

• PXI 5122 & PXI 4461 constitute only one slot each
• Wide variety of other modular instruments available
  • RF Signal Analyzer, RF Signal Generator, Arbitrary Waveform
    Generator, DC Source, DMM, LVDS, FPGA cards etc.
• With the synchronization capabilities of PXI, complete
test system can be built on PXI platform