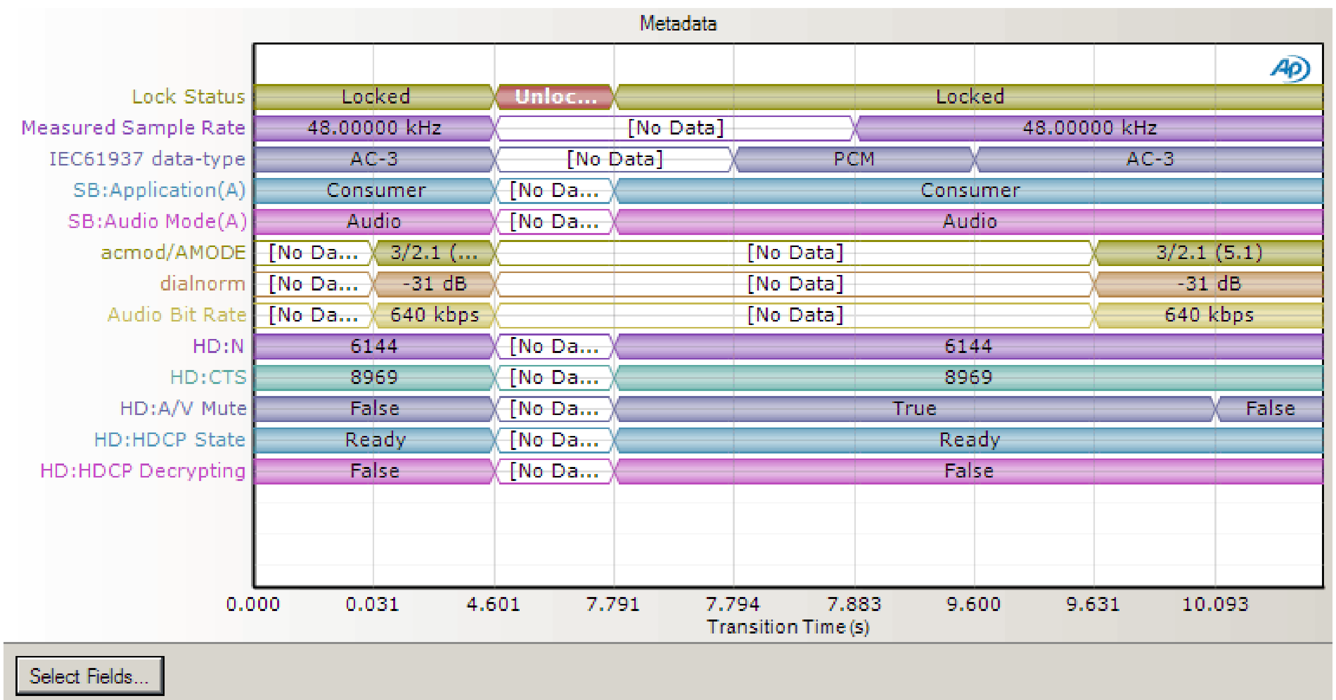
Digital Protocol Analysis

Viewing and manipulating the data behind the audio

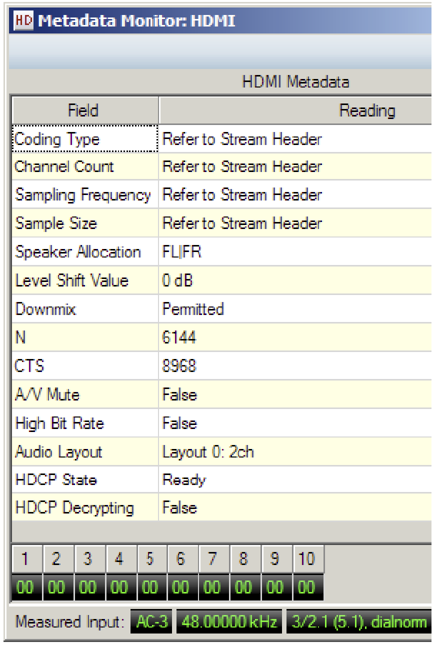


Digital protocol analysis is essential for any designer of modern digital audio equipment. In contrast to older protocols such as S/PDIF, where only a few pieces of metadata accompany the audio, metadata streams now can carry hundreds of pieces of essential information. The failure of a device either to send or receive the proper data can lead to serious difficulties and failures connecting to other devices.

HDMI, for example, carries multiple types of metadata. Status and user bits carry information such as sample frequency, bit depth, and channel number.

The Audio InfoFrame holds data about channel allocations, encoding formats, and level adjustments for multi-channel surround sound. And EDID, while not technically metadata, lets one hardware device tell another what it is capable of (number of channels, sample rates, decoders, etc.).

Inside, we'll discuss setting and analyzing metadata and EDID, and we'll look at the relevant features and tools you should look for in an audio analyzer. We'll also learn how a metadata recorder can display metadata that changes over time.



Metadata Monitor: HDMI

Field	Reading
Coding Type	Refer to Stream Header
Channel Count	Refer to Stream Header
Sampling Frequency	Refer to Stream Header
Sample Size	Refer to Stream Header
Speaker Allocation	FL|FR
Level Shift Value	0 dB
Downmix	Permitted
N	6144
CTS	8968
A/V Mute	False
High Bit Rate	False
Audio Layout	Layout 0: 2ch
HDCP State	Ready
HDCP Decrypting	False

1	2	3	4	5	6	7	8	9	10
00	00	00	00	00	00	00	00	00	00

Measured Input: AC-3 48.00000 kHz 3/2.1 (5.1), dialnorm

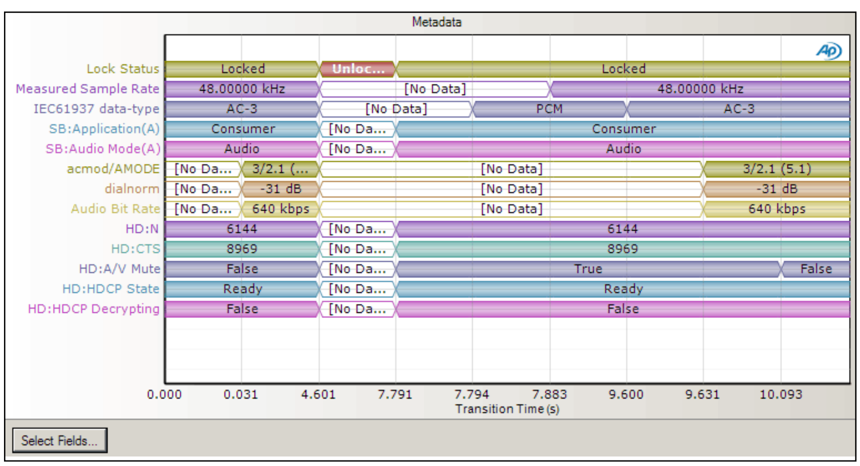
Use Case:
Blu-ray Disc Player Testing

Blu-ray disc players send out a continuous stream of metadata, and errors here can cause a range of problems, from a degraded audio experience to no audio at all. That's why it's important for equipment designers, manufacturers, and product test labs to have the ability to view this data. In the APx500 software, this is done with the status bits monitor and the HDMI metadata monitor. In addition to viewing the settings for each field, the monitors show the actual hex values, which is helpful to engineers trying to track down the origin of a metadata problem.

Putting different discs into the player is an important step in testing. Does the player show all the available audio formats on the disc? Does it show the correct number of channels, the correct speaker allocation, and the correct protection status? It's necessary to check all this to determine if the device is performing properly and if it can interface properly with other audio equipment. But if you want to know what metadata gets output during dynamic operations, it's best to use a metadata recorder.

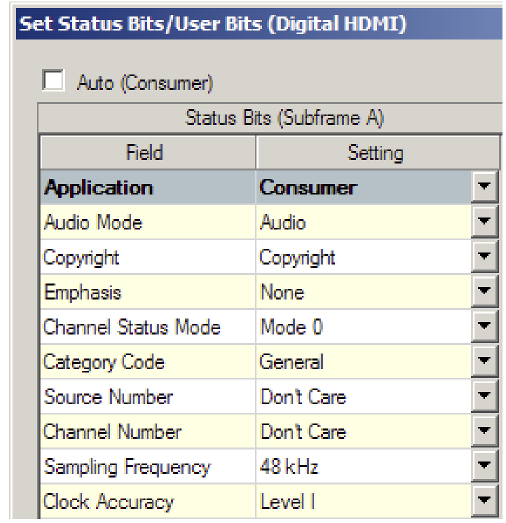
Metadata Recorder

Being able to see metadata changing over time allows you to analyze dynamically occurring events. When testing a Blu-ray disc player, for example, you can see if the Audio InfoFrame values hold steady or change in pause mode, what happens to the sampling frequency while searching tracks, and how long it takes to stabilize, lock, and un-mute after plugging in an HDMI cable or after initiating various transport actions.



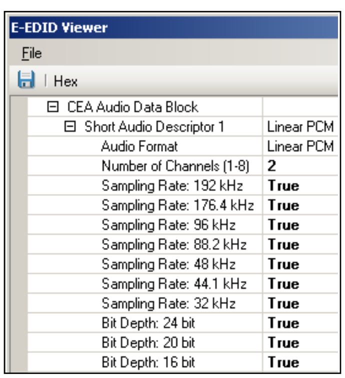
A metadata recorder also helps in detecting glitches. For example, you can see if incorrect data is being momentarily output when changing modes, such as when going into pause or search—a condition that might cause problems at the receiving device. You can also see if any glitches or interruptions in the metadata are occurring in normal operation, while the audio is playing. The recorder lets you select and display up to 16 data fields at one time from all those that are available. All fields, however, are simultaneously recorded and may selected for display at a later time.

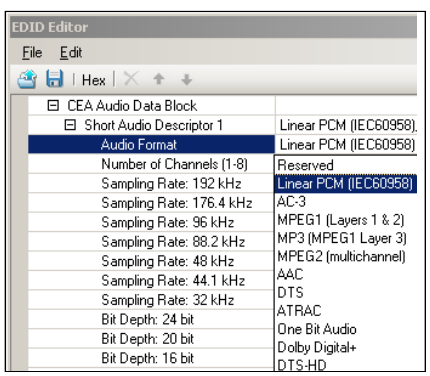
Use Case: A/V Receiver Testing



Let's use the audio analyzer to generate and send audio and metadata to an A/V receiver. Now, we're in the pilot's seat. Instead of analyzing what gets sent to us, we're going to do the sending and see how the receiver behaves. To do that, we need complete control over both audio and metadata. With the APx500 software, we can send both linear and Dolby or dts encoded audio. We can also set the status/user bits and the Audio InfoFrame to any values.

Now, let's run some tests. First, we'll let the APx automatically set the metadata values, and see if the A/V receiver plays without problems. We'll do this with a variety of channel counts and formats, to make sure everything works as promised. Then comes the really fun part. We're going to deliberately set some of the metadata values incorrectly, and see how the receiver reacts. Does it ignore the incorrect settings when possible? Does the audio mute? Does it give the user a useful error message, or just do nothing? The answer to that is vital to the user experience with this A/V receiver, and our tests will reveal exactly what happens in each scenario.





EDID

EDID errors are a major cause of interoperability problems between devices. EDID isn't metadata—information about the audio. It's information about what the hardware (Blu-ray player, AV receiver, HD camcorder…) can do. While audio and video data travel downstream on an HDMI cable to the next device, EDID swims upstream to tell the previous device what to send.

Why is reading and editing EDID useful? So that we can check if the data sent by a device correctly describes its capabilities, and if the data received by it is being handled properly. For example, if our device supports a 192 kHz sample rate on its input, need to check that the EDID data it sends back to the audio source reflects that. In the APx500 software, this is done with the EDID viewer.

Conversely, we need to verify that the audio source reads the incoming EDID data correctly and sends audio in an acceptable format with the best fidelity possible. To do this, APx500 includes an EDID editor. With the EDID editor, you can, for example, indicate that a particular format is unsupported and see if the connected source device falls back properly to another.

APx585 with HDMI and DSIO options shown

Digital Protocol Analysis Glossary

ACMOD: A setting in the Dolby frame header that defines the number and layout of encoded channels.

AMODE: A setting in the dts frame header that defines the number and layout of encoded channels.

Audio InfoFrame: Audio metadata sent at least once per two video frames over HDMI. Data includes speaker allocation for linear streams, level shift value for downmixing, and more.

CEC: Consumer Electronics Control—shares control information among all HDMI-connected devices, such as one-touch play and record, automatic source switching, timer programming, and system audio control.

CTS: The audio sample clock is not transmitted across HDMI. Instead, the N and CTS (Cycle Time Stamp) values contained in the Audio InfoFrame are used along with the TMDS clock to regenerate the audio sample clock at the HDMI sink.

E-EDID: Enhanced Extended Display Identification Data is a data structure supplied by the sink device. It informs the source of the sink's rendering capabilities, including video resolution and interlacing, video frame rates and color space, number of audio channels, and types of compressed formats.

HDCP: High-bandwidth Digital Content Protection—an authentication/encryption scheme used by HDMI, DVI, and DisplayPort.

HDMI: High Definition Multimedia Interface is a standard for audio/video transmission between a source and sink over a single cable. It provides for high definition video and high resolution audio (up to 192 kHz, 24 bits, 8 channels, uncompressed). The source sends audio and video data, and the sink receives audio and video data.

IEC 60958: Protocol and connection standard for transporting digital audio. Includes balanced professional AES3, unbalanced consumer S/PDIF, and optical consumer Toslink. The protocol is also applied to audio transported over HDMI.

IEC 61937: Interface for non-linear PCM encoded audio bitstreams carried over IEC 60958.

Status Bits: Audio metadata that is embedded in the audio word (audio mode, number of channels, clock frequency…).

TMDS: Transition Minimized Differential Signaling. HDMI uses four TMDS lines, including three for data and one for the clock.

User Bits: Unreserved unused metadata bits embedded in the audio word that may be used for special purposes.

Additional Resources @ AP.com

APx500 User Manual
http://ap.com/display/file/25

APx500 HDMI EDID configuration files
http://ap.com/display/file/259

For more information or a demonstration, please contact your local AP sales partner http://ap.com/contact.

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