QA402 User's Manual

Revision 0.95

Safety Notice

- ✓ This device is not designed for working on potentially dangerous voltages.
- ✓ This device is not designed for working on high energy circuits.
- ✓ The maximum DC input voltage is +/- 50V into the device inputs.
- ✓ The maximum AC input voltage is +/- 40Vrms into the device inputs.
- ✓ The combined AC + DC must not exceed +/- 56V peak.
- ✓ Do not apply any voltage to the outputs.
- ✓ If the above are not clear, seek guidance from a person trained in electrical safety.
- ✓ See additional safety notices throughout this document.

Limited Warranty

This product has a limited warranty of 6 months from the time of purchase. During this time, a device failure that occurs under normal operating conditions will be replaced or repaired for free, not including shipping. Generally, you will be responsible for shipping to us, and we will be responsible for shipping it back to you. Devices that have suffered a failure due to operation in excess of specified parameters can usually be repaired for a nominal fee. The contents of this document are provided “as-is” and may be changed or updated without notice. The specifications on a particular product may also be changed at any time and without notice as we seek to improve a product or improve availability of a product. The limit of our warranty will not exceed the value of the product purchased under any conditions.

Legal

Contents

In the Box

The box should contain a QA402 Audio Analyzer. We do not ship cables with our products. The software for the products may be downloaded from Github. The link for QA402 downloads is located here.

Important Things to Know

This section covers some important details about the analyzer.

Ground Reference

There are two grounds to consider on the QA402. The USB connection shares a ground with the PC, which in turn shares a ground with the power distribution in your office. The audio side of the QA402 analyzer is isolated from the USB ground: it is *floating*. When you connect the QA402 to a device-under-test (DUT) to make a measurement, you will need to establish a common reference point for the measurements. The DUT will have its own ground (which may be similar to the PC ground). The isolation provided by the QA402 ensures noise related to ground currents is eliminated.

BNC Input Voltages

The inputs on the QA402 are designed for AC inputs, with some DC present. The DC will be blocked by the input capacitor and cannot be measured. DO NOT EXCEED THE SPECIFIED LIMITS, OR YOU WILL DAMAGE THE QA402 AND/OR MIGHT INJURE YOURSELF.

BNC Output Voltages

The BNC outputs our DC coupled. They cannot withstand inadvertent connections to DC voltages where more than 10 mA of current might flow. Extended shorting of the outputs will result in an increase in temperature of the output stage, which would cause a permanent shift in performance.

QA402 Output Voltage Offsets, Click and Pops

The QA402 outputs may exhibited DC offsets up to +/- 2 mV or so. Additionally, operations such as sample rate changes may generate momentary clicks or pops. If you are working on very high gain stages or driving a power amp that is driving a speaker, be aware that these offsets, clicks and pops might impact your DUT.

QA402 Analyzer Features

The QA402 is our third-generation analyzer. It builds on the QA401 by adding additional input and output handling in addition to a front-panel expansion port.

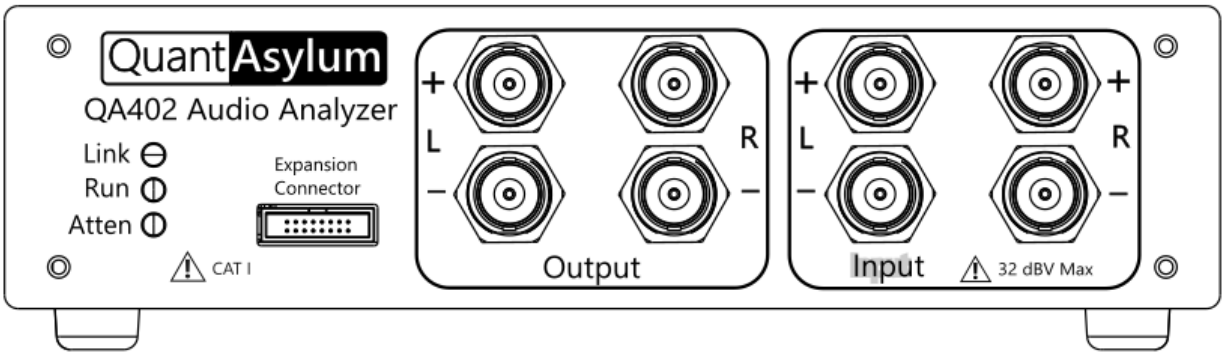
The QA402 features:

- Stereo Differential Left + Right Inputs
- Stereo Differential Left + Right Outputs
- 24-bit ADC and DAC
- Fully Isolated from the PC
- 8 Input Gain Stages, from 0 dBV to +42 dBV full scale (the maximum input is +32 dBV)
- 4 Output Gain Stages, with a maximum output level of +8 dBV (single ended) or +14 dBV balanced.

We hope you enjoy your purchase. Our forum is a great place to learn more about how to use your new analyzer, or you may contact us at support@QuantAsylum.com. We welcome all questions, no matter how simple. Analyzers are complex products, and your questions help us improve our products.

Analyzer Front Panel

The front panel of the analyzer is shown below:



From left to right, the following elements are described below:

LEDs

There are 3 LEDs that glow green when active.

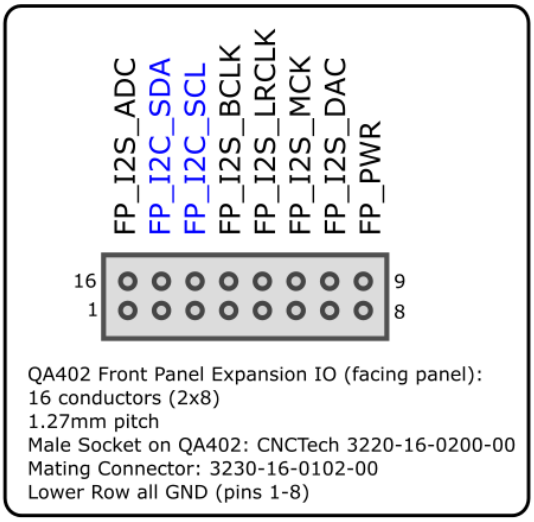
Link LED: This indicates the QA402 is "talking" to the desktop application software.

Run LED: This indicates the QA402 is running an acquisition.

Atten LED: This indicates the QA402 input attenuator is active. If you are going to connect the QA402 to large signal, it is best to pick one of the higher input ranges that enable the input attenuator as you attempt to learn the characteristics of the signal you are measuring. This is especially true if you are measuring equipment that is being repaired that might have potentially unexpected outputs behavior. The LED allows you to readily see if the input attenuator is active, ensuring the QA402 can protect itself from unexpected inputs.

Expansion Connector

The expansion connector is a 2x8 pin male connector with a 1.27 mm pitch. As you face the connector and front-panel, the connector pin out appears as follows:



In the future, software will be provided to enable control of the front-panel I2S interface. The degree of control that will be provided isn't yet known.

BNC Inputs and Outputs

The QA402 has 4 outputs, or left and right differential pairs. The + and – signals are always complementary. That is, when the L+ signal is rising, the L- signal is falling. Viewed on a scope, the + and – signals are always moving in equal but opposite directions.

The left and right outputs largely work in unison, but there are certain modes (for example, muting or external waveforms from an API) where the left and right outputs can work independently.

Most consumer gear will take a single-ended input and output signal. Pro-audio will often take a differential signal. Differential signals are commonly used in noisy environments because interfering signals that appear on both inputs simultaneously are "cancelled" or at least greatly attenuated. However, for much of your audio work, you may prefer to use the device in single ended mode especially if you are working on line-level consumer audio type equipment. If you wish to use the inputs single ended, then you could use a BNC terminator on the L- input, and treat the L+ input as a single ended input. If you do not use the input terminator, then you will see some thermal noise from the unused input resistor, which will raise the overall noise floor.

Understanding Differential Measurements

Differential measurements can create confusion even among very experienced engineers. Some examples will help highlight the differences. If you set the generator to 0 dBV and connect an Output+ to an Input+ and ground the Input- via BNC terminator, then the measured input will be reported as 0 dBV. With the output set to 0 dBV, each output will measure 1Vrms on a DVM relative to ground (the BNC outer conductor). A differential measurement on a DVM (from Out+ to Out-) will measure as 2Vrms. This is because the Out+ and Out- are 180 degrees out of phase with each other. If you set the output to -10 dBV and connect both the Out+ and Out- connectors to the In+ and In- connectors, then the QA402 measurement will show a peak of -4 dBV. This is because you are driving the inputs differentially. This can be very confusing to first-time users: You are driving the inputs at 100 mVrms (-20 dBV), and yet the QA402 is reporting -4 dBV. But this is precisely the same measurement reported by the DVM when you placed the DVM across the outputs. Keep in mind the QA402 inputs have no idea if you are driving a single input with 1Vrms and grounding the other input OR if you are

driving both inputs with 0.5Vrms. In both cases, you are hitting the ADC with the same differential voltage. That is, the differential input of the ADC is seeing 0.5Vrms on each input in both cases.

Rear Panel Summary

The rear panel has a single USB connector. This is designed for high speed (480Mbps) USB connections. The device consumes between 700 and 900 mA during normal operation. The device is not sensitive to USB voltage variations, but it can be sensitive to USB voltages that fall below 4.6V as measured inside the QA402. For this reason, use USB cables that are short and have 24g power conductors. You can often read the wire gauge directly off the side of the USB cable. Note that some computers may employ very strict current sensing on the USB current flowing out of the USB port. When the current exceeds a bit over 500 mA, the PC hardware might signal a fault. If you suspect your PC has strict limits on the power, then you can use a USB Y connector. These are connectors that plug into 2 USB ports and allow USB hardware to pull up to 1000 mA. One of the USB ports has no data connection. It just takes power from the second port. Alternately, most low-cost USB hubs that are self-powered do no sensing or limiting at all.

Electrical Characteristics of the Connectors

BNC Inputs

The 4 audio signal inputs pass through a 4.7uF series capacitor, followed a series 470 ohm resistor, and followed by a resistor divider with a total impedance of 100K ohms. The corner frequency of this input network is about 0.4 Hz. The input DC blocking capacitor is an aluminum electrolytic non-polarized, with a 50V rating. Keep in mind that aluminum electrolytic capacitors have limited lifetimes that is dictated by their stress and temperature. These lifetime specifications are usually at high ripple currents and high temperatures, which won't be seen by the analyzer. But don't leave large signals or high DC values connected to the analyzer overnight if you are not actively measuring something.

Excessive input voltages can also stress the 470 ohm input resistor. The purpose of this resistor is to limit current in fault conditions, and it's a special composition resistor that can cope with very high pulse currents. But under extreme conditions the resistor might open to protect the inputs.

BNC Outputs

The output op-amps have a 100-ohm series R in an 0805 form factor. If the output is accidentally connected to a voltage more than few volts in magnitude, the 100-ohm resistor could act as a fuse and open or the output op-amps could be damaged. Do not short the output stages. Do not drive the output stages into loads that are below 100 ohms or so, especially at higher output levels.

Software Installation

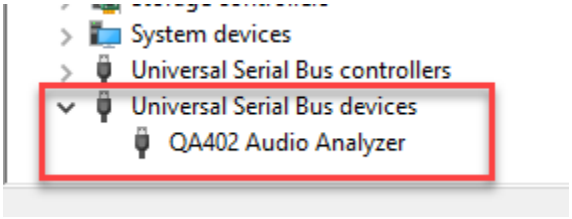
The QA40x application has an installer, but it can also run from a USB key without any installation (although support files such as this help document won't be present).

Windows Version

The QA40x application was developed on Windows 10, although it might run on previous versions of Windows.

USB Drivers

On Windows, you do not need to install drivers. The hardware uses special descriptors to tell Windows to use a WinUSB driver. The first time you plug the hardware in, Windows should automatically load the drivers. When successfully installed, you should see the QA402 appear in the USB Devices section in Hardware Manager



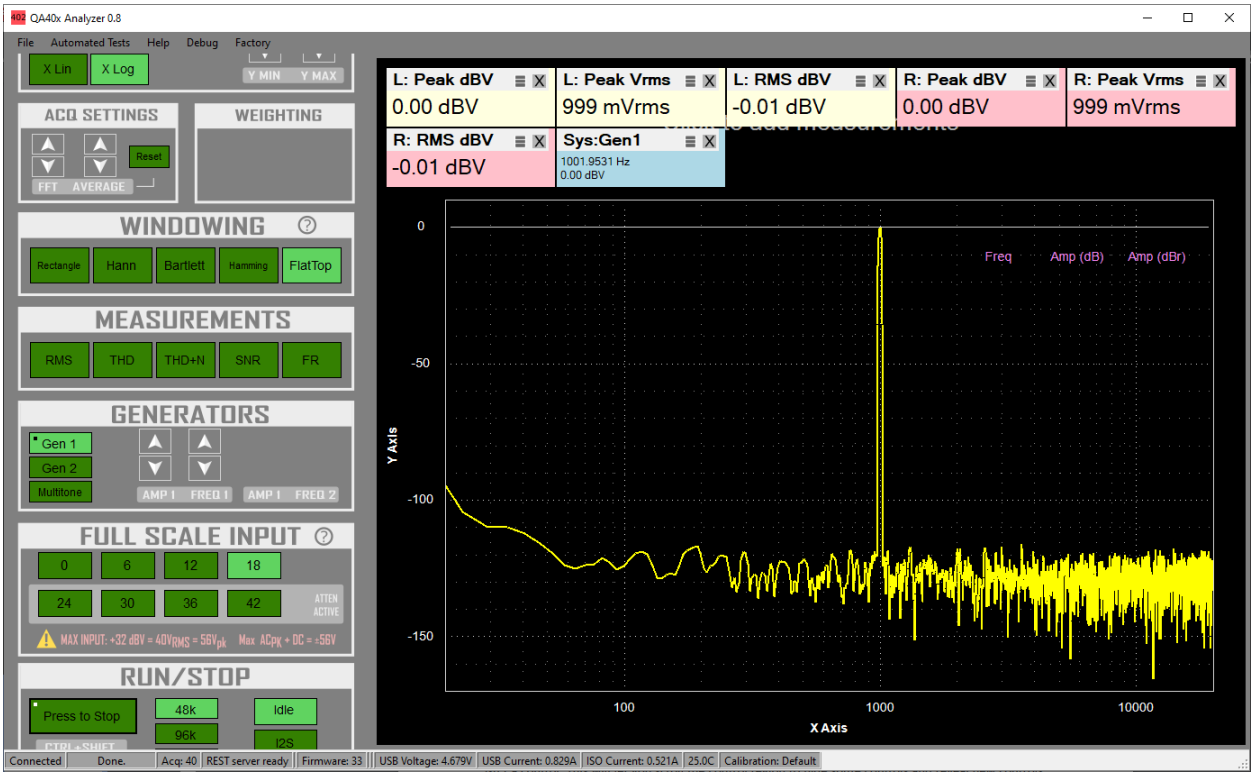
Calibration

The QA402 was calibrated at the factory and should deliver +/- 2% accuracy across all input and output ranges. If you measure the QA402 outputs with your DVM, keep in mind that DVMs are generally specified at 50 or 60 Hz and their accuracy at 1 kHz and higher is degrading quickly. A better solution for confirming accuracy is a benchtop DVM. These will typically have +/-0.05% accuracy for signals up to 20 kHz or so.

When measuring the QA402 outputs, remember the QA402 uses bursted outputs for measurements. See the description of the IDLE button to ensure the outputs are not bursted.

QA402 Basic Controls

The QA402 application, or QA40x application, is shown below:



On the left side of the application is the CONTROL region. On the right side of the application is the SPECTRUM or GRAPH region.

In the control region, you can use the mouse wheel to scroll the control set up and down. On a latop, this can usually be done by using two fingers on the track pad (check with your laptop vendor to see how they recommend emulating a mouse wheel if the two finger technique doesn't work).

Control Groups

The control panel on the left side has several groups of controls. Inside each group, there are two control types. We can see an example of this in the Axis Settings control group. On the left side you can see four buttons, and on the right side you can see a pair of up/down controls.

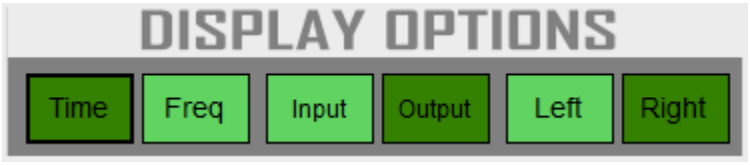
The up/down controls allow you to increase or decrease a quantity. They are sized for fingers on a touch screen, but you can also click them with a mouse.

The buttons on the left side are also sized for a finger on a touch screen. Note the dot in the upper left corner of the buttons. That indicates a "context menu" is available for that button. To active a context menu, you can either:

1) Click and hold. After 1 second, the menu will open. This is useful if you are using a finger on a touch screen.
2) Mouse right click. The menu will immediately open.
3) Control + mouse left click. The menu will immediately open.

Display Options

The Display Options control group is shown below:



The Time and Frequency buttons will toggle between the time and frequency domains. If you press the time button, you'll see a trace that shows input and output waveforms in the time domain, with volts as the Y axis and time for the X axis.

The Input and Output buttons allows you to toggle between displaying what is being output to the DAC or to see what is being captured by the ADC.

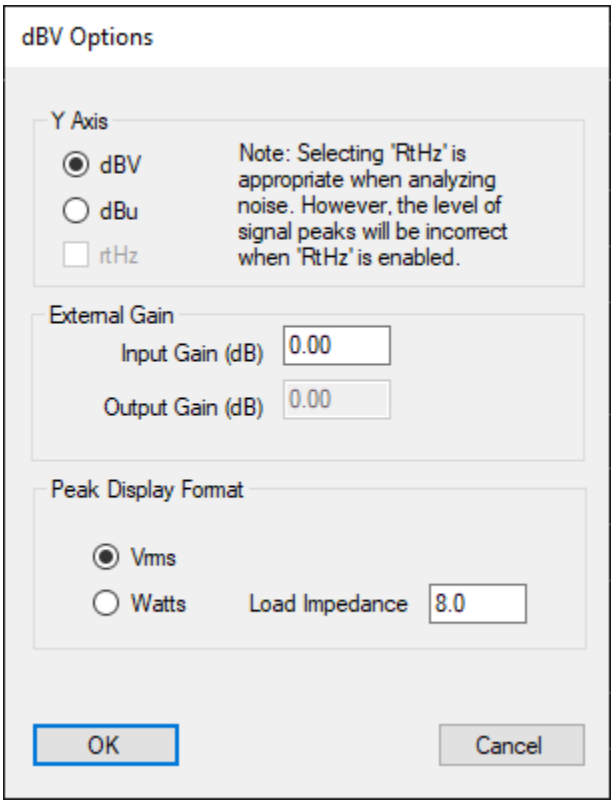
The Left and Right buttons allows to pick which traces will be displayed. Left is always shown in Yellow and Right is always shown in Red.

Axis Settings

The Axis Settings control group is shown below:

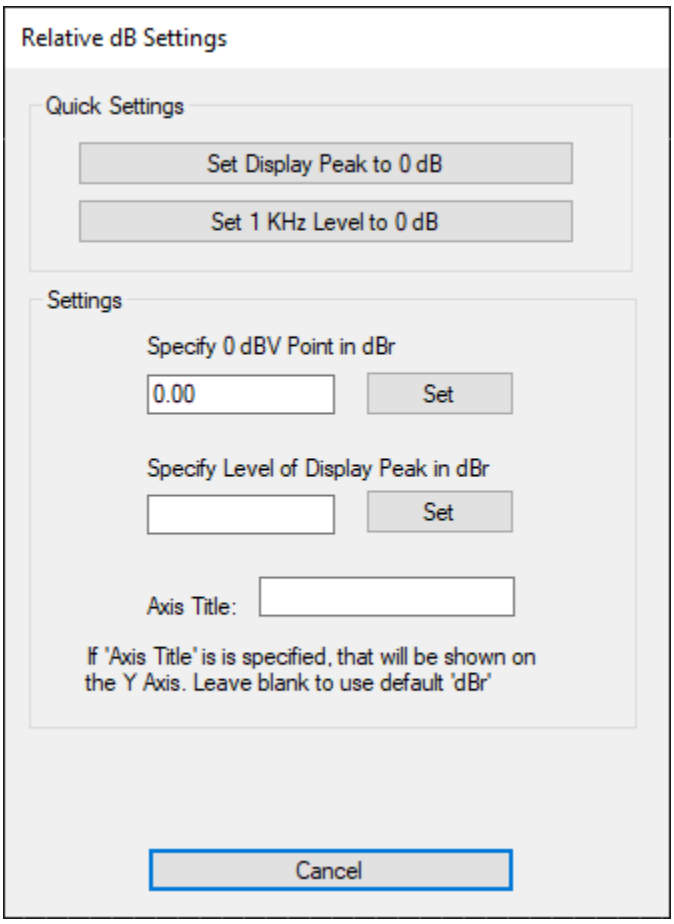
The dBV button will display the frequency domain in the absolute units of dBV, while the dBr button will display the frequency domain relative to a signal you specify.

The context menu for the dBV button is shown below:



In this dialog, you can specify the units for the Y axis. Normally, dBV is used. But you can also specify dBu. You can also specify if you have any external gains being used. For example, if you have a mic pre-amp of 20 dB, then you could specify 20 dB of input gain and then the display would show you an input-referred noise measurement (for example).

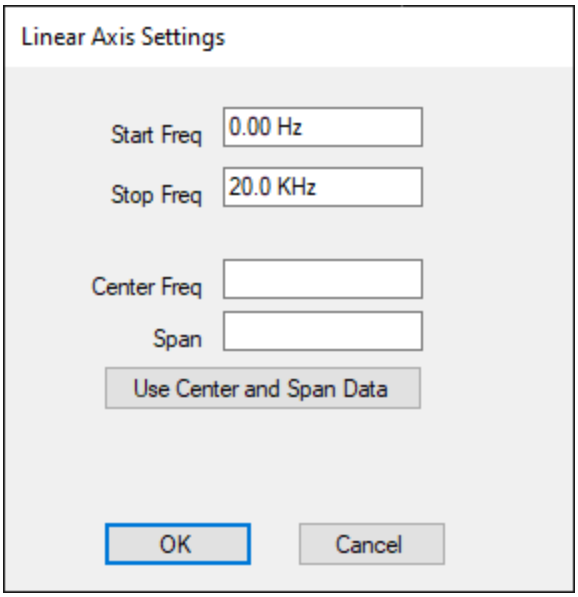
The dBr context menu is shown below:



When using the dBr display option, you need to specify your reference amplitude. This dialog allows you to quickly specify the reference using the display peak or the left measured at 1 kHz. Or you can specify the dBV value that should map to 0 dB. Or, you could specify the level in dBr. This is useful if, for example, you know that a mic should generated a certain output at a given sound pressure level.

When using the dBR setting, you can also override the Y-Axis units and specify your own units (for example, dBSPL).

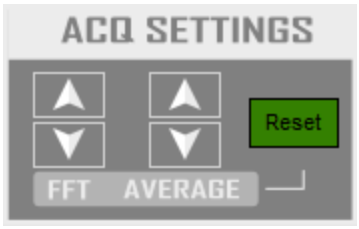
The “X Lin” button enables a linear display on the X axis. In this mode, all frequencies are equally space. The context menu for X Lin is as follows, and it allows you specify the start and stop frequencies.



The “X Log” button is similar, except it selects a logarithmic X axis. The dialog box options are similar.

Acq Settings

The Acquisition Settings control group allows to set FFT sizes and averaging.



Larger FFTs will take more time to acquire. Generally, it’s good to work with an 8k to 32k FFT for most work. Some measurements, such as THD+N will show little benefit at higher FFT settings. But other measurements, such as THD, will indeed show marked improvements at larger FFT sizes as the noise floor is reduced and harmonics are revealed.

When averaging, you might wish to start the averaging process for some reason. That can be done with the Reset button.

Windowing

The Windowing controls allow to select the window type. You can click on the “?” mark for some hints on the different types of windows.

Measurements

You can quickly select the types of measurements you'd like to make from this control group. The FR button on the right puts the analyzer into a chirp mode, which disables the 5 measurements on the left.