

E-MU 0204 Test Report using Multi-Instrument



Rev: 01
June 08, 2011

This report is valid only for the particular E-MU 0204 unit we tested. The purpose of these tests was not only to evaluate the performance of E-MU 0204, but also to find the conditions under which the best performance of E-MU 0204 can be obtained. The information obtained from these tests can be used as a reference for those who want to use E-MU 0204 as a test and measurement instrument to measure other devices or signals.

Note: VIRTINS TECHNOLOGY reserves the right to make modifications to this document at any time without notice. This document may contain typographical errors.

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1. Test Setup

- (1) E-MU 0204 USB2.0 Audio Interface (www.emu.com).
- (2) Dell Studio 15 laptop, with 64-bit Windows 7 Professional, Intel Core 2 Duo Processor P8700 (2.53GHz/1066FSB/3MB Cache), 4GB memory.
- (3) Multi-Instrument 3.2 (Full version, Build 3.2.0.3). (21-day fully functional FREE trial available at: www.virtins.com/MIsetup.exe, or www.multi-instrument.com/MIsetup.exe)

Operational Note

- A USB 2.0 port of the computer must be used in order to test the sampling frequencies higher than 48 kHz and the sampling bit resolution of 24. Some computers may have both USB 1.1 and USB 2.0 ports. The E-MU 0204 Control Panel will show the type of the USB port connected.
- With ASIO driver, E-MU 0204 works for all its directly supported sampling frequencies stated in its manual under 32-bit and 64-bit Windows XP, Vista, 7. You do not need to use the E-MU 0204 Control Panel to set the sampling frequency. It should be set from Multi-Instrument.
- With MME driver, E-MU 0204 works for all its directly supported sampling frequencies stated in its manual under Windows XP and 7. However, you must use the E-MU 0204 Control Panel to set the sampling frequency to match what you are using in Multi-Instrument. Under Windows Vista, from our tests, it appeared that it worked only for the sampling frequency 48 kHz (48kHz was always displayed in E-MU 0204 Control Panel no matter which sampling frequency was chosen in Multi-Instrument).
- You should only use the sampling frequencies directly supported by E-MU 0204. Otherwise, with MME driver, Windows will perform a Sampling Rate Conversion (SRC) automatically which may deteriorate the quality of test signals and cause measurement inaccuracy. Under ASIO driver, the unsupported sampling frequencies will be rejected. In our tests, the results obtained from ASIO driver were always better than those obtained from MME driver. This may imply that the MME driver is not bit-perfect even if the requested sampling frequency is supported directly by the E-MU 0204 hardware.
- In Multi-Instrument, the sampling frequency and sampling bit resolution of the Oscilloscope and the Signal Generator must be set to the same values. You should use either MME driver or ASIO driver for both ADC and DAC. Mixed use of MME and ASIO drivers should be avoided.
- The speaker volume slider under Windows Control Panel works for both MME driver and ASIO driver. However, the microphone volume slider (shown under Windows 7 only) under Windows Control Panel works with MME driver only, and has no effect with ASIO driver. It was found that under Windows 7 with ASIO driver, the input gain is actually controlled by the speaker volume slider as well.

Tips:

- *To reduce the CPU time consumption, in Multi-Instrument, you can set the Trigger Mode to “Auto” if necessary, use integer test frequency in the Signal Generator if possible, and*

if you are using ASIO driver, you can go to [Setting]>[Display]>and set “ASIO Buffer Size” to “Max” if necessary. These methods may help if you encounter erratic behavior caused by insufficient computing power of the computer.

- *For THD measurement, use a test frequency with no spectral leakage. If you do not know what the “no spectral leakage” frequency is, just enter the test frequency you want in the Signal Generator and then tick the “no spectral leakage” option. The Signal Generator will then calculate the “no spectral leakage” frequency for you based on the current sampling frequency and FFT size. In most of cases, the “no spectral leakage” frequency is not an integer value. With a “no spectral leakage” test frequency, Rectangle window function should be used in the Spectrum Analyzer. Otherwise, Kaiser 6 window function is recommended. For both cases, the record length of the Oscilloscope should be set to a value equal or greater value than the FFT size to avoid zero padding.*
- *The screenshots of this document are of high resolution. You can zoom in to see all the details.*

2. Headphone Jack -> Mic Input

The following tests were carried out by looping back the output from the headphone jack to the mic input. This was an unbalanced connection.

2.1 Noise Level

Test Conditions

On E-MU 0204:

- [Headphone Jack] was connected to [Mic Input] via a 1/4" male to 1/8" male TRS cable
- The knob for [Input L-Mic/Hi-Z/Line] was at +22dB roughly. The knob for the headphone was at roughly 90% percent. The knob for direct monitor was set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: No signal
- Noise Measurement Range: 20~20 kHz
- Harmonic Order: 2 (In Multi-Instrument, the peak frequency and its harmonics is excluded from the noise level calculation. As there is no test signal present, the excluded portion of energy would be negligibly small if the harmonic order is set to 2.)
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Sine, 1000.4882812 Hz
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.9 dBFS.

THD (1kHz, -9.9dBFS): 0.000543% (-105.3 dB)

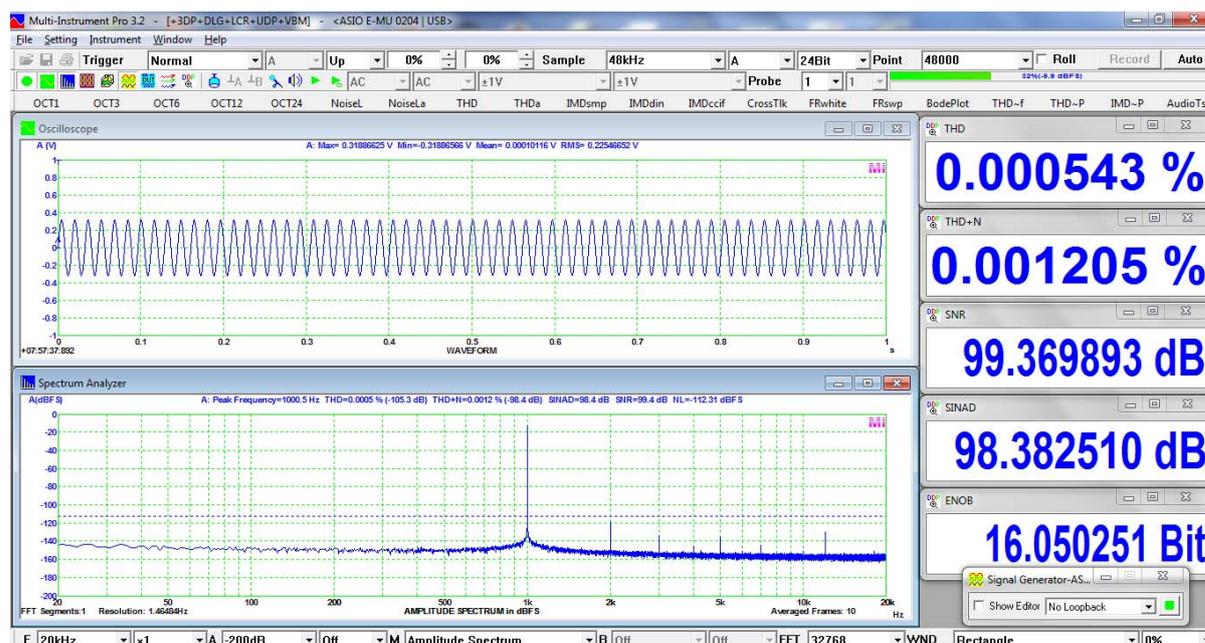
THD+N (1kHz, -9.9dBFS): 0.001205% (-98.4 dB)

SINAD (1kHz, -9.9dBFS): 98.4 dB

SNR (1kHz, -9.9dBFS): 99.4 dB

ENOB (1kHz, -9.9dBFS): 16.05 Bit

Noise Level (1kHz, -9.9dBFS): -112.3 dBFS (represented by the dotted line in the following screen shot)



Other Test Results:

It has been found through additional tests that:

- Changing the sampling frequency does not have discernible effect on the above results.
- Changing the sampling bit resolution to 16 will make the THD a little worse, and the rest results about 10dB worse.
- The combination of the input gain and output volume in the above test was optimized in order to obtain the best results. Other combination may make the above results worse.

- Changing the laptop's power supply from the AC adapter to its internal battery does not have discernible effect on the above results.
- Applying A-weighting profile will make the THD+N, SNR, SINAD, ENOB, Noise Level a little better.

2.3 IMD

Test Conditions

On E-MU 0204:

- [Headphone Jack] was connected to [Mic Input] via a 1/4" male to 1/8" male TRS cable
- The knob for [Input L-Mic/Hi-Z/Line] was at +22dB roughly. The knob for the headphone was at roughly 90% percent. The knob for direct monitor was set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Kaiser 6
- Linear average: 10 frames

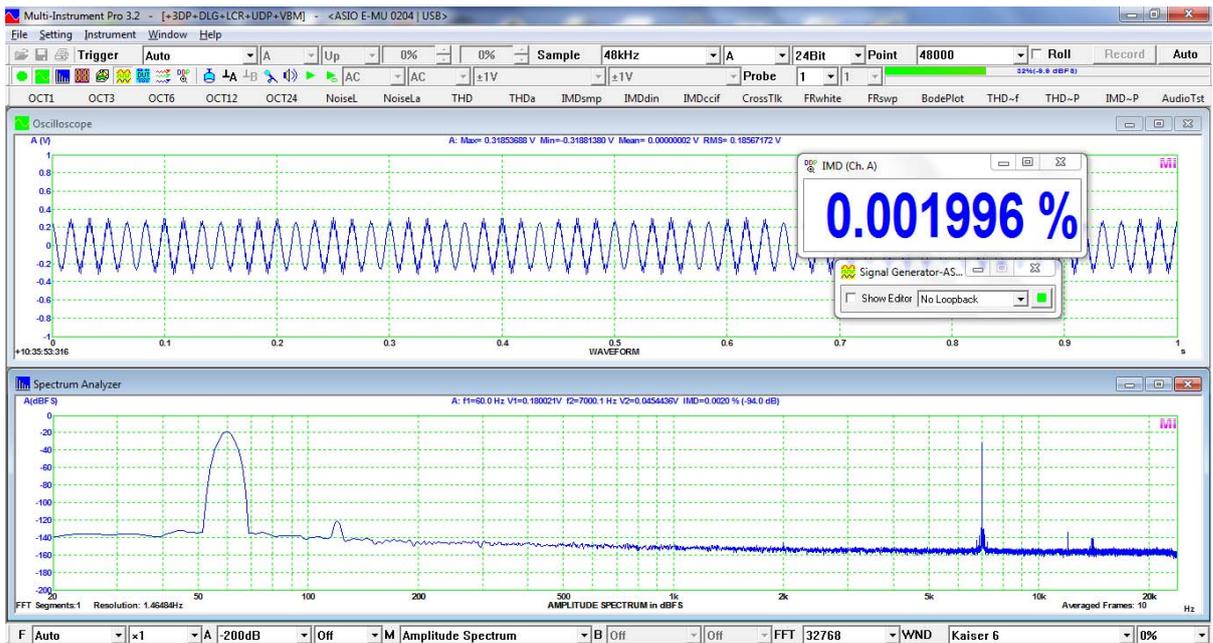
Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.9 dBFS.

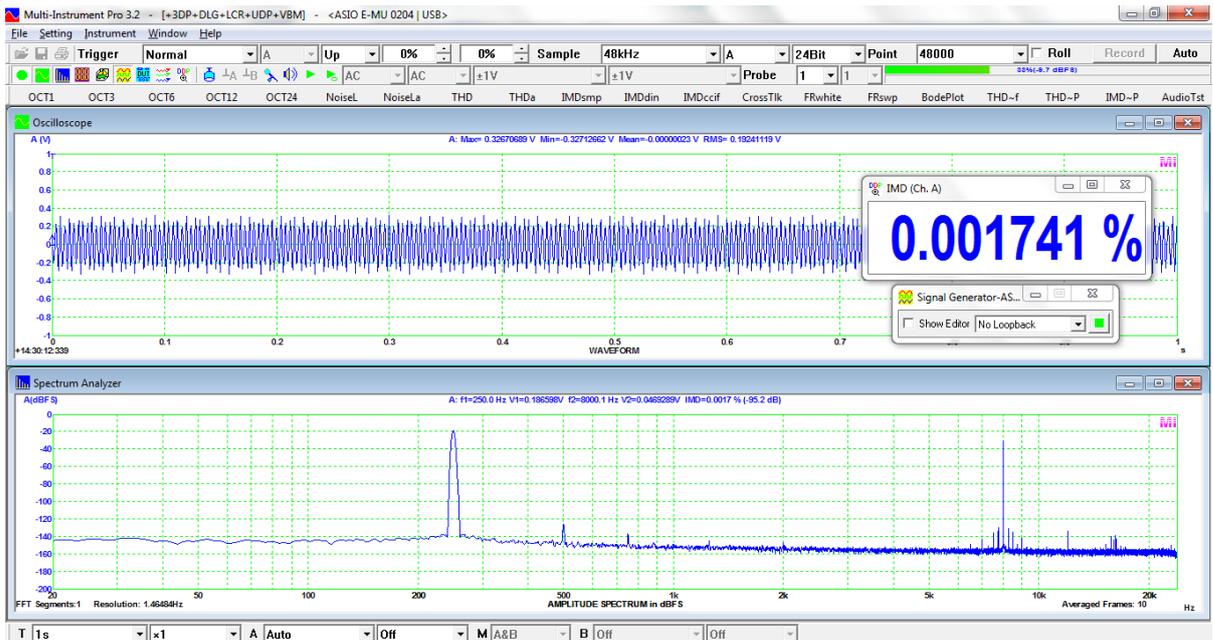
SMPTE IMD (-9.9dBFS): 0.001996% (-94.0 dB)

DIN IMD (-9.9dBFS): 0.001741% (-95.2 dB)

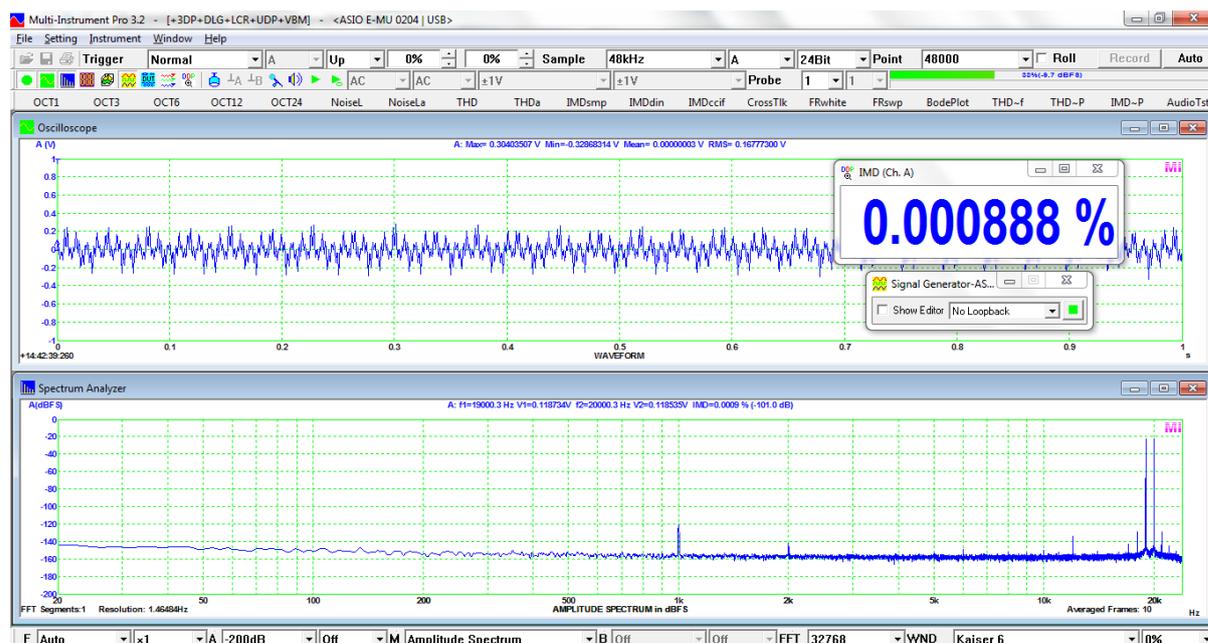
CCIF2 IMD (-9.9dBFS): 0.000888% (-101.0 dB)



SMPTE IMD (Test Tone: 60Hz and 7kHz mixed at an amplitude ratio of 4:1)



DIN IMD (Test Tone: 250Hz and 8kHz mixed at an amplitude ratio of 4:1)



CCIF2 IMD (Test Tone: 19kHz and 20kHz mixed at an amplitude ratio of 1:1)

2.4 Bandwidth

Test Conditions

On E-MU 0204:

- [Headphone Jack] was connected to [Mic Input] via a 1/4" male to 1/8" male TRS cable
- The knob for [Input L-Mic/Hi-Z/Line] was at +22dB roughly. The knob for the headphone was at roughly 90% percent. The knob for direct monitor was set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Window Function: Rectangle

- Test Tone: White Noise
- Linear average: 200 frames

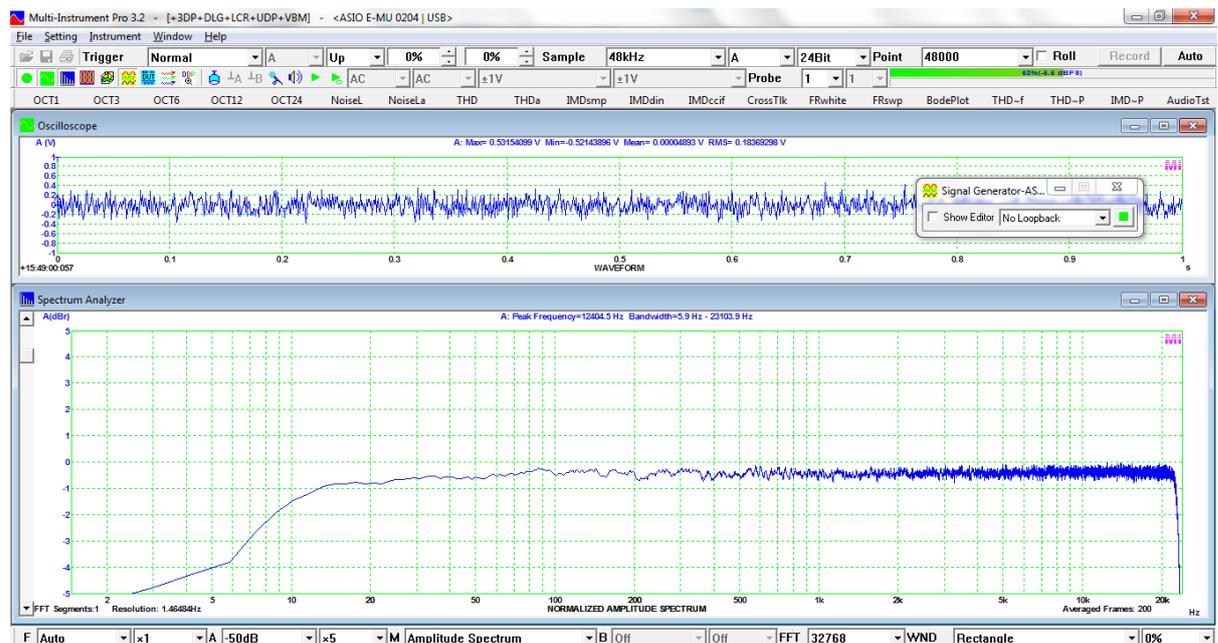
Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

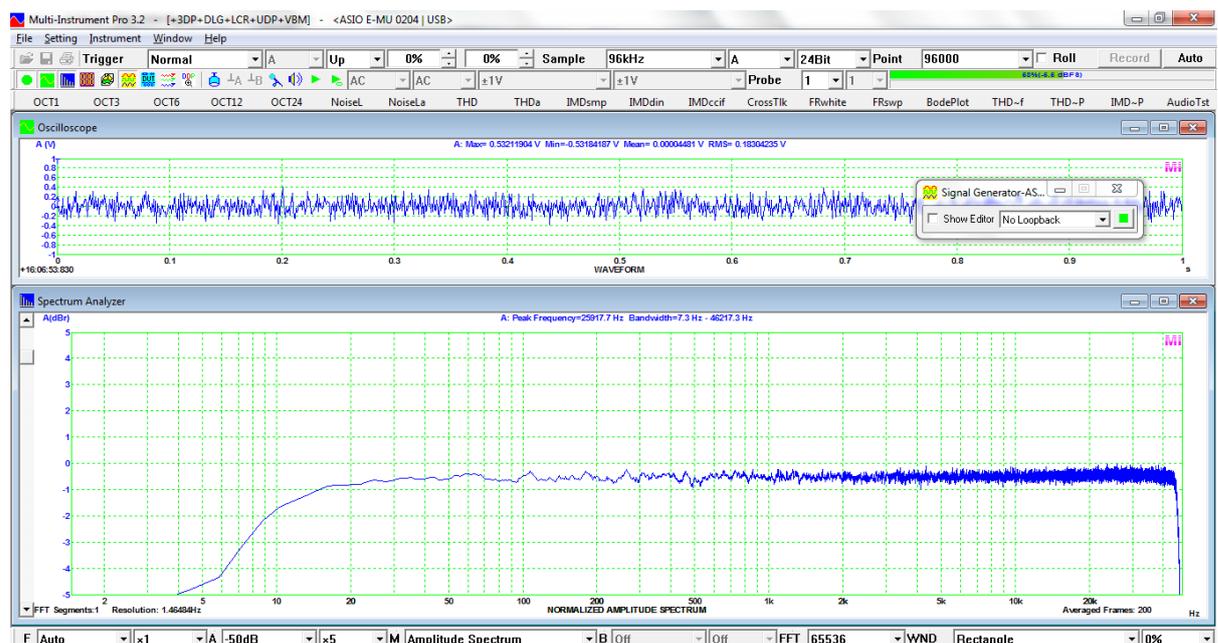
Bandwidth (-3dB) at the sampling rate of 48kHz: 5.9Hz ~23104Hz

Bandwidth (-3dB) at the sampling rate of 96kHz: 7.3Hz ~46217Hz

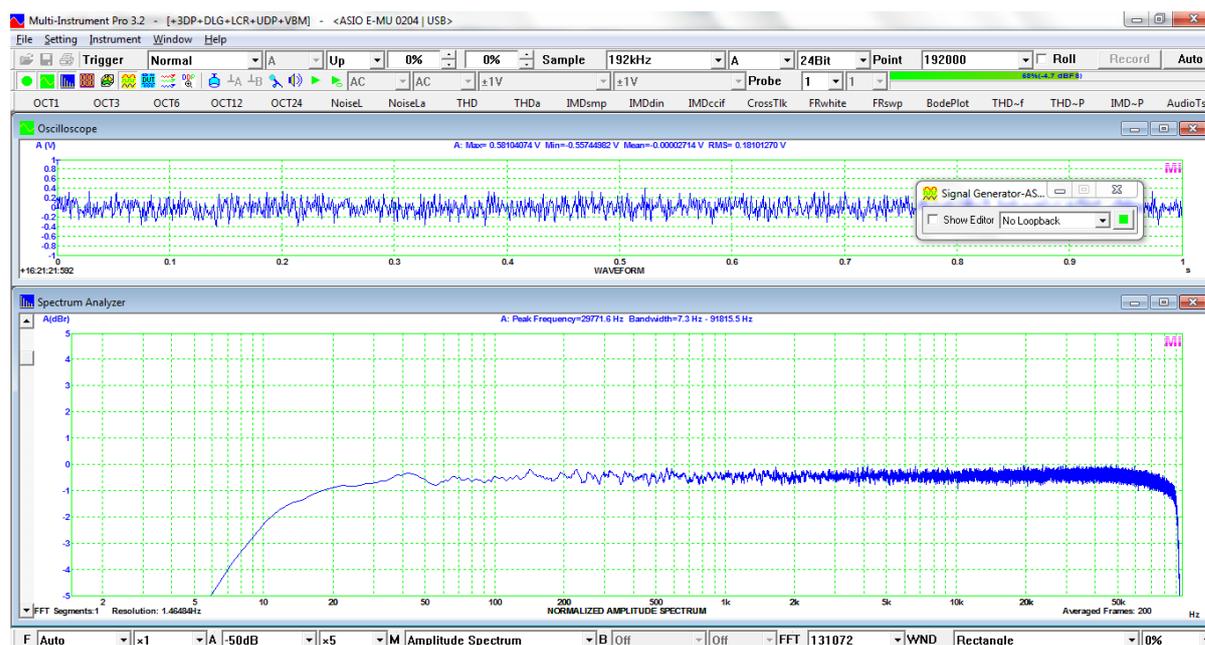
Bandwidth (-3dB) at the sampling rate of 192kHz: 7.3Hz ~91816Hz



Bandwidth (-3dB) (Sampling Rate = 48kHz, Record Length =48000, FFT Size=32768)



Bandwidth (-3dB) (Sampling Rate = 96kHz, Record Length =96000, FFT Size=65536)



Bandwidth (-3dB) (Sampling Rate = 192kHz, Record Length =192000, FFT Size=131072)

2.5 Dynamic Range

Test Conditions

On E-MU 0204:

- [Headphone Jack] was connected to [Mic Input] via a 1/4" male to 1/8" male TRS cable
- The knob for [Input L-Mic/Hi-Z/Line] was at +22dB roughly. The knob for the headphone was at roughly 25% percent. The knob for direct monitor was set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz

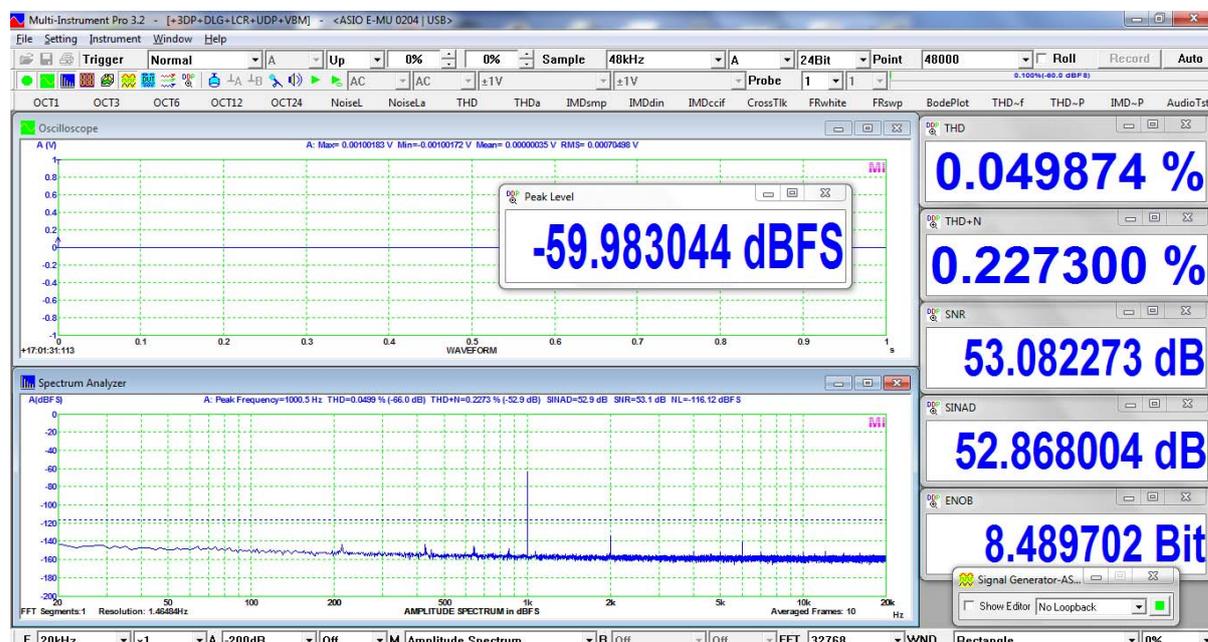
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Sine, 1000.4882812 Hz
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -60 dBFS.

SNR (-60dBFS, 1kHz): 53.1 dB

Dynamic Range: $53.1+60=113.1$ dB



2.6 THD+N, THD, SNR, Magnitude Response vs Frequency

Test Conditions

On E-MU 0204:

- [Headphone Jack] was connected to [Mic Input] via a 1/4" male to 1/8" male TRS cable
- The knob for [Input L-Mic/Hi-Z/Line] was at +22dB roughly. The knob for the headphone was at roughly 90% percent. The knob for direct monitor was set to minimum.

Direct Monitor: Off

On Laptop:
Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

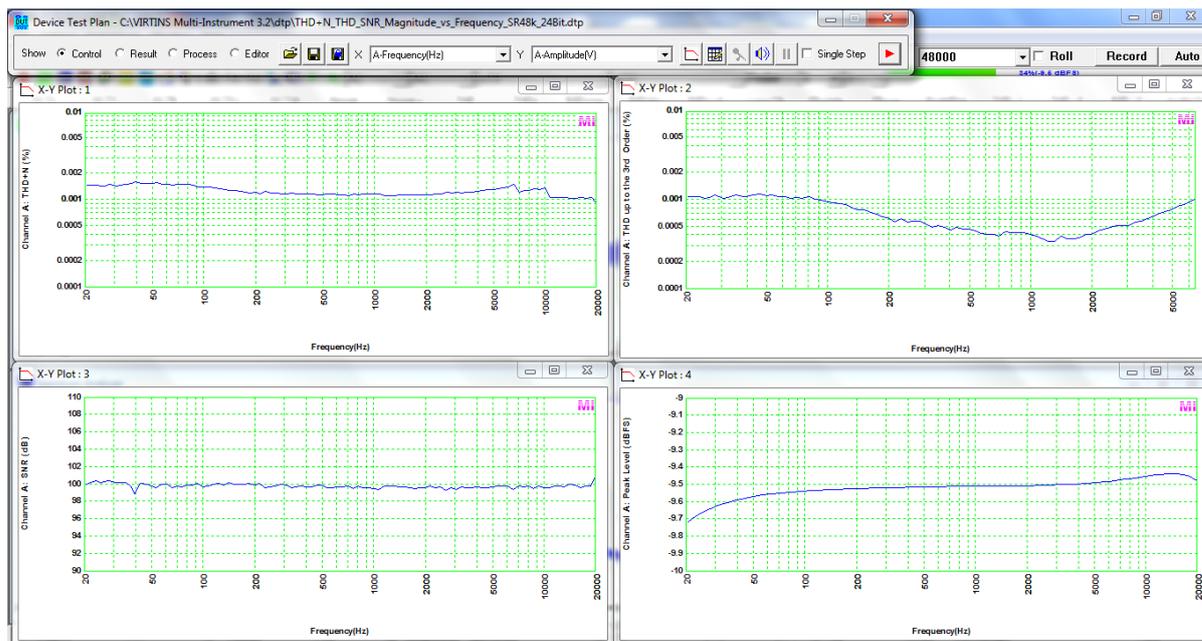
In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Channel A: 100-point Logarithmically Stepped Sine in the range of 20Hz~20kHz (No Spectral Leakage).
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Harmonic Order: 3
- Device Test Plan is used

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.9 dBFS.

- (1) Upper left graph: THD+N vs Frequency
- (2) Upper right graph: THD (up to 3rd order) vs Frequency
- (3) Lower left graph: SNR vs Frequency
- (4) Lower right graph: Peak Level vs Frequency.
Frequency Response (20Hz~20kHz): -0.21/0.03 dB (obtained by examining the data)



Discussion

In the above THD+N vs Frequency Plot (upper left), two small dips of THD+N can be observed at 6667Hz and 10000Hz. As we know, THD+N consists of harmonic distortion and noise. In the above test, the Harmonic Distortion and Noise Measurement Range was set to 20~20 kHz and the Harmonic Order was set to 3. This implies that, for a 6 kHz test tone, THD+N consists of the 2nd and 3rd order harmonic distortions and noise; for a 7 kHz test tone, THD+N consists of only the 2nd order harmonic distortion and noise; and for a 11kHz test tone, THD+N contains noise only without any harmonic distortion of the test tone. 6667Hz and 10000Hz are the critical points where the 3rd and 2nd order harmonic distortions are excluded from the THD+N calculation respectively.

3. Line Out -> Line In

The following tests were carried out by looping back the output from the Line Out to the Line Input. This was an unbalanced connection (although TRS cables were used).

3.1 Noise Level

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

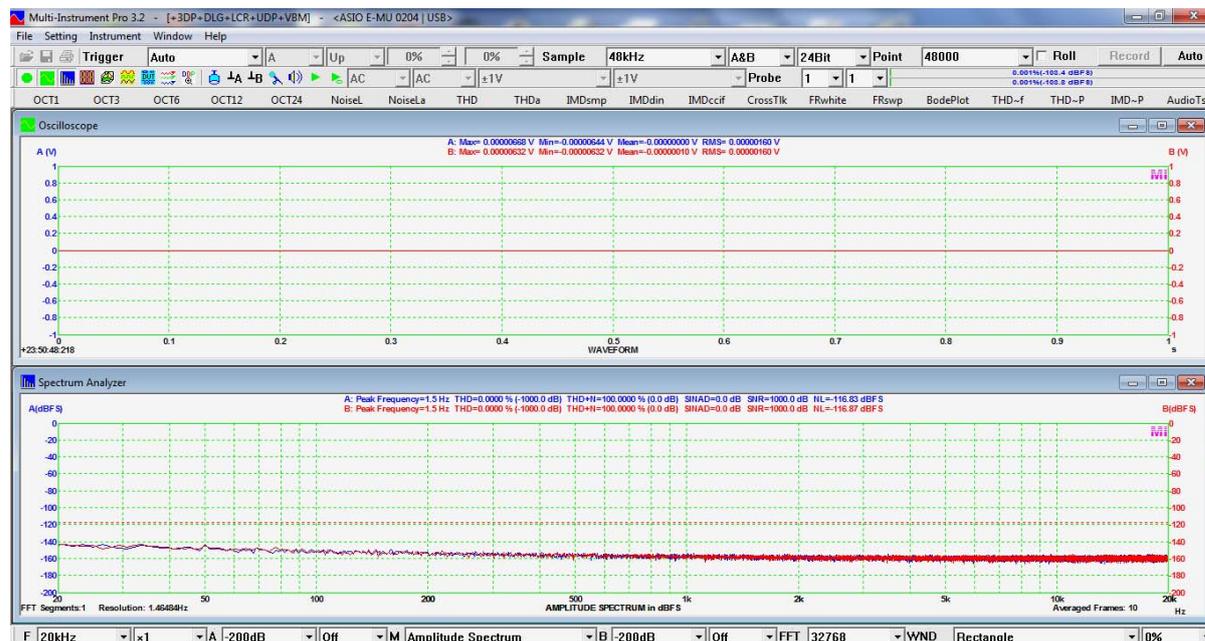
In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A&B (stereo)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: No signal
- Noise Measurement Range: 20~20 kHz
- Harmonic Order: 2 (In Multi-Instrument, the peak frequency and its harmonics is excluded from the noise level calculation. As there is no test signal present, the excluded portion of energy would be negligibly small if the harmonic order is set to 2.)
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

Noise Level (no signal): -116.8 dBFS (represented by the dotted line in the following screen shot)



3.2 THD, THD+N, SNR, SINAD, ENOB, Noise Level

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a 1/4" male to 1/4" male TRS cable
- [Output R] was connected to [Input R-Hi-Z/Line] via a 1/4" male to 1/4" male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver

- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Sine, 1000.4882812 Hz
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -9.6 dBFS.

THD (1kHz, -9.6dBFS): 0.000588% (-104.6 dB)

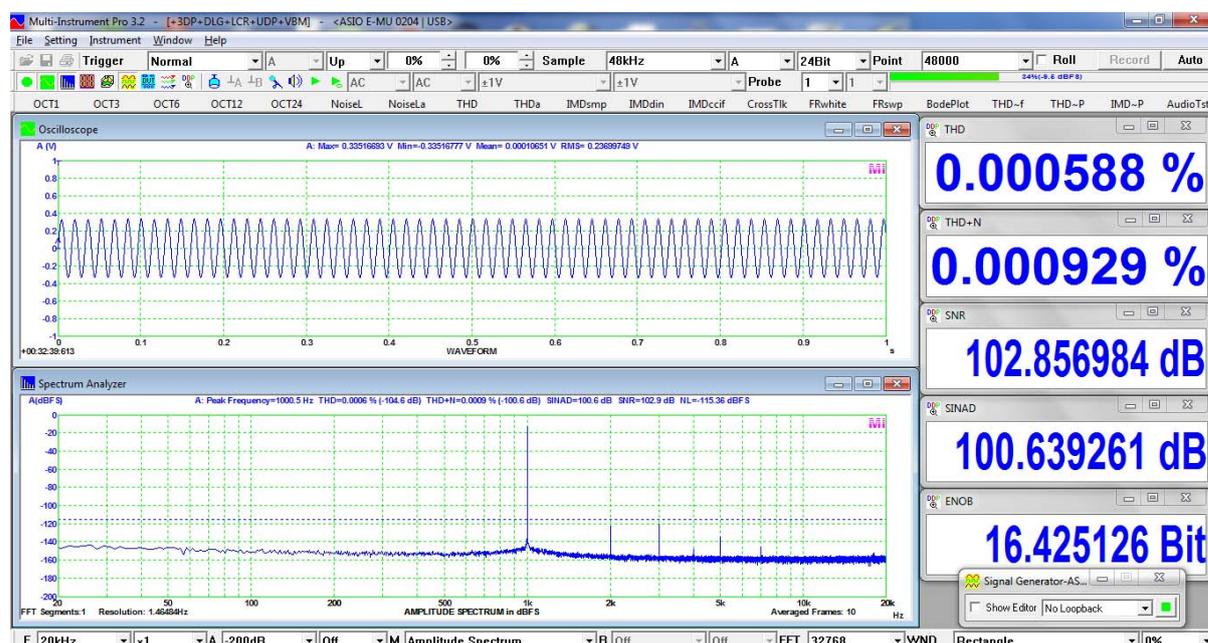
THD+N (1kHz, -9.6dBFS): 0.000929% (-100.6 dB)

SINAD (1kHz, -9.6dBFS): 100.6 dB

SNR (1kHz, -9.6dBFS): 102.9 dB

ENOB (1kHz, -9.6dBFS): 16.43 Bit

Noise Level (1kHz, -9.6dBFS): -115.4 dBFS (represented by the dotted line in the following screen shot)



Other Test Results:

It has been found through additional tests that:

- Changing the sampling frequency does not have discernible effect on the above results.
- Changing the sampling bit resolution to 16 will make the THD a little worse, and the rest results about 10dB worse.

- The combination of the input gain and output volume in the above test was optimized in order to obtain the best results. Other combination may make the above results worse.
- Changing the laptop's power supply from the AC adapter to its internal battery does not have discernible effect on the above results.
- Applying A-weighting profile will make the THD+N, SNR, SINAD, ENOB, Noise Level a little better.

3.3 IMD

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Kaiser 6
- Linear average: 10 frames

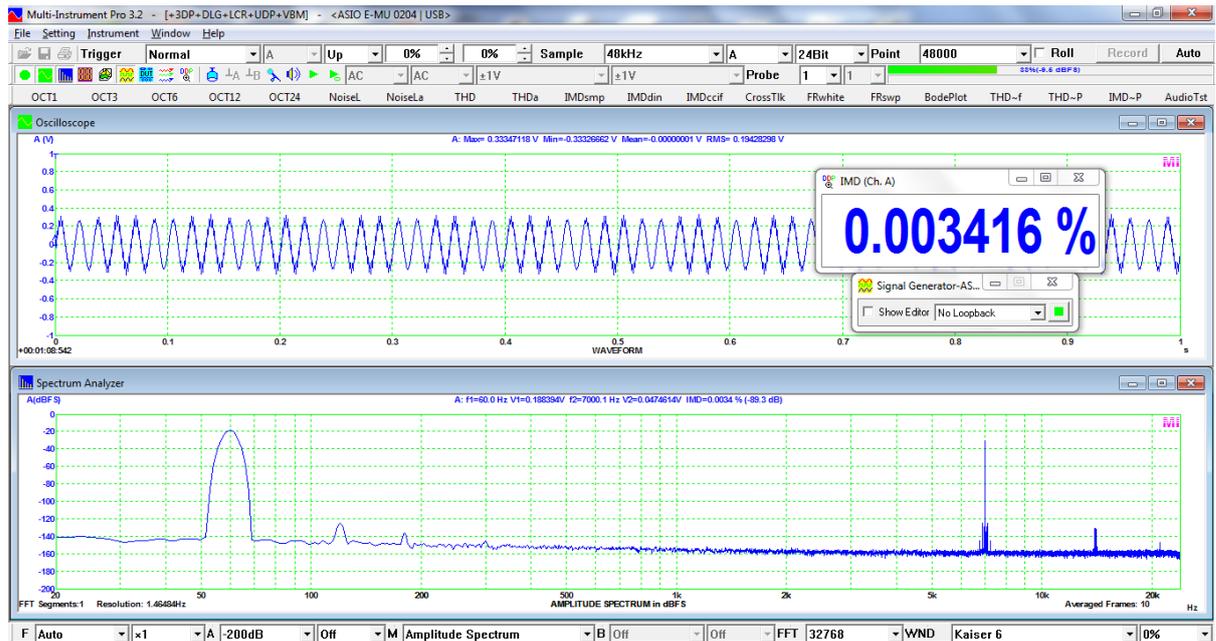
Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -9.6 dBFS.

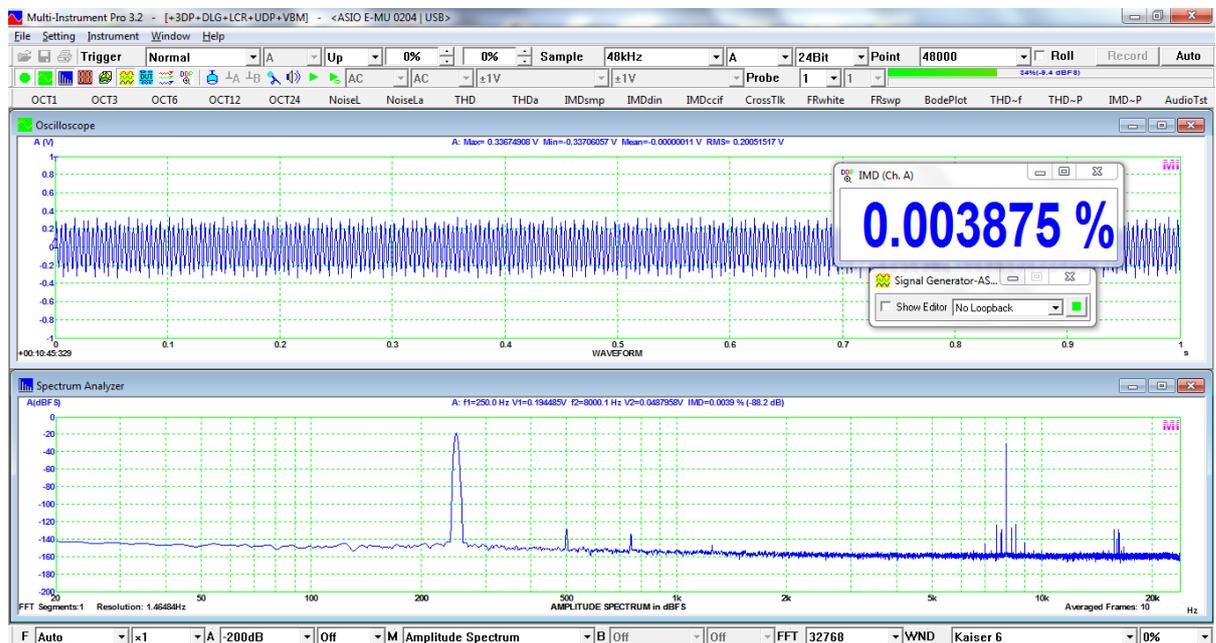
SMPTE IMD (-9.6dBFS) : 0.003416% (-89.3 dB)

DIN IMD (-9.6dBFS): 0.003875% (-88.2 dB)

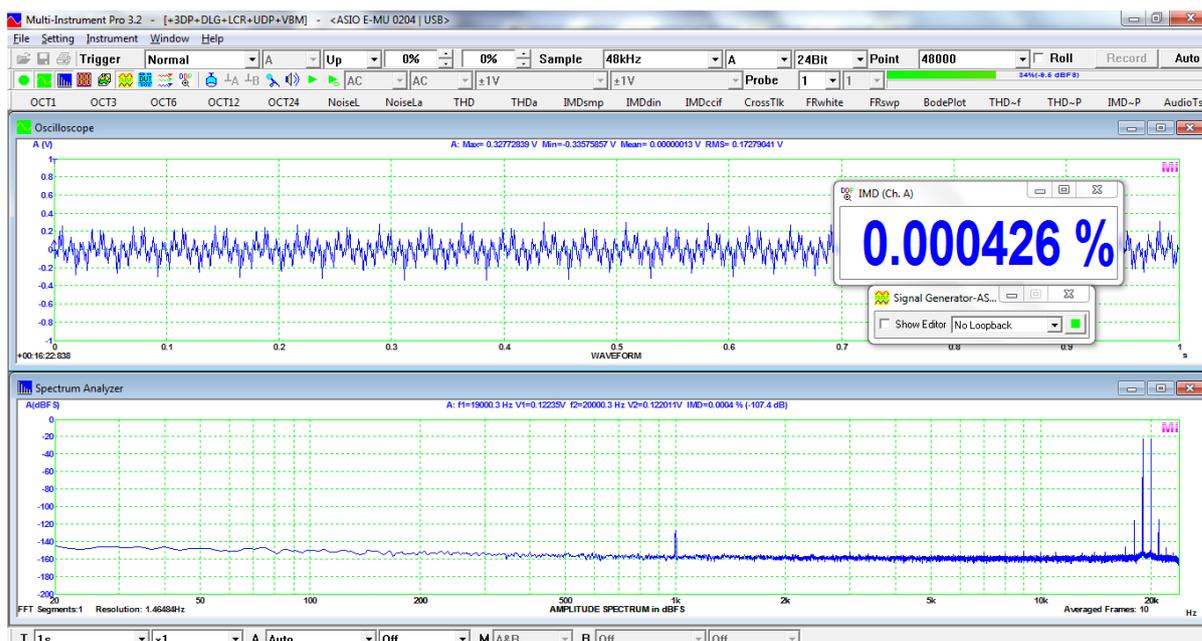
CCIF2 IMD (-9.6dBFS): 0.000426% (-107.4 dB)



SMPTE IMD (Test Tone: 60Hz and 7kHz mixed at an amplitude ratio of 4:1)



DIN IMD (Test Tone: 250Hz and 8kHz mixed at an amplitude ratio of 4:1)



CCIF2 IMD (Test Tone: 19kHz and 20kHz mixed at an amplitude ratio of 1:1)

3.4 Bandwidth

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)

- Window Function: Rectangle
- Test Tone: White Noise
- Linear average: 200 frames

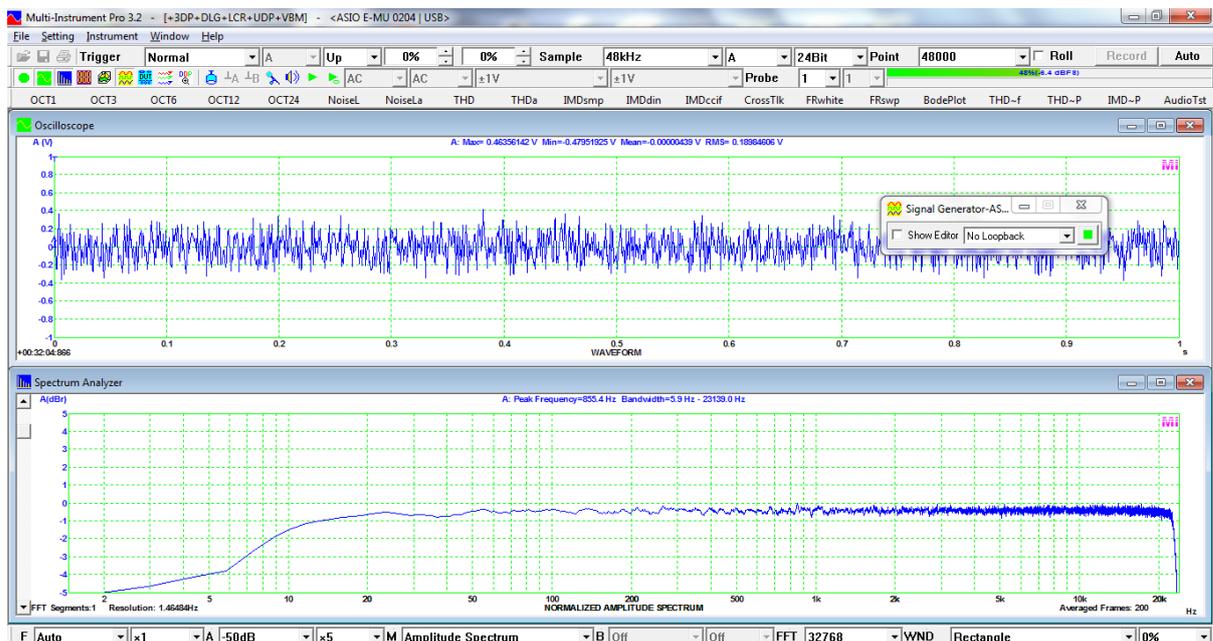
Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

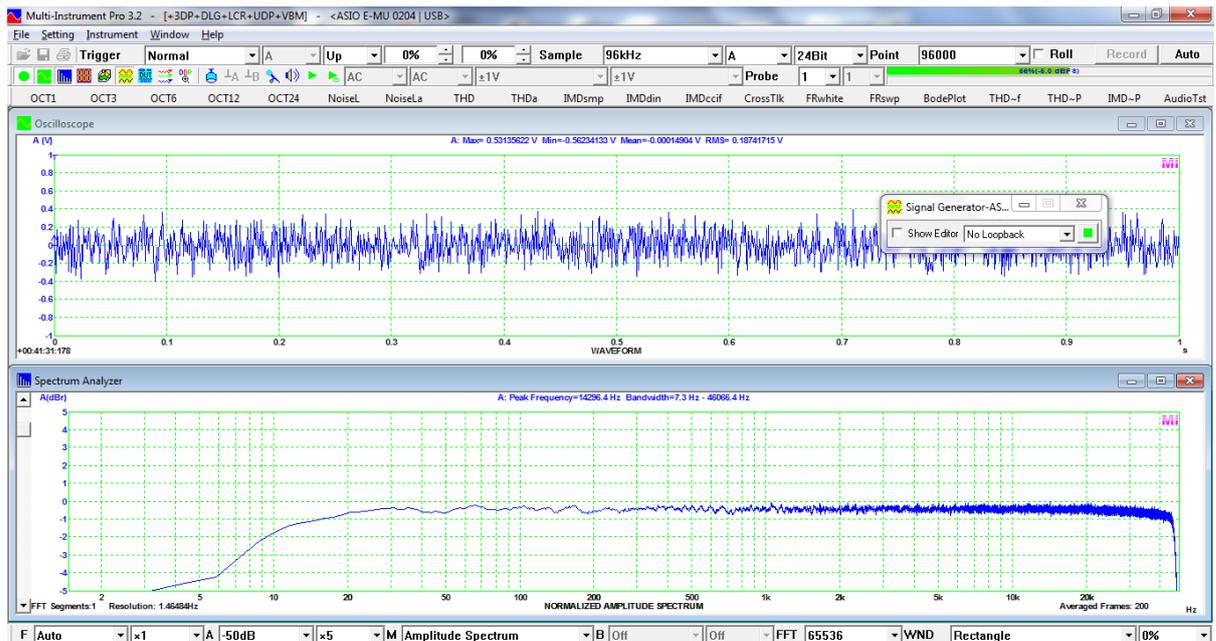
Bandwidth (-3dB) at the sampling rate of 48kHz: 5.9Hz ~23139Hz

Bandwidth (-3dB) at the sampling rate of 96kHz: 7.3Hz ~46066Hz

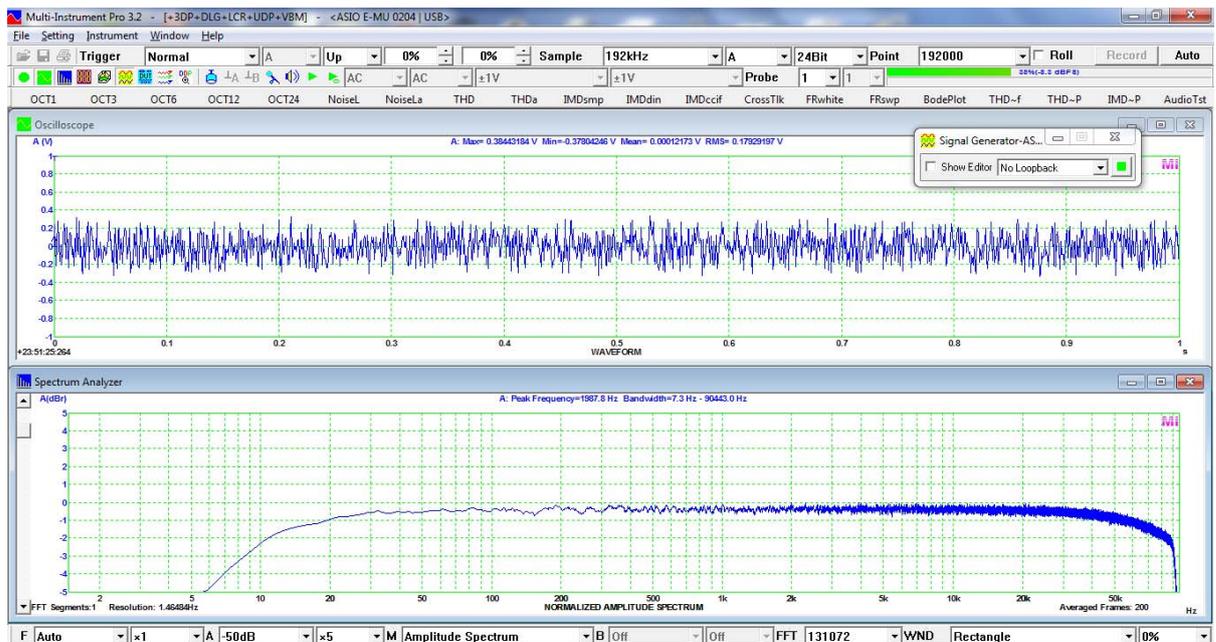
Bandwidth (-3dB) at the sampling rate of 192kHz: 7.3Hz ~90443Hz



Bandwidth (-3dB) (Sampling Rate = 48kHz, Record Length =48000, FFT Size=32768)



Bandwidth (-3dB) (Sampling Rate = 96kHz, Record Length =96000, FFT Size=65536)



Bandwidth (-3dB) (Sampling Rate = 192kHz, Record Length =192000, FFT Size=131072)

3.5 Crosstalk

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a 1/4" male to 1/4" male TRS cable

- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼” male to ¼” male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:
Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

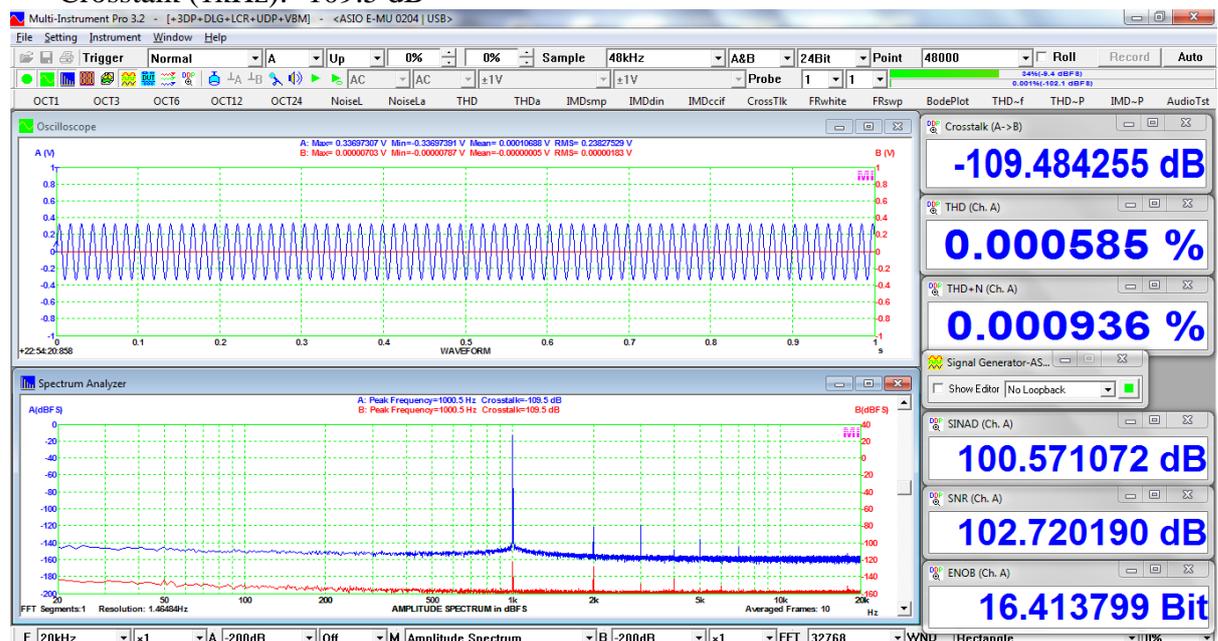
In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A&B (stereo)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Channel A: Sine, 1000.4882812 Hz Channel B: No signal
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.4 dBFS.

Crosstalk (1kHz): -109.5 dB



3.6 Dynamic Range

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a ¼” male to ¼” male TRS cable
- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼” male to ¼” male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

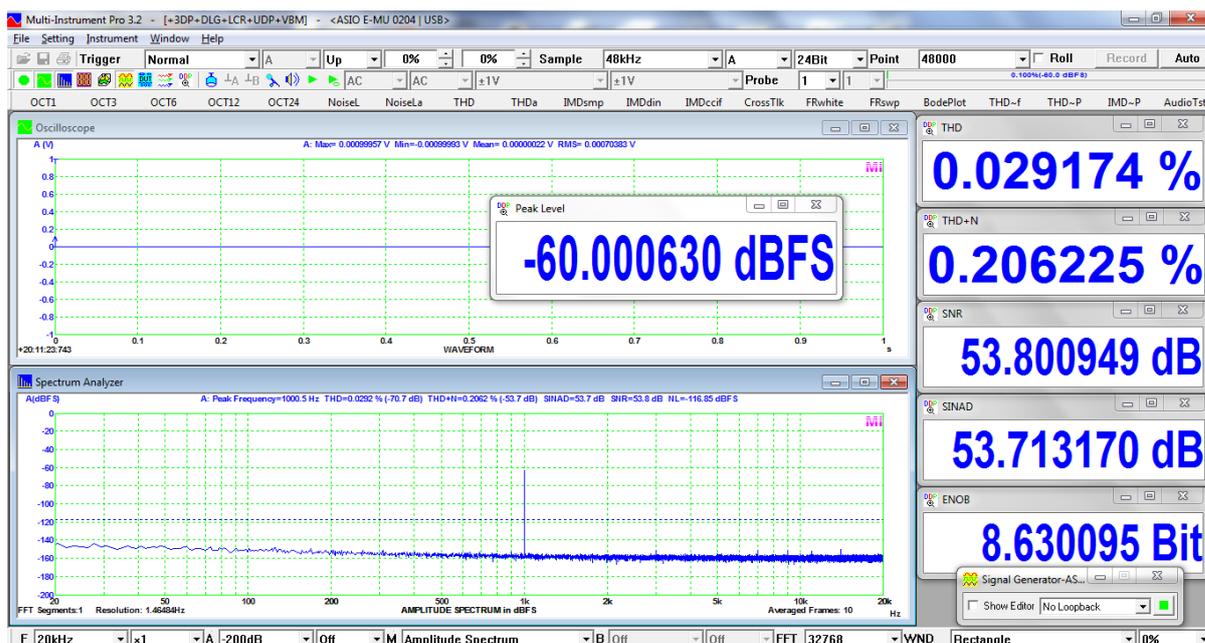
- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Sine, 1000.4882812 Hz
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Output Amplitude of the Signal Generator: 0.295% of the full scale
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -60 dBFS.

SNR (-60dBFS, 1kHz): 53.8 dB

Dynamic Range: $53.8+60=113.8$ dB



3.7 Gain and Phase Difference between Channels

This test is important if you want to measure the transfer function (Bode plot, or frequency response) of a DUT using the dual-FFT method.

Test Conditions

On E-MU 0204:

- [Output L] was connected to both [Input L-Mic/Hi-Z/Line] and [Input R-Hi-Z/Line] via an in-house made ¼" male to 2× ¼" male TRS cables
- [Output 2L] was not connected.
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit

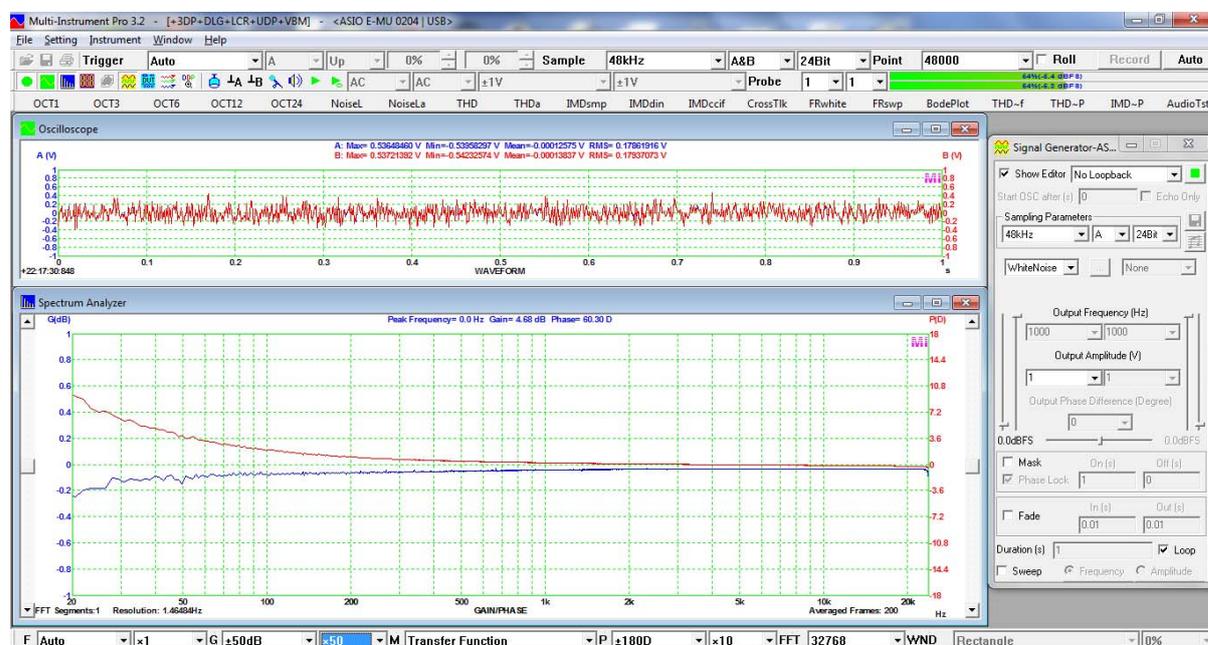
- Sampling Channels: A&B (stereo)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: White Noise
- Measurement Range: 0~24 kHz
- Linear average: 50 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

Gain Difference (20 Hz ~ 24 kHz): < 0.22 dB

Phase Difference (20 Hz ~ 24 kHz): < 9.36 degree



The above figure shows that the gain and phase difference between channels are very small (less than 0.03dB and 1 degree when the frequency is greater than 200Hz) except for the low frequency region where the frequency is less than 200Hz.

3.8 THD+N, THD, SNR, Magnitude Response vs Frequency

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a 1/4" male to 1/4" male TRS cable

- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼” male to ¼” male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

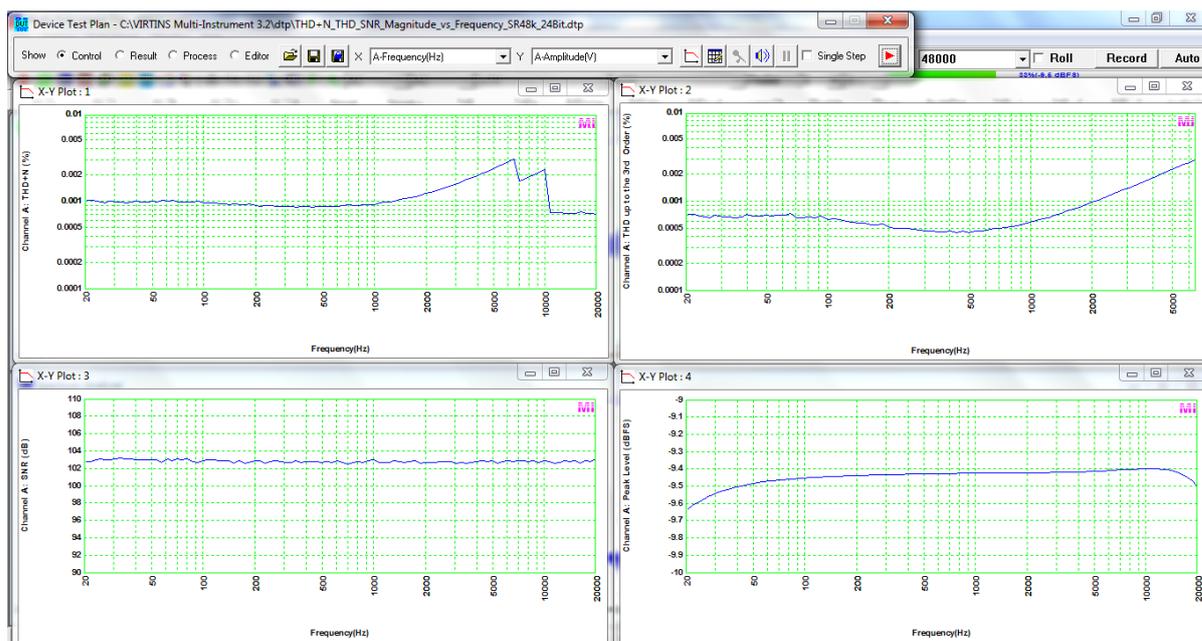
In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: 100-point Logarithmically Stepped Sine in the range of 20Hz~20kHz (No Spectral Leakage).
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Harmonic Order: 3
- Device Test Plan is used

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.4 dBFS.

- (1) Upper left graph: THD+N vs Frequency
- (2) Upper right graph: THD (up to 3rd order) vs Frequency
- (3) Lower left graph: SNR vs Frequency
- (4) Lower right graph: Peak Level vs Frequency.
Frequency Response (20Hz~20kHz): -0.21/-0.08 dB (obtained by examining the data)



Discussion

In the above THD+N vs Frequency plot (upper left), two sharp dips of THD+N at 6667Hz and 10000Hz are observed. As we know, THD+N consists of harmonic distortion and noise. In the above test, the Harmonic Distortion and Noise Measurement Range was set to 20~20 kHz and the Harmonic Order was set to 3. This implies that, for a 6 kHz test tone, THD+N consists of the 2nd and 3rd order harmonic distortions and noise; for a 7 kHz test tone, THD+N consists of only the 2nd order harmonic distortion and noise; and for a 11kHz test tone, THD+N contains noise only without any harmonic distortion of the test tone. 6667Hz and 10000Hz are the critical points where the 3rd and 2nd order harmonic distortions are excluded from the THD+N calculation respectively.

3.9 Crosstalk vs Frequency

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- [Output R] was connected to [Input R-Hi-Z/Line] via a ¼" male to ¼" male TRS cable
- The knobs for [Input L-Mic/HiZ/Line] and [Input R-Hi-Z/Line] were at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect

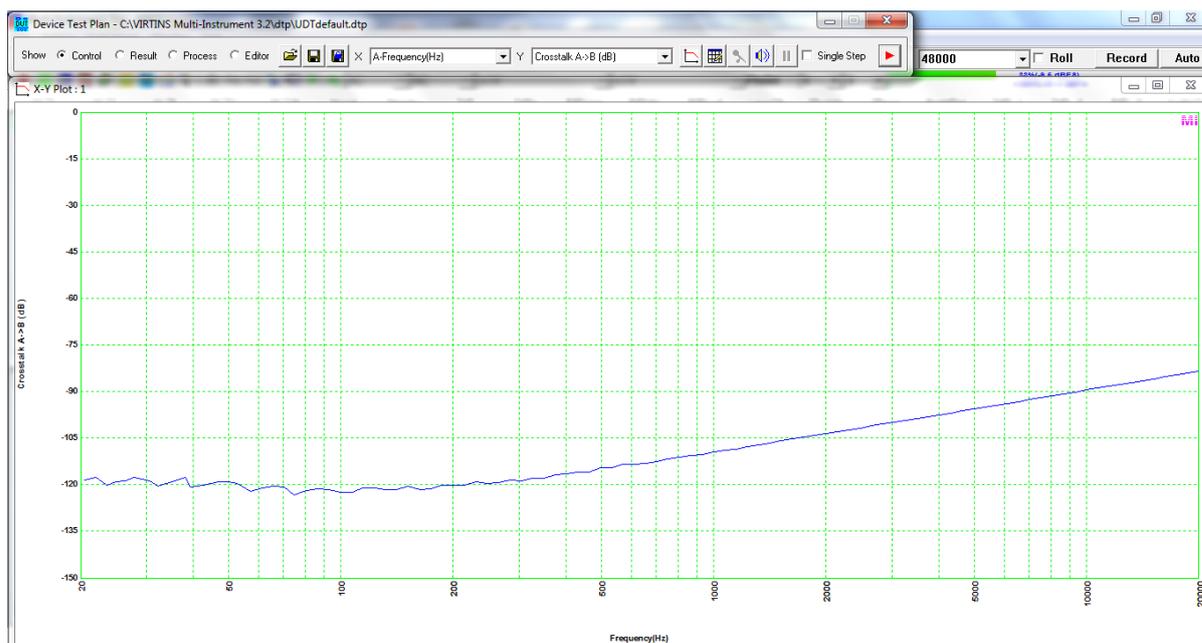
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A&B (stereo)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Channel A: 100-point Logarithmically Stepped Sine in the range of 20Hz~20kHz (No Spectral Leakage), Channel B: No signal.
- Device Test Plan is used.

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.6 dBFS.



4. Line Out -> XLR Mic

4.1 Noise Level

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/HiZ/Line] via a ¼" TRS male to XLR male cable
- The knobs for [Input L-Mic/HiZ/Line] was at +18dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

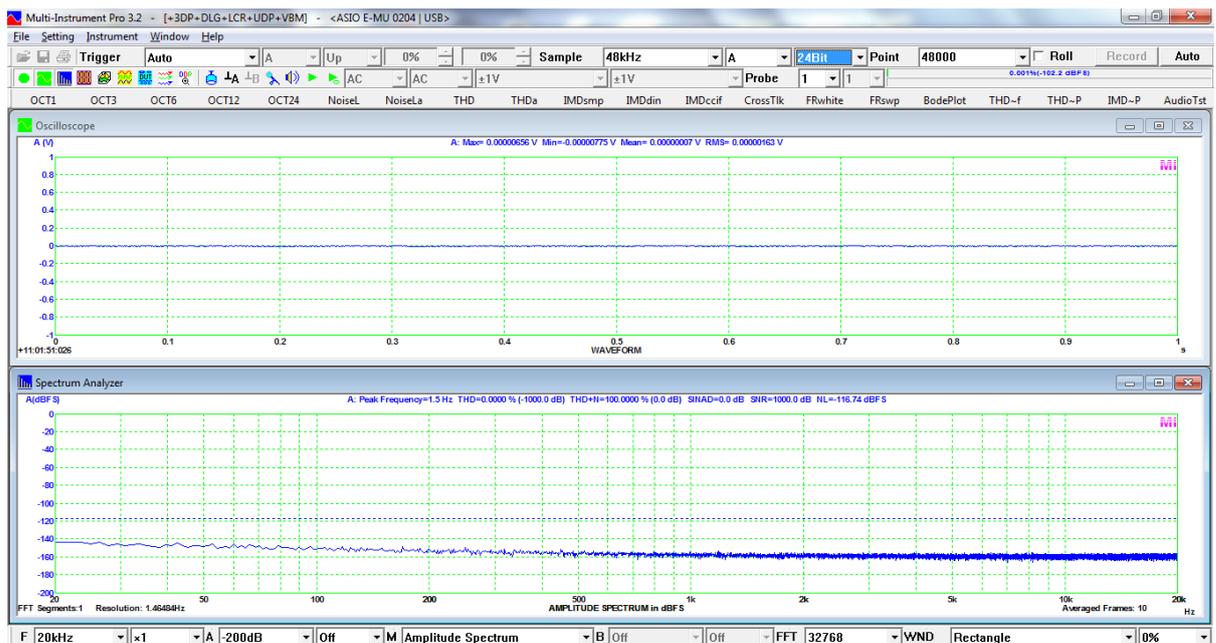
In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: No signal
- Noise Measurement Range: 20~20 kHz
- Harmonic Order: 2 (In Multi-Instrument, the peak frequency and its harmonics is excluded from the noise level calculation. As there is no test signal present, the excluded portion of energy would be negligibly small if the harmonic order is set to 2.)
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

Noise Level (no signal): -116.7 dBFS (represented by the dotted line in the following screen shot)



4.2 THD, THD+N, SNR, SINAD, ENOB, Noise Level

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/HiZ/Line] via a ¼" TRS male to XLR male cable
- The knobs for [Input L-Mic/HiZ/Line] was at +18dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle

- Test Tone: Sine, 1000.4882812 Hz
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at a peak level of -9.6 dBFS.

THD (1kHz, -9.6dBFS): 0.000398% (-108.0 dB)

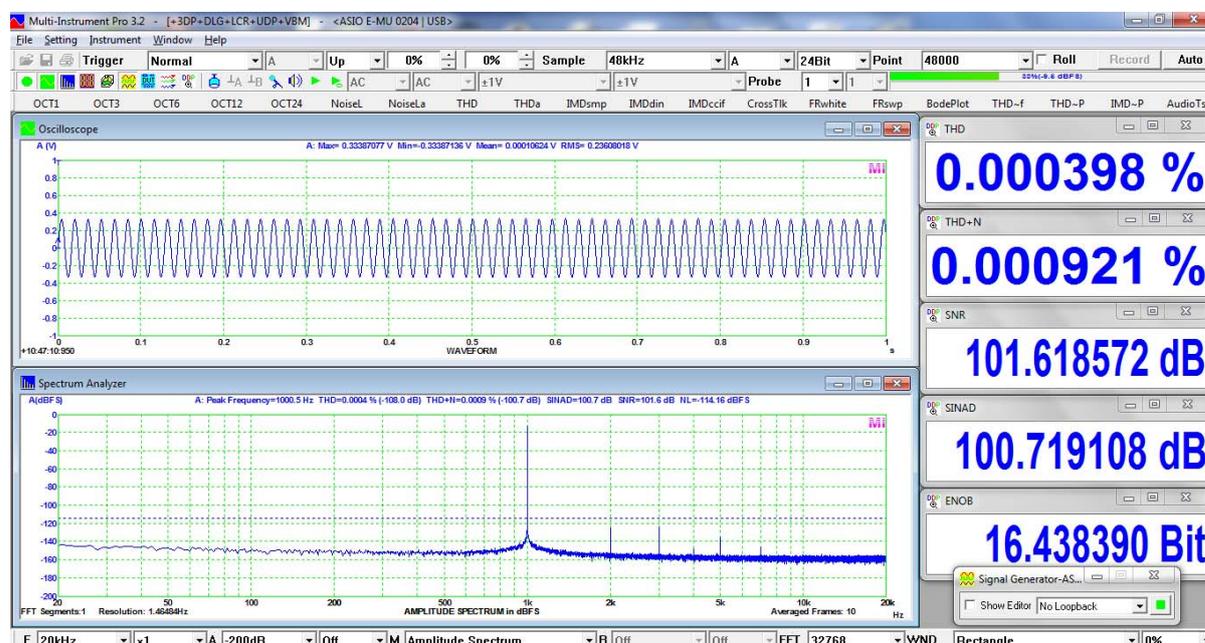
THD+N (1kHz, -9.6dBFS): 0.000921% (-100.7 dB)

SINAD (1kHz, -9.6dBFS): 100.7 dB

SNR (1kHz, -9.6dBFS): 101.6 dB

ENOB (1kHz, -9.6dBFS): 16.44 Bit

Noise Level (1kHz, -9.6dBFS): -114.2 dBFS (represented by the dotted line in the following screen shot)



Other Test Results:

It has been found through additional tests that:

- Changing the sampling frequency does not have discernible effect on the above results.
- Changing the sampling bit resolution to 16 will make the THD a little worse, and the rest results about 10dB worse.
- The combination of the input gain and output volume in the above test was optimized in order to obtain the best results. Other combination may make the above results worse.
- Changing the laptop's power supply from the AC adapter to its internal battery does not have discernible effect on the above results.

- Applying A-weighting profile will make the THD+N, SNR, SINAD, ENOB, Noise Level a little better.

4.3 IMD

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/HiZ/Line] via a ¼" TRS male to XLR male cable
- The knobs for [Input L-Mic/HiZ/Line] was at +18dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A&B (stereo)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Kaiser 6
- Linear average: 10 frames

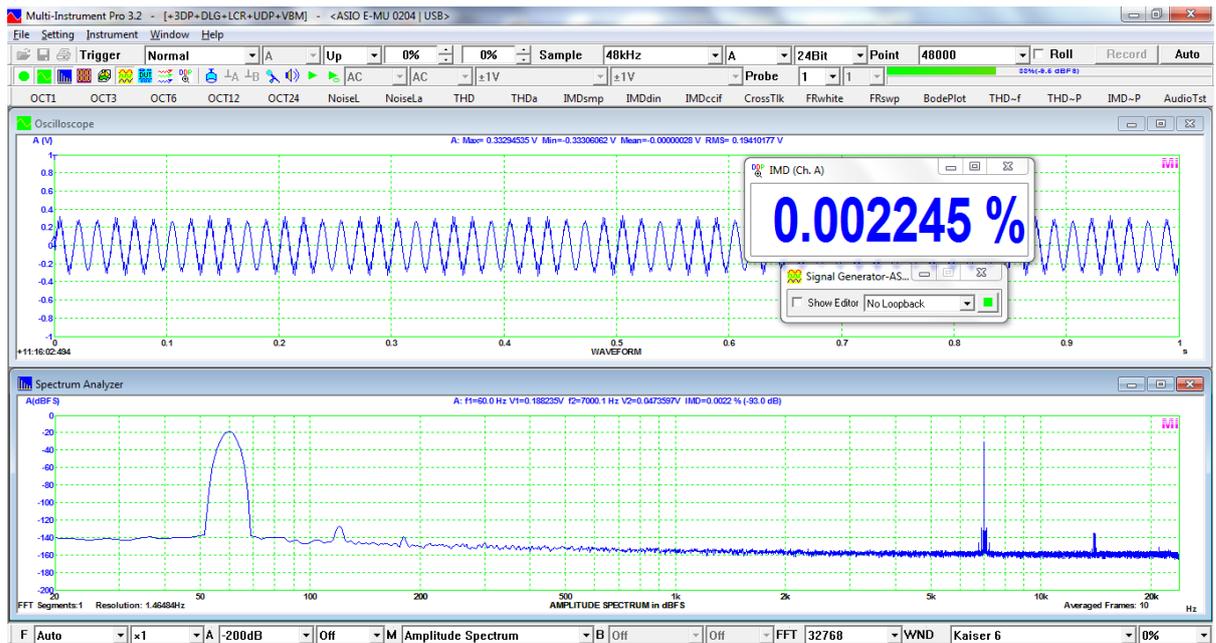
Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -9.6 dBFS.

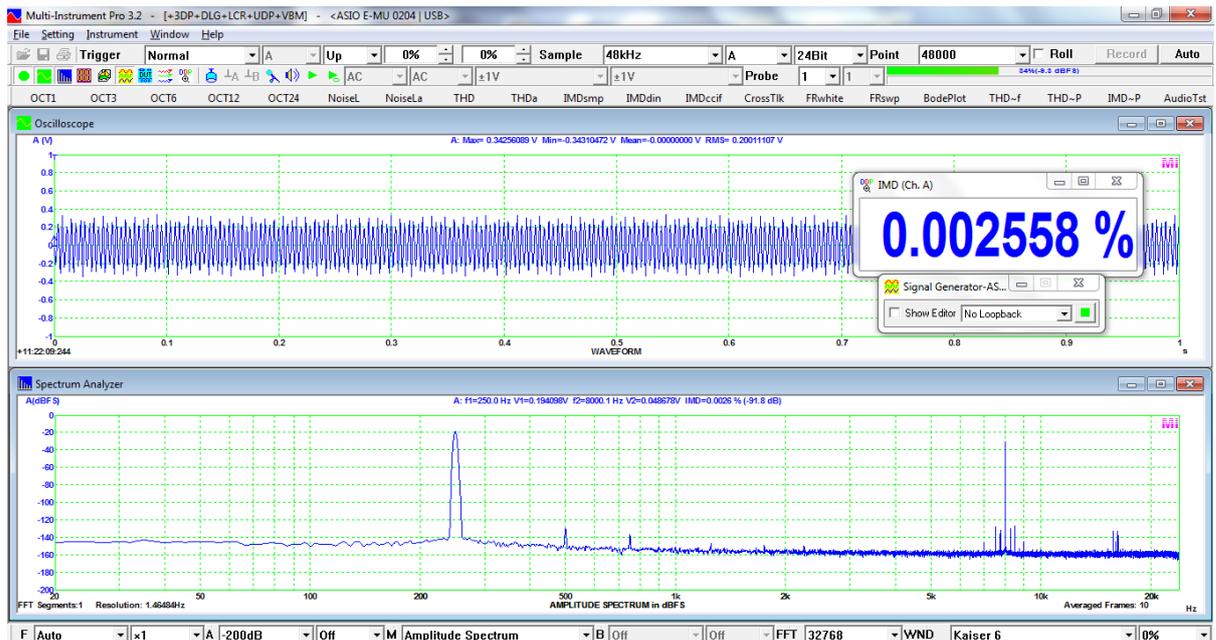
SMPTE IMD: 0.002245% (-93.0 dB)

DIN IMD: 0.002558% (-91.8 dB)

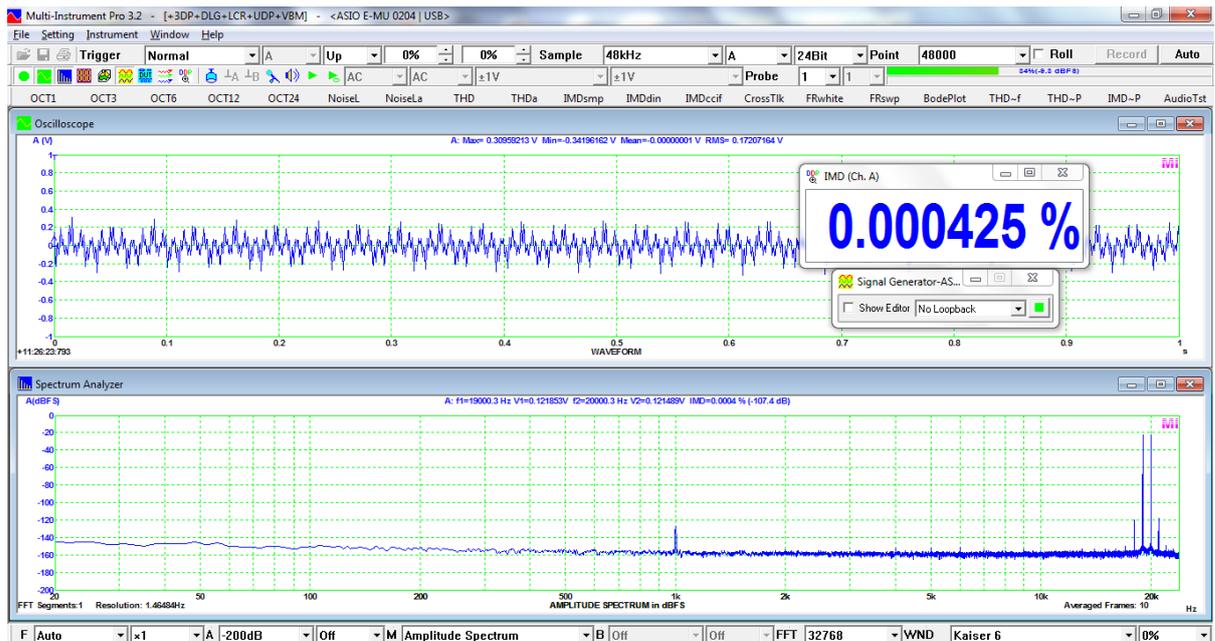
CCIF2 IMD: 0.000425% (-107.4 dB)



SMPTE IMD (Test Tone: 60Hz and 7kHz mixed at an amplitude ratio of 4:1)



DIN IMD (Test Tone: 250Hz and 8kHz mixed at an amplitude ratio of 4:1)



CCIF2 IMD (Test Tone: 19kHz and 20kHz mixed at an amplitude ratio of 1:1)

4.4 Bandwidth

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/HiZ/Line] via a ¼" TRS male to XLR male cable
- The knobs for [Input L-Mic/HiZ/Line] was at +18dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Window Function: Rectangle
- Test Tone: White Noise

- Linear average: 200 frames

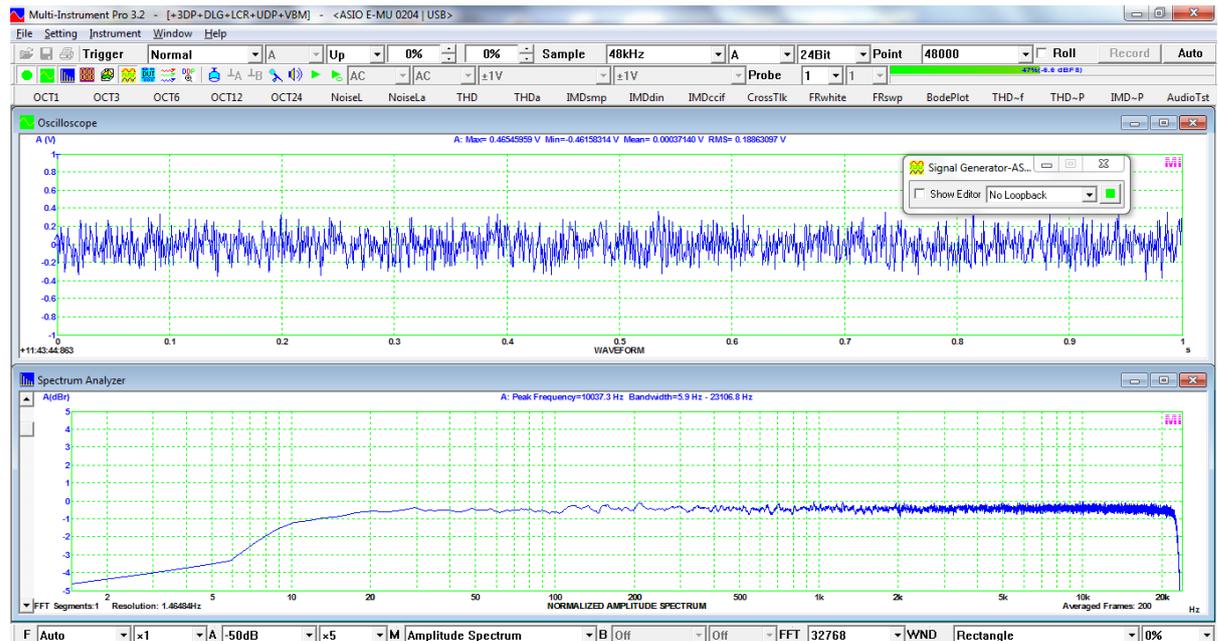
Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters.

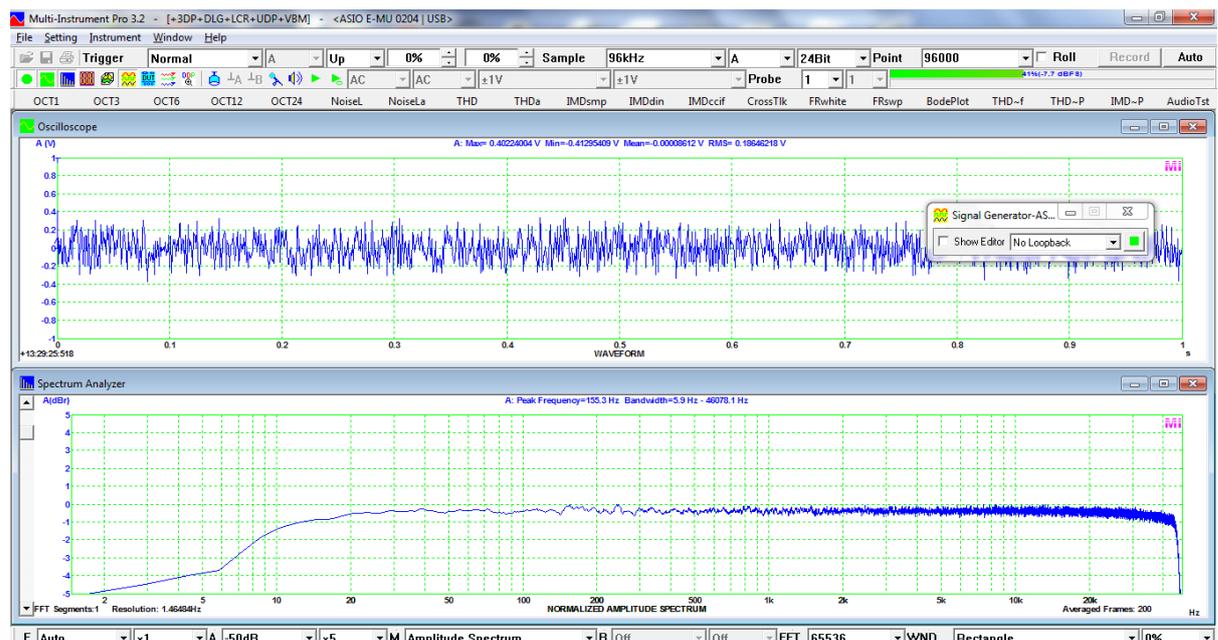
Bandwidth (-3dB) at the sampling rate of 48kHz: 5.9Hz ~23107Hz

Bandwidth (-3dB) at the sampling rate of 96kHz: 5.9Hz ~46078Hz

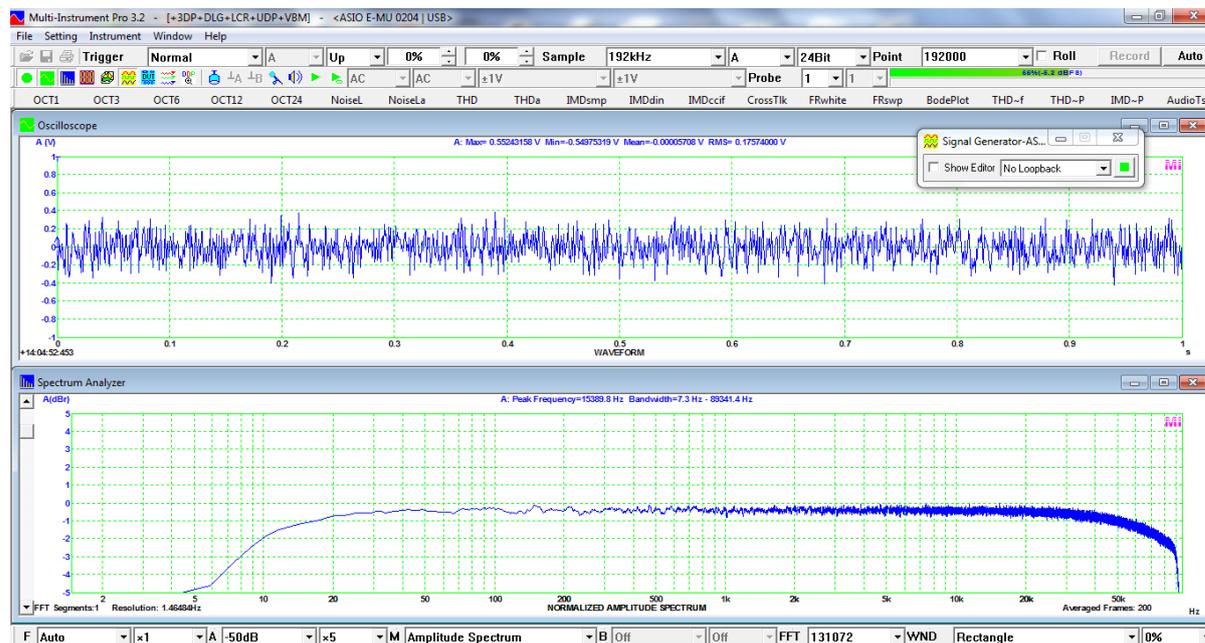
Bandwidth (-3dB) at the sampling rate of 192kHz: 7.3Hz ~89341Hz



Bandwidth (-3dB) (Sampling Rate = 48kHz, Record Length =48000, FFT Size=32768)



Bandwidth (-3dB) (Sampling Rate = 96kHz, Record Length =96000, FFT Size=65536)



Bandwidth (-3dB) (Sampling Rate = 192kHz, Record Length =192000, FFT Size=131072)

4.5 Dynamic Range

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/HiZ/Line] via a ¼" TRS male to XLR male cable
- The knobs for [Input L-Mic/HiZ/Line] was at +12dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:

Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit

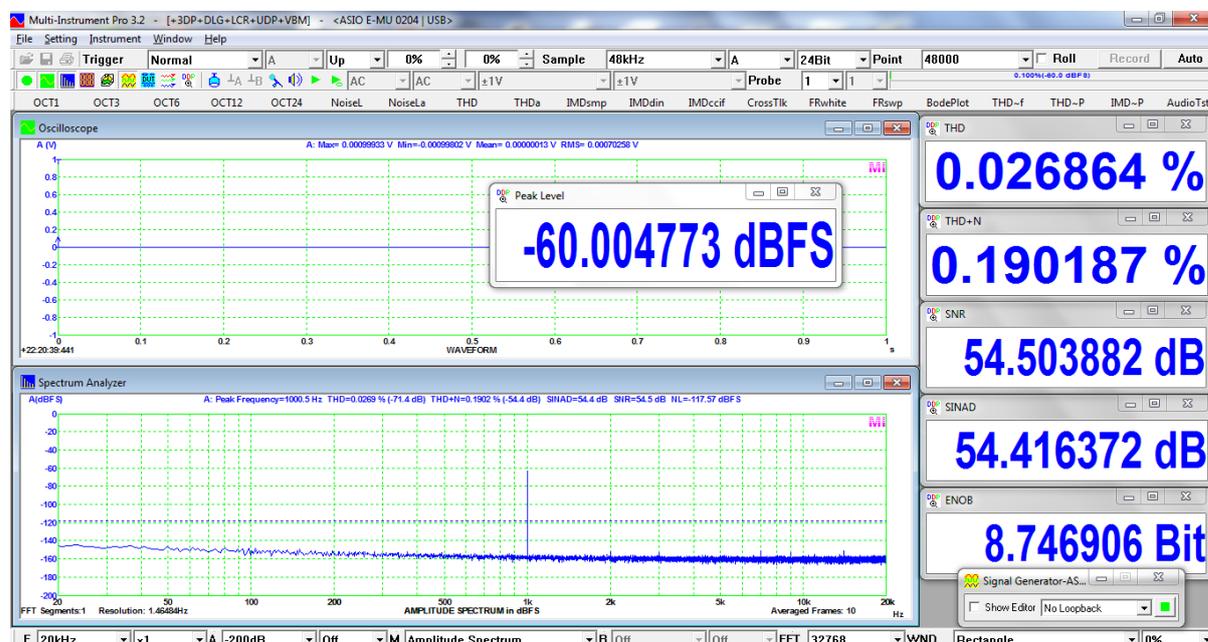
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: Sine, 1000.4882812 Hz
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Output Amplitude of the Signal Generator: 0.387% of the full scale
- Linear average: 10 frames

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -60 dBFS.

SNR (-60dBFS, 1kHz): 54.5 dB

Dynamic Range: $54.5+60=114.5$ dB



4.6 THD+N, THD, SNR, Magnitude Response vs Frequency

Test Conditions

On E-MU 0204:

- [Output L] was connected to [Input L-Mic/HiZ/Line] via a 1/4" TRS male to XLR male cable
- The knobs for [Input L-Mic/HiZ/Line] was at +18dB roughly, the rest of knobs on the panel were set to minimum.
- Direct Monitor: Off

On Laptop:
Powered by its AC adapter.

On Windows Control Panel:

- [Sound]>[Recording]>[E-MU 0204 Microphone]>[Levels]>[Main Volume]: No effect
- [Sound]>[Playback]>[E-MU 0204 Speakers]>[Levels]>[Main Volume]: 70%

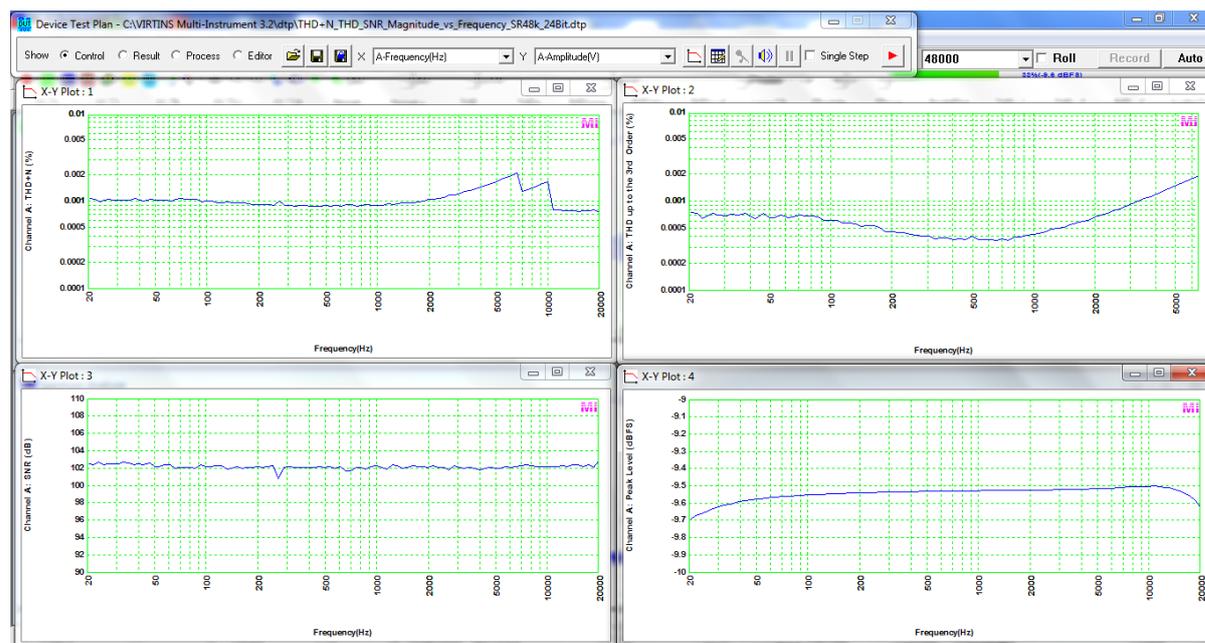
In Multi-Instrument:

- ASIO Driver
- Sampling Rate: 48 kHz
- Sampling Bit Resolution: 24 Bit
- Sampling Channels: A (mono)
- Record Length: 48000
- FFT Size: 32768
- Window Function: Rectangle
- Test Tone: 100-point Logarithmically Stepped Sine in the range of 20Hz~20kHz (No Spectral Leakage).
- Harmonic Distortion and Noise Measurement Range: 20~20 kHz
- Harmonic Order: 3
- Device Test Plan is used

Test Results

Please refer to the Multi-Instrument manual for a clear definition of the following parameters. They were measured at peak level: -9.6 dBFS.

- (1) Upper left graph: THD+N vs Frequency
- (2) Upper right graph: THD (up to 3rd order) vs Frequency
- (3) Lower left graph: SNR vs Frequency
- (4) Lower right graph: Peak Level vs Frequency.
Frequency Response (20Hz~20kHz): -0.16/-0.09 dB (obtained by examining the data)



Discussion

In the above THD+N vs Frequency plot (upper left), two sharp dips of THD+N at 6667Hz and 10000Hz are observed. As we know, THD+N consists of harmonic distortion and noise. In the above test, the Harmonic Distortion and Noise Measurement Range was set to 20~20 kHz and the Harmonic Order was set to 3. This implies that, for a 6 kHz test tone, THD+N consists of the 2nd and 3rd order harmonic distortions and noise; for a 7 kHz test tone, THD+N consists of only the 2nd order harmonic distortion and noise; and for a 11kHz test tone, THD+N contains noise only without any harmonic distortion of the test tone. 6667Hz and 10000Hz are the critical points where the 3rd and 2nd order harmonic distortions are excluded from the THD+N calculation respectively.

5. Conclusion

E-MU 0204 has excellent performance in THD, SNR, IMD, Noise Level, Dynamic Range, Crosstalk within audio frequency range. With ASIO driver, its bandwidth is from a few Hz to about 1/2 of the sampling frequency chosen. These parameters are as good as those of E-MU Tracker Pre (please refer to www.virtins.com/doc/D1004/EMU_Tracker_Pre_Report_D1004.pdf for a similar report for E-MU Tracker Pre). However, the gain and phase differences between the two Line In/Out channels of E-MU 0204, were noticeably greater than those of E-MU Tracker Pre, probably due to the fact that E-MU Tracker Pre is designed to have two identical HiZ/Line/Mic inputs whereas E-MU 0204 is designed to be asymmetric, with one input to be HiZ/Line/Mic, and the other to be HiZ/Line. Nonetheless, E-MU 0204 would still be able to provide reasonably good results in transfer function measurement when the frequency of interest is greater than 200Hz.