Mezzo Sound Intensity Probe

with Mezzo Intensity Analyzer Module

User Guide – 2022-02-17

SoftdB

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Contents

1   Introduction

Congratulations on your purchase of the Mezzo Sound Intensity Probe. This instrument provides an innovative and cost-effective solution for sound intensity measurements. More than just a DAQ system, the DSP embedded in each MEZZO Intensity Probe ensures real-time signal processing.

Designed to be used with a tablet PC or any other Windows-based PC, the MEZZO Intensity Probe benefits from the versatility and flexibility provided by computers. This approach allows the MEZZO Intensity Probe along with the MEZZO Intensity Analyzer Module to be offered at a very competitive price.

The current user's manual describes the Mezzo Sound Intensity Probe hardware and its use through the Mezzo Intensity Analyzer module.

2 Specifications

2.1 Mezzo Sound Intensity Probe

Mezzo Sound Intensity Probe Specifications

Item	Specifications
Microphones	GRAS 40GK[1]
Intensity Processor	IEC 61043 Class 1
Peak Maximum Level[2]	Low Range: 122 dB$_{pk}$ High Range: 136 dB$_{pk}$
Noise Level[3]	Low Range: 34 dBA, 32 dBC, 37 dBZ High Range: 44 dBA, 42 dBC, 47 dBZ
Under-Range Limit Level[4]	Low Range: 44 dBA, 42 dBC, 47 dBZ High Range: 51 dBA, 49 dBC, 54 dBZ
Maximum Sampling Rate	48 kHz
Signal Conditioning	IEPE
Communication	USB 2.0 (Mini B connector)
Dimensions	370 x 32 x 23 mm
Power Supply	USB Powered (Max 0.35W)

Included Accessories

Component	Description
Intensity Probe	Mezzo Sound Intensity Probe with 40GK-26CB mic-set (12.5 mV/Pa, IEC 61043 (1993) Class 1)
USB Cable	3 m USB 2.0 cable with Mini B connector
Windscreen	190 x 100 mm elliptical windscreen
Case	Plastic transport case Dimension: 450x395x115mm (17.75x15.5x4.5")

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[1] 40GK Mic with 26CB Preamp – 12.5 mV/Pa, IEC 61043 (1993) Class 1

[2,3,4] Evaluated according to IEC 61672 (2013) Class 1, using 12.5 mV/Pa sensitivity.

2.2 Mezzo Intensity Analyzer Module

Module Specifications

| Parameter	Value
Available Data	Global levels and Spectrums (1/1 octave, 1/3 octave, 1/24 octave or FFT) Frequency weighting : A,C and Z Sound Intensity Level (Li),
Bandwidth	1/1 octave: 16 Hz to 16 kHz 1/3 octave: 12.5 Hz to 20 kHz 1/24 octave: 11.4 Hz to 22.1 kHz FFT: 0 to 22 kHz
Data save	Overall data is saved at the end of the measurement
Display	All measured data (both live and overall) can be displayed during the acquisition. Only the overall data can be viewed once the acquisition is completed
Miscellaneous	Export the overall data to Excel.

Computer Requirements

Item	Minimum Requirements
Operating System	Windows XP SP3, Windows Vista, Windows 7, Windows 8
CPU	Dual-Core at1.2 GHz[3]
Memory	2 GB RAM
Hard drive	300 MB free hard disk space
Port	USB 2.0
Display resolution	800 x 600

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[3] If using the 1/24 octave spectrum, the CPU requirement is Dual-Core at 2.4 GHz.

3   Setting up the Mezzo Sound Intensity Probe

3.1   Mounting the microphones

1) Identify microphone 1 and 2 by looking at the serial numbers from the calibration certificate;
2) Assemble the microphone 1 by using the right-angle preamplifier adapter;
3) Connect the microphone 1 to the cable labeled "1";
4) Assemble the microphone 2 by using the straight preamplifier adapter;
5) Insert the microphone 2 in the microphone holder;
6) Connect the microphone 2 to the cable labeled "2".
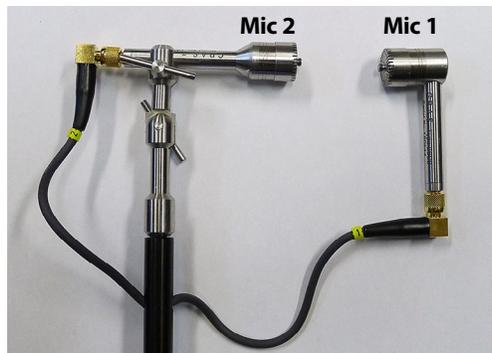
7) Select the appropriate microphone spacer corresponding to the frequency bandwidth of interest. Refer to section 4.1.3, Selecting the Microphone Spacer, p.10 for more information.
8) Screw the spacer cup to mic 1 and the plastic spacer to mic 2.
9) Insert the plastic spacer in the metal cup by pressing the two microphones together.
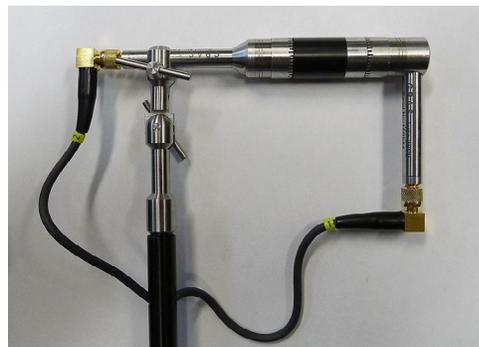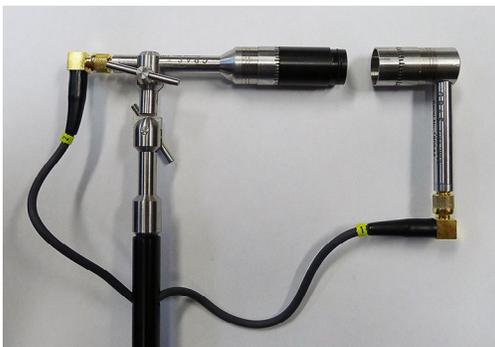
3.2 Installing the windscreen

It is recommended to use the windscreen on the probe to limit effect of wind noise and also to protect the probe.

4 Setting up the Mezzo Intensity Analyzer Module

4.1 Input Setup

Click on the ![Input button] button from the "Setup" tab to enter the input setup:
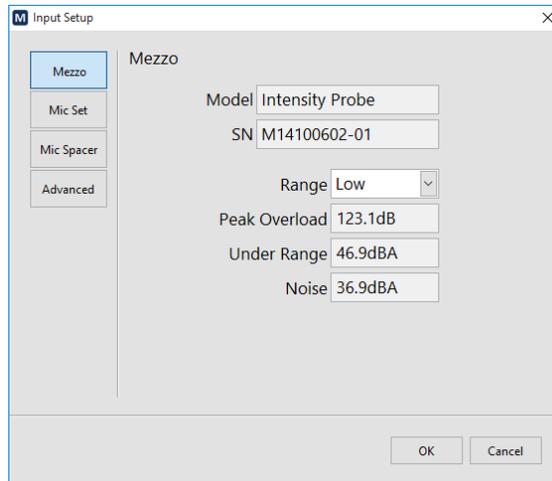
4.1.1 Retrieving Microphone Set Information from Mezzo Sound Intensity Probe

Click on the "Mic Set" button:

Click on the "Load Info From Mezzo" to load the calibration information from the Mezzo Sound Intensity Probe:
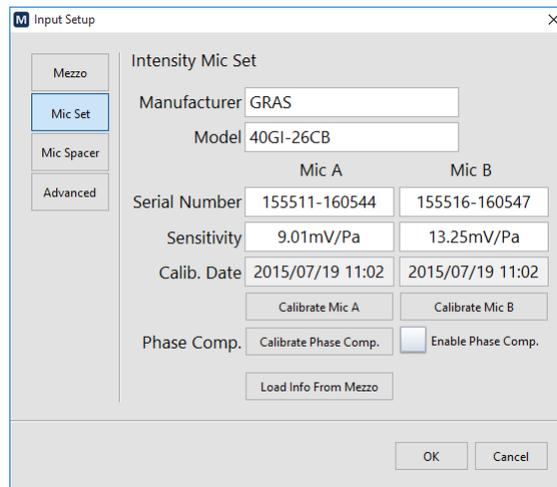
4.1.2   Calibrating each microphone

Click on the "Calibrate Mic A" button:
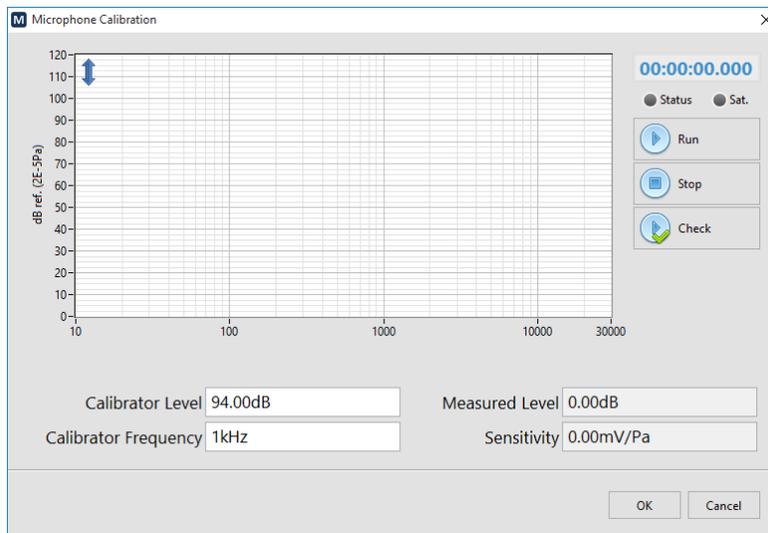
Enter the calibrator level and frequency.

Insert the microphone in the calibrator:

Turn ON the calibrator and click on "Run"
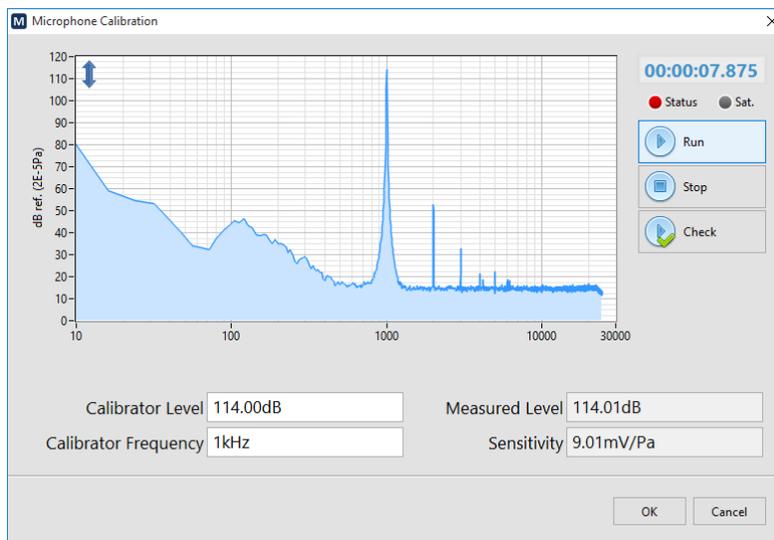
Click on "Stop" when level is stable
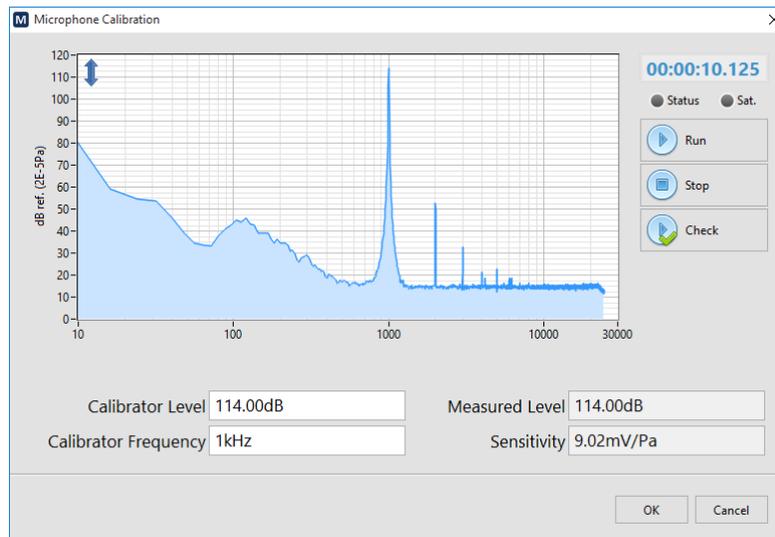
The calibration function will adjust the sensitivity according to the measured level and the calibrator level at the calibrator frequency.

Click OK to accept.

Repeat for the second microphone.

Note: The calibration level can be checked by clicking "Check" instead of "Run". This allows to measure the calibration level without changing the sensitivity. It is recommended to check the calibration after each measurement campaign to validate the correct operation of the probe.

Click on the "Enable Phase Comp." button. It is recommended to enable the phase mismatch compensation to increase the Pressure Residual Intensity Index and thus increase the dynamic capability of the probe.

4.1.3 Selecting the Microphone Spacer

Click on the "Mic Spacer" button.
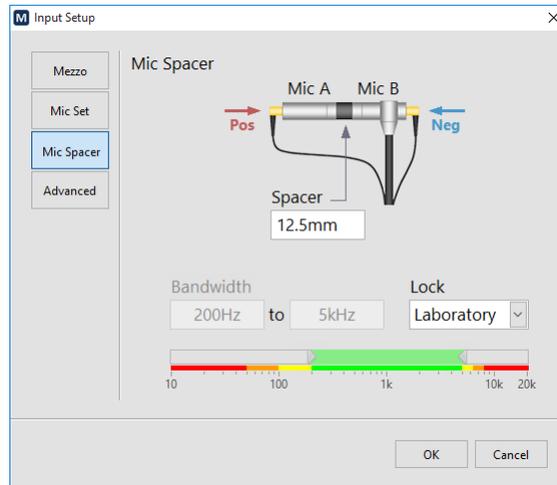
The microphone spacer is an important part of the sound intensity measuring technique using a pair of microphones. Separated by a distance, the two microphones can measure the sound particle velocity by using the pressure gradient. However for this estimation to be right, the separation distance must be adapted to the wavelength. The following table shows the different spacers and their associated bandwidth relative to the degree of precision:

|	Laboratory	Expertise	Control
Probe Intensity Response (H-F Limit)	< 1 dB	< 2 dB	< 3 dB
Pressure Residual Intensity Index (L-F. limit)	> 15 dB	> 12 dB	> 9 dB
12.5 mm	200Hz – 5kHz	100Hz – 6.3kHz	50Hz – 8kHz
25 mm	100Hz – 2.5kHz	50Hz – 3.15kHz	25Hz – 4kHz
50 mm	50Hz – 1.25kHz	25Hz – 1.6kHz	12.5Hz – 2kHz

Only the selected bandwidth is considered during the measurement. Hence, only the bands located in the selected spectrum region will be calculated. Also, the Global levels (A, C and Z) will be computed on this reduced bandwidth using a band-pass filter.

To cover a wider range, it is recommended to perform two measurements using two different spacers.

4.2   Selecting Data Type

Click on the button to select the spectrum type:
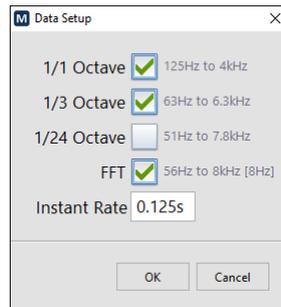
Use the spectrum drop-down list to select from the available spectrum types (1/1, 1/3, 1/24 Octave and FFT). The numbers on the right show the resulting bandwidth. Note that the available bandwidth is affected by the microphone spacer bandwidth. Refer to section 4.1.3, Selecting the Microphone Spacer, p. 10 for more information.

The instant rate is the live data rate. This rate only affects the display rate with the fractional octave spectrums (1/1, 1/3, and 1/24 octave). When using the FFT spectrum, this parameter has also an effect on the frequency definition of the spectrum using the following relationship:

$$dF\ (Hz) = \frac{48832\ (Hz)}{\lfloor 48832\ (Hz) \times Instant\ Rate\ (s) \rfloor}$$

4.3 Selecting the record directory

Click the [Record] button from the "Setup" tab:
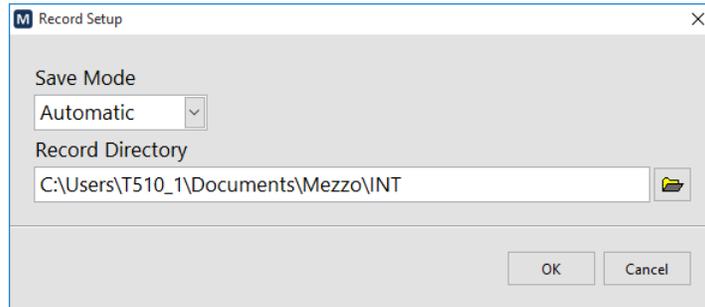
Select the "Automatic" save mode in the drop-down list. The manual mode requires to click the save button once the measurement has ended, whereas the automatic mode records the file automatically at the end of the measurement.

Browse to the desired record directory. The recorded files will have a 0001.int pattern. It is recommended to create a record directory for each measurement campaign.

The default record directory is C:\Users\CurrentUser\Documents\Mezzo\INT

5 Performing a quick field check

Click on the "Compass" button from the "Tools" tab:

Locate the sound intensity towards the sound source and check the compass indicator:

The compass indicator should be in the red region indicating a PI index inferior to 3 dB and positive intensity.

Locate the sound intensity away from the sound source and check the compass indicator. Be sure to locate the sound probe at the same point. You can use a tripod or a similar object as a reference point.


The compass indicator should be in the blue region indicating a PI index inferior to 3 dB and negative intensity.

Note that pressure and intensity levels should be very close when pointing towards and away from the source.

6 Performing a measurement

6.1 Method of measurement

Sound intensity measurements are performed on an integrating box around the device under test (DUT). Each surface is measured using a scanning technique to measure the average sound intensity of this surface. The sound intensity level can then be converted to sound power level using the area of the measuring surface.
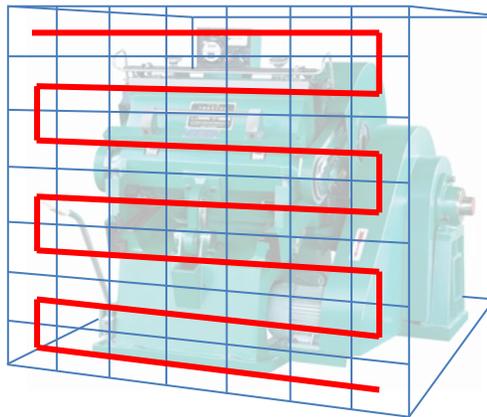
The scanning path must be uniformly distributed on the measurement surface and it must be followed with the probe at a constant speed. For more information on how to select an appropriate path, refer to ISO 9614-2 standard.

The probe must be held so that:

- The reference axis of the probe is perpendicular to the measurement plane;
- The measurement surface crosses the reference axis of the probe at the reference point of the probe;
- The probe reference direction must be pointing towards the source (into the bounding box).
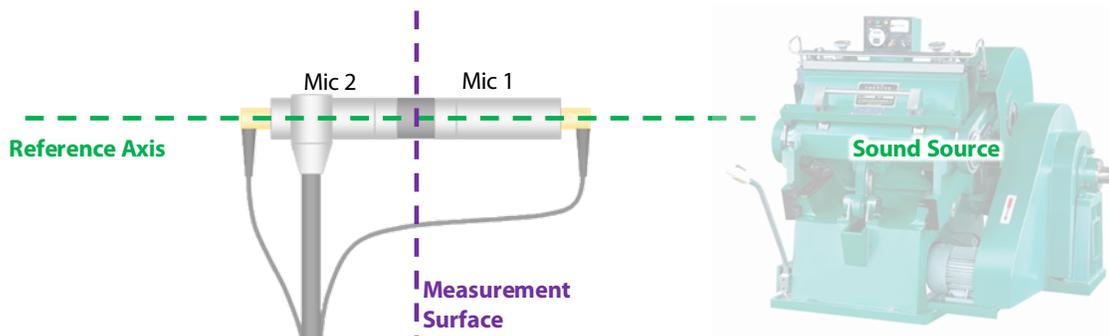
6.2 Step-by-Step Operation

10) Position the probe perpendicularly to the measurement surface at the starting point of the scanning path.

11) Back to the main interface, click the [Run] button on the interface or press the [probe] button on the probe to start the measurement.
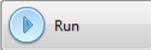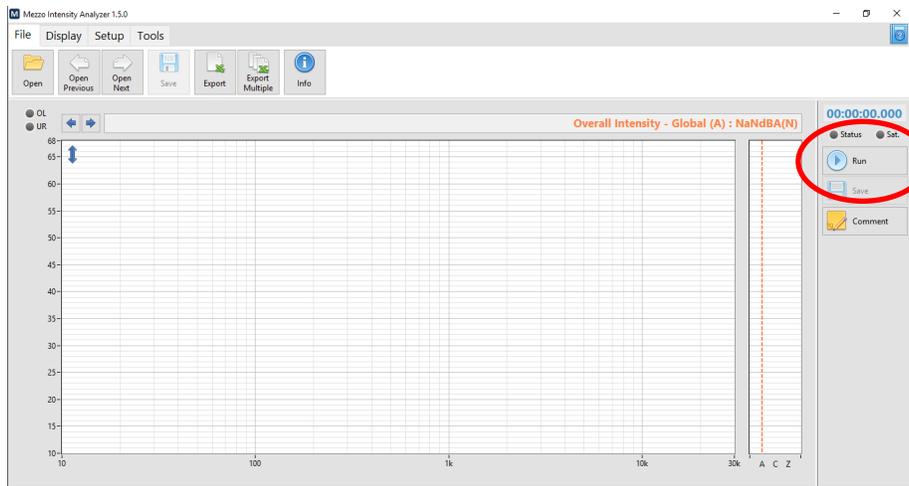
12) As soon as the measurement is started, move the probe at constant speed along the scanning path.

13) At the end of the scanning path, click the [Stop] button on the interface or press the [probe] on the sound intensity probe.
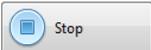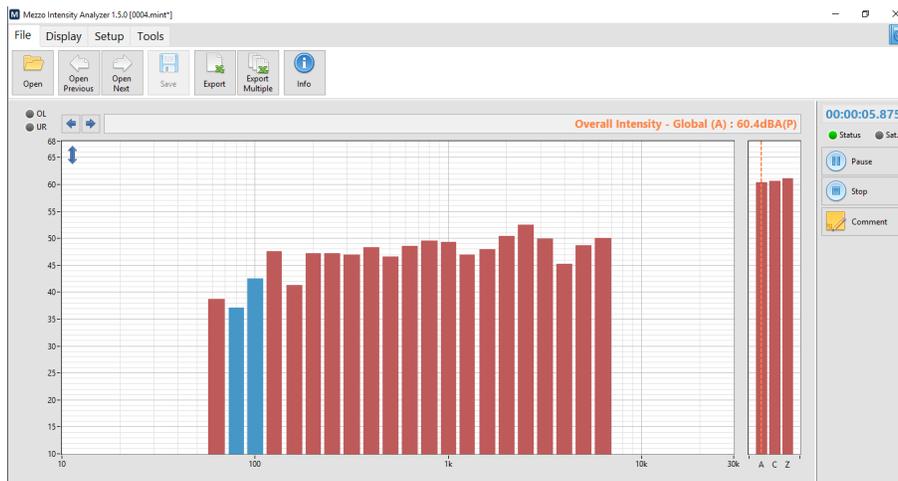
7   Analyzing Data

7.1   Theory

7.1.1   Sound Intensity vs Sound Pressure

Sound Intensity is a vector quantity with a magnitude and a direction. It represents the rate of sound energy flow through a unit area.

A sound intensity probe using a pair of pressure sensing microphones will pick-up only the vector component which is in-line with the reference axis of the probe. Hence, a sound intensity probe measures the normal component of sound energy flow through a surface.
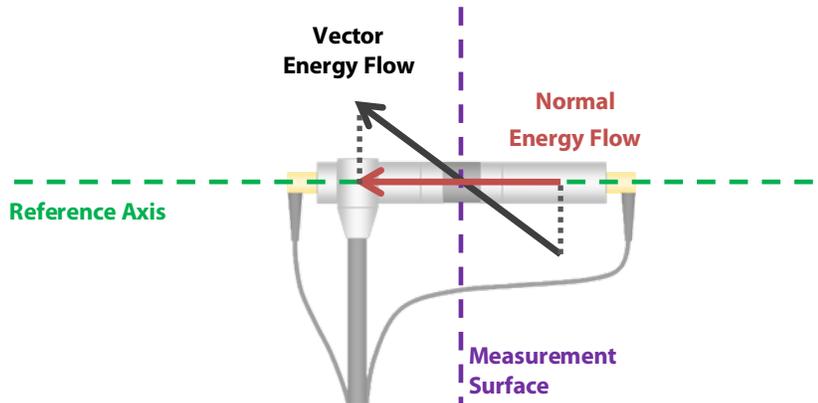
Thus the normal energy flow will equal the full magnitude of the sound intensity vector when the vector is in line with the reference axis. It will be positive when pointing in the reference direction (from mic 1 to mic 2) and it will be negative when pointing in the opposite direction (from mic 2 to mic 1). In addition, a null energy flow will be measured when the vector is perpendicular to the reference axis.
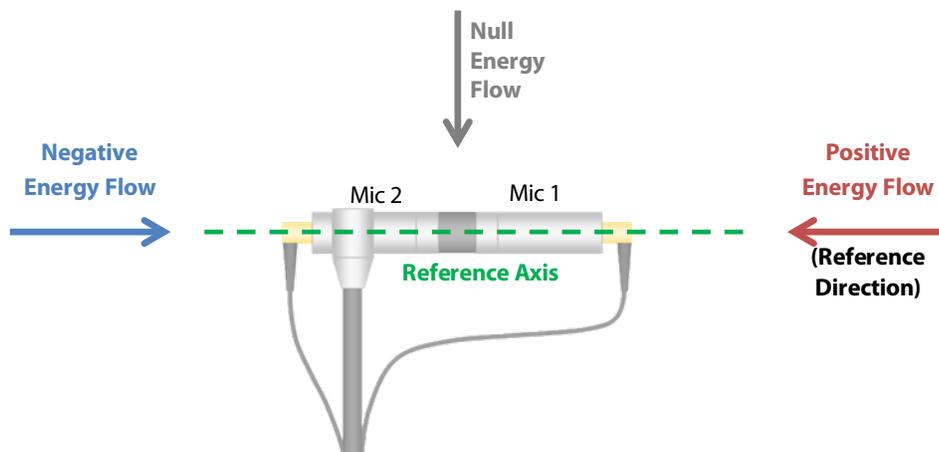
On the other hand, the sound pressure level indicates the sound pressure energy regardless of the direction of the flow of energy. Thus, with the energy flow vector in the reference axis, both sound intensity level will give the same result. However, with the energy flow vector perpendicular to the reference axis, the sound pressure remains unchanged but the sound intensity will be null.

The following image shows the directivity pattern of the sound intensity probe.
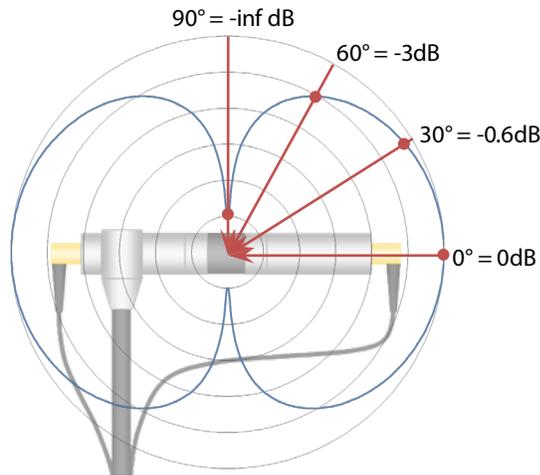
For example, a sound field yielding a sound pressure of 75 dB yields a sound intensity level of 75 dB when the direction of propagation is in-line with the reference axis. It will be 72 dB when the direction of propagation is 60° with respect to the reference axis, and –inf dB when it's 90°.

7.1.2   PI index

In practice, the sound field is not perfectly perpendicular to the measuring surface. Hence, there will always be a difference between the sound intensity level and the sound pressure level. The absolute difference between Pressure and Intensity levels is known as the PI index.

$$PI = Lp - Li$$

A high PI index (> 6dB) indicates a low intensity level compared to the pressure level. This means that the sound field is either reactive or that its propagation is mostly perpendicular to the reference axis.

A low PI index (< 2dB) indicates a sound intensity level close to the sound pressure level. This means that the propagation of the sound field is mostly in-line with the reference axis.

7.1.3   Advanced Indicators

<u>Extraneous Sources</u>

The extraneous sources index (Called F_3-F_2 in ISO 9614-1 and $F_{+/-}$ in ISO 9614-2) indicates the difference between the average sound intensity level and the average of absolute sound intensity levels.

$$Ext.Src. = L|i| - Li$$

When the extraneous sources indicator is close to zero (< 1dB), it means that the sign of the intensity does not change significantly during the measurement.

When the extraneous sources indicator is high (> 6dB), it means that the sign of intensity changes significantly from negative to positive during the measurement. This is a strong sign of reactive field.

<u>P|I| index</u>

This index is called F2, or Surface Pressure-Intensity indicator in ISO 9614-1. It represents the difference between the average sound pressure level and the average of absolute intensity levels. It can be used to determine the extraneous sources index and is generally not used by itself.

<u>Variability</u>

This indicator shows the time variability of sound intensity. It is used in ISO 9614-1 and 3 to evaluate the time variability of the sound field and determine the minimal duration of a measurement to be representative of the sound field. The time variability should be lower than 0.6.

7.2   Using the Mezzo Intensity Analyzer Module to analyze data

The "Display" tab contains all the different controls to select the appropriate data to display.

The buttons allow to view the live data (instantaneous data) and overall average. The "Live" setting is only available during the measurement. Once the measurement has ended, only the "Overall" average data is available.

The buttons allow to select which spectrum type to display from the selected spectrums in the Data Setup. See section 4.2 Selecting Data Type, p. 11.

The buttons allow to view the basic data which are Sound Intensity Level, Sound Pressure Level, and PI index.

When displaying sound intensity levels, the red bars shows positive sign intensity, whereas the blue bars shows the negative sign intensity.

The buttons allow to view the advanced field indicators which are P|I| index, Extraneous Sources, and Time Variability. These indicators are not available in "Live" view because they need the whole dataset in their determination.

The buttons allow to add a dBA, dBC or dBZ frequency weight to the spectrum. Note that global levels in dBA, dBC and dBZ are always shown on the right of the spectrum.

8 Exporting Data

Click on the [Export] [Export Multiple] buttons to export data from the Mezzo Intensity Analyzer to a tab delimited file to import in Excel.

9 Viewing Measurement info

A measurement file contains all the setup information. It's also possible to add a comment to a measurement file to document the measurement. Click on the [Info] button from the "File" Tab to access the file info interface.