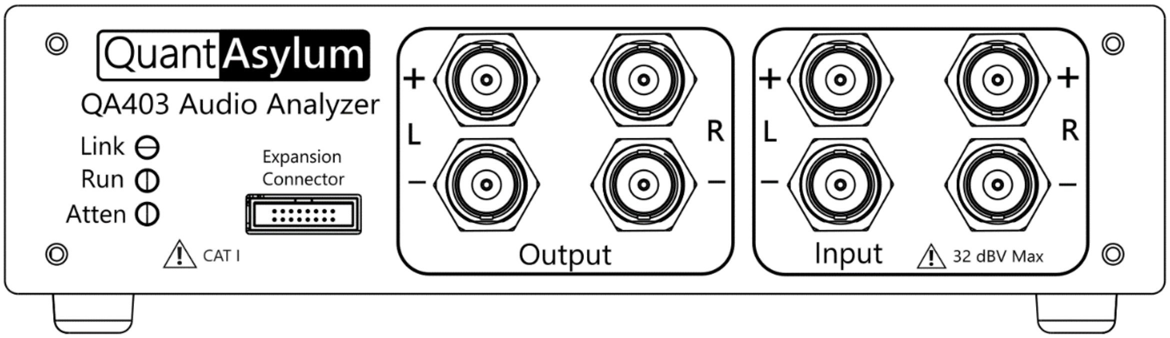
QuantAsylum

QA403 32-bit 192K SPS Audio Analyzer



Introduction

The QA403 is our fourth-generation audio analyzer. The QA403 extends the functionality of the QA402 with improved noise and distortion performance, in addition to a flatter response at band edges.

The compact size of the QA403 (177W x 44H x 97D mm and 450g) means you can take it just about anywhere.

Fast Bootup and Driverless

The QA403 is a driverless USB device, meaning it's ready as soon as you plug it in. The software is free, not locked, and it is quick and easy to move the hardware from one machine to the next. So, if you need to head to the factory to troubleshoot a problem or take the QA403 home for a work-from-home day, you can do it without hassle.

The software is very lightweight, needing under 10Mbytes of space, and can run directly from a thumb drive if needed.

No-Cal Design

The QA403 comes with a factory calibration in its flash memory, ensuring consistent unit-to-unit performance. On your manufacturing line you can install another QA403 and be confident what you read on one unit will be very similar to the next unit. It is not expected that re-calibration will be required at regular intervals.

Measurements

Making basic measurements is quick and easy. In a few clicks you will understand the frequency response, THD(+N), gain, SNR and more of your device-under test.

Dynamic Range

The QA403 offers 8 gain ranges on the input (0 to +42 dBV in 6 steps), and 4 gain ranges on the output (-12 to +18 dBV in 10 dB steps). This ensures consistent performance over very wide ranges of input and output levels.

The maximum AC input to the QA403 is +32 dBV = 40Vrms. The maximum DC is ±40V, and the maximum AC_{PEAK} + DC = ±56V.

Easy Programmability

The QA403 supports a REST interface, making it easy to automate measurements in just about any language you might anticipate. From Python to C++ to Visual Basic—if you know how to load a web page in your favorite language, you can control the QA403 remotely. Measurements are fast and responsive, usually with dozens of commands being processed per second.

Isolated and USB Powered

The QA403 is isolated from the PC, meaning you are measuring your DUT and not chasing some phantom ground loop. The QA403 is USB powered, like nearly all our instruments. If you are setting up remotely, throw a powered hub in your bag and your entire test setup can be running with a minimum of cables.

Goodbye Soundcard, Hello QA403

Tired of trying to make a soundcard work? The calibration nightmare? The lack of gain stages? The limited drive? Are you tired of dealing with the fixed input ranges? The worry that you might destroy it with too much DC or AC? Tired of the ground loops? That's why we built the QA403.

Easy Returns

We know getting comfortable with a new analyzer is an investment. That is why we offer a 15-day no-questions-asked return policy. Try it. And if you don't find the QA403 helpful in your workflow, just send us an email and we'll arrange a return.

Specifications

Figures below are subject to change without notice. See the description adjacent the spec to understand the operating conditions. Following the specifications, you will find measurement plots showing representative performance. There will be unit-to-unit variation on these graphs. Reasonable efforts have been made to ensure the accuracy of this document. However, QuantAsylum USA LLC assumes no liability for inaccuracies or omissions.

General

OS Supported	Windows 10. Other versions of Windows may work but are not routinely tested. The software *should* run under Mono on Linux and MacOS, but it will require additional manual configurations that you may have to discover yourself. Additionally, there are likely bugs that are platform dependent. If those are reported, we will generally try to fix them quickly. If you cannot get the software to run on your platform, we will gladly refund the purchase via our 15-day return policy.
USB Connector	USB Type B
USB Current	800 to 900 mA or more depending on connected loads. This is readily provided by a powered hub but might be too much for some laptops. Additionally, the additional current can put demands on the cable leading to excessive voltage drop. Use a USB cable with 24g power conductors. See more HERE. The QA40x application reports USB voltage and current in the status bar, making it easy to see if you are adequately meeting the power demands of the analyzer.
Isolation	The QA403 was tested during design to offer >10Gohm of isolation between Audio Common (BNC Shell) and USB ground (USB shell) @ 1 kV test voltage. The digital isolator is rated for 1kV, the I2C isolator is rated for 2.5 kV, and the isolation transformer is rated for 2.5 kV (1minute). Isolation is not confirmed on each unit, but can be verified using a DVM or Megger. Do not exceed 100V in ground potentials between USB and Audio common.
Sample Rates	48, 96 and 192k SPS for ADC and DAC. ADC and DAC always have the same sample rate. 384k SPS may be supported for the ADC alone. The schedule is TBD.
Front Panel Expansion	A front-panel connector allows I2S master playback with 16- and 32-bit word widths, and 48ksps sample rate. This connector allows an interface to manufacturer hardware. Additional features may be provided in the future.
Operating Temperature	10°C to 35°C ambient, with 5-minute warmup. Operation outside those limits generally isn't a problem, but the accuracy may be degraded and/or the noise floor may increase.
Accuracy	Amplitude accuracy is across all input and output ranges is better than ±2%. Relative accuracy over the above specified operating temperature range is better than ±0.5%.

Mechanical

Dimensions	177W x 44H x 97D
Weight	435 grams
Case Material	Powder-coating Aluminum (2mm thick front panel, 1.6mm thick top/bottom)

Electrical ADC (See Attached Performance Plots)

Inputs	Differential, BNC x 2 for LEFT and BNC x 2 for RIGHT
Input Z	100KΩ AC-coupled unbalanced (single-ended) 200KΩ AC-coupled balanced
Input Coupling	AC, F_c < 1 Hz
Input Max DC	±40V balanced or single-ended. |AC + DC| must not exceed $56V_{PK}$ on any input
Input Full Scale (Atten OFF)	+18 dBV = $8V_{RMS}$ balanced or single-ended
Input Full Scale (Atten ON)	+42 dBV, but input is clipped by software to +32 dBV = $40V_{RMS.}$

Input Overload Protection	With attenuator off, momentary application of +32 dBV = 40V_{RMS} can be tolerated. With attenuator on, momentary application of up to 37 dBV = 70V_{RMS} can be tolerated.
Input Noise Floor	-115 dBV, 0 dBV input range, inputs shorted, 32K FFT, avg 5, rectangular window, 48k SPS
THD	-115 dB (loopback, 0 dBV input range, single-ended, L- shorted, -2 dBV input, 128K FFT, Hann window, 20 kHz BW)
THD+N	-105 dB (loopback, 0 dBV input range, single-ended, L- shorted, -2 dBV input, 128K FFT, Hann window)

Electrical DAC (See Attached Performance Plots)

Outputs	Differential, BNC x 2 for LEFT and BNC x 2 for RIGHT
Output Z	100Ω DC-coupled unbalanced (single-ended) 200Ω DC-coupled balanced
Expected Load	Minimum = 200Ω || 100pF. Preferred load is resistive and > 1kΩ. Output stage will limit to ±60 mA. Extended operation at limits can cause heating in output stage and could cause a shift in performance. Output can drive into non-zero DC loads between ±10V, but current must be limited to ±5mA. Contact support if you have non-typical loads (reactive or otherwise) and we can provide a more detailed assessment.
Output Full Scale	+18 dBV = 8V_{RMS}
Output Attenuators	0, 10, 20 and 30 dB. Output ranges are automatically selected.
Output Overload Protection	The output can withstand momentary connection to voltages beyond ±10V, but current must be limited to ±5mA.
Output Noise Floor	All generators disabled: -124 dBV (20 kHz, no weighting)[1] 0 dBV Output: Noise (minus distortion) -110 dBV[2] 15 dBV Output: Noise (minus distortion) -100 dBV
THD	-115 dB (loopback, 0 dBV input range, single-ended, L- shorted, -2 dBV input, 128K FFT, Hann window, 20 kHz BW)
THD+N	-105 dB (loopback, 0 dBV input range, single-ended, L- shorted, -2 dBV input, 128K FFT, Hann window)

Other

Included Accessories	None
Box Size	The QA403 box is 180x130x21 mm. For bulk shipping, up to 6 analyzer can be shipped in a single carton.

Representative Performance Plots

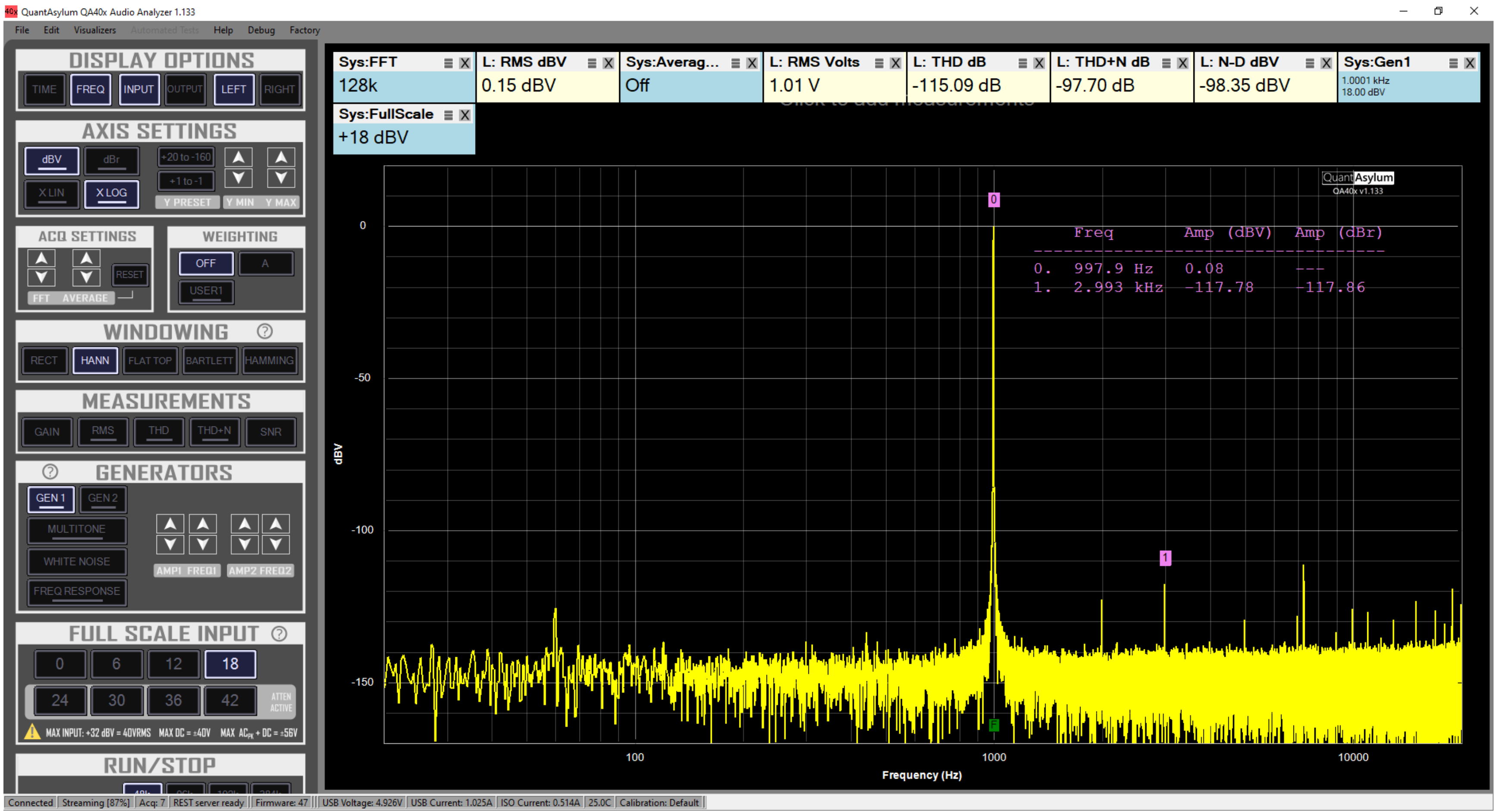
Notes for the following plots:

- The following graphs represent typical performance of the QA403. Some units will perform slightly better, and some units will perform slightly worse.
- The plots shown on the following pages were made via automated sweeps. See the menu item labeled "Automated Tests" to replicate the plots on your QA403.
- Left channel is yellow, right channel is red
- Plots are single-ended unless noted
- For the tests below, no harmonic distortion compensation has been used

[1] Measured with low-noise 30 dB amp on QA471
[2] Measured using QA480 notch filter, and then noise minus distortion on QA40x

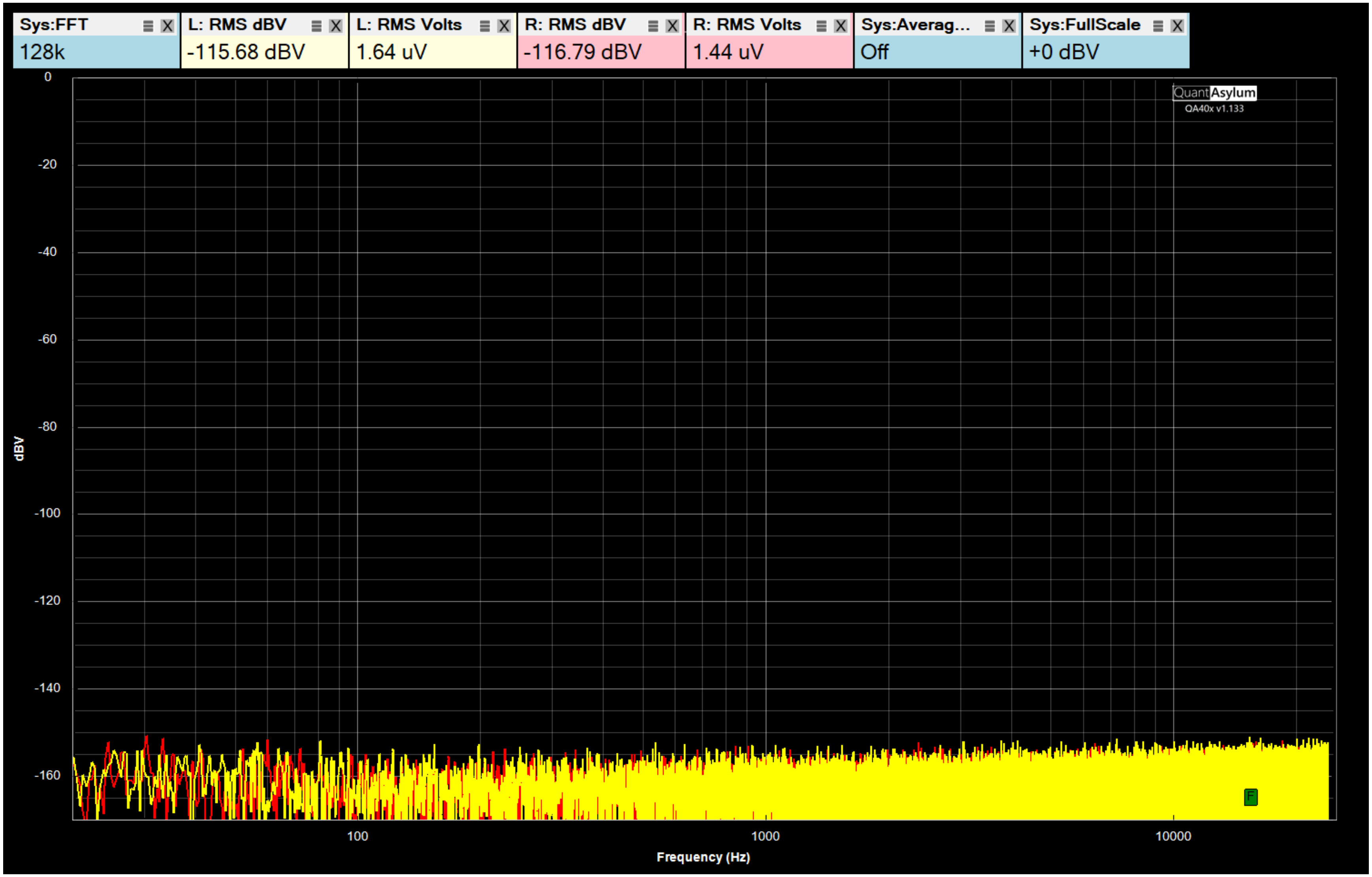
User Interface

The image below shows the QA40x software. The software and manual are under 10Mbytes in size and can be run from a USB drive. The software may be remotely controlled by 3rd party software for making measurements if the provided swept tests are not sufficient. The control panel on the left slides up and down, and controls are sized for touch-screen operation. All the sweeps shown in this document were prepared using this software.



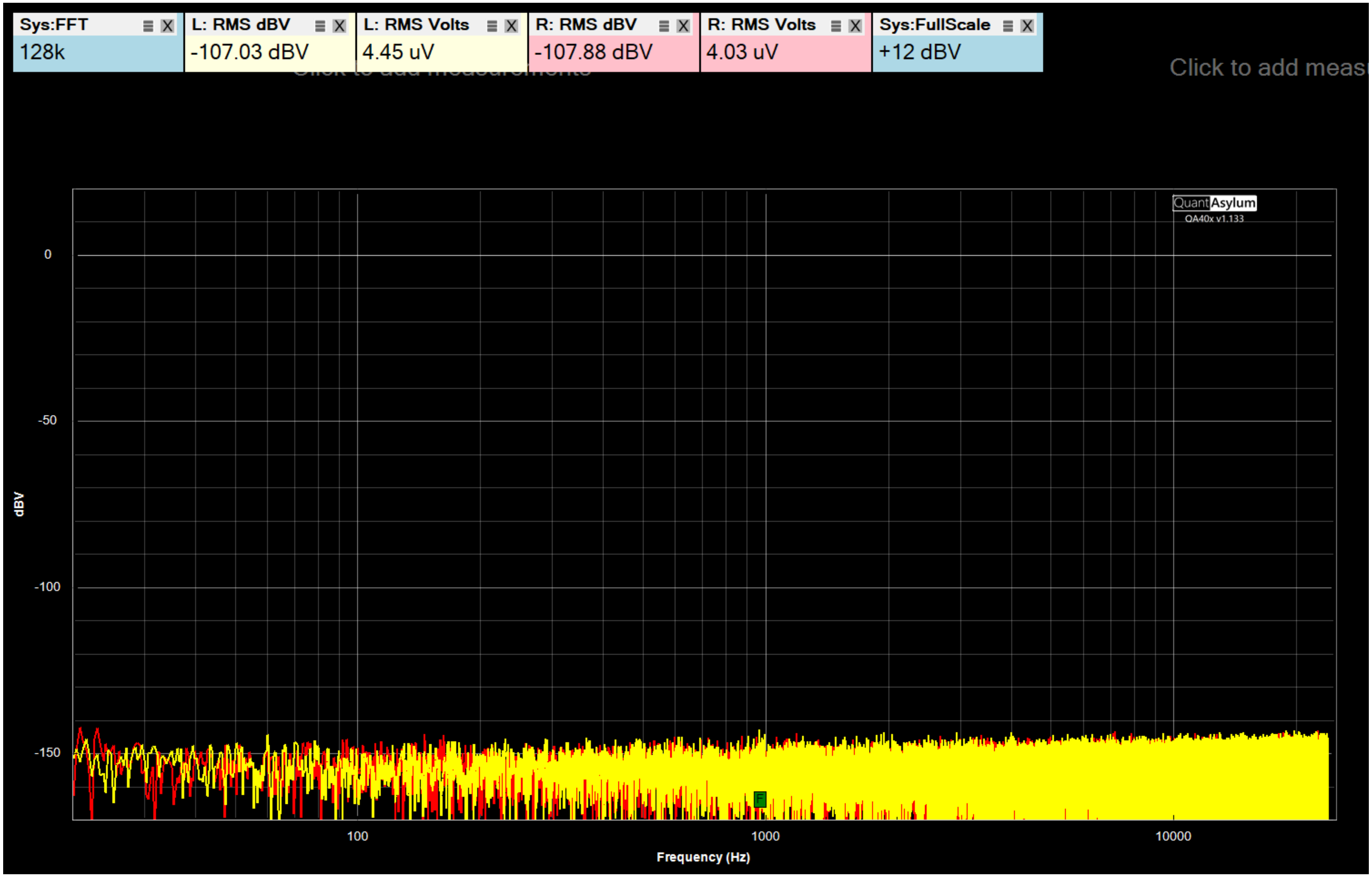
Noise Floor: 48k SPS, +0 dBV Full Scale Input

The following plot shows the noise floor in 48k SPS mode with inputs shorted. RMS readings are 20-20 kHz, no weighting. This is about 116 dB of dynamic range on the 0 dBV input range. A-weighting improves this 116 dB figure by about 2.5 dB. The dynamic range of this input range is slightly compressed due to the input stage gain.



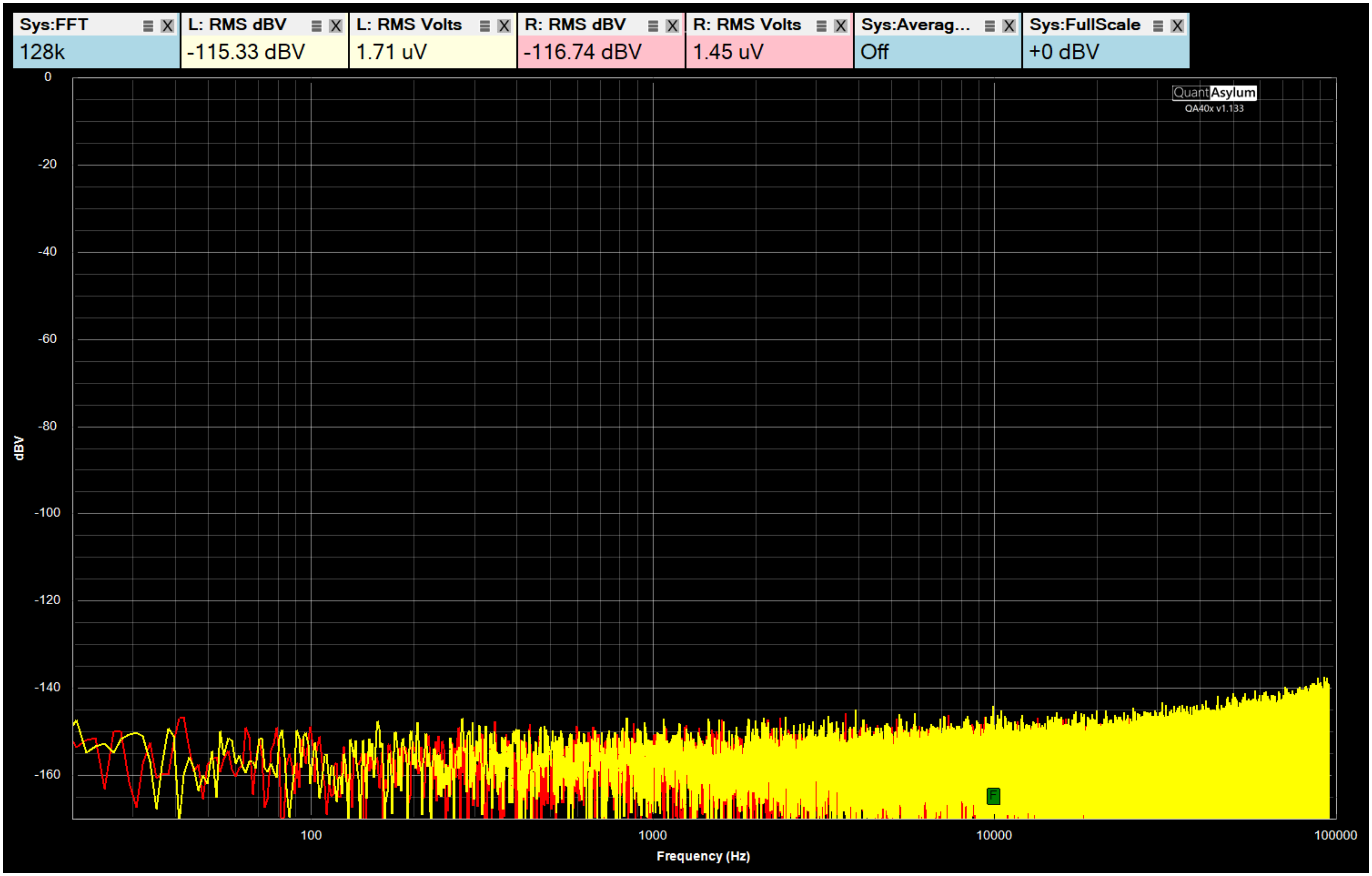
Noise Floor: 48k SPS, +12 dBV Full Scale Input

The following plot shows the noise floor in 48k SPS mode with inputs shorted. RMS readings are 20-20 kHz, no weighting. This is about 119.5 dB of dynamic range on the +12 dBV input range. A-weighting improves this 119.5 dB figure by about 2.5 dB.



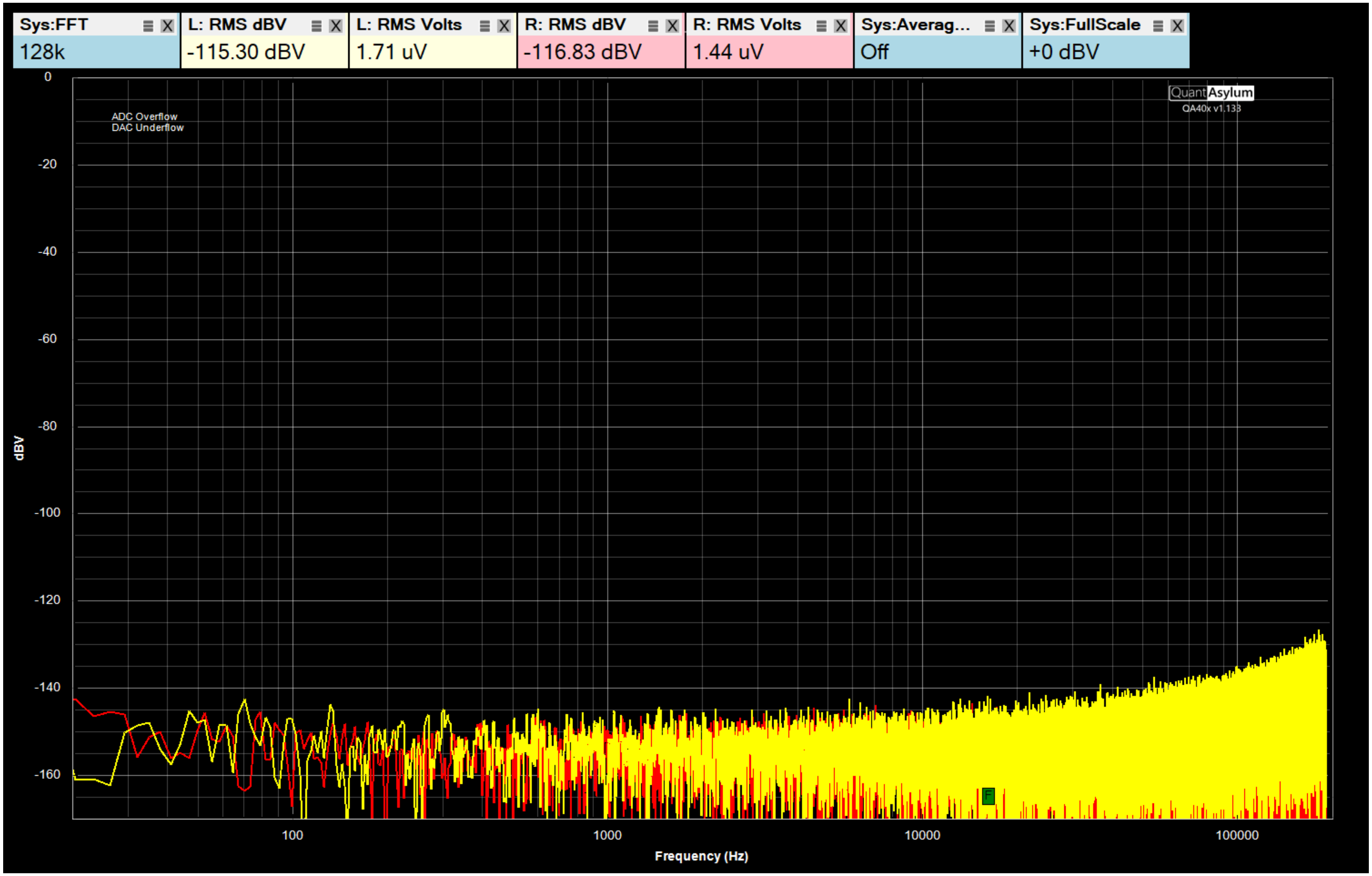
Noise Floor: 192k SPS

The following plot shows the noise floor in 192k SPS mode with inputs shorted. RMS readings are 20-20 kHz, no weighting.



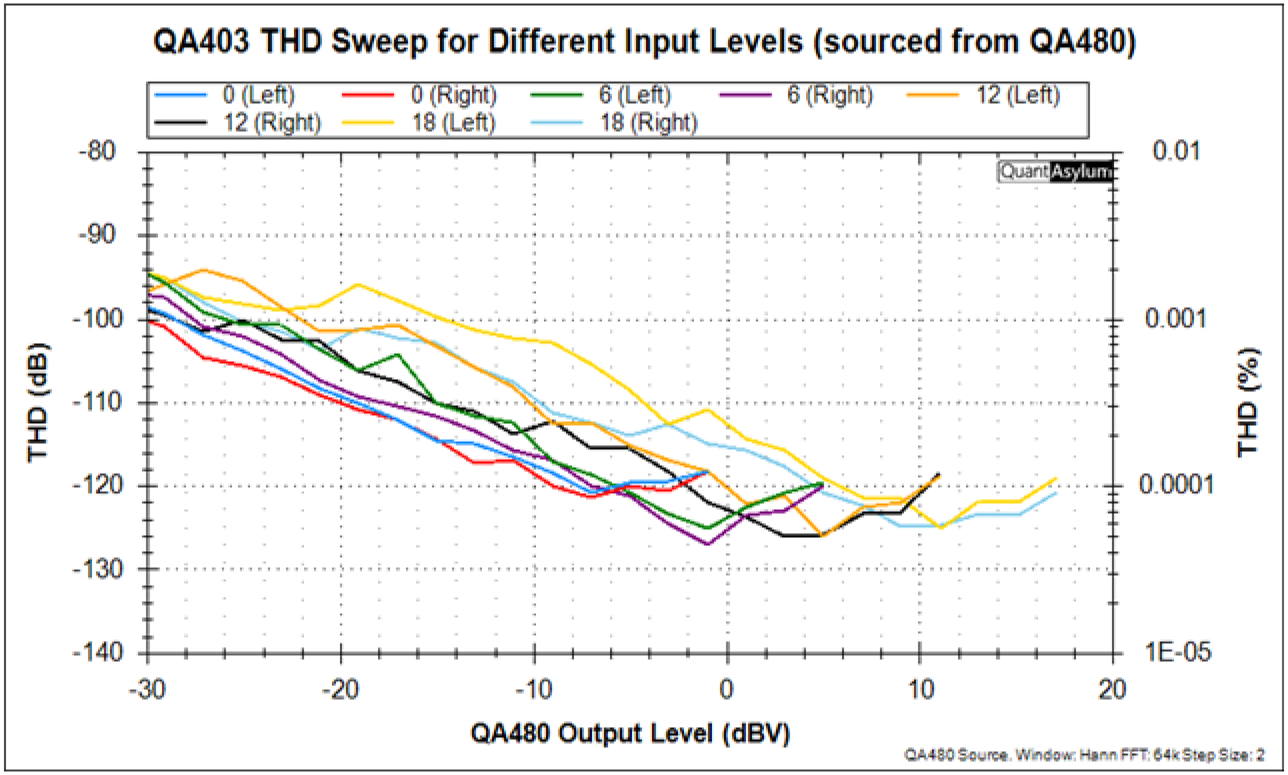
Noise Floor: 348k SPS

The following plot shows the noise floor in 384k SPS mode with inputs shorted. RMS readings are 20-20 kHz, no weighting



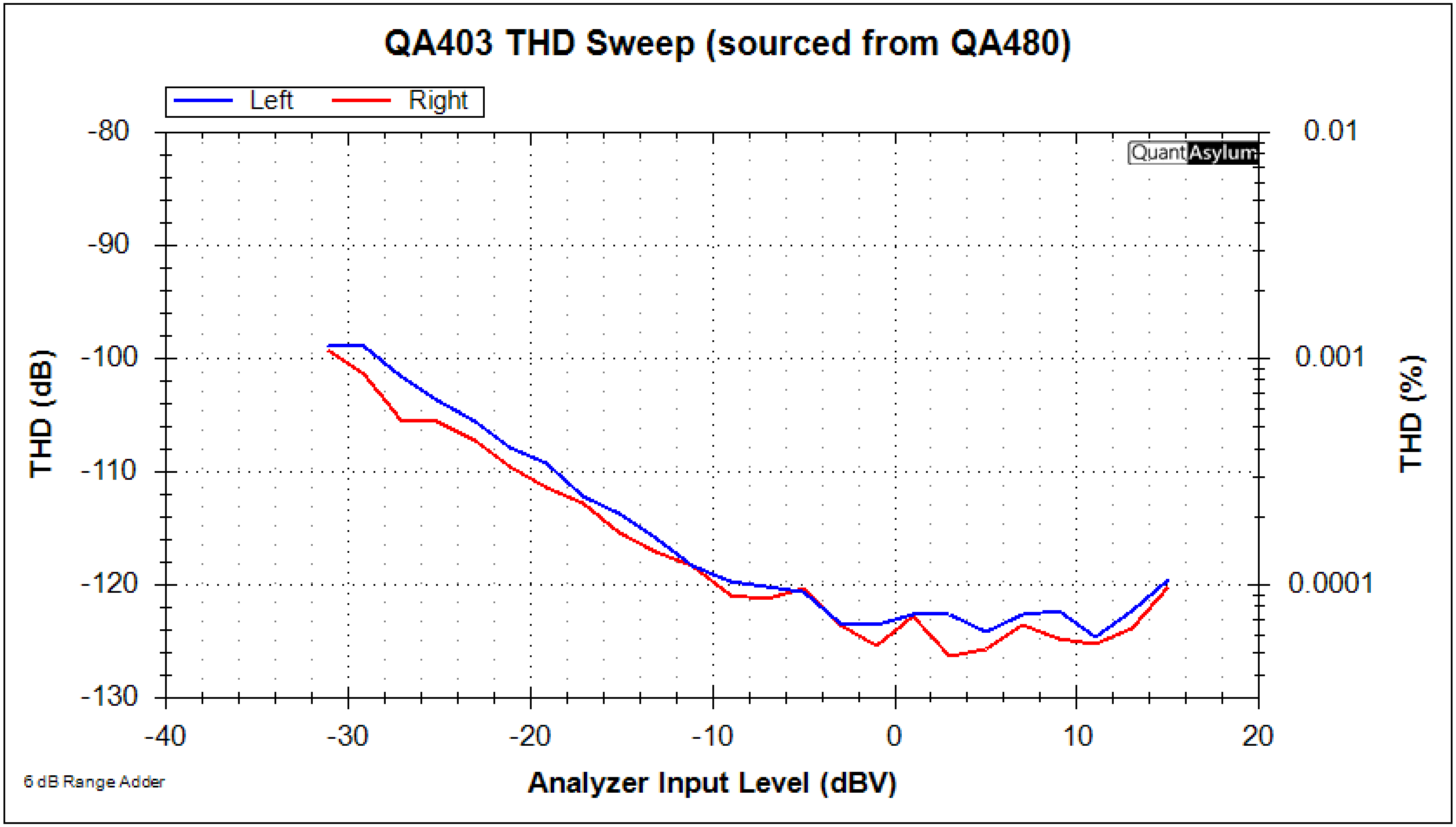
Plot: THD from External Source

The following plot shows the THD of the QA403 ADC when swept from a very high quality 1 kHz analog source (QA480). There is one sweep per input range. So, on 0 dBV full scale input range, the QA480 is swept from -30 dBV to 0 dBV, and then on the 6 dBV input range, the QA480 is swept from -30 to 6 dBV. This allows you to see the best-case THD for each input range on the QA403.



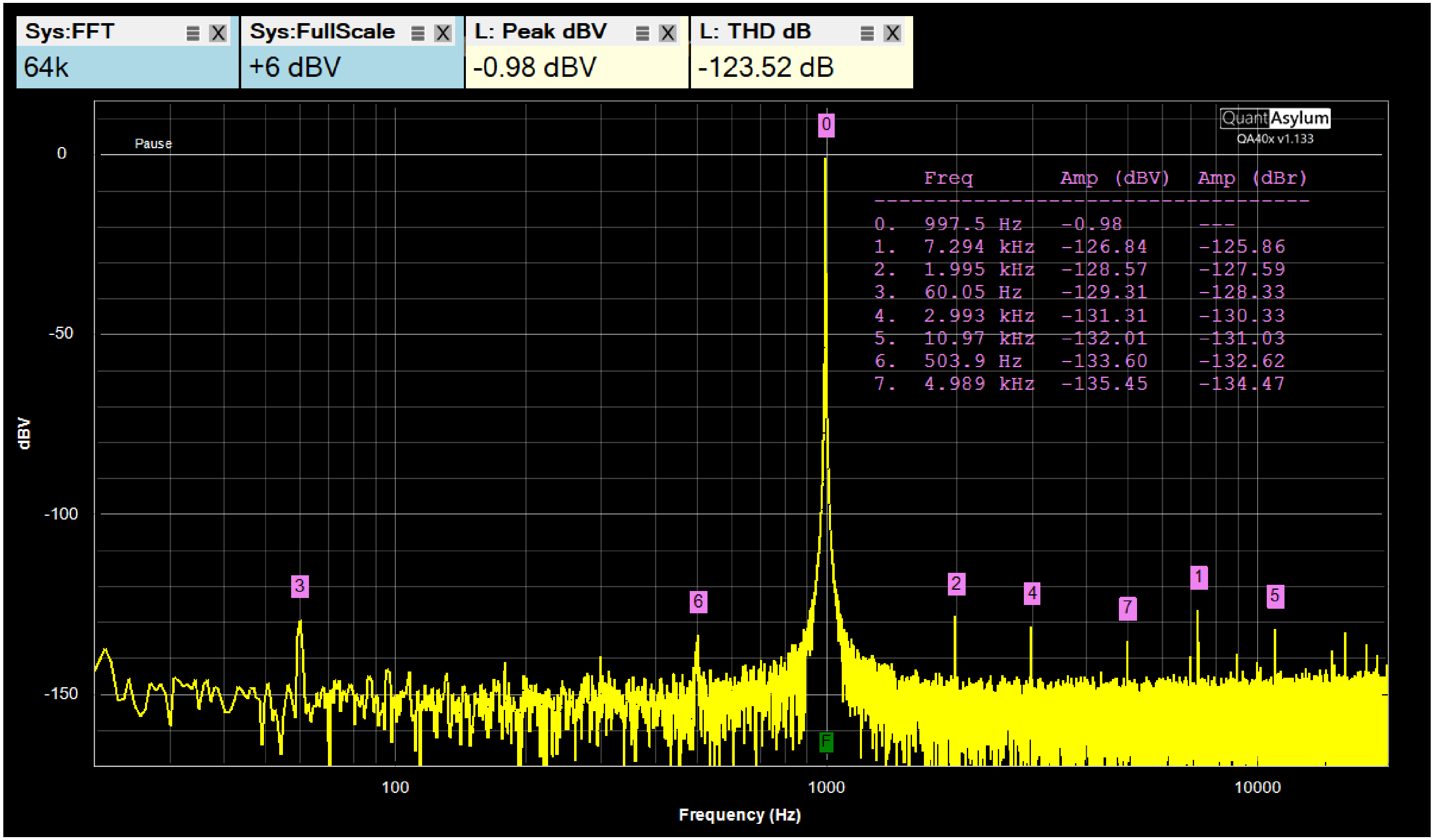
Plot: THD from External Source

The following plot shows the measured THD when source from the QA480. The QA403 input range is automatically adjusted to keep the input range at least 6 dB above the measured input signal level.



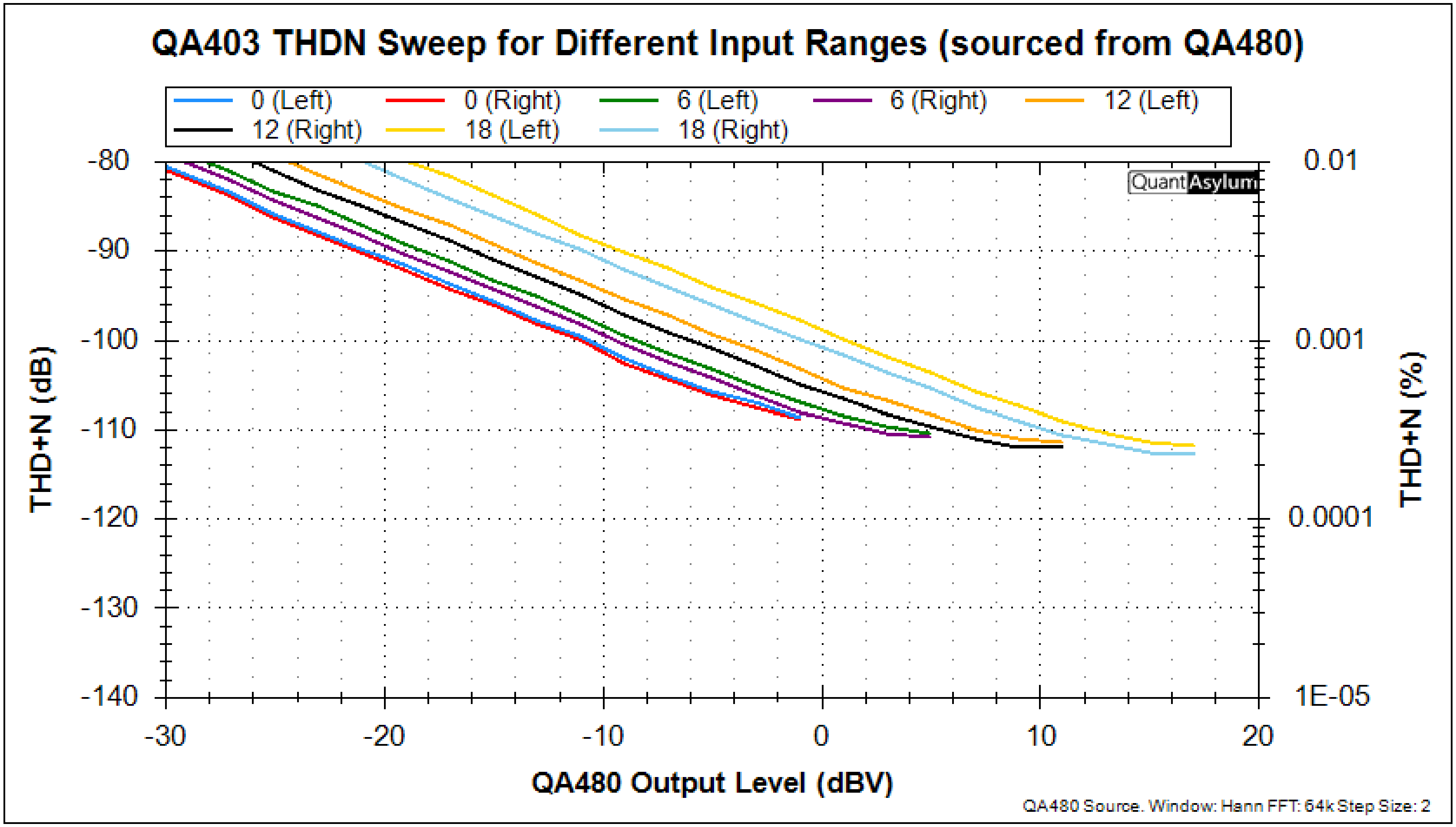
Plot: THD Spectrum from External Source

The plot below shows the spectrum of the left channel with markers added. From the previous plot, we can see the left channel should measure about -123 dB at this operating point.



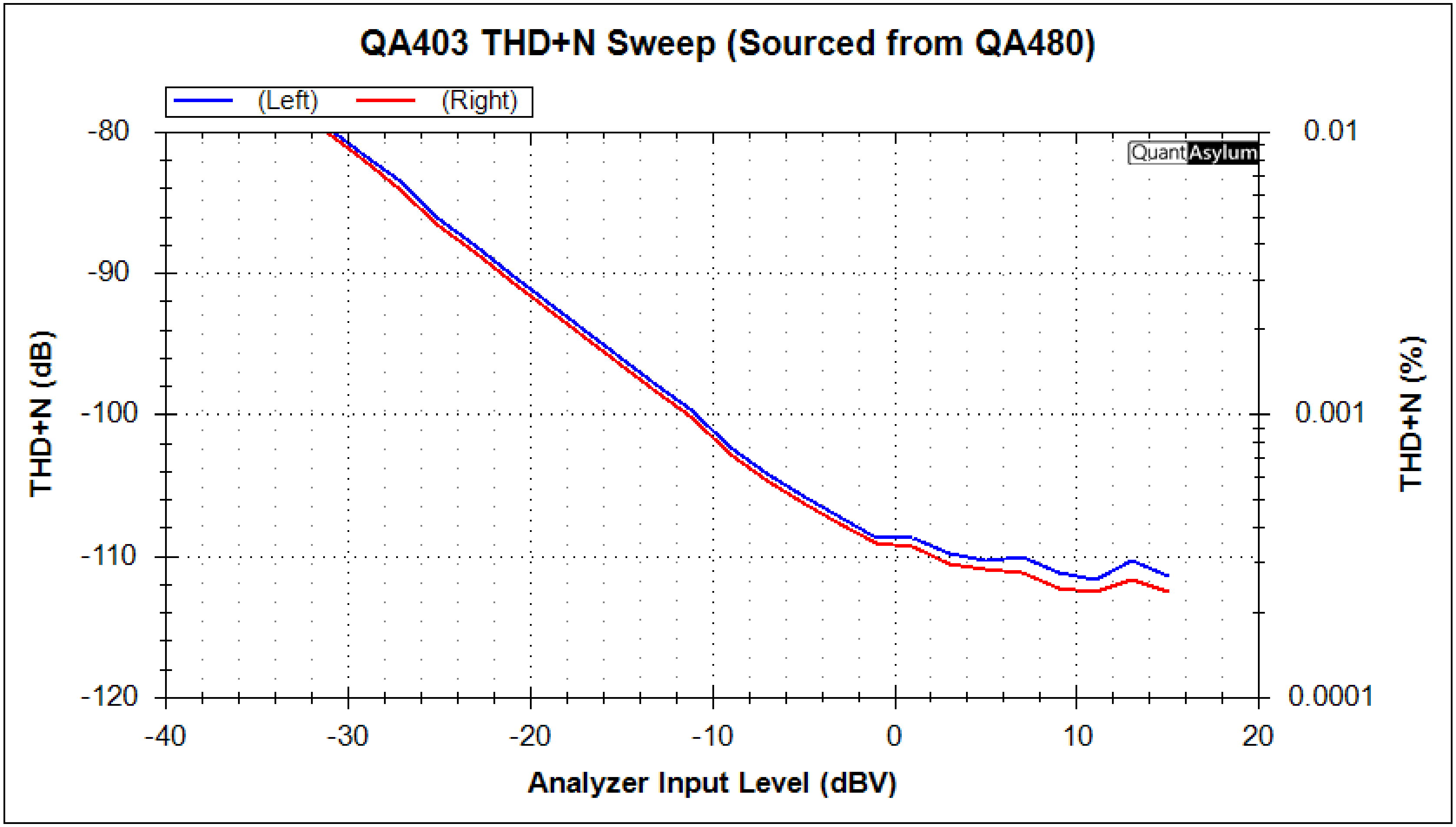
Plot: THD+N from External Source

The plot below shows the THD+N swept for each input range when sourced from the QA480.



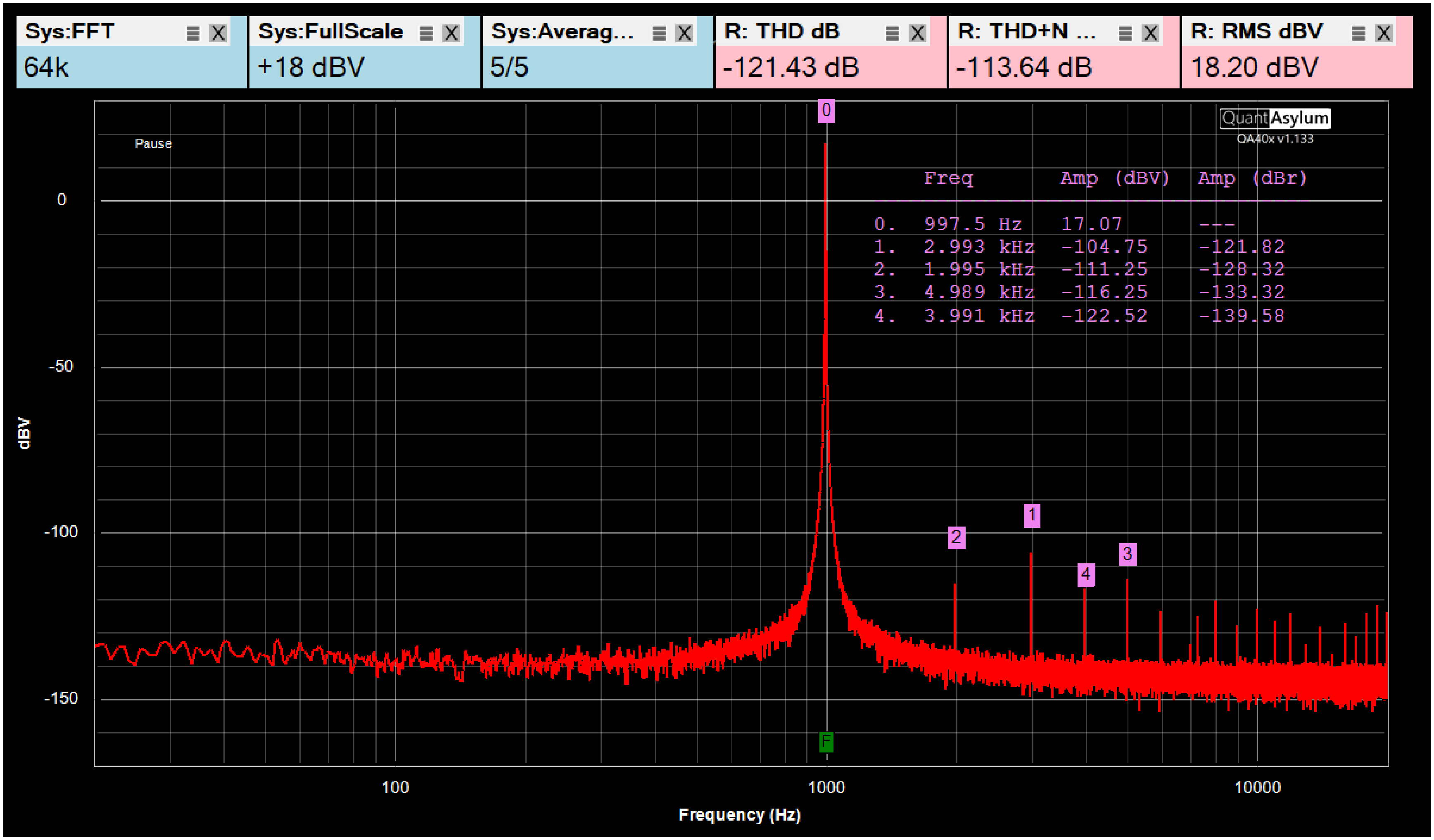
Plot: THD+N From External Source

The plot below shows the composite THD+N response when sourced from the QA480. In this plot, the QA403 is automatically selecting the input gain range to optimize THD+N.



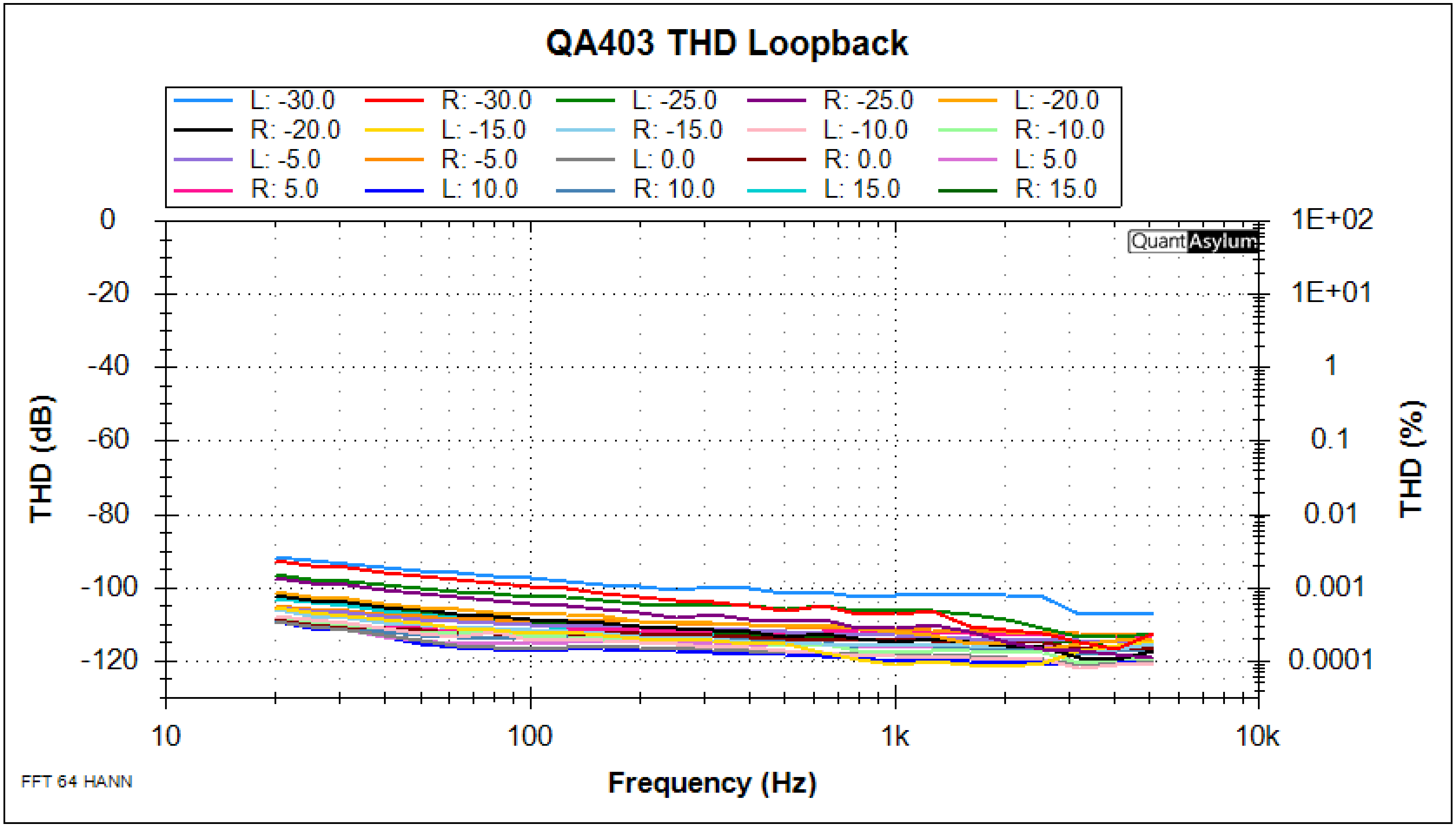
Plot: THD+N Spectrum from External Source

The plot below represents the best-case operating point from the sweep shown on the previous page.



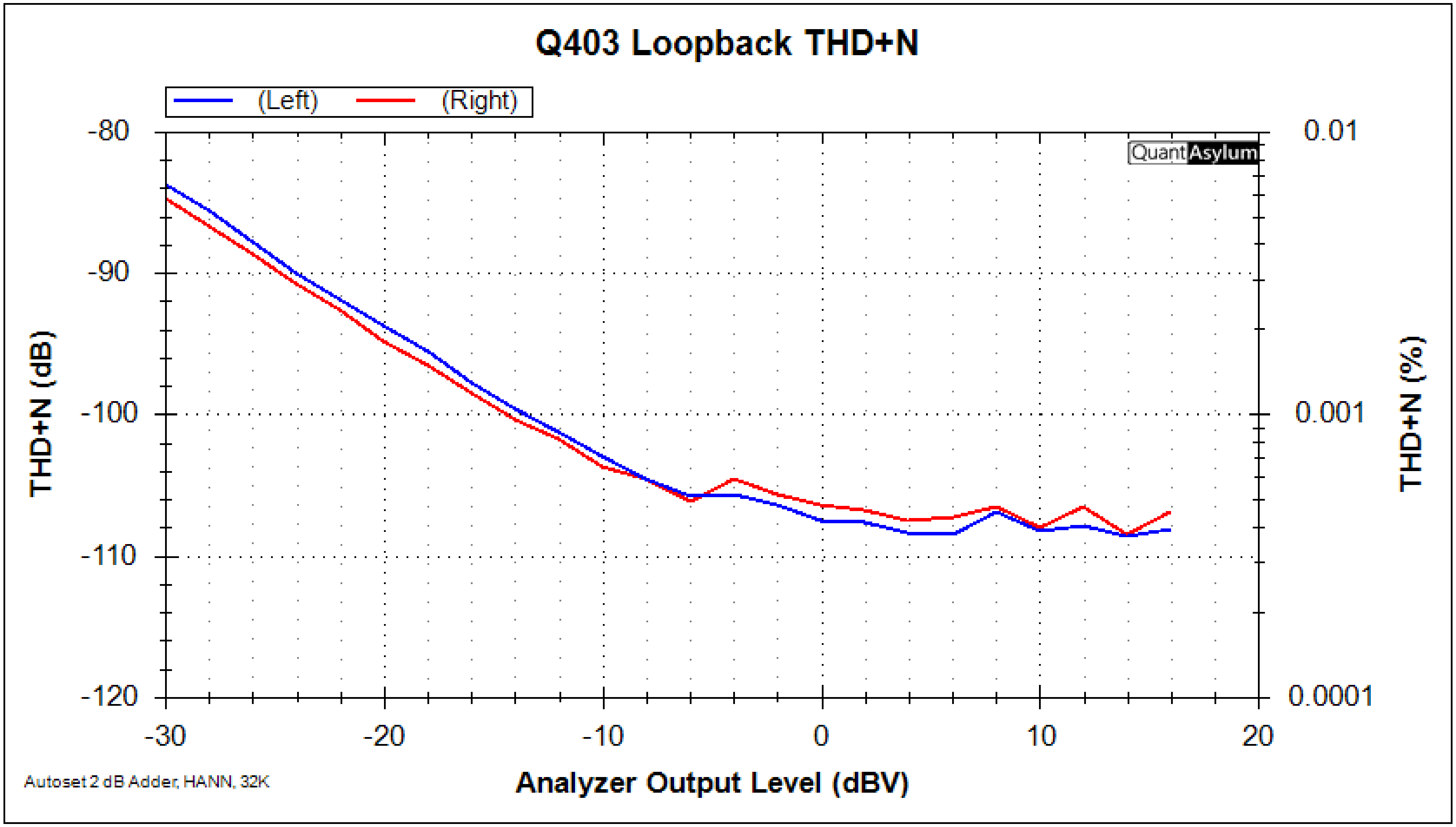
Loopback THD versus Frequency

The plot below shows loopback response of THD from 20 to 6 kHz at varying levels of input (from -30 to +15 dB).



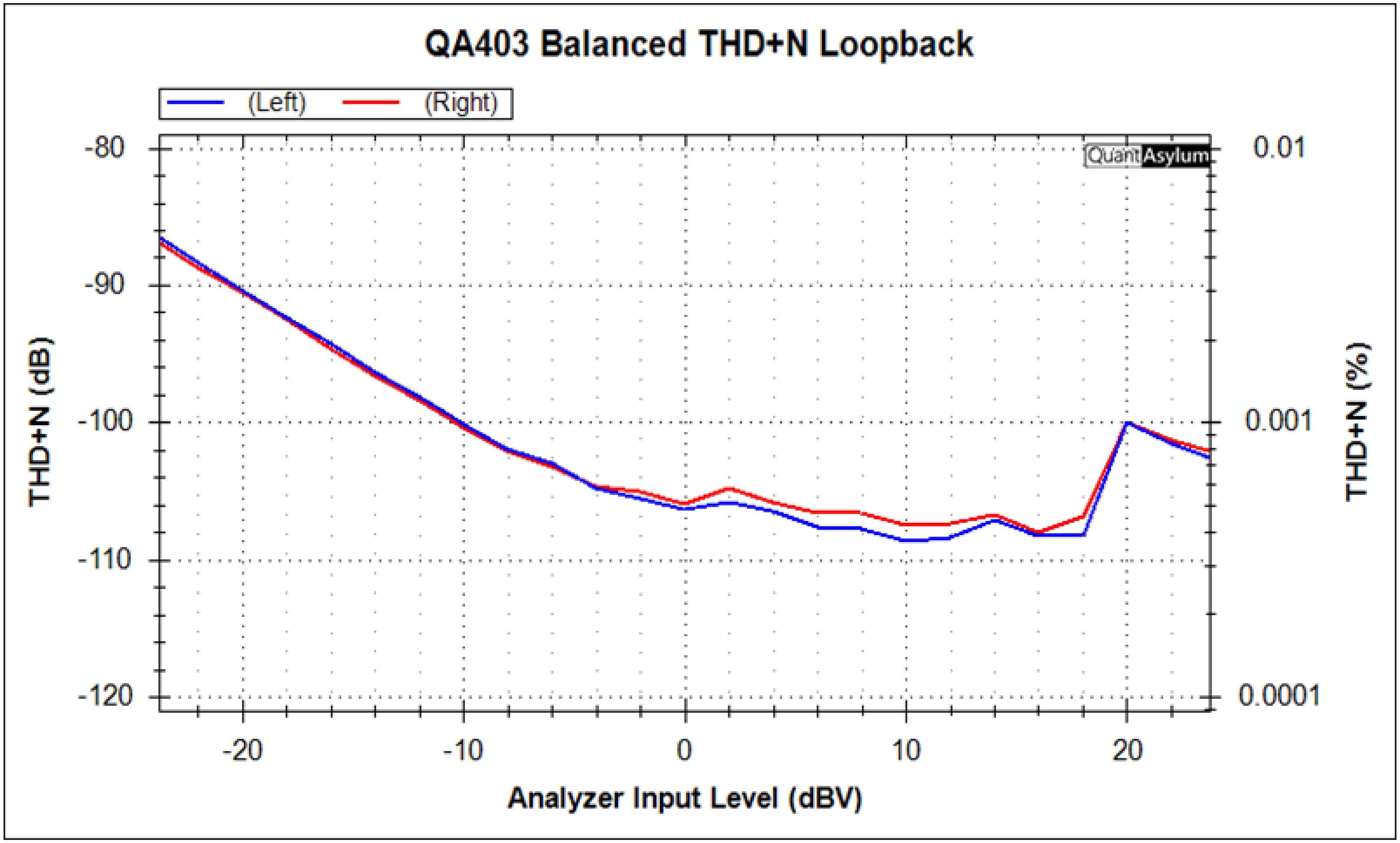
QA403 Loopback THD+N

The plot below shows the THD+N in loopback.



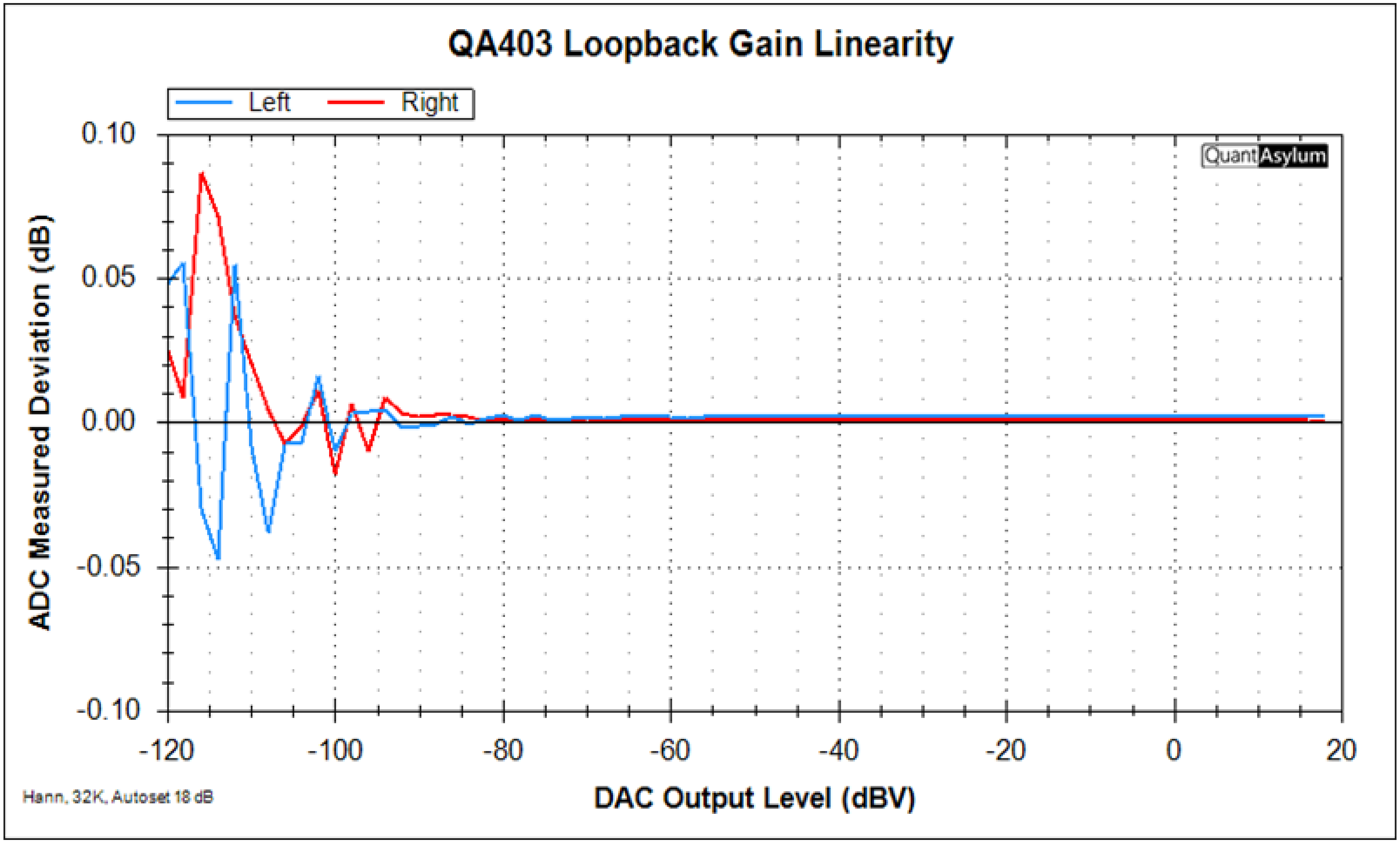
QA403 Balanced Loopback THD+N

In balanced loopback, the maximum output is effectively doubled over single-ended, meaning the maximum output level is +24 dBV (versus +18 dBV in single-ended mode).



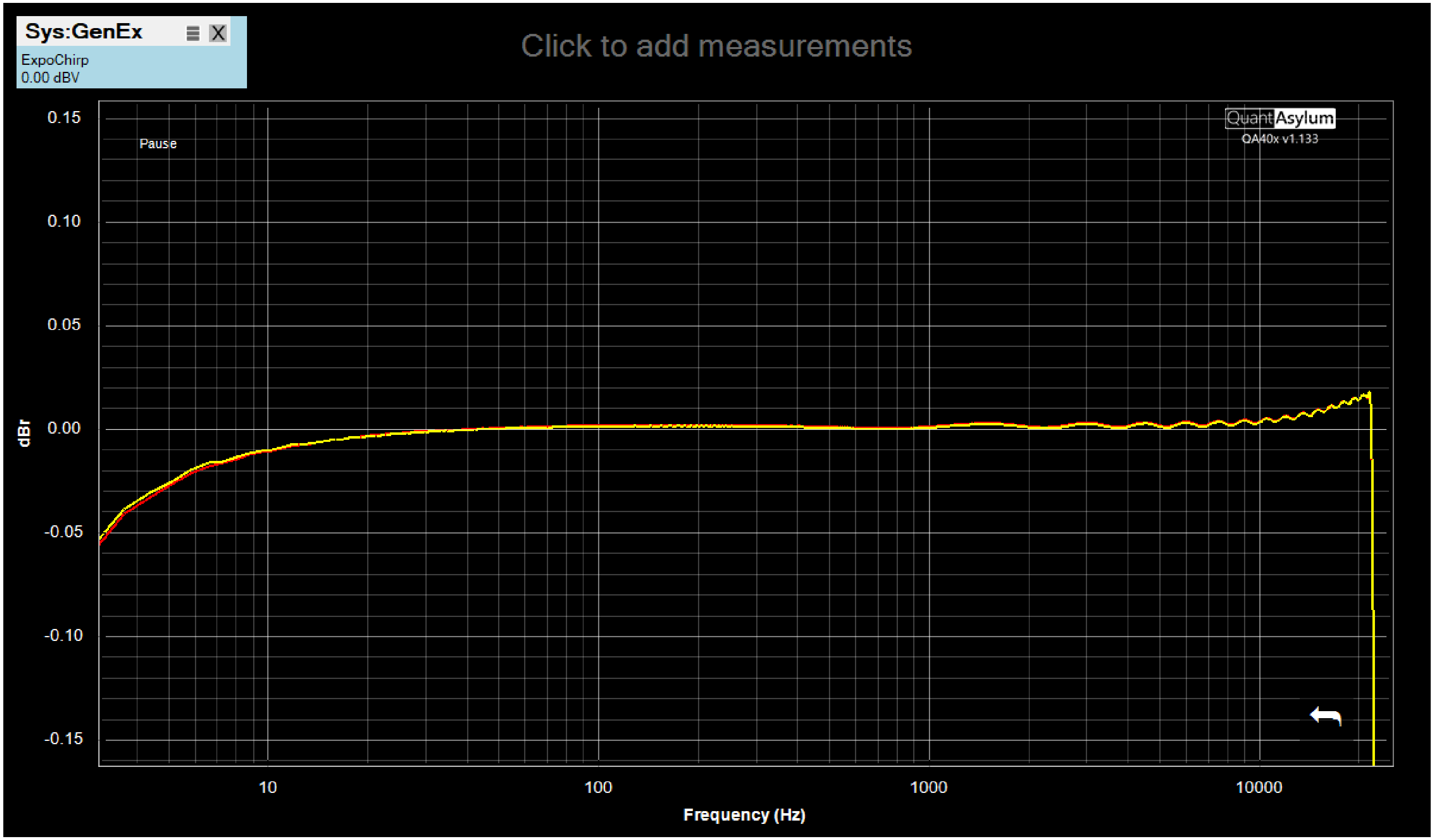
QA403 Loopback Gain Linearity

The plot shows the amplitude measurement error (or DAC amplitude accuracy) for given DAC output levels.



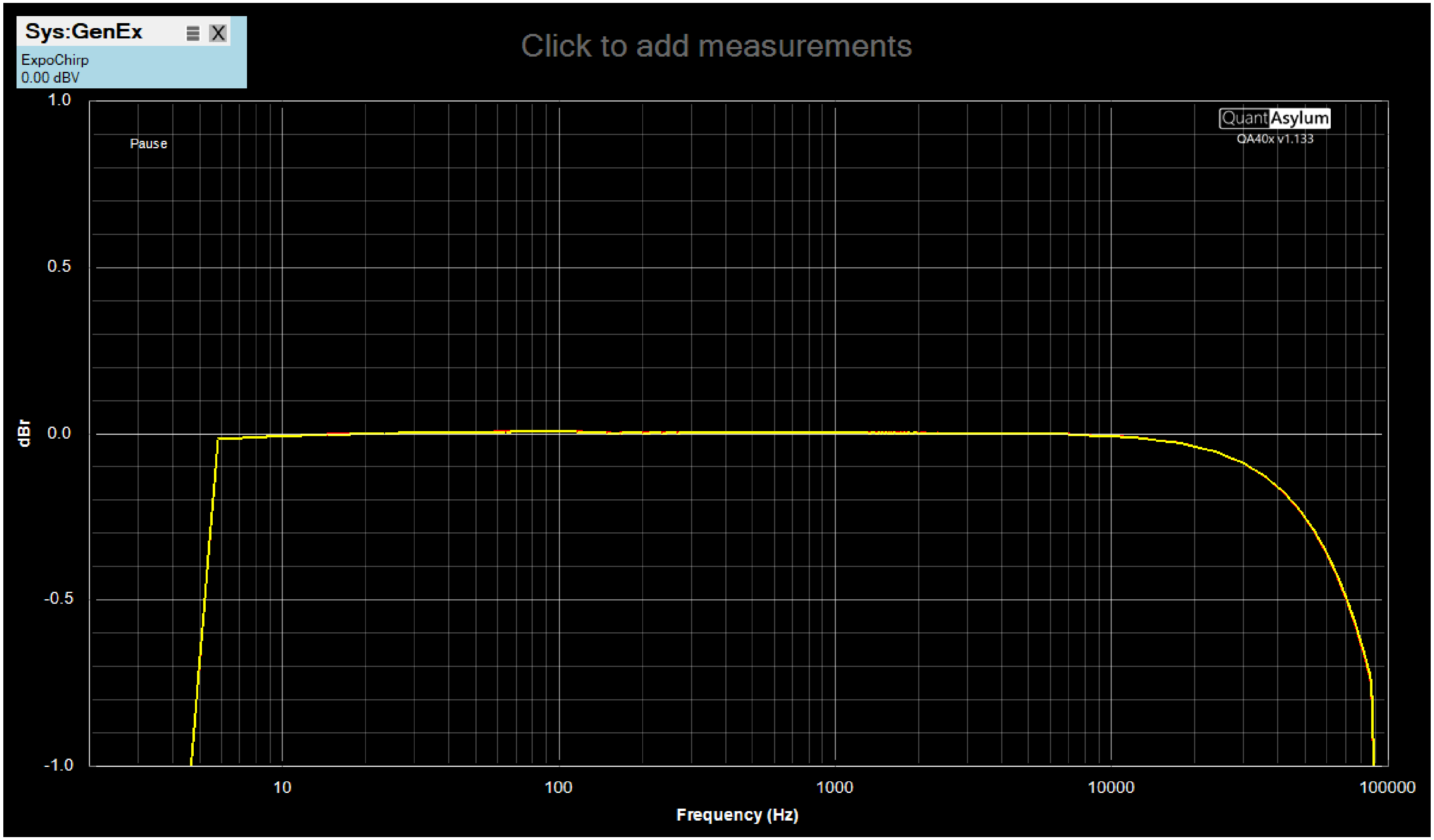
Loopback Frequency Response: 48k SPS

Response is show below. Lower frequency for 0.05 dB rolloff (relative to 1 kHz) is about 3 Hz. Upper frequency for 0.05 dB rolloff is 22 kHz. Ripple is combined ADC + DAC filter performance. Peaking shown is about 0.02 dB in amplitude (relative to 1 kHz)



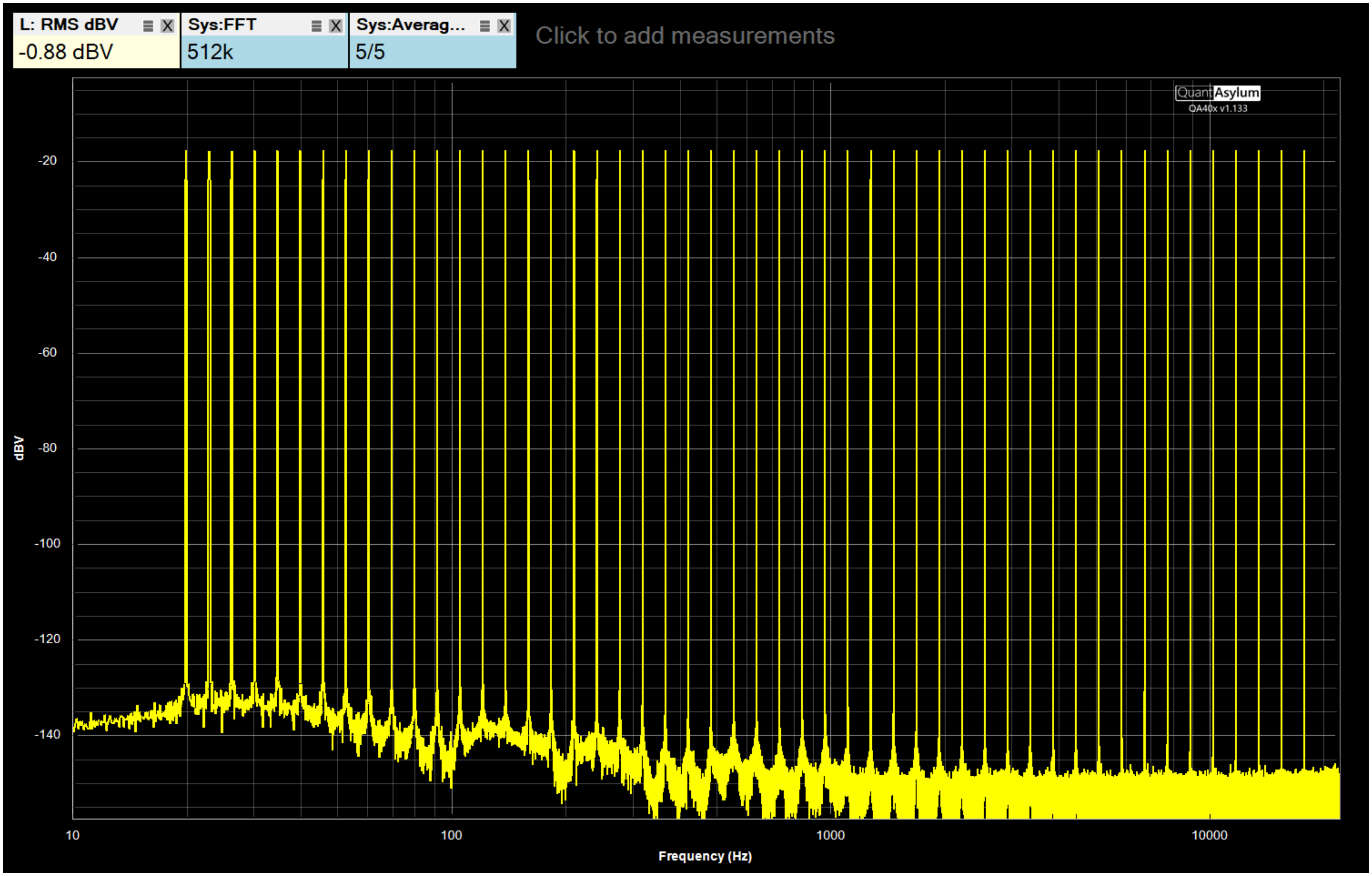
Loopback Frequency Response: 192k SPS

Response is show below. At 70 kHz, the response is down about 0.5 dB relative to 1 kHz.



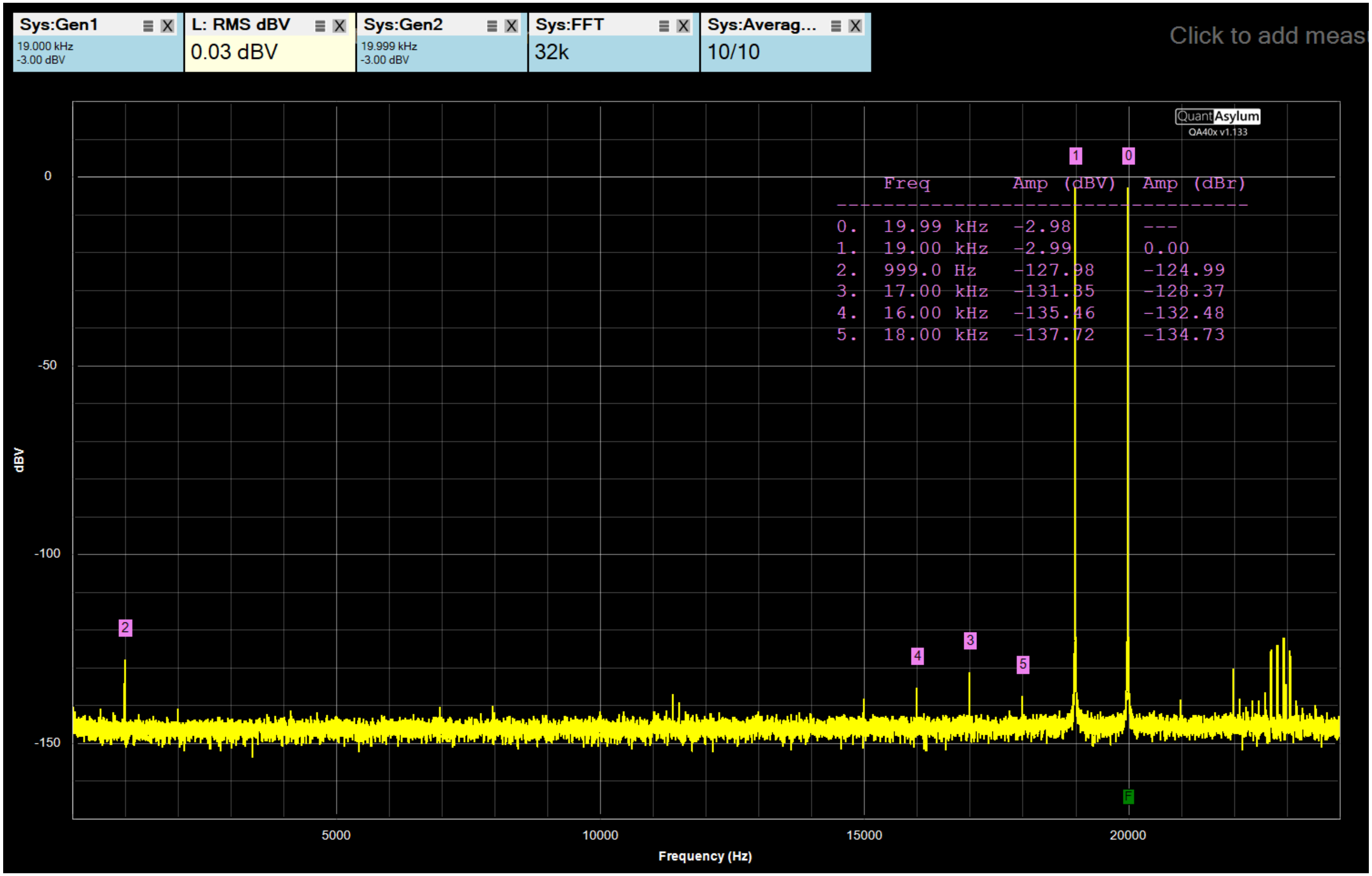
Multitone Loopback

The following plot shows multitone loopback (5 tones per octave, 0 dBV RMS 20 to 20 kHz). Relative to the 20 kHz RMS value of 0 dBV, any IMD products are well below -120 dBC.



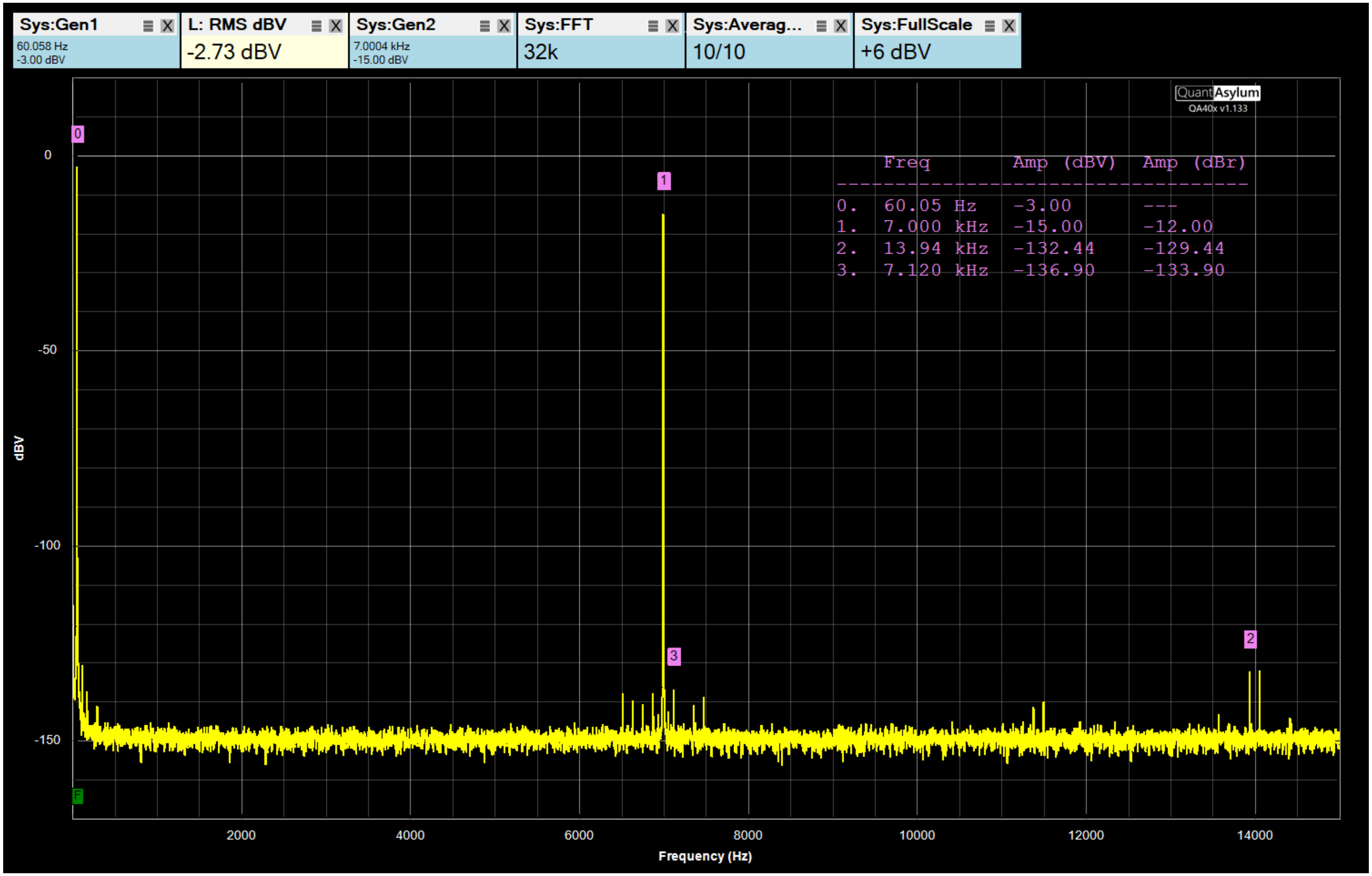
Two Tone IMD (19+20 kHz)

The 1 kHz product is about -124 dB below the combined 0 dBV from the 19 and 20 kHz tones.



Two Tone IMD (60 + 7 kHz)

Close-in mixing products off the 7 kHz tone are about -133 dB below the 60 Hz level.



ADC Aliasing

Class D amplifiers have “carrier” frequencies often between 200 kHz and 500 kHz. It’s important to understand the rejection the ADC lineup offers to interferers in that region. With a 48k SPS sampling rate, a 346 kHz interferer will alias and present itself at 10 kHz. The 346 kHz generator used in this case was a DDS generator, which means that it is a comparatively noisy generator when compared to an audio analyzer. The 10 kHz target was picked because it’s considerably clearer than the 1 kHz, which is rife with DDS noise. A 0 dBV signal at 346 kHz shows more than 120 dB of suppression at its alias frequency of 10 kHz.