

Dolby Test & Measurement Application Notes

Overview

The daily use of technologies such as Dolby[®] E, Dolby[®] Digital and Dolby[®] Digital Plus in all areas of broadcast television content delivery requires an understanding of the importance of metadata, the transport mechanism as well as the tools to check them.

Dolby support is available for the full range of PHABRIX Sx and PHABRIX Rx rack range of products. The Sx and Rx main menu and meters display the presence of Dolby E, Dolby Digital and Dolby Digital Plus on any of the SDI embedded audio channels. This means that any PHABRIX unit can be used to check the presence of Dolby Digital audio.

```
Aud Grp: 1 2 3 4
1:PPPP 2:PPPP 3:EE++ 4:DDPP
```

The Dolby Metadata Analyzer option on the Sx and Rx range allows the program metadata of Dolby E, Dolby D and Dolby D+ to be extracted and displayed.

This allows the analysis of over 140 different program configurations, bit depths and data rates and allows the metadata value of program audio level to be displayed on the meter display to give a quick indication that the program levels are correct.

The Dolby Metadata Generator option on the Sx and Rx range allows the generation of program metadata for over 140 different Dolby E, Dolby D and Dolby D+ program configurations, bit depths and data rates.

The combination of the Dolby Metadata Generator and Dolby Metadata Analyzer allow closed loop testing of equipment for compliance with all of the permitted Dolby program configurations that are in everyday use.

The Dolby Decoder Module, available on the Rx range, allows the full decode of the Dolby digital audio into its base audio channels. These decoded channels can be monitored, using speakers or headphones, measured using the Audio and Loudness meters and routed via an PHRXM-4AES module (option) to other equipment.

Dolby Metadata Detection

All PHABRIX Sx hand held and PHABRIX Rx rack mount systems recognize Dolby E, Dolby Digital and Dolby Digital Plus audio pairs embedded in the SDI datastream.

Dolby E, Dolby Digital and Dolby Digital Plus audio is embedded as an audio pair in the SDI datastream as encoded data rather than PCM audio which is typically for SDI audio. The audio level of the Dolby audio is critical and therefore all PHABRIX units can recognise this and measure the levels accordingly.

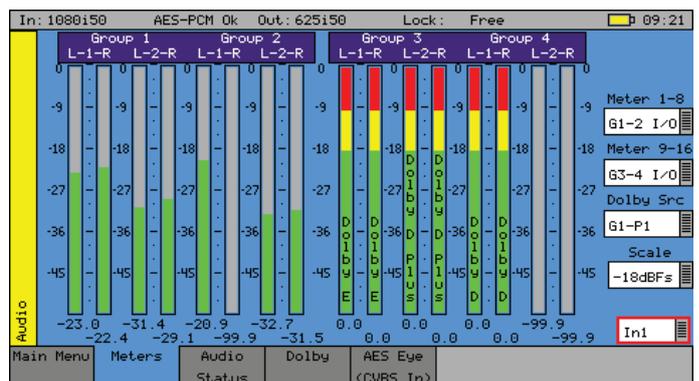


Image of SxTAG meters showing Dolby E, D and D+.

Dolby Metadata Analysis

The Dolby Metadata Analyzer option on the Sx and Rx range allows the program metadata of Dolby E, Dolby Digital and Dolby Digital Plus to be extracted and displayed allowing the analysis of over 140 different Dolby program configurations, bit depths and data rates. This option also allows the metadata value of program audio level to be displayed on the meter display to give a quick indication that the program levels are correct and allows the analysis of the Dolby Program metadata and the measurement of Dolby E timing.



Dolby Metadata Generation

The Dolby Metadata Generator option on the Sx and Rx range allows the generation of program metadata for over 140 different Dolby E, Dolby Digital and Dolby Digital Plus program configurations, bit depths and data rates.

Dolby Metadata is setup in the Dolby page and is then embedded as an audio pair (using the Audio Group 1/2 or 3/4 menus) in the SDI video output of the generated test pattern.

Note that the Dolby Metadata can also be output as an AES audio pair.

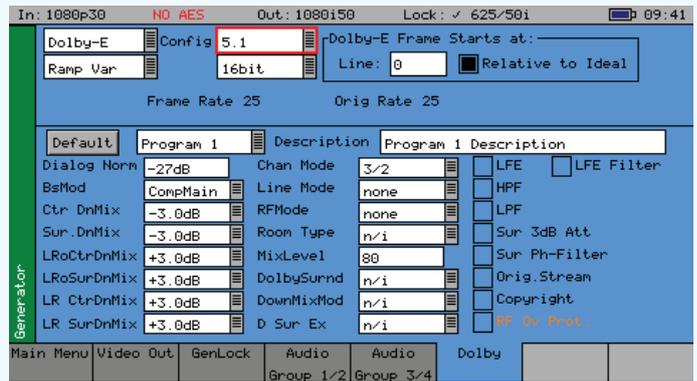


Image of Sx Dolby Metadata Generator

Closed Loop Testing

The combination of the Dolby Metadata Generator and Dolby Metadata Analyzer allow closed loop testing of equipment for compliance with all of the permitted Dolby program configurations that are in everyday use.

Any failures and non-compliances will be displayed in red on the Dolby Metadata display and can be logged for over 140 different Dolby program configurations of mono, stereo, 5.1 and 7.1 channels working as Dolby E, Dolby Digital and Dolby Digital Plus.



Engineers and Manufacturers alike face the challenge of dealing with the myriad of possible Dolby programme combinations within broadcast. Testing needs to ensure that equipment is correctly designed and that all programme combinations are correctly supported.

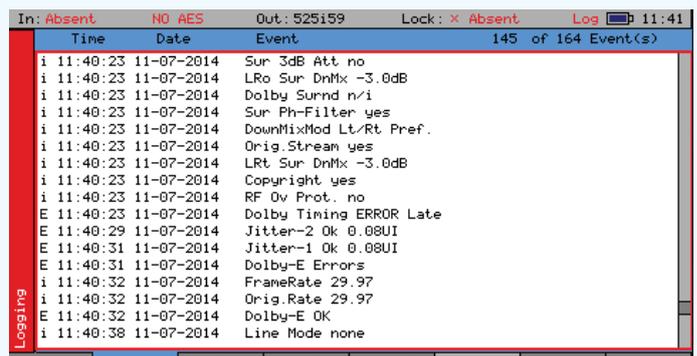
Closed loop testing can be performed manually but can also use scripts (Sx only) and use remote control (Sx and Rx).

Automated scripts and remote control can be used to make systematic selection of video formats, Dolby types, bit depth and programme configurations while the output of the Unit Under Test is monitored and errors reported using the inbuilt logging system. Ideal for manufacturers performing compliance testing of their designs and production output.

Monitoring

In environments where programs of different audio content are being distributed or transmitted over the same wire it is important to monitor any changes between PCM audio and Dolby audio and any changes in Dolby programme configuration as this may have a knock on effect downstream.

The built-in logging and alarm facilities and the ability to monitor PHABRIX equipment remotely via standard networks mean that undesired changes can be spotted early.



Full Dolby Decode

The Dolby Decoder module, available on the Rx range, allows the full decode of the Dolby digital audio into its base audio channels. These decoded channels can be monitored, using speakers or headphones, measured using the Audio and Loudness meters and routed via the optional PHRXM-4AES module as AES audio for use by other equipment. This makes the Dolby Decoder a 'must have' anywhere in the broadcast chain where Dolby Digital audio is in use and especially anywhere before Dolby audio is transmitted back to a studio and on to the viewer.

The Dolby Decoder module plugs into the CPU module and provides 2 independent decoded streams from the selected SDI or AES audio sources. The decoded or mixed-down audio can be treated as PCM audio and measured and monitored using the audio analysis tools.

The Dolby configuration page allows the easy configuration of Dolby digital audio source as well as the routing of decoded audio channels to the audio monitoring and instrumentation and routing via the optional PHRXM-4AES module to 3rd party equipment.

The dual stream decoding allows 2 simultaneously transmitted Dolby versions (for example 2 different languages) to be monitored constantly via instrumentation, via the audio output or via AES audio output.

With the Dolby Decoder module installed, the loudspeakers (Rx 2000), headphone and rear panel audio output allow the Dolby Downmix to be heard. The Analyser Audio Metering Mix Down function allows individual decoded Dolby audio channels to be selected as part of the downmix

The modular flexibility of the PHABRIX Rx rack mount range means that it can be tailored to suit specific installations. Presets can be used to store system configurations and can be dynamically recalled to suit different inputs and system configurations.

The audio meters can display the exact audio levels of all channels of the Dolby program. The Loudness meters can be used to measure and log the program loudness for ITU and EBU Loudness Compliance.

The channel phase relationship can be monitored using the Lissajous display. All of which provide a complete audio compliance tool kit the envy of many very expensive audio installations.

If the Dolby Metadata Analysis option is included then every aspect of the Dolby Program can be checked, monitored and logged.

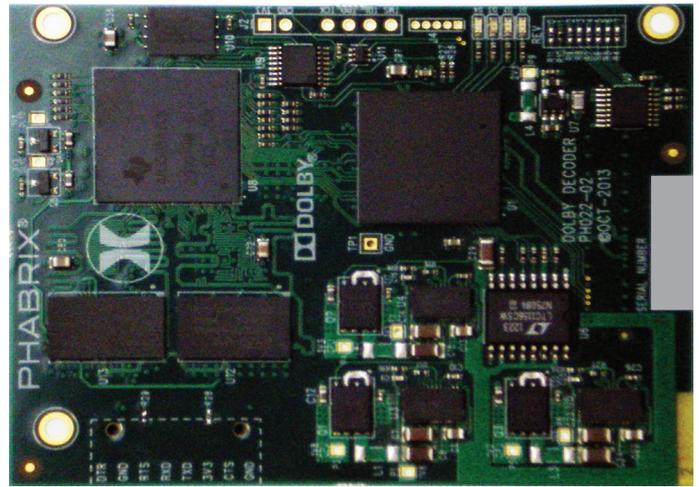
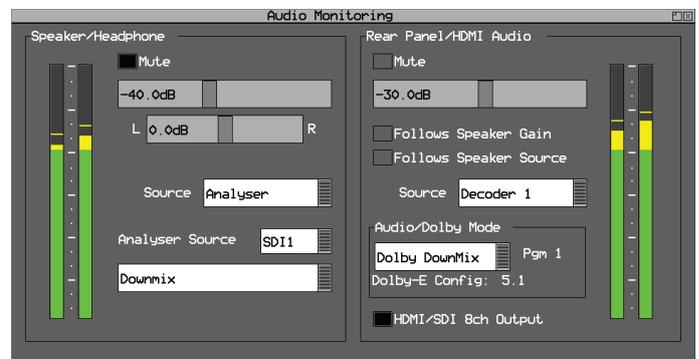
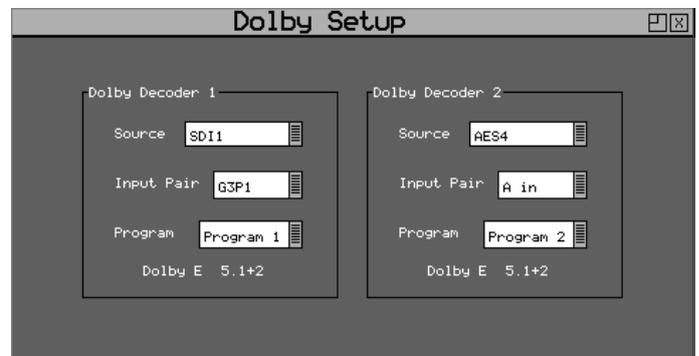


Image of Rx Dolby Decoder Module



About Dolby Digital Audio

There are a number of Dolby® digital audio standards, developed by Dolby Laboratories™, that transport audio data within the SMPTE 337M-2000 data burst or AES audio and embedded within the SDI data stream. These include:

- Dolby® E
- Dolby® Digital
- Dolby® Digital Plus

These standards can be used to transport mono, stereo, 5.1 and 7.1 audio programmes:

Dolby® 5.1 uses five channels for normal-range speakers (right front, centre, left front, surround right and surround left) and one channel for the subwoofer driven low-frequency effects.

Dolby® 7.1 (non broadcast) uses six channels in the primary program (Independent Substream) for a standard 5.1 surround sound mix and then the remaining 2 channels in an ancillary programme (Dependent Substream) to provide the additional down-mix version.

Dolby® E

Dolby® E is a video frame-based audio encoding and decoding technology developed by Dolby Laboratories that allows up to 8 channels of audio (mono, stereo, 5.1 or 7.1) for a primary programme (Programme 1) and optional ancillary programs. These 8 channels are compressed into a digital stream that can be transferred between compatible devices and stored on a standard stereo pair of audio tracks.

Delivery using HANC Encoding

Unlike PCM audio the Dolby® data burst contains both the encoded audio channels as well as metadata. This Dolby® metadata carries specific information about the encoded surround sound audio including the Dolby® encoding method, the number and type of audio channels and the specific matrix coefficients required to re-assemble the surround sound audio at the receiver. The Dolby® metadata is delivered to the receiver with the encoded audio channels to ensure that the correct audio levels and the correct channel separation

The complexity of Dolby® encoding, its metadata and its transport using HANC SMPTE 337M data packet embedded within the SDI data, means that it is susceptible to video timing, switching issues, decoding and encoding and the insertion of additional broadcast metadata within the broadcast chain. It is therefore important to be able to analyse the metadata at each stage to ensure that all data is transmitted transparently and decoded successfully at its final destinations.

The header information within the Dolby® E and Dolby® Digital encoded audio package is used by decoders to identify specific encoding method used

Dolby® E is primarily a production format that allows the relatively transparent movement of a finished Dolby Surround Sound audio programme, via SD-SDI, HD-SDI or 3G-SDI, through the production chain until it reaches the point of transmission where it is converted to Dolby® Digital or Dolby® Digital Plus. As Dolby® E is frame-based it allows cuts editing that does not affect the audio.

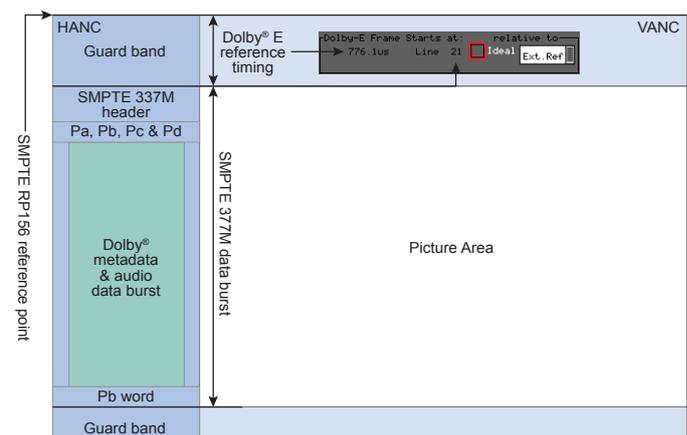
Dolby® Digital

Dolby® Digital (AC-3), developed primarily for DTV, DVD and HDTV, is a 'perceptual audio' system for digital audio that allows the reduction of data needed to deliver high-quality sound. This system relies on the fact that the human ear will screen out certain levels of sound that are perceived to be noise. The removal of this noise reduces the amount of data needed to deliver the sound.

Dolby® Digital technology was developed to allow up to six channels of sound (mono, stereo or 5.1) in the form of a single 'program' that can be delivered at different bit rates. These 6 channels are compressed (lossy) into a digital stream that can be broadcast.

Dolby® Digital Plus

Dolby® Digital Plus (E-AC-3) is a more advanced version of Dolby® Digital that provides a more efficient encoding algorithm that provides enough bandwidth to support sophisticated multi-programme content combining mono, stereo, 5.1, 7.1 & 13.1 for a primary programme and optional ancillary programs that can be delivered at much lower bit rates than Dolby® Digital. Channels are compressed (lossy) into multiple independent digital data stream plus up to 8 dependent sub streams.



In the case of Dolby® E, if this header information is missing then the audio is assumed to be PCM which can effectively cause a full scale noise burst that can damage audio monitoring equipment. Only when the next frame where a valid Dolby® E header appears, will the Dolby® circuitry be able to decode the data correctly.

In the case of Dolby® Digital and Dolby® Digital Plus, if this header information is missing, or if the Dolby® programme is interrupted, only when the next valid Dolby® Digital header appears will the Dolby® circuitry decode the data correctly.

Things to look out for

In most cases it has to be assumed that the actual Dolby® Surround Sound programme data is correct as it is difficult to interpret without decoding it first to its base band channels. When moving SDI video containing Dolby® audio around a facility the highest risks of failure are likely to be the caused by timing issues that critically affect the detection of the Dolby® header as well as interruptions or corruptions of the data stream.

Dolby® E Framing Values

A Dolby® E encoded audio programme is a video frame-based system whose data occupies the area of ancillary data normally occupied by the AES/EBU PCM audio. Unlike PCM audio that can tolerate video switching anywhere within a large range of lines in the vertical interval, Dolby® E has a narrow guard band which contains no audio and in which video switching can take place without loss of critical Dolby® header information.

The Dolby® Reference Point (immediately following the Dolby® guard band) is where the encoded Dolby® E audio packet starts. This can be defined as specific video lines and timed approximately $700\mu\text{s} \pm 80\mu\text{s}$ from the SMPTE RP156 Reference Point.

It is important for the Dolby® E packet to be positioned well away from the video switching line so that Dolby® E packets are not corrupted by downstream switchers.

Incorrect positioning of the Dolby® E packet will result in full scale audio being output as PCM audio to downstream equipment.

Test equipment such as the Sx hand held range with Dolby® option can measure the timing of the Dolby® E packet relative to the SDI input or the External reference.

Corruption of Dolby® Metadata

As mentioned earlier, the Dolby® metadata contained with the audio data burst is as important as the encoded audio itself.

Equipment such as play-out servers, that store complete Dolby® Digital and Dolby® Digital Plus video/audio programs, must deliver the Dolby® data burst exactly as it was created otherwise it will not be decoded correctly at the receiver.

Equipment that decodes and re-encodes the video/audio data stream must re-assemble the data stream exactly to ensure that it can be decoded by the receiver as intended.

It can be difficult to inspect or interpret a Dolby® data stream as it passes through a broadcast chain. It can be more useful to inject a known Dolby® program with known metadata values and then check at each stage in the broadcast chain that the injected program and metadata is the same.

Equipment such as the PHABRIX® Sx hand held and PHABRIX® Rx rack mount systems allow closed loop testing of any equipment can be performed.

Dolby® CRC and SMPTE Pa/Pb Sync Word Spacing

There are a number of critical measurements that can be used to ensure that the Dolby® data burst is correct:

The Dolby® data burst provides a CRC word for each data burst. This allows the integrity of the Dolby® audio data to be checked by the receiving equipment.

With Dolby® Digital and Dolby® Digital Plus, the audio data burst is a constant length each frame and is bounded by the SMPTE 377M-2000 Pa and Pb sync words.

If this spacing is incorrect, or changes during a programme, it can indicate that the data burst is not generated correctly or that it is corrupt.

It may not be possible to detect random Pa/Pb spacing changes or CRC errors during a program transmission so it is may be necessary to log these errors for later analysis.

Dolby® Programme Combinations

Dolby® programs can consist of mono channels, stereo pairs, 5.1 surround sound and 7.1 surround sound and even 13.1 surround sound as Main, Dependent or Independent programme streams. There are a large number of possible programme combinations that are permitted by Dolby® E, Dolby® Digital and Dolby® Digital Plus and therefore equipment manufacturers and installers need to test all of these combinations to ensure that they are compliant.

Audio Buzz

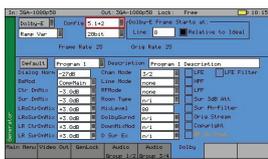
When Dolby® encoded audio is not processed or decoded correctly it can produce a distinctive audio buzz. If the audio programme is interrupted the decoder may repeat the same audio segment repeatedly until the programme is restored.

Products such as the PHABRIX® Sx hand held and Rx rack mount equipment allow the automated testing of each of the possible combinations to ensure compliance.

Option Information



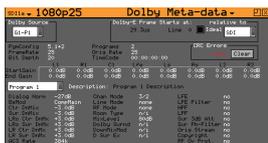
The Sx Dolby analysis option (Order reference PHSXOBD) displays Dolby E, Dolby D or Dolby D+ meta data present in a selected audio stream and determines whether the Dolby-E packet is timed correctly on the SDI video stream. The Dolby-E may peak audio levels metering is also displayed.



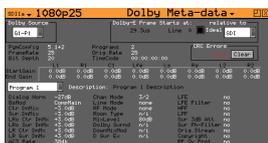
The Sx Dolby generation option (Order reference PHSXODG) allows the generation of Dolby E, Dolby D or Dolby D+ program metadata and includes the ability to adjust the 'start of frame' for Dolby E packets. Dolby streams are provided for all program configurations with fixed audio data. Metadata can be edited by the user and stored in memories.



The Sx Dolby generation + analysis option (Order reference PHSXO-DAG) combines the functionality of these two option in a single purchasable option to allow closed loop testing to be performed.



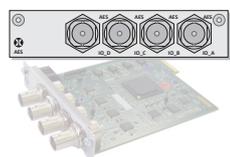
The Rx Dolby analysis option (Order reference PHRXO-BDA) displays the Dolby E, Dolby D or Dolby D+ metadata present in a selected audio stream and determines whether the Dolby-E packet is timed correctly on the SDI video stream. The Dolby may be monitored from any of the SDI input embedded audio channel pairs or the AES input. Dolby E peak audio levels metering is also displayed.



The Rx Dolby generation option (Order reference PHRX-BDG) allows the generation of Dolby E, Dolby D or Dolby D+ program metadata and includes the ability to adjust the 'start of frame' for Dolby E packets. Dolby streams are provided for all program configurations with fixed audio data. Metadata can be edited by the user and stored in memories.



The Rx Dolby Decode module (Order reference PHRXM-DD) is a mezzanine board for the CPU module that decodes the 1 (standard) or 2 (optional) channels of Dolby E, Dolby Digital or Dolby Digital Plus into base band audio channels that can monitored and heard.



The Rx AES Input & Output module (Order reference PHRXM-4AES) has been designed for AES audio centric installations and allows 4 x AES digital audio pairs to be routed to the Audio Meter and Loudness instruments. This module can also be used to output 4 x AES digital audio pairs from the selected Analyser/Generator module within the Rx chassis.