

20 QC BY EXAMPLES, TCP-IP MEASUREMENT SERVER AND SYNTAX REFERENCE

20.1 A COMPLETE, FAST, SINGLE-TEST LOUDSPEAKER QUALITY CONTROL

CLIO QC is able to program and execute a very fast, accurate and complete, single-test quality control of a loudspeaker using the new functionality of the sinusoidal measurement menu.

One of the key features of this approach is represented by the new FAST-TRACK™ rub&buzz detection that is carried out along the sinusoidal sweep.

With just one sinusoidal sweep it is possible to measure:

- Frequency response
- Impedance response
- Sensitivity
- Polarity
- Total harmonic distortion response
- Single harmonic response (from 2nd to 10th)
- Rub&Buzz
- T&S parameters ($F_s, Q_t, Q_e, Q_m, C_{ms}, M_{ms}, M_{md}, V_{as}, B_l, dB_{SPL}, Z_{Min}$)

Choosing among the various settings of the sinusoidal test it is possible to tailor the QC test easily, controlling the trade-offs between speed and accuracy.

This example describes a test setup and the relative QC script that may be implemented in an automatic production line capable of cycle times of 1 to 2 seconds with a sweep time of around 1s.

20.1.1 HARDWARE REQUIRED

The following parts of the CLIO system are needed to achieve this kind of QC test:

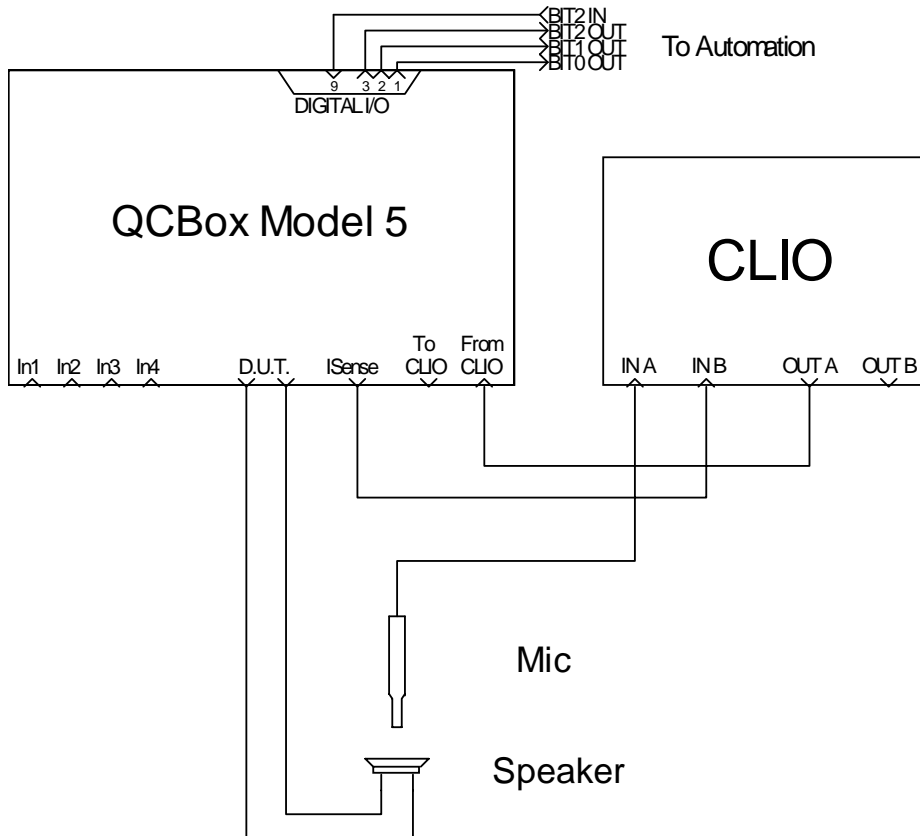
- CLIO FW-01
- QCBox Model 5
- Microphone (MIC-01,02 or 03)
- Optional 19" rack QC panel

The CLIO system hardware presents itself as in this picture:



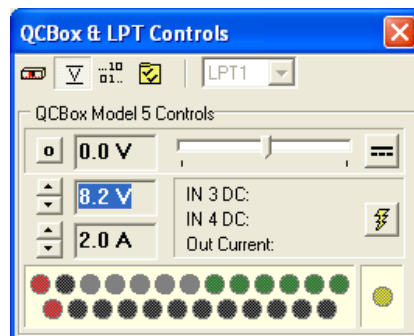
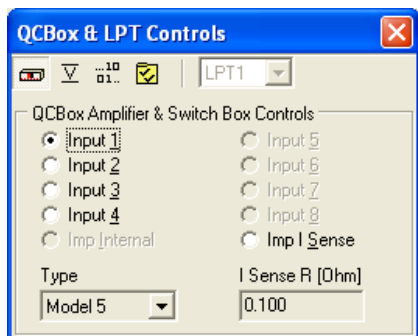
The basic connections required are listed here:

- 1) On the electro-acoustic side we find the QCBox used as power amplifier, microphone directly connected to CLIO, current sensing to channel B input to measure impedance.
- 2) On the digital side we find the connection with an external automation that gives a TTL start signal to the QC test and is informed by three output bits of its current status.



3) On the loudspeaker under test side a suitable acoustic test fixture should be setup to properly isolate from the outside environment. The example is not dealing with this topic.

To properly control the QCBox Model 5 verify its settings within the QCBox&LPT Controls dialog; default settings (i.e. 2A output current limiting) should be OK for many DUTs.



We will deal later with QCBox settings for connecting with the automation.

Once the hardware connections are firmly setup take a reference loudspeaker representative of the production and put it in place ready to be measured. We suppose to deal with a wideband automotive 4" loudspeaker.

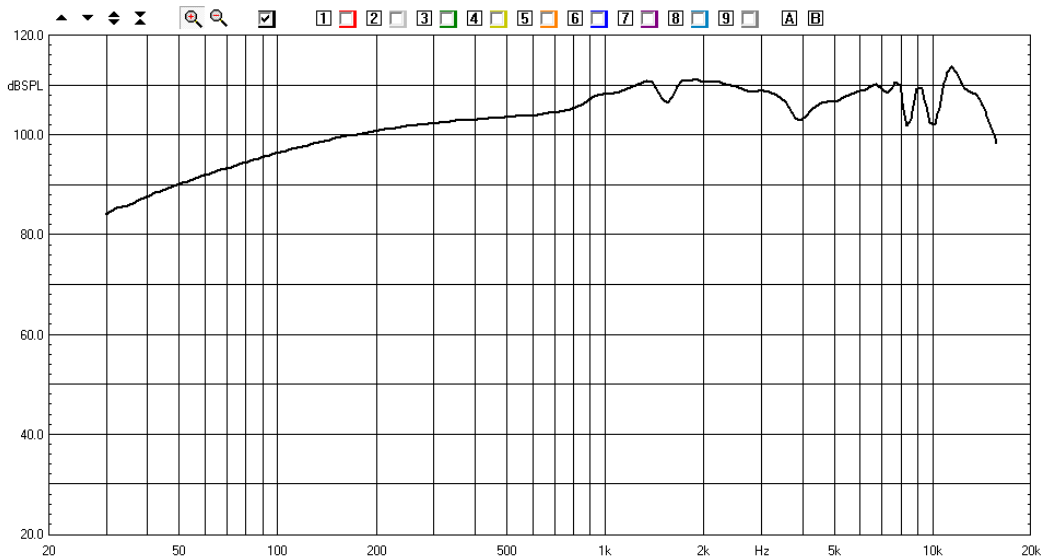
This quality control application relies on a stereo sinusoidal test that simultaneously measures frequency response by means of a microphone connected to input A and impedance sensing load current to input B. It is suggested to divide the initial approach in two separate single channel measurements of the two quantities and finally integrate them into a single stereo one.

20.1.2 MEASURING THE REFERENCE FREQUENCY RESPONSE

Open the sinusoidal menu. Let's start with the acoustic frequency response and set up the required sweep opening the the settings dialog. The main parameters affecting sweep are: frequency range chosen from 30Hz to 15kHz, resolution of 1/12 of octave supposed to be fine and speed that is set to "Fast" as best tradeoff for rub&buzz testing.

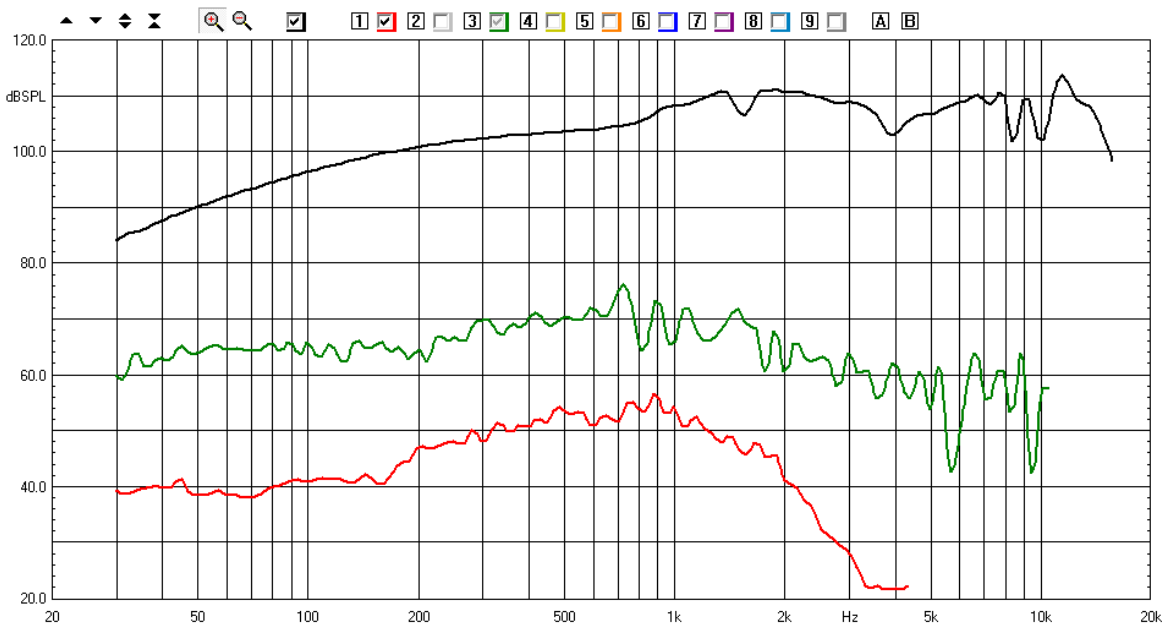
Before taking the first reference measurement you still need to set the proper output level (here chosen 1V at speaker terminals) as indicated by DUT specifications and accordingly set input sensitivity of CLIO input A; as the final measurement will be stereo operate separately the two input channel controls releasing the Link Input Controls **A/B** button in the hardware toolbar; initial input A sensitivity is -10dBV (channel B is left to 0dBV).

Now, within the sinusoidal menu, choose CHA input channel selection and dB SPL as Y scale unit. Press go. The first measurement gives you the following result



one important parameter now clear is the sweep time that is shown in the sinusoidal menu status bar: with these settings we have 1.05 seconds sweep time. Consider it fine. Save the result to "response.sin" file.

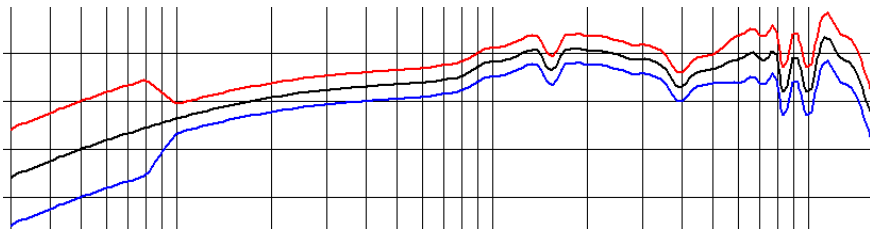
The test should now be tuned up to take into account the acoustic environment and completed with missing settings. Open the sinusoidal settings dialog; proper delay should be set to compensate for microphone distance to loudspeaker, this may be evaluated by the two common ways CLIO gives you i.e. taking a trial sinusoidal measurement with auto delay active or taking a parallel MLS&LogChirp measurement and inspecting the impulse response; in our case we found a 0.2ms delay to be compensated, due to a quasi near field measurement with a microphone to DUT distance, in the acoustic fixture, of circa 7cm. Final settings required are about distortion curves; we need to activate THD and Rub&Buzz calculations clicking on "THD Enabled" and "R&B Enabled", the Rise parameter is set to 0dB as we are going to accommodate all displayed curves inside one single 100dB Y scale graph. Execute the measurement with final frequency response settings.



After the measurement is done we may inspect THD and Rub&Buzz pressing the relative buttons, in figure they are shown as overlays (green THD, red R&B). Repeat the measurement until fully confident with the results obtained, eventually refine the settings as needed.

We are now ready to define QC masks for frequency response, THD and Rub&Buzz. Open the QC menu, press the limits button to start defining a limit definition; we require, and manually input, a relative mask to frequency response with the following behaviour:

```
[RELATIVE]
[UPPER LIMIT DATA]
20          10
80          10
100         3
5000        3
6000        5
20000       5
[LOWER LIMIT DATA]
20          -10
80          -10
100         -3
5000        -3
6000        -5
20000       -5
```



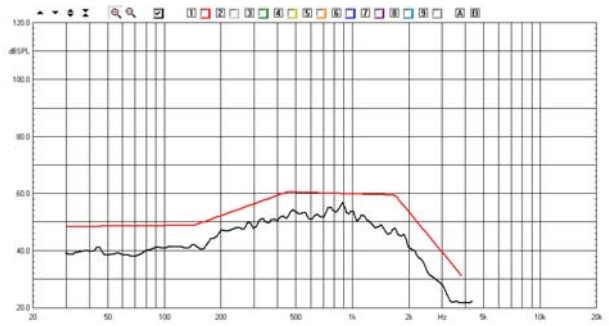
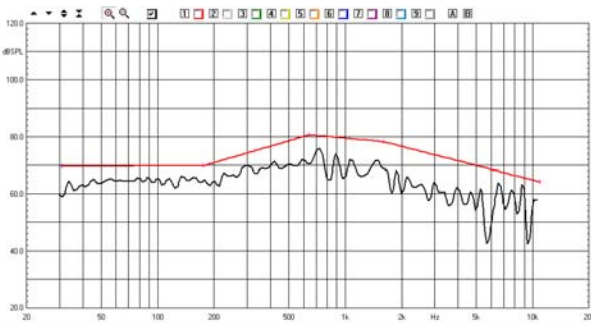
The limits definition for THD and R&B is, for their nature, inherently absolute and only requires an upper curve so we may begin defining them by direct, on-screen, drawing.

Pressing the THD button, inside sinusoidal menu, you obtain the THD curve; inside QC you press the "Draw Limits Controls" button and you are allowed to draw a limit curve directly on the sinusoidal graph; at the end the QC limit definition panel will be filled with data about the drawn limit:

```
[THD UPPER LIMIT DATA]
30.81          69.56
174.96         69.78
639.82         80.62
1603.03        78.19
10869.90       64.25
10869.90       64.25
```

Pressing the R&B button, inside sinusoidal menu, you obtain the R&B curve; inside QC you press the "Draw Limits Controls" button and you are allowed to draw a limit curve directly on the sinusoidal graph; at the end the QC limit definition panel will be filled with data about the drawn limit:

```
[RUB+BUZZ UPPER LIMIT DATA]
30.11          48.32
143.15         48.76
445.16         60.49
1692.02        59.38
3924.35        30.18
```

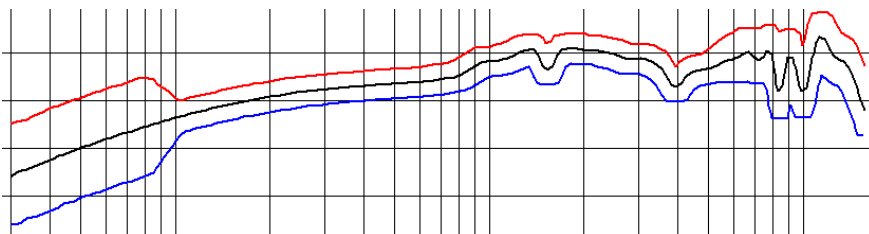


It is time to save the limits file as "response.lim".

As we are dealing with an unsmoothed frequency response that is presenting some high frequency "peaks and dips" we like to give a 1/6 of octave frequency jittering to the calculated limits curve:

```
[RELATIVE]
FREQJITTER=0.16
```

That gives our frequency mask a more comfortable behaviour that is less prone to give false negatives in that troubled spectrum range.



The final parameter that we should take into account is the sensitivity of the loudspeaker; programming a chirp with same frequency extremes and analyzing it with the multimeter we obtain a sensitivity of the reference of 106 dB SPL; this value leads us to complete the limits file definition with sensitivity data.

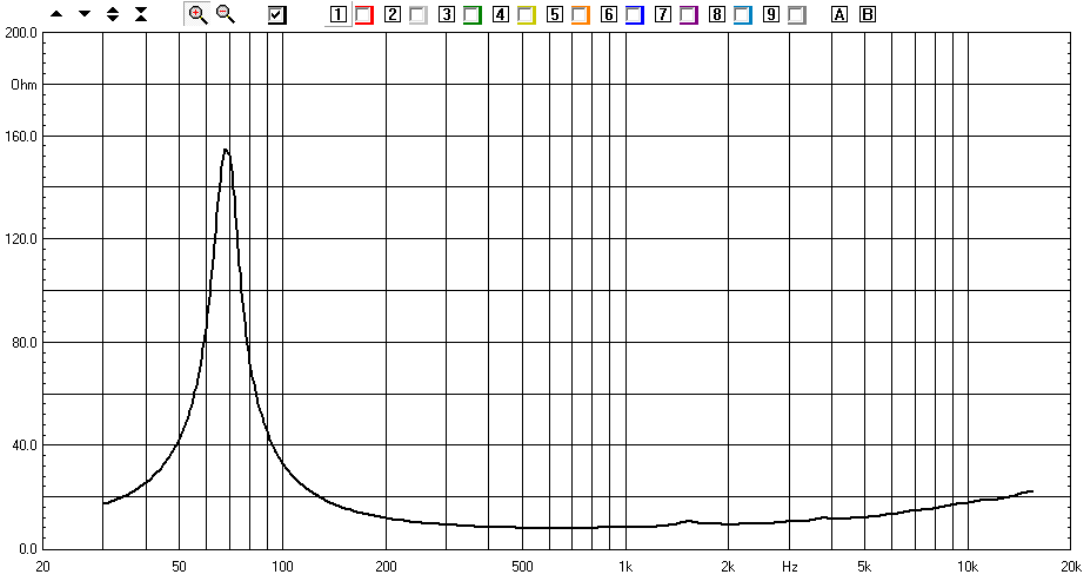
```
[SENSITIVITY]
UPPER=109
LOWER=103
```

20.1.3 MEASURING THE REFERENCE IMPEDANCE RESPONSE

We put now our attention to the impedance response of our loudspeaker.

Going back to sinusoidal menu we choose CHB with the input channel selector and Ohm as Y Scale unit; inside the sinusoidal settings dialog leave all previous settings unchanged as they will accompany us to the final reference measurement; only change the impedance settings to "QCBox Select" to reflect QCBox operation.

As the output level has already been set for the acoustic test we only have to deal with input sensitivity for channel B; a settings of -30dBV or -40dBV is usually correct for ISense impedance tests. The measurement looks as follow.



Save the result to "impedance.sin" file.

We are now able to define also the limits file needed to check the impedance response. Going back to the QC menu, inside limits control panel, we should clear information about frequency response masks and be ready for new input.

A response check mask may be defined as follow:

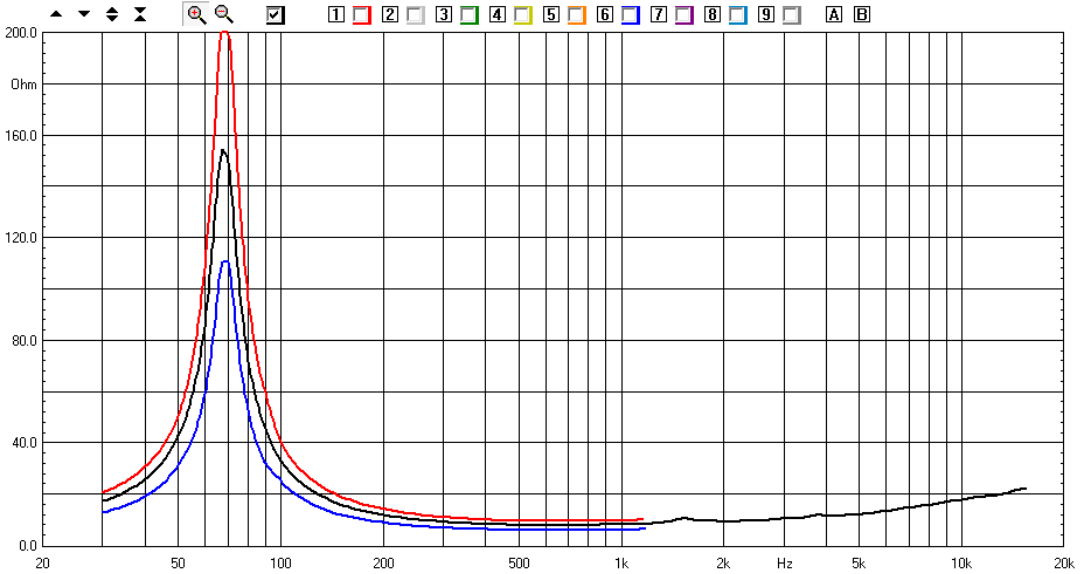
```
[RELATIVE]
PERCENT=1
[UPPER LIMIT DATA]
20          20
50          20
60          30
90          30
100         20
```

```

200          20
1200         20
[LOWER LIMIT DATA]
20          -25
50          -25
60          -30
90          -30
100         -25
200         -25
1200        -25

```

This 20% wide mask spans from below resonance to slightly higher the ZMin region and opens up to 30% in resonance region.



The most important QC checks will be done on T&S parameters that take into account all possible defects from the impedance point of view. In this definition we check F_s , Q_{ms} and Z_{min} to be within 10% from reference.

```

[TSPARAMETERS]
PERCENT=1
DIAMETER=10
REDC=7
KNOWNMMD=5
FSUPPER=10
FSLOWER=-10
QMSUPPER=10
QMSLOWER=-10
ZMINUPPER=10
ZMINLOWER=-10

```

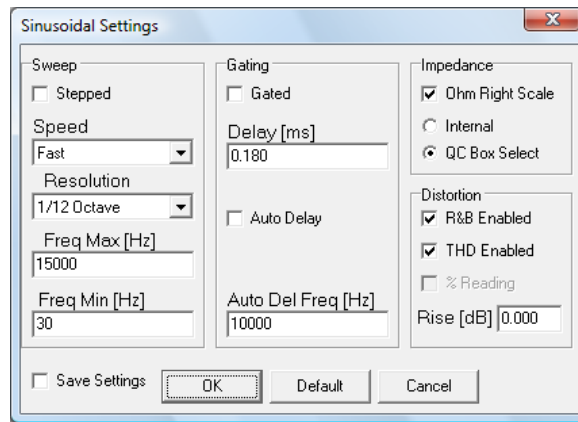
It is time to save the limits file as "impedance.lim".

20.1.4 INTEGRATING THE QC REFERENCE FILE

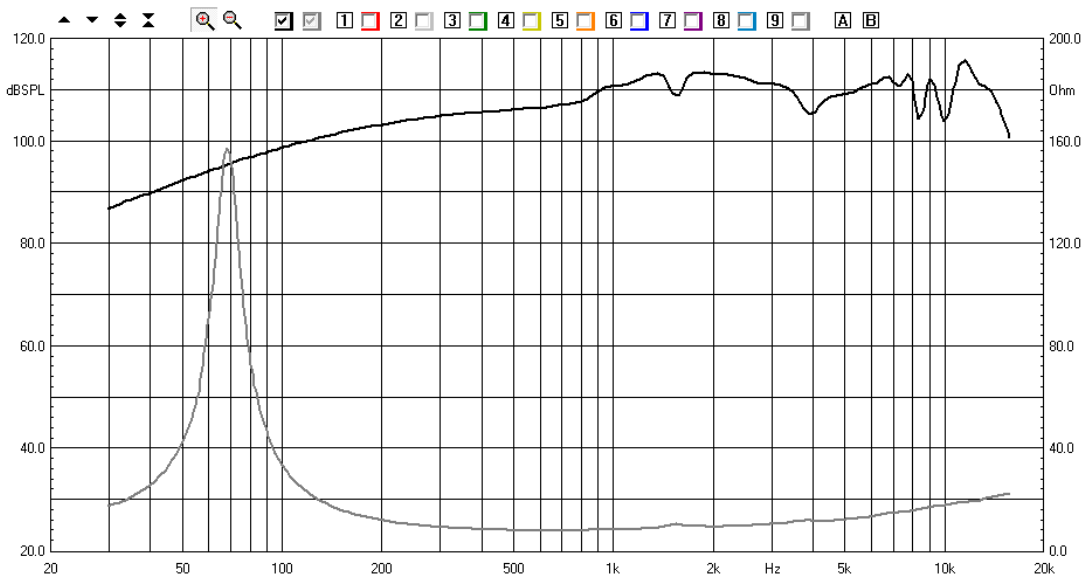
Starting from the actual situation, i.e. having just measured impedance relying on settings that accumulated from the previous frequency response measurement, we are now ready to integrate all of our work to realize a single stereo sinusoidal measurement that will be the reference for our QC script.

Go to the sinusoidal menu, have the impedance measurement loaded in memory; select CHA&B with the input selector, change the Y Scale unit to dB SPL; CLIO is now ready to take a two channels measurement with main unit set to dB SPL; as the measured unit for channel B needs to be Ohm we must open the sinusoidal settings dialog and select "Ohm Right Scale": **in this way channel B will measure impedance using the right scale to identify it.**

The final sinusoidal settings are:



Press Go; the graph obtained has frequency response measured from channel A and refers to left scale while impedance response comes from channel B referring to right scale. Note that the two curves displayed are measured and controlled by dedicated checkboxes, no overlays are active.



This measurement is OK to be the reference for our QC test; once the frequency scale, Y right and left scales are OK for the visualization under QC it can be saved as "reference.sin". To properly set scales it is useful to directly input values at their extremes; refer to 6.2 and 6.4 for details about this.

20.1.5 PROGRAMMING THE QC SCRIPT

We are ready to write the QC script; the files involved are the stereo sinusoidal measurement stored inside the "reference.sin" file, the limits file for channel A in "response.lim" and the limits file for channel B in "impedance.lim".

```
[SIN]
OUTQCBOX=1V
INA=-10
INB=-40
REFERENCE=REFERENCE.SIN
LIMITSA=RESPONSE.LIM
LIMITSB=IMPEDANCE.LIM
```

Two things are still missing: the polarity check and the visualization of the rub&buzz curve.

1) To add polarity check over the frequency response we simply add POLARITY=1 under [SIN]

2) To add rub&buzz display as a third curve together frequency response and impedance we add [RUB+BUZZ DISPLAY] in the "response.lim" file.

The final script will thus be:

```
[SIN]
OUTQCBOX=1V
INA=-10
INB=-30
REFERENCE=REFERENCE.SIN
LIMITSA=RESPONSE.LIM
LIMITSB=IMPEDANCE.LIM
POLARITY=1
```

This script may now be saved as "faststereosweep.qc".

The final "response.lim" file will be:

```
[RELATIVE]
FREQJITTER=0.16
[SENSITIVITY]
UPPER=109
LOWER=103
[UPPER LIMIT DATA]
20          10
80          10
100         3
5000        3
6000        5
20000       5
[LOWER LIMIT DATA]
20          -10
80          -10
100         -3
5000        -3
```

```

6000          -5
20000        -5
[THD UPPER LIMIT DATA]
30.81         69.56
174.96        69.78
639.82        80.62
1603.03       78.19
10869.90      64.25
10869.90      64.25
[RUB+BUZZ DISPLAY]
[RUB+BUZZ UPPER LIMIT DATA]
30.11         48.32
143.15        48.76
445.16        60.49
1692.02       59.38
3924.35       30.18

```

The final "response.lim" file will be:

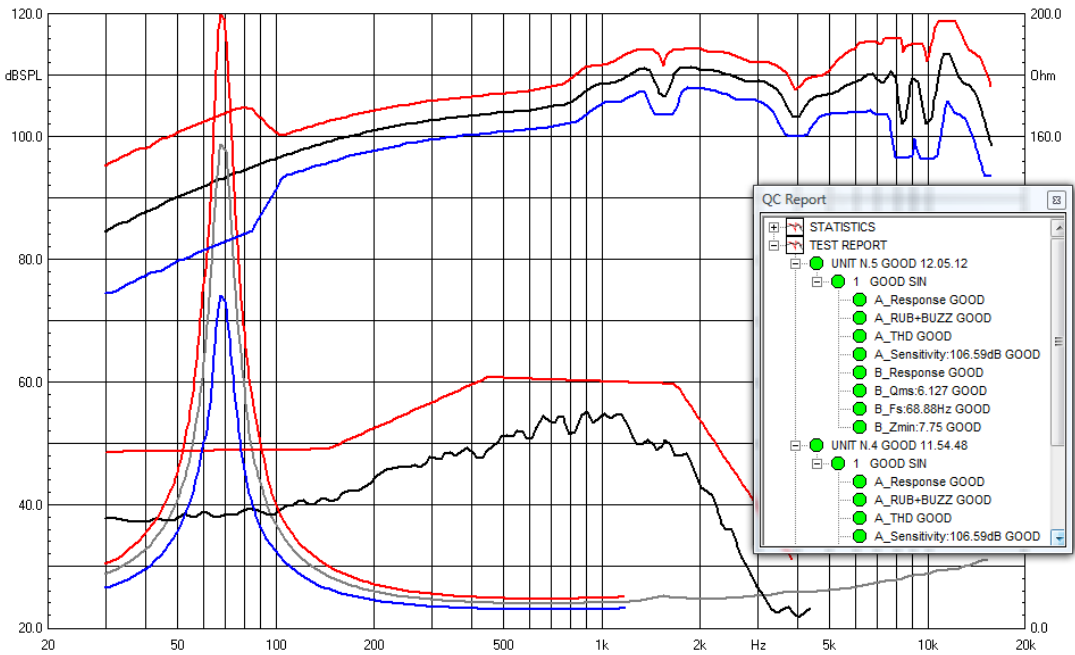
```

[RELATIVE]
PERCENT=1
[UPPER LIMIT DATA]
20           20
50           20
60           30
90           30
100          20
200          20
1200         20
[LOWER LIMIT DATA]
20           -25
50           -25
60           -30
90           -30
100          -25
200          -25
1200         -25
[TSPARAMETERS]
PERCENT=1
DIAMETER=10
REDC=7
KNOWNMMD=5
FSUPPER=10
FSLOWER=-10
QMSUPPER=10
QMSLOWER=-10
ZMINUPPER=10
ZMINLOWER=-10

```

20.1.6 RUNNING THE QC TEST

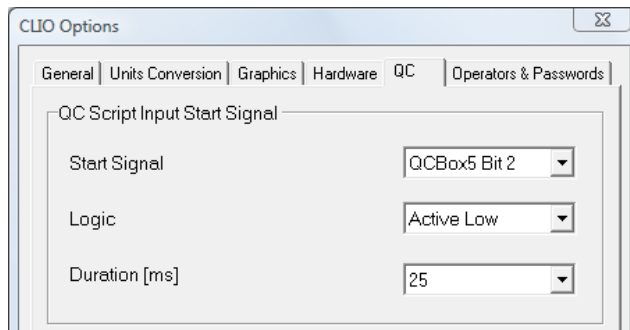
Running the complete QC test we will obtain a comprehensive graph display as in figure.



20.1.7 ADDING THE INTERFACE TO AUTOMATION

To manage TTL signals that connect the system QCBox Model 5 digital I/O port to the external automation we must include some programming inside CLIO and inside the QC script.

As we have chosen input Bit 2 to trigger the QC test we must set this inside CLIO Options>QC dialog.



The output bits operation should be defined directly inside the QC script and should reflect how CLIO and the automation interact.

We suppose the following meaning of the output TTL bits:

BIT0 -> Signals the end of the sweep.

BIT1 -> Signals if result is good.

BIT2 -> Signals if result is bad.

The keywords that should be added to our script lead to the following situation

```
[PERFORM]
QCBOXOUTBYTE=0
```

```
[SIN]
OUTQCBOX=1V
INA=-10
INB=-30
REFERENCE=REFERENCE.SIN
LIMITSA=RESPONSE.LIM
LIMITSB=IMPEDANCE.LIM
POLARITY=1
```

```
[PERFORM]
QCBOXOUTBIT0=1
```

```
[IF ALL GOOD]
QCBOXOUTBIT1=1
```

```
[IF ALL BAD]
QCBOXOUTBIT2=1
```

Here you may see the initial keyword QCBOXOUTBYTE=0 that resets all three signals to zero. Then, after the test is finished they are set to reflect the end of sweep and the result of the test.

The only thing to be noted is that BIT0 (end of sweep) is output when the sinusoidal test is finished, i.e. right after all calculations and measurement managements are made. This means that it will be delayed with respect to the actual end of the sweep by the time the computer takes to make all the calculations and actions related to a sinusoidal test; this time is usually small but not zero and may range in some hundred of milliseconds depending on the platform chosen.

If very tight synchronization is needed and you want to save also this time it is possible to require that the signal is output right after the sweep is completed without waiting for the sinusoidal test to end; to do this, place the relative keyword right under the [SIN] definitions thus changing the script to:

```
[PERFORM]
QCBOXOUTBYTE=0
```

```
[SIN]
OUTQCBOX=1V
INA=-10
INB=-30
REFERENCE=REFERENCE.SIN
LIMITSA=RESPONSE.LIM
LIMITSB=IMPEDANCE.LIM
POLARITY=1
QCBOXOUTBIT0=1
```

```
[IF ALL GOOD]
QCBOXOUTBIT1=1
```

```
[IF ALL BAD]
QCBOXOUTBIT2=1
```

You can find these example files in the **'My Documents\Audiomatica\CLIO 10 EXAMPLES\EXAMPLE0'** folder.