

Technical Documentation

FFT Analysis Software BZ-7230
and Tone Assessment Option BZ-7231

For use with
Hand-held Analyzers Types 2270 and 2250

User Manual

Brüel & Kjær 

FFT Analysis Software BZ-7230 and Tone Assessment Option BZ-7231

**For use with
Hand-held Analyzers Types 2270 and 2250**

User Manual



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Chapter 1

Introduction

1.1 Personal Preparation

FFT Analysis Software BZ-7230, and the Tone Assessment Option BZ-7231, are just two of the application packages available for Hand-held Analyzers Types 2270 and 2250.

If you are newcomer to the world of Type 2270 and Type 2250, you are strongly advised to study the User Manual for Hand-held Analyzers Types 2270 and 2250 before reading this manual. By doing this you will get a better understanding of the platform concept and how the BZ-7230 and BZ-7231 application packages fit into the portfolio. You will also become familiar with some terms used in this manual that apply to the Hand-held Analyzers in general.

This manual instructs you on how to set up your Hand-held Analyzer for FFT measurements, how to measure, and how to look at your results. Anything that is independent of BZ-7230 or BZ-7231 will be found in the User Manual for Types 2270 and 2250, BE 1713.

This manual assumes that you are familiar with the concepts of measuring sound using a microphone and some form of sound level meter/analyzer.

1.2 Summary of Contents

- **Chapter 1 – Introduction**
- **Chapter 2 – Getting Started:** includes a general description of FFT Signal Analysis, followed by a ‘step by step’ tutorial which allows you to familiarise yourself with how FFT Analysis Software BZ-7230 (together with your Hand-held Analyzer) performs FFT measurements
- **Chapter 3 – Using Accelerometers for Vibration Measurement:** a guide to choosing and mounting your accelerometer, configuring the instrument’s input for vibration measurements and information on calibration
- **Chapter 4 – Measuring Random Signals:** gives a brief description of random signals (including examples), tells you how to prepare for measurement, how to measure random signals and how to fine tune

- **Chapter 5 – Measuring Transient and Continuous Signals:** gives a brief description of transient and continuous signals (including examples), tells you how to prepare for measurement and how to measure transient and continuous signals
- **Chapter 6 – Measuring Deterministic Signals:** gives a brief description of deterministic signals (including examples), tells you how to prepare for measurement, how to measure deterministic signals and describes how to use reference spectra
- **Chapter 7 – Tone Assessment Option BZ-7231:** describes how to perform FFT-based tone assessment measurements and includes a general introduction, how to set up and measure with your Hand-held Analyzer, and how to view and recall your measurements
- **Chapter 8 – Specifications:** technical specifications for FFT Analysis Software BZ-7230 and FFT-based Tone Assessment Software BZ-7231
- **Appendix A – Setup Parameters:** lists and explains the various parameters that you can choose when performing FFT measurements
- **Appendix B – Measurement Parameters:** lists the various parameters that you can choose when viewing FFT measurements
- **Appendix C – Glossary:** contains descriptions of FFT and Tone Assessment parameters and is a continuation of the Glossary in the User Manual for Hand-held Analyzers Types 2270 and 2250
- **Index**

1.3 Conventions Used in this Manual

Instructions and descriptions that refer to Hand-held Analyzer pushbuttons are shown with the pushbutton icons as seen on the instrument. (See the User Manual for Hand-held Analyzers Types 2270 and 2250, BE 1713, Chapter 2, for a list of pushbutton icons and their functions.)

Menu Items and Buttons/tabs used on the Screen

Indicated by bold type face (for example, select **Calibration** from the list of options).

Parameter Text Appearing on the Screen

Parameters, instructions and descriptions appearing on the screen are indicated by italics (for example, *Measurement Mode*).

Path Denotations

Indicated by capitals (for example, SETUP\BZ7230\).

Chapter 2

Getting Started

This chapter starts with an introduction to FFT Signal Analysis, which gives you a better understanding of some of the methods and terms used when making this kind of measurement. This should be very useful for those of you who are not familiar with FFT and vibration measurements, and serve as a ‘refresher’ to those of you who are familiar with these measurements. An overview of a typical FFT measurement screen is provided for reference.

The rest of the chapter is presented as a tutorial to familiarise you with the important features of FFT Analysis Software BZ-7230, in relation to measurements on a stationary signal. If you need information on how to perform FFT measurements on other types of signal, for instance, random or transient signals, please refer to the relevant chapter (listed under Contents).

2.1 Introduction to Fourier (FFT) Signal Analysis

The object of frequency analysis is to break down a complex signal into its components at various frequencies, and in order to do this, the practical engineer needs to understand the frequency analysis parameters and how to interpret the results of spectrum measurements.

2.1.1 CB or CPB?

There are primarily two common spectrum analysis techniques: Constant Bandwidth (CB) and Constant Percentage Bandwidth Analysis (CPB). CPB Analysis can be implemented with analog or digital signal processing, while CB analysis is usually implemented using the digital FFT (Fast Fourier Transform) technique.

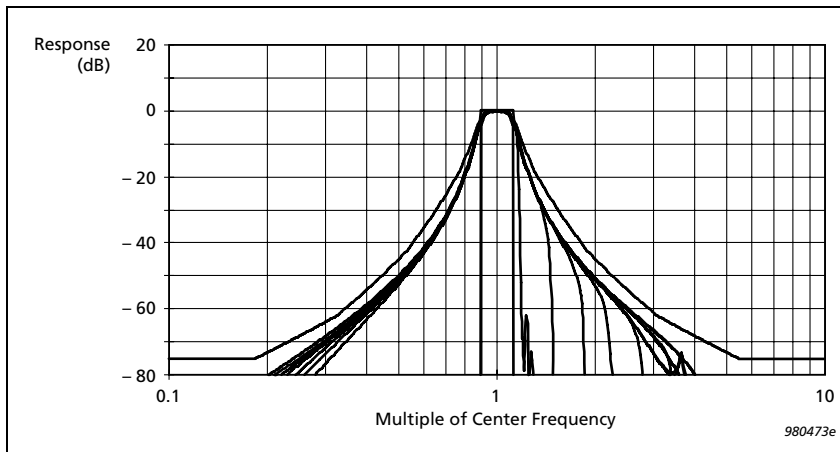
Constant Percentage Bandwidth Analysis

Traditionally the frequency analysis of sound, and occasionally vibration, is made using constant percentage bandwidth (CPB) filters. The filters may be 1/3-octave (approximately 21%) or 1/1-octave (approximately 70%) band pass filters. Sometimes CPB analyzers are called ‘Octave’ analyzers for this reason. The constant percentage bandwidth matches human perception of sound, and the filters are well defined by international standards, ensuring consistent results.

Constant Percentage Bandwidth frequency analysis is appropriate where the frequency scaling is logarithmic and where octave analysis is specified, such as in acoustic or human vibration measurements, or in quality control measurements of rotating machinery, where you need to compare spectra when there are minor fluctuations in running speed.

Fig. 2.1 shows the Hand-held Analyzer's 1/3-octave filters used in BZ-7223 (Frequency Analysis Software). They all approximate to the same filter shape relative to their respective centre frequencies.

Fig. 2.1 The shapes of the 1/3-octave band filters (from 0 to -80 dB). The innermost and outermost curves show IEC 61260 limits



A real-time CPB analysis is characterised by a continuous stream of results, with averaging controlled exponentially (for example, Fast or Slow) or linearly (L_{eq}). The BZ-7223 application, for Types 2270 and 2250, is an example of a 1/3- or 1/1-octave real-time analyzer capable of simultaneous linear and exponential averaging.

Constant Bandwidth Analysis

Constant Bandwidth analysis is included with FFT Analysis Software BZ-7230 and is performed using the FFT algorithm. With this kind of analysis, the filters are placed evenly on a linear frequency axis, where each filter has a constant bandwidth, making FFT a 'constant bandwidth' method of analysis.

FFT analysis is characterised by producing results 'stepwise', from time-blocks (records) of acquired data, though with modern digital processors and overlapping the blocks of data the FFT analysis appears almost as continuous as CPB measurements.

The other characteristic of FFT analysis is the narrow bandwidth relative to the measured frequency span, providing the common synonym for the FFT analyzer, the "narrowband" frequency analyzer. A common reason to use a narrowband analyzer is to identify features of stationary signals such as resonance frequencies and rotational harmonics. The constant bandwidth spacing is ideal for identifying the harmonic and sideband components of a signal, when displayed on the FFT analyzer's linear frequency axis.

FFT Analysis Software BZ-7230 is actually a ‘zoom’ type of FFT analysis, where the baseband is achieved by setting the centre frequency to half of the frequency span. With this software, if one of the lines of analysis falls on 0Hz, it will not be displayed (this is because the hardware does not go down to DC).

In modern frequency analyzers, the operator can select the frequency span and the number of narrowband filters, or lines of analysis. With the Hand-held Analyzer’s FFT Analysis Software, you can select frequency spans from 100Hz to 20000Hz in a 1-2-5 sequence, while selecting the number of lines of analysis from 100 to 6400 in a binary sequence. Dividing the frequency span by the number of lines provides the resolution of the analyzer’s spectrum analysis. Table 2.1 shows the available resolutions in FFT Analysis Software BZ-7230.

Table 2.1 Frequency resolutions available in FFT Analysis Software BZ-7230

		Frequency Resolution (Hz)							
		100	200	500	1000	2000	5000	10000	20000
No. of Lines	100	1	2	5	10	20	50	100	200
	200	0.5	1	2.5	5	10	25	50	100
	400	0.25	0.5	1.25	2.5	5	12.5	25	50
	800	0.125	0.25	0.625	1.25	2.5	6.25	12.5	25
	1600	0.0625	0.125	0.3125	0.625	1.25	3.125	6.25	12.5
	3200	0.03125	0.0625	0.15625	0.3125	0.625	1.5625	3.125	6.25
	6400	0.015625	0.03125	0.078125	0.15625	0.3125	0.78125	1.5625	3.125

Note: The NBW (Noise Bandwidth) equals the Frequency Resolution for the Rectangular window, Hanning weighting makes the NBW of the filters 1.5 x Frequency Resolution. The Record Length is 1/Frequency Resolution

The resolution also determines the length of time it takes for the analyzer to gather a block of data. This time, or record length, is equal to the reciprocal of the resolution. So, for example, if the resolution is 5 Hz, then the record length will be 0.20 seconds.

Note that with narrower resolutions, the record length will be longer, meaning the response time for the analysis can be slower. For example, if we choose a 100 Hz frequency span with 6400 lines of analysis, our record length will be over a minute! ($1/0.015625 = 64$ seconds). With continuous signals, we use an overlap of the time records of 67%, so the second update of the frequency spectrum will occur just 22 seconds later.

With continuous signals, the time recorded signal is shaped by a time window to reduce the transients caused by the start and end of each time record. This shaping is called a “Hanning window” and the overlap of 67% matches the Hanning window so that no time data is lost.

All the time data is then equally weighted. If the signal type is set to “transient” – that is, its length is less than the record length – no shaping or overlap is required and the type of window reverts to rectangular.

A side effect of the Hanning weighting is that the noise bandwidth^a of the filters is forced to be wider than the line spacing of the analysis. Normally, this of little consequence to the user; however, when summing the levels of a span of filters (such as when we display a total or delta-cursor total of level) this 50% increase in filter noise bandwidth is automatically corrected for.

To average time variations in the signal, either linear or exponential spectrum averaging is used.

In linear averaging all averaged spectra are weighted equally. The operator specifies a number of spectra to be included in the linear average and after this number of spectra has been averaged the measurement is completed.

In exponential averaging, all spectra are averaged with a weight based on order – the most recent spectrum weighted the most significantly, with earlier spectra weighted in an exponentially decaying fashion. Exponential averaging proceeds indefinitely until stopped by the user, and is useful in evaluating non-stationary signals or surveying potential measurement positions.

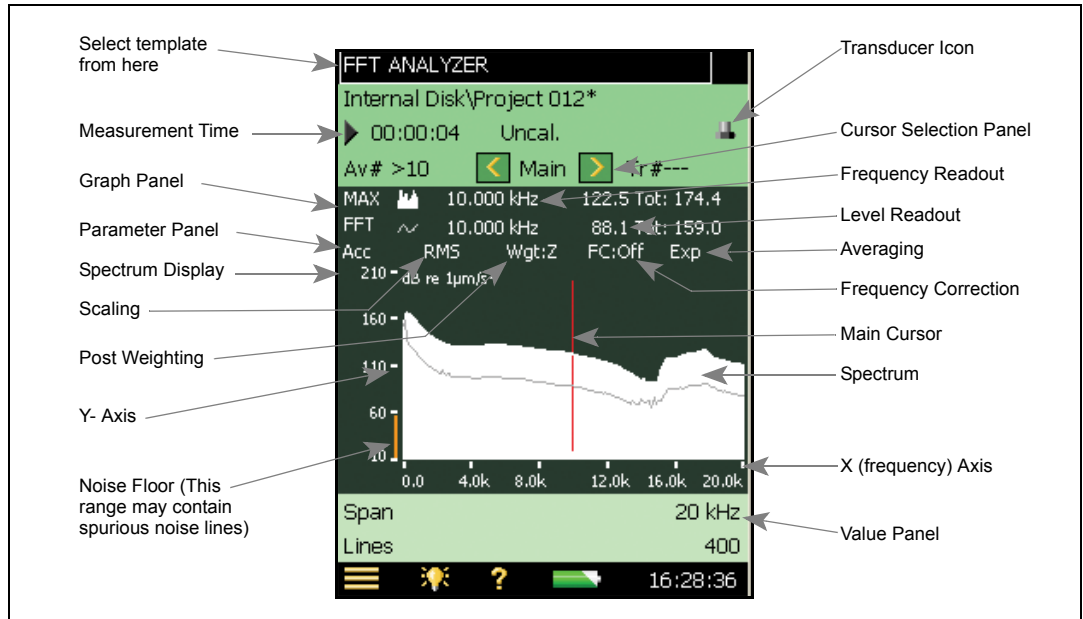
A maximum hold display (sometimes called peak averaging) is also available when using FFT Analysis Software BZ-7230, to capture the highest value in any frequency band during the measurement.

a. The Noise Bandwidth (NBW) is the bandwidth of an ideal (box-shape) filter passing the same noise power.

2.2 Overview

An overview of the measurement screen is provided in Fig. 2.2. Accelerometer Type 4397-A has been selected as the current transducer.

Fig. 2.2 Typical FFT spectrum display, showing the various fields



2.3 Tutorial – Measurements on a Stationary Signal

To work through this tutorial, you will need the following equipment:

Hand-held Analyzer Type 2270, or Type 2250, with:

- Microphone Type 4189
- Accelerometer Type 4397-A
- Sound Calibrator Type 4231
- Calibrator Exciter Type 4294
- Earphones HT-0015 or equivalent

This tutorial provides a step-by-step guide on how to perform FFT measurements on a stationary source, including familiarisation with the important features of BZ-7230.

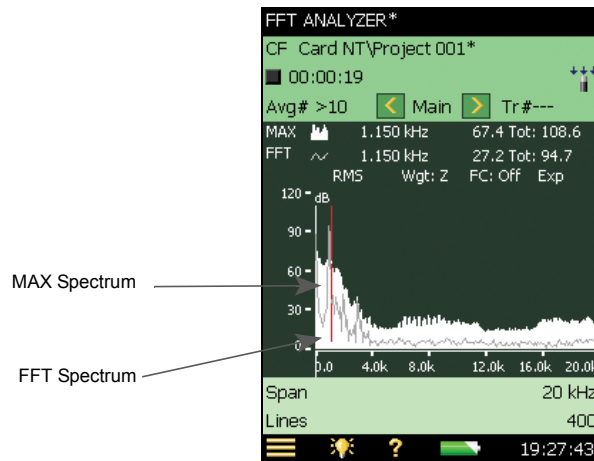
Note: If you don't have the Sound Recording option BZ-7226 installed, please skip section 2.3.7.

- 1) Fit the supplied microphone onto the Hand-Held Analyzer.
- 2) Turn the analyzer on.

- 3) Select the **FFT ANALYZER** template.
- 4) Mount Sound Calibrator Type 4231 and switch it on.
- 5) Press **Start/Pause** (⏸) to start a measurement.
- 6) Observe the spectrum.
- 7) Using the stylus, move the cursor to any other line.
- 8) Observe the spectra and the readings (see Fig. 2.3).

Fig. 2.3

FFT and MAX spectra
being measured are
displayed on screen



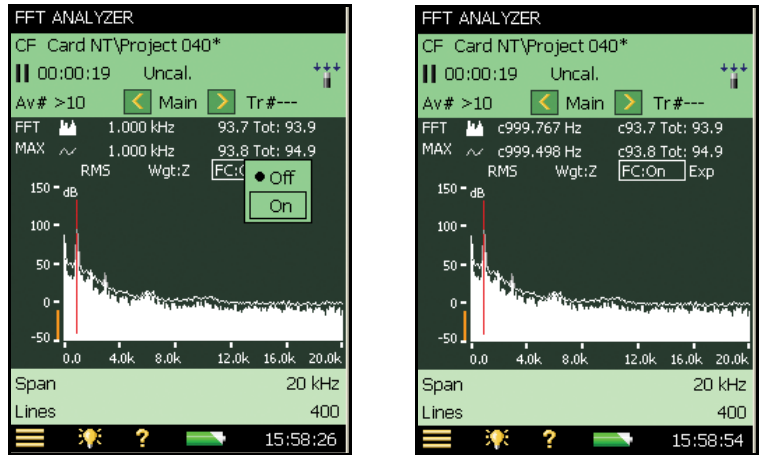
2.3.1 Frequency Correction

For a single tone to be measured correctly it has to fall exactly at the frequency of one line in the FFT spectrum. In practice, tones falls between two lines and their energy are shared between these two lines.

The Corrected Frequency facility analyses the FFT lines adjacent to a peak of energy, and determines where the actual energy peak is, to an accuracy approximately 10 times greater than the FFT line spacing, and determines the corresponding level. Frequency correction is available for main as well as auxiliary cursor readouts, but for spectra measured with Hanning time windows only.

- 9) Select *Auto-Peak* from the Cursor Selection Panel.
- 10) Observe the frequency and level values.
- 11) Turn Frequency Correction on by tapping directly on *FC:Off* on the Spectrum Display, see Fig. 2.4, and choose **On** from the resulting drop-down menu.

Fig. 2.4
Setting Frequency
Correction:
Left: before
Right: after



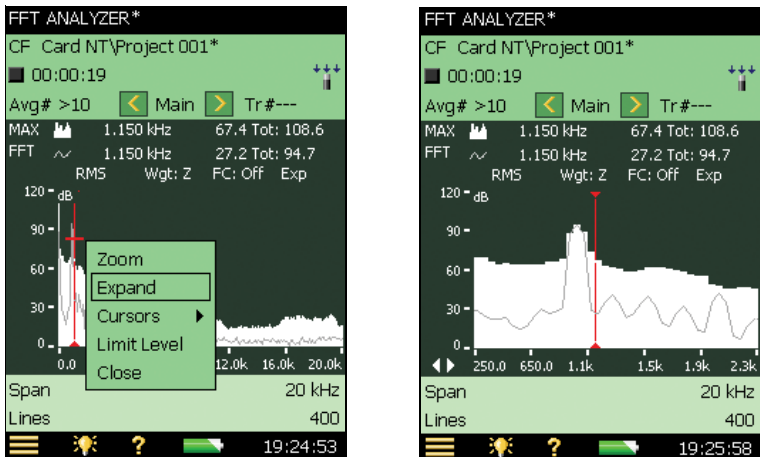
12) Observe the corrected values for frequency and level. (When a frequency or amplitude is corrected, it is preceded by a 'c', see Fig. 2.4.)

2.3.2 Expanding the Display

The Hand-held Analyzer, with BZ-7230, can measure FFT spectra with line resolutions of up to 6400 lines. It is impossible to have 6400 pixels resolution on the display however, so in the default mode every line displayed on screen will contain more than one measured value (the amplitude on the displayed line is determined by the maximum of the underlying FFT lines). Expanding the display allows you to expand around a specific area on the screen to see more details for that particular area.

13) Using the stylus, tap and hold the stylus on the spectra display, to the left of the calibrator tone, then drag it across the calibrator tone to a position on the other side, and release. (This will be referred to as 'drag-and-release'.) See Fig. 2.5.

Fig. 2.5
Expanding the display:
Left: before
Right: after



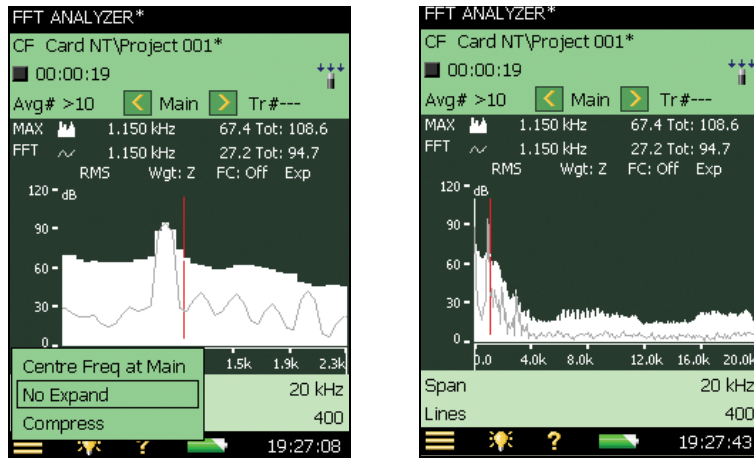
14) Select **Expand** from the resulting drop-down menu.

15) Observe the spectra and the frequency axis.

Note: The frequency axis now displays a narrower frequency range and the spectrum on the display is displayed at a higher resolution. You can expand the display until only 20 FFT lines are displayed.

16) Using the stylus, tap the frequency axis. Select **No Expand** from the drop-down menu, see Fig. 2.6.

Fig. 2.6
Performing a 'No Expand'
operation:
Left: before
Right: after



17) Observe the spectra and the frequency axis.

Note: The frequency axis now displays the full frequency range (0 Hz to 20 kHz) and the spectrum is now at the default resolution again.

2.3.3 Zooming In

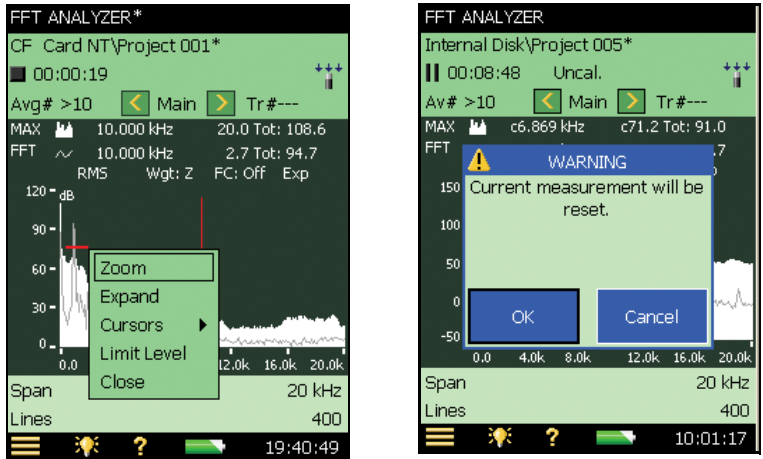
The default frequency span of the FFT Analysis Software BZ-7230 is 20 kHz, with a centre frequency of 10 kHz. The zoom function is used to change this frequency range to provide a more detailed FFT analysis of a narrower frequency band. Unlike the expand function, the zoom function actually changes the frequencies included in the FFT analysis (the expand function is purely a display tool). The zoom function can be activated either by drag-and-release on the spectrum (this gives you a graphical method to zoom around an interesting area) or through the setup page (this method allows you to configure frequency span and centre frequency precisely).

18) Use the stylus to drag-and-release across the calibrator tone.

19) Select **Zoom** from the resulting drop-down menu, see Fig. 2.7.

Fig. 2.7

Left: Spectrum before 'zoom' operation
Right: Message box for measurement reset




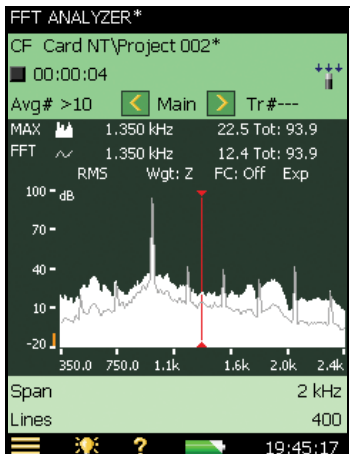
- 20) If the measurement is in Running/Paused state, a message box will be displayed, see Fig. 2.7. Tap **OK** to allow the measurement to be reset. This has to be done since FFT analysis is being restarted. Press **Start/Pause**  to restart the measurement.
- 21) Observe the spectrum and the frequency axis, see Fig. 2.8.
Note: The axis now has a new span and centre frequency.

Fig. 2.8

Spectrum after 'zoom' operation




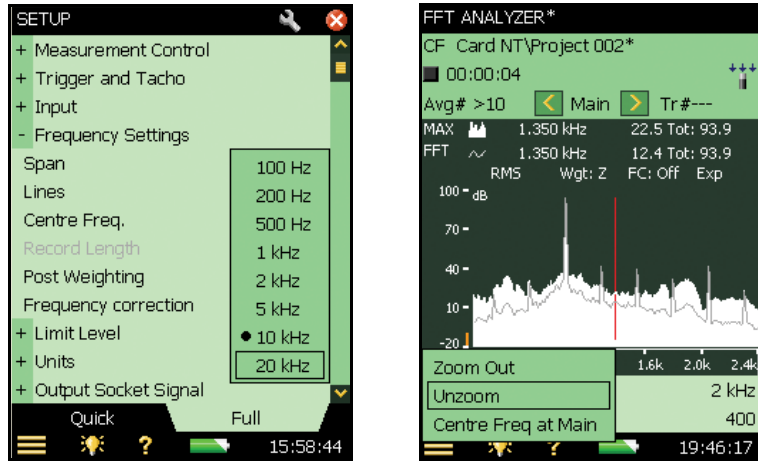
- 22) Tap the Main Menu icon  and select **Setup** from the list of options.
- 23) On the **Quick** setup tab, locate the *Centre Frequency* and *Frequency Span*.
- 24) Change the frequency span to 20 kHz, see Fig. 2.9. This will automatically set your centre frequency to 10 kHz.
Note: It is also possible to un-zoom by tapping the frequency axis and selecting **Un-zoom** from the drop-down menu, see Fig. 2.9.

Fig. 2.9

Left: Drop-down list showing selectable frequency spans
Right: Alternative method of unzooming



25) Return to the measurement display.

26) Observe the spectrum and frequency axis.

Note: The frequency axis now covers the full 0 Hz to 20 kHz range again and the measurement has restarted.

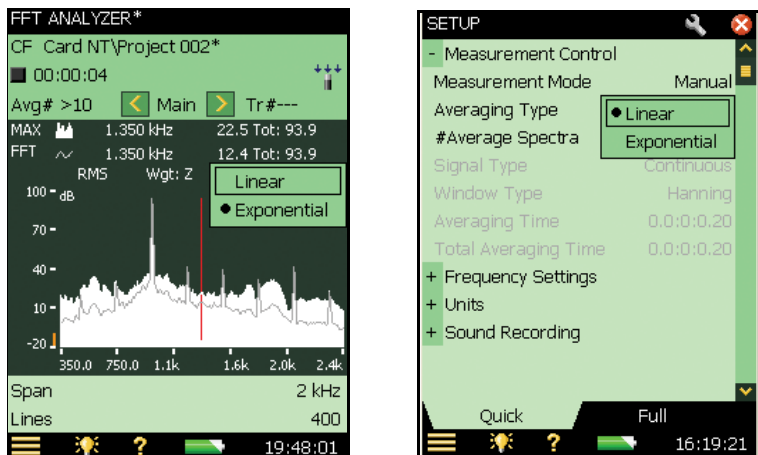
2.3.4 Averaging





Exponential averaging, which has been used up to now, is typically used to find the signal of interest using the setup, zoom and display facilities. To make a well-defined measurements of stationary signals, you should switch to Linear averaging. In a triggered mode of measurement, averaging type is set to *Linear* by default and cannot be changed to *Exponential*.

27) Select *Linear* averaging by tapping directly on the measurement display, see Fig. 2.10.

Fig. 2.10

Left: Setting *Linear* averaging directly
Right: Setting *Linear* averaging via the Setup menu



- 28) If the measurement is in Running/Paused state, a message box will be displayed, similar to the one shown in Fig. 2.7. Tap **OK** to allow the measurement to be reset. This has to be done since FFT analysis is being restarted. Press **Start/Pause**  to restart the measurement (not needed if an exponential average measurement was running).
- 29) Observe the spectrum, the number of averages display and the elapsed time. Observe that the measurement automatically goes to the paused state  after the pre-configured number of averages has been reached (default setup is 10 averages).
- 30) You can also select averaging from the setup page, see Fig. 2.10.
- 31) Tap the Main Menu icon  and select **Setup** from the list of options. On the **Quick** setup tab, locate the # *Average Spectra* and change the value to 20.
- 32) Return to the measurement display.
- 33) Press **Start/Pause**  to continue the measurement.
- 34) Observe the spectrum, the number of averages display and the elapsed time.
Note: The measurement continues for another 20 averages, making the total number of averages in your measurement up to 30.
- 35) To set the measurement in free run mode again, select *Exponential* averaging by tapping directly on the measurement display.

2.3.5 Cursors

FFT Analysis Software BZ-7230 provides a range of cursors to assist in making various measurements. Until now you have been working solely with the main cursor, which is used to read the data for a single line. Now, you will also work with various auxiliary cursors, such as delta, reference, harmonic and symmetric delta, and with the auto-peak find function.

Delta Cursor




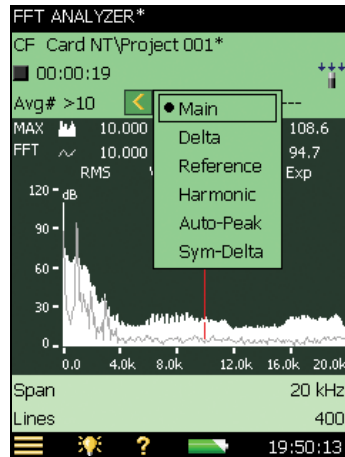
- 36) Use your stylus to tap the cursor selector (between the  and  buttons). Select **Delta** cursor from the cursor selection dropdown.
- 37) Use the  pushbutton to navigate down until the main cursor is active.

Fig. 2.11

The cursor selection drop-down menu

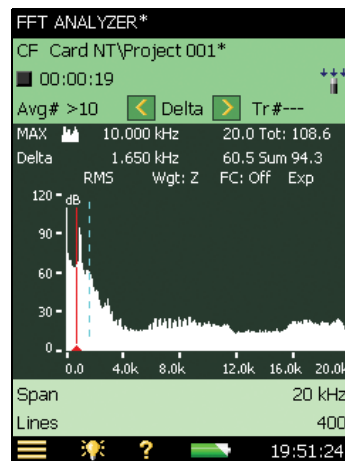


- 38) Use the ◀ or ▶ pushbuttons to place the main (together with the delta cursor) at a position to the left of the calibrator tone.
- 39) Use the ◀ or ▶ buttons to move the delta cursor to a position further to the right of the calibrator tone.
- 40) Observe the cursor reading, see Fig. 2.12.

Note: The delta cursor reading indicates the frequency difference between the main and delta cursor as well as the sum of all FFT lines between them.



Fig. 2.12

Delta cursor reading



Reference Cursor and Auto Peak Find

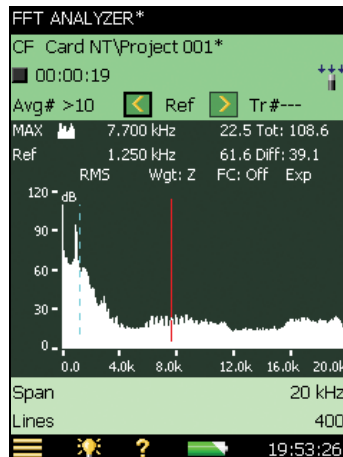
- 41) Use your stylus to tap the cursor selector again. Select **Reference** cursor from the cursor selection drop-down.

42) Use the  or  buttons to navigate the reference cursor to a position close to the calibrator tone.

43) Observe the cursor readout, see Fig. 2.13.

Note: The reference cursor readout displays the amplitude difference between the main cursor and the reference cursor.



Fig. 2.13
Reference cursor reading




44) Use your stylus to tap the cursor selector and select the **Auto-Peak** function. This will place your main cursor on the highest peak in the spectrum. Unless you are working in a very noisy environment this should be the calibrator tone.

Harmonic Cursor

45) Use your stylus to tap the cursor selector again. Select the **Harmonic** cursor from the cursor selection drop-down. This cursor assists in identifying harmonics, see Fig. 2.14.

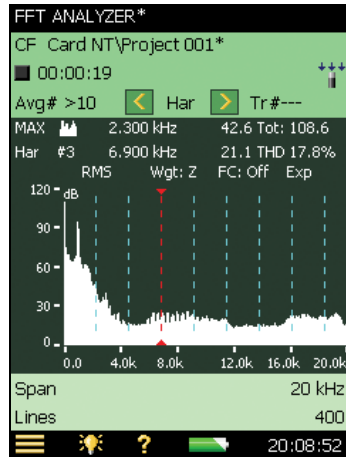
46) Use the  or  buttons to navigate to the third harmonic.

47) Use the  pushbutton to navigate down until the main cursor is active.


48) Use the  or  pushbuttons to move the third harmonic.

Note: The other harmonics are also adjusted. This allows you to align your harmonics based on a high order harmonic. You can set the *Frequency Correction* parameter *On* (tap directly on *FC:Off* on the Spectrum Display) to more easily match peaks with harmonics.

Fig. 2.14
Harmonic cursor reading

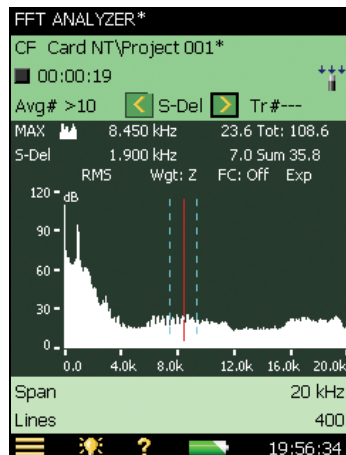


Symmetric Delta Cursor

- 49) Use your stylus to tap the cursor selector. Select **Sym-Delta** (symmetric delta cursor) from the cursor selection drop-down. You can also drag-and-release on the spectrum to select the symmetric delta cursor. This gives you a graphical method to position the symmetric delta cursor around an interesting area. You will find that the symmetric cursors are drawn at the start and end point of the drag line. The main cursor will be equidistant from both the symmetric cursors.
- 50) Use the  button to increase the delta span.
- 51) Observe the spectrum and cursor reading, see Fig. 2.15.

Note: The two cursors are positioned symmetrically around the main cursor. The difference in frequency, and the sum of the delta span, can be seen in the cursor reading.

Fig. 2.15
Symmetric Delta cursor reading



Selecting Cursors by Dragging the Stylus Over the Spectrum

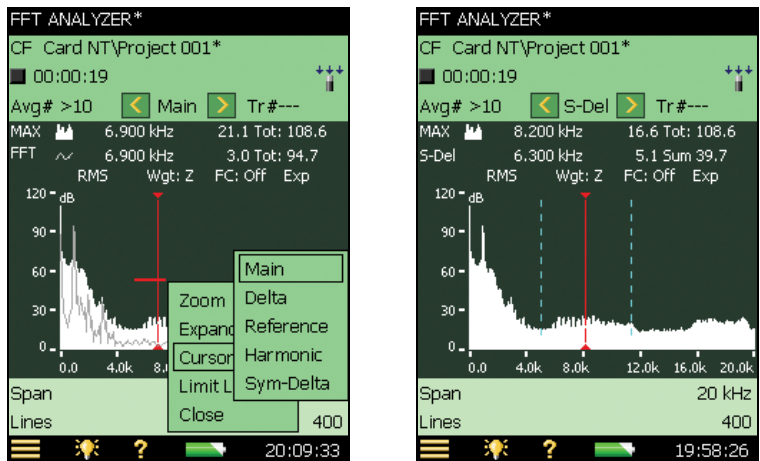
You can also select a cursor by dragging the stylus over part of the spectrum. When you drag the cursor from left to right, the cursors are placed as follows:

- **Main cursor:** positioned at left end of the drag-and-release line
- **Delta cursor:** Main cursor on left end and delta cursor on right end of the drag-and-release line
- **Reference cursor:** Main cursor on left end and reference cursor on right end of the drag-and-release line
- **Harmonic cursor:** Main cursor on left end, and the first harmonic cursor on right end of the drag-and-release line
- **Symmetric Delta cursor:** Left symmetric delta cursor on the left end, right symmetric delta cursor on the right end, and main cursor adjusted exactly in between these two

Fig. 2.16

Left: Dragging stylus over part of spectrum to select Main cursor

Right: Example of left and right symmetric delta cursors placed on the left and right ends of a drag-and-release line, Main cursor in the centre



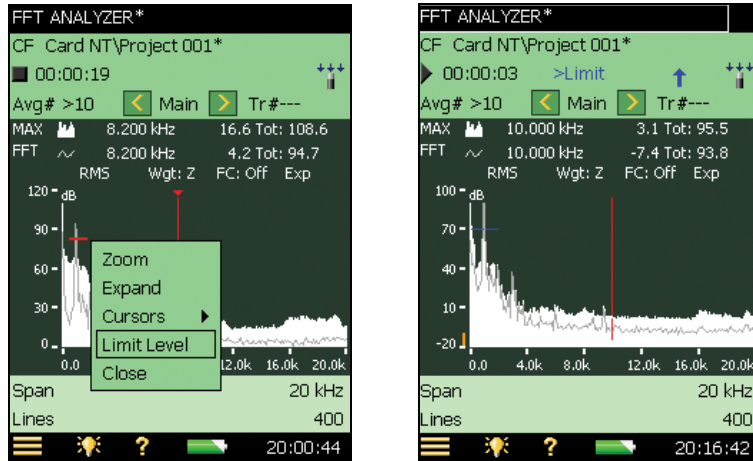
2.3.6 Limit Level

When you need an indication that your measured level has exceeded a particular value, in a particular frequency range of your choice, use the limit level feature. You can set these values on the setup page, as well as the measurement display. You can also configure the system to start recording automatically when data exceeds the level limit.

- 52) Using your stylus, drag-and-release a line somewhere between the noise floor and the calibrator tone's maximum level.
- 53) Select **Limit Level** from the resulting drop-down menu, see Fig. 2.17.
- 54) Observe the spectrum.
Note: The level indication is visible on the display, see Fig. 2.17.
- 55) Start the calibrator again.

Fig. 2.17

Left: Selecting limit level indications – Latched Limit Level (blue >Limit) or Instantaneous Limit Level (blue arrow)



56) Observe the spectrum and the status field, see Fig. 2.17.

Note 1: Two indicators are displayed in the status field, one for instantaneous level limit exceedance (text indicating that there is a level limit exceedance now) and one latched level limit exceedance (an icon indicating that there has been at least one level limit exceedance during the measurement).

Note 2: The status of one of the indicators may be selected as a signal at the Output Socket, please refer to the Specifications.

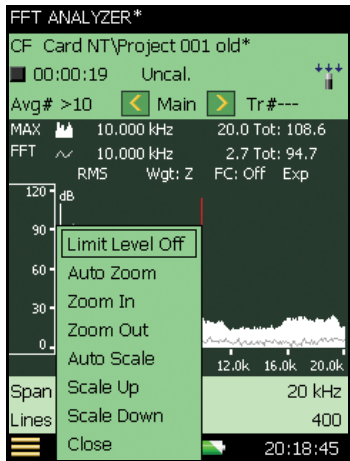
57) Turn off the calibrator again.

58) Observe the spectrum.

Note: The indication for instantaneous level limit exceedance disappears while the indicator for latched level limit exceedance remains.

59) Turn the level limit off by clicking on the Y-axis, and selecting **Limit Level Off**, see Fig. 2.18.

Fig. 2.18
Setting Limit Level Off



2.3.7 (Sound) Recording

Note: This section is only applicable if you have BZ-7226 Sound Recording option. If not, please proceed directly to section 2.3.8.

As well as recording sound, the BZ-7226 Sound Recording Option can also be used to record signals during FFT analysis. It has special relevance in conjunction with the level limit. The recording can be set to start whenever the set limit is exceeded, allowing you to record the signal only during the incident that caused the limit to be exceeded.


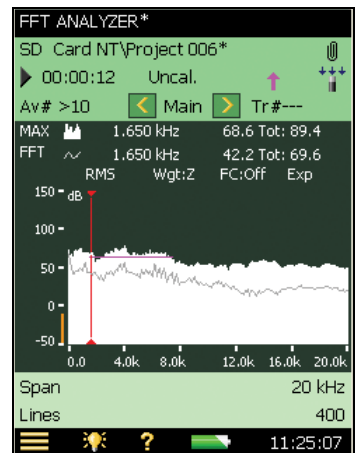
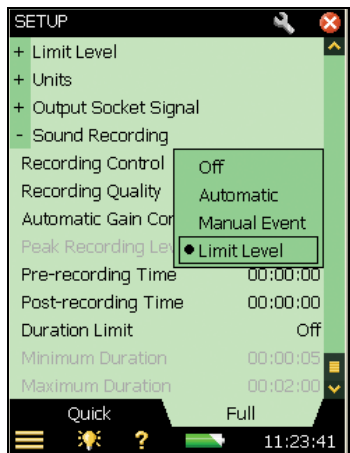


- 60) Tap the Main Menu icon  and select **Setup** from the list of options.
- 61) On the **Quick** setup tab, locate the *Recording* group and set *Recording Control* to *Limit Level*, see Fig. 2.19.

Fig. 2.19
Left: Selecting limit level
in Sound Recording
Right: Limit level
indications



62) Repeat the measurement described in the previous ‘Limit Level’ section – steps 52) to 59).

63) Observe the display.


Note: The  icon is displayed in the status field while the limit is exceeded and after the limit exceedance stops, a paper clip icon  appears indicating that there is an annotation to the project.

64) Click the paper clip icon and play back the recording.

Note: When measuring in Triggered mode, **trigger points are indicated in the recorded file**. However, this function only works with the highest recording quality, so set the *Recording Quality to High (20 kHz)*.

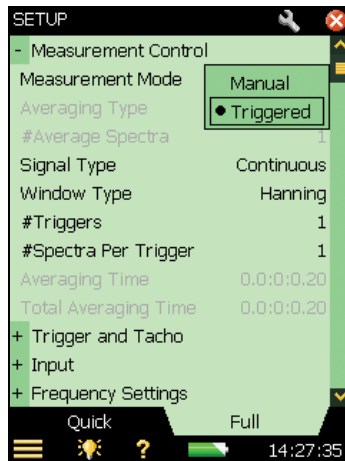
2.3.8 Triggering

So far we have been measuring a stationary signal (a calibrator tone), however, there are many signals that are not stationary. Some exist for only a short duration, so the triggered measurement mode assists in measuring non-stationary and intermittent signals. For this measurement demonstration you need an empty porcelain cup, a pencil, and a jug of tea/coffee.

65) Tap the Main Menu icon  and select **Setup** from the list of options.

66) On the **Full** setup tab, locate the *Measurement Control* group and change the *Measurement Mode to Triggered*, see Fig. 2.20.

Fig. 2.20
Setting Triggered mode

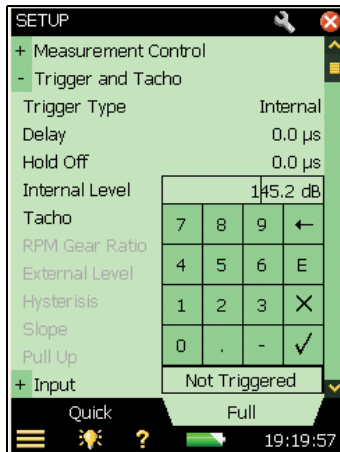


67) Set the *Signal Type to Transient* under *Measurement Control* parameters.

68) Open the keyboard panel for configuring the Trigger Level by tapping on the value next to the *Internal Level* parameter, see Fig. 2.21. (If the *Internal Level* parameter is

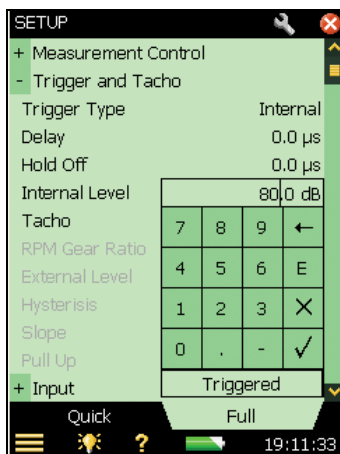
greyed-out, check that the Trigger Type parameter is set to *Internal*.) Set the level to 70 dB, then press the **Accept** pushbutton (✓) or tap the ✓ button on the screen to enter the level. (Tap on the ✕ button on the screen, or outside the number keyboard to cancel the change of value.)

Fig. 2.21
Setting the Trigger level



- 69) Keep the keyboard panel open. Hold the porcelain cup 10 cm from your microphone and hit the rim of the cup with your pencil.
- 70) If the keyboard panel indicates a trigger (see Fig. 2.22) then all is fine and you have successfully set your Hand-held Analyzer up for a triggered measurement. If not, try to adjust the level down in 3 dB steps until you get a trigger when hitting the rim.

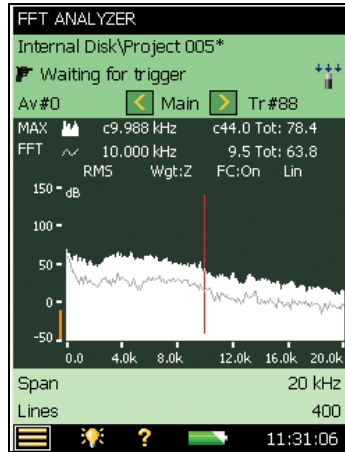
Fig. 2.22
Successful setup of the Trigger level



- 71) Return to the measurement display – tap on the ✕ button on the screen, or outside the number keyboard to close the keyboard.

- 72) Start a measurement, by pressing **Start/Pause** (⏸).
- 73) The Hand-held Analyzer should indicate *Waiting for Trigger*, see Fig. 2.23.

Fig. 2.23
Waiting for Trigger
indication on
measurement display



- 74) Tap the rim of the porcelain cup with your pencil.
- 75) The Hand-held Analyzer should trigger and measure a spectrum.

2.3.9 Reference Spectrum

In many measurement scenarios you want to compare one spectrum to another you measured previously. The Hand-held Analyzer (with BZ-7230) provides a quick and easy way to do this through the reference spectrum.

- 76) Save the current spectrum (from the porcelain cup, above) directly from the measurement display, and use this as a reference. You do this by tapping *FFT* on the primary cursor line, with your stylus, and selecting **Set as Ref** from the drop-down list.
- 77) Now fill the porcelain cup with tea or coffee and repeat the measurement described in section 2.3.8, steps 72) to 75).
- 78) The display now shows the spectrum for the full porcelain cup on the primary cursor line.
- 79) Select *Ref* on the secondary cursor line.
- 80) Observe the spectrum. Note the two spectra, one for a full porcelain cup and one for an empty cup.

2.3.10 Y-axis Operations

By clicking on the Y-axis you can perform the following operations:

- Zoom In^a

- Zoom Out^a
- Auto Zoom
- Scale Up
- Scale Down
- Auto Scale

Additionally, if the Y-axis is using an engineering scale, you can also switch between linear and logarithmic scales.

Change current transducer to Type 4397-A, and calibrate it using Calibration Exciter Type 4294 (see Chapter 3).

Zoom-In

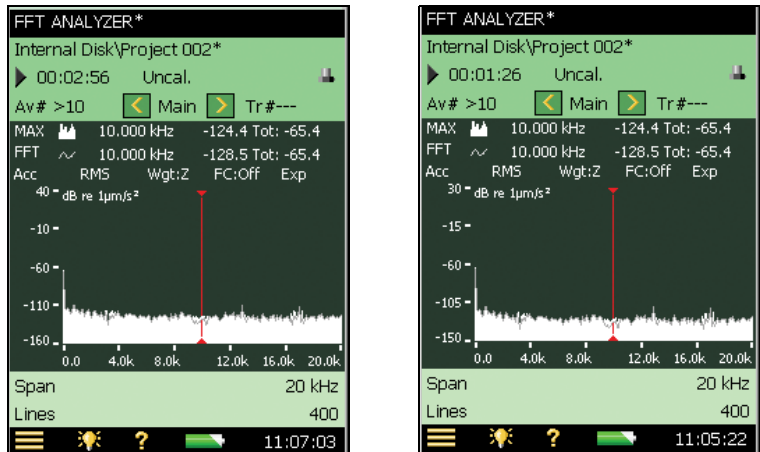
This operation works differently when using the ‘dB’ scale or ‘engineering’ scale for the Y-axis. (Select these scales from the *Y-axis* parameters, found in the *Units* parameters of the **Setup** menu).

Zoom-in on ‘dB’ Scale

This operation works just like the zoom lens of a camera, but in one dimension. On performing a Zoom-in, the range of the Y-axis is reduced, giving the impression that you are ‘zooming in’ on an expanding Y-axis scale. For example, if you perform a Zoom-in with the default range of the Y-axis selected (which has a range of 200 dB, that is, from –160 dB to 40 dB) and after the Zoom-in operation it changes to a range from –150 dB to 30 dB, then the range has reduced to 180 dB, see Fig. 2.24. Thus we get a ‘zoomed-in’ view of our data, after successive Zoom-in operations.

Fig. 2.24

Left: Performing a Zoom-in operation on the ‘dB’ scale, before zoom-in
Right: after zoom-in



To perform a Zoom-in operation, do the following:

- a. These zoom in and zoom out operations should not be confused with the zoom operations available for the frequency, or x-axis, covered in section 2.3.3.

81) Tap on the Y-axis.

82) Select **Zoom-in** from the resulting drop-down menu and observe the display.

Zoom-in for 'Engineering' Scale

This operation works like an object moving towards a half-length mirror. As the object gets closer, a more and more partial view of the object is seen in the mirror. Similarly, on performing a Zoom-in, the range of the Y-axis is reduced (from the top of the scale only) giving the impression that you are 'zooming in' on the bottom of an expanding Y-axis scale.

For example, if you perform a Zoom-in on the default range of the Y-axis (which has a range of $100 \mu\text{m/s}^2$, that is, a scale from 0 to $100 \mu\text{m/s}^2$) and after the Zoom-in operation it changes to a scale from 0 to $50 \mu\text{m/s}^2$, then the range has reduced to $50 \mu\text{m/s}^2$, see Fig. 2.25.

Fig. 2.25

Left: Performing a Zoom-in operation on the 'engineering' scale, before zoom-in

Right: after zoom-in



Perform the following steps:

83) Change Y-axis parameter to *Engineering*. (Found in the *Units* parameters of the **Setup** menu.)

84) Tap on the Y-axis.

85) A drop-down is displayed. Select **Zoom-In**.

The other operations you can perform are listed in Table 2.2.

Table 2.2 Y-axis Operations

Operation	Principal Function
Zoom In	This operation works just like the zoom lens of a camera, but in one dimension. The range of the Y-axis is reduced each time you zoom in, so you get a 'zoomed-in' view of your data.
Zoom Out	This operation is the exact reverse of the Zoom-in operation. User can 'zoom out' only up to the maximum range, however, and not beyond that.
Auto Zoom	This operation zooms-in on the data, in such a way that the data of the highest and the lowest values is visible on the screen.
Scale Up	This operation moves the area currently being displayed on the Y-axis up by a fixed value, up to the maximum limit. (This is only possible, after the first zoom in operation on the Y-axis.)
Scale Down	This operation moves the area currently being displayed on the Y-axis down by a fixed value, up to the maximum limit. (This is only possible, after the first zoom in operation on the Y-axis.)
Auto Scale	This operation scales the Y-axis up or down, in such a way that the maximum value in the data is visible on screen. While doing this, it maintains the current range.

Congratulations, you've finished with the Getting Started guide, so enjoy your tea/coffee!
Have fun using the Hand-Held Analyzer with BZ-7230.

Chapter 3

Using Accelerometers for Vibration Measurement

3.1 Introduction

For a good introduction to accelerometers, consult Brüel & Kjær's "Piezoelectric Accelerometers and Vibration Preamplifiers, Theory and Application Handbook" (order number BB 0694).

The piezoelectric accelerometer is today accepted as the standard vibration transducer for most general purpose vibration measurement situations. The reason for the high degree of acceptance is that the piezoelectric accelerometer offers the following properties:

- Linear amplitude response across a wide dynamic range, limited only by built-in electronics
- Wide and flat frequency response (with proper mounting)
- Self-generating piezoelectric element, which simplifies power supply and signal conditioning
- No moving parts – a rugged transducer that will not wear out
- High stability in most test environments – temperature, humidity, dust and fluids
- Compact, often very low weight, so easy to mount in any orientation

One limitation is the very high output impedance of the piezoelectric element. Therefore, most modern accelerometers include a charge-to-voltage converter circuit in the housing.

To distinguish them from traditional piezoelectric devices, these accelerometers are known generically as Integrated Electronics Piezoelectric (IEPE) accelerometers (or commercially as DeltaTron[®] or ISOTRON[®] accelerometers).

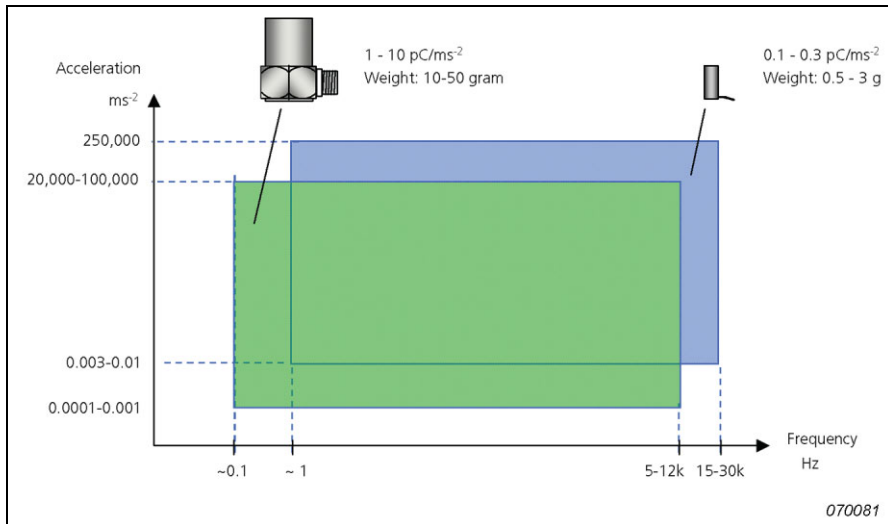
The circuit in a DeltaTron accelerometer is powered from an input with Constant-Current Line Drive (CCLD) power supply. The Hand-held Analyzer is able to deliver such a power supply on its Rear Input Socket when CCLD is selected. The Hand-held Analyzer then receives an input signal, in the form of a modulated voltage on the input, which is proportional to the acceleration measured.

We recommend that DeltaTron accelerometers be used with Hand-held Analyzer FFT Analysis Software BZ-7230 and this will be assumed in this manual, unless otherwise stated.

3.1.1 Choosing an Accelerometer

Fig. 3.1 shows two typical groups of accelerometers with typical specifications.

Fig. 3.1 Two typical groups of accelerometers with typical specifications



Notice, that accelerometer responses extend to considerably lower frequencies than sound measurements. You can also see that the output of the accelerometers is given in pC/ms^{-2} . This is in recognition of the fact that fundamentally they are charge-based devices. However, the charge-to-voltage converters incorporated in accelerometers are usually designed to give “nice number” conversions. For example, if an accelerometer supplies 1 pC/ms^{-2} , the charge converter output might typically be 1 mV/ms^{-2} . With a ratio of 9.81:1 of SI units (ms^{-2}) to US/UK units (g), this means that you may also get accelerometers with specified sensitivities like 98.1 mV/g .

Sensitivity and Frequency Range

All accelerometers will give a constant output signal for a constant acceleration from very low frequencies up to a limit set by the increase in output due to resonance of the accelerometer. In general, however, the accelerometer is not used close to its resonance as this will result in a big error in the measured signal (as the sensitivity at the mounted resonance is often 10 to 30 times the transducer’s specified sensitivity). As a rule of thumb, the accelerometer’s useful frequency is limited to one third of its resonance frequency. This will then ensure that the error at that frequency does not exceed approximately 12% or 1 dB.

The sensitivity and frequency range of an accelerometer are related; in general, the bigger the accelerometer, the higher its sensitivity, and the lower its useful frequency range, and vice versa.

3.1.2 The Importance of Correct Mounting

Bad mounting of the accelerometer can spoil vibration measurements by severely reducing the usable frequency range. The main requirement is for close mechanical contact between the accelerometer base and the surface to which it is to be attached.

Stud Mounting

Mounting the accelerometer with the aid of a steel stud is the best mounting method and should be used wherever possible.

Cementing Studs

In places where it is not wished to drill and tap fixing holes, a cementing stud can be fixed onto the machine with the aid of an epoxy or cyanoacrylate cement. The frequency response will be nearly as good as that obtained using a plain stud. Soft glues must be avoided.

Mounting with the Aid of Beeswax

For quick mounting of the accelerometers, for example, for surveying vibration in various locations, beeswax can be used for mounting the accelerometer. Because beeswax becomes soft at high temperatures, the method is restricted to about 40°C.

Isolated Mounting

In places where it is desirable to isolate the accelerometer from the test object, an isolated stud and a mica washer should be used. This could be either because the potential of the test object is different from the ground potential of the test instrumentation or because direct stud mounting will create a ground loop which could affect the measurement. The latter is the most common reason for use of an isolated mounting.

Mounting with the Aid of a Magnet

An easy and fast method of mounting the accelerometer is by using a permanent magnet which can very easily be shifted from one position to another. This is especially useful for surveying. The method is restricted to use on ferro-magnetic surfaces and the dynamic range is limited due to the limited force of the magnet. To obtain the maximum frequency range and dynamic range, the ferro-magnetic surface must be clean and flat. By fitting a self-adhesive disc on the magnet, it will provide electrical isolation between the accelerometer and the surface to which it is attached.

Use of a Hand-held Probe

A hand-held probe with the accelerometer mounted on top is very convenient for quick-look survey work, but can give gross measuring errors because of the low overall stiffness.

Mechanical Filter

As mentioned earlier (in section 3.1.1), when vibration energy is present at (or near) the resonance peak of an accelerometer, the resonance can cause a 10 to 30 times boost in the signal level. This can give strange overload indications on the Hand-held Analyzer if there are vibrations near the mounted resonance frequency of the accelerometer, even though the

upper frequency of the analysis is set to a lower frequency. In practice you can to some extent use the wide dynamic range of the Hand-held Analyzer to reduce this problem, by selecting a less sensitive accelerometer and still measure the vibration of interest.

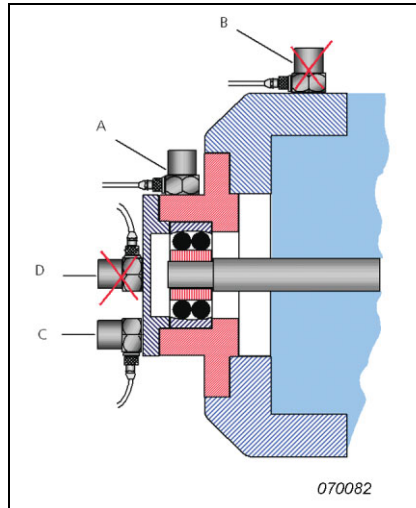
If you would like to reduce the effect of the mounted resonance on an accelerometer's measured response, it can be accomplished with the aid of a mechanical filter, which is mounted between the accelerometer and the test object. The mechanical filter prevents energy from exciting the resonance, protecting the whole measurement chain. The mechanical filter can also provide electrical isolation between the accelerometer base and the mounting point. Note that the attenuation achieved depends upon the mass of the accelerometer, so not all accelerometers are compatible with mechanical filters.

3.1.3 Choosing a Mounting Position

The accelerometer should be mounted so that the desired measuring direction coincides with the main sensitivity axis. Accelerometers are slightly sensitive to vibrations in the transverse direction, but this can normally be ignored as the maximum transverse sensitivity is typically only a few percent of the main axis sensitivity.

The reason for measuring vibration will normally dictate the position of the accelerometer. In Fig. 3.2 the reason is to monitor the condition of the shaft and bearing. The accelerometer should be positioned to maintain a direct path for the vibration from the bearing.

Fig. 3.2
Examples of different
accelerometer mounting
positions on the bearing
of a drive shaft



Accelerometer "A" detects the vibration signal from the bearing predominant over vibrations from other parts of the machine, but accelerometer "B" receives the bearing vibration modified by transmission through a joint, mixed with signals from other parts of the machine. Likewise, accelerometer "C" is positioned in a more direct path than accelerometer "D".

It is very difficult to give general rules about placement of accelerometers, as the response of mechanical objects to forced vibrations is a complex phenomenon, so that one can expect, especially at high frequencies, to measure significantly different vibration levels and frequency spectra, even at adjacent measuring points on the same machine element.

3.1.4 Recommended Accelerometers

Table 3.1 Recommended DeltaTron accelerometers^a

Type	Description	Frequency Range (Hz)	Nominal Sensitivity
4397	Miniature	1–25000	1 mV/ms ⁻²
4513	General Purpose	1–10000	1 mV/ms ⁻²
4513-001	General Purpose	1–10000	10 mV/ms ⁻²
4513-002	General Purpose	1–10000	50 mV/ms ⁻²

3.2 Configuring the Input

DeltaTron accelerometers should be connected to the ‘Rear Input’ socket of the Hand-held Analyzer – this is used for Direct or CCLD inputs. (Also called ‘Rear Socket’ in the software.)

Use Cable AO-0702-D-030 to connect accelerometers with a 10–32 UNF connector (or charge converter) to the ‘Rear Input’ socket of the Hand-held Analyzer. For accelerometers with a smaller M3 connector, use cable AO-0701-D-030.

Other Accelerometers

If you have chosen to use a charge accelerometer, you need to incorporate a charge converter in the signal chain. For example, two charge converters that are compatible are:

- Type 2647-A – Charge to DeltaTron Converter (1 mV/pC)
- Type 2647-B – Charge to DeltaTron Converter (10 mV/pC)

Notice that the only difference between the two is the gain (re: 1 pC).

3.2.1 Transducer Database

Any transducer used by the Hand-held Analyzer, whether it is a microphone for acoustic signals, or an accelerometer for vibration signals, must be entered in the transducer database. This enables easy switching between transducers, and allows a calibration history to be maintained for each transducer. Entering microphone transducers is discussed in the User Manual for Hand-held Analyzers Types 2270 and 2250 (BE 1713). Instructions for adding an accelerometer are described in the next section.

a. See relevant accelerometer data sheet for complete specifications.

3.2.2 Adding an Accelerometer



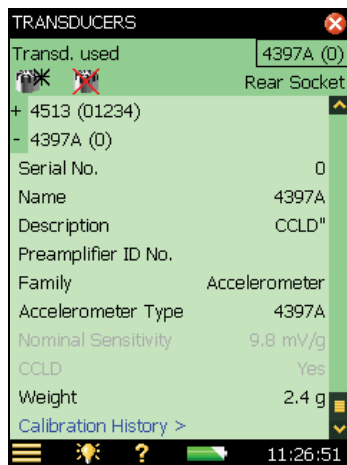
- 1) Tap the Main Menu icon  and select **Transducers** from the list of options.
- 2) Tap on the Add New Transducer icon  and select **Accelerometer** from the drop-down that appears. (The entry defaults to a general purpose DeltaTron Accelerometer Type 4397-A, though other accelerometer names and types can be used.) The transducer you have chosen now appears in the *Transd. Used* title of the status field. If you have chosen an accelerometer, the field below automatically changes to *Rear Socket*.
- 3) Enter the type number of the accelerometer you are using under the *Accelerometer Type* parameter, or select *Unknown* if you don't know. (For unknown accelerometers you should enter a value under *Nominal Sensitivity*, whether or not to use the *CCLD* power supply, and the weight of the accelerometer, see Fig. 3.3.)
- 4) Enter the name of the accelerometer under *Name*, up to 10 characters can be used. (The name of the accelerometer will be displayed in the *Transd. used* title of the status field, appended with the serial number of the accelerometer.)
- 5) You can also enter the serial number, and edit the description of the accelerometer, if required.

Fig. 3.3
Transducer used
parameters





3.3 Calibration

After you have configured the input, you need to calibrate your Hand-held Analyzer.

The calibration procedure is very similar to that for acoustically calibrating a microphone using Sound Calibrator Type 4231 – please refer to Chapter 5 of User Manual for Hand-held Analyzers Types 2270 and 2250 (BE 1713) if you are not familiar with this procedure.

The only difference between this procedure and the acoustic calibration procedure already mentioned, is that you attach Calibration Exciter Type 4294 to the accelerometer you have just connected and configured. Proceed as follows:

- 1) Tap on the Main Menu icon  and select **Calibration** from the list of options, the initial calibration screen appears.
- 2) Mount^a Calibration Exciter Type 4294 onto the accelerometer, turn on Type 4294 and tap the  button on the screen to start the calibration.

The rest of the procedure is similar to the microphone calibration procedure.

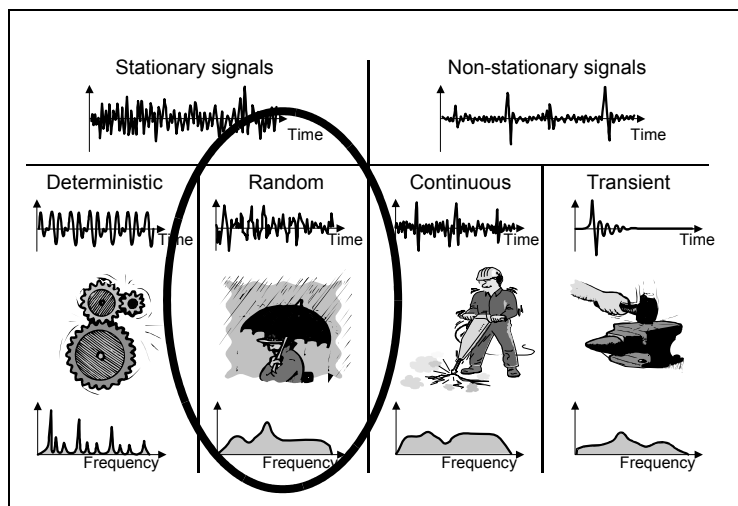
a. Various mountings are available, depending on the type of accelerometer you are using, please refer to the User Manual for Calibration Exciters Types 4294 and 4294-002.

Chapter 4

Measuring Random Signals

4.1 Random Signals

Fig.4.1
Random signals



A random signal is a continuous stationary signal whose properties can only be described using statistical parameters. Random signals have a frequency spectrum that is continuously distributed with frequency. Acousticians would generally call random signals “noise”.

Examples of random signals are background noise in the environment (such as rain), and the effects of cavitations and turbulence.

4.2 Preparing for Measurement

This section will guide you in choosing suitable start values for measurement of random signals.

4.2.1 Configuring the Input

Configuring the input is a three-step process:

- 1) Choosing the correct transducer.
- 2) Setting the signal source and type.
- 3) Calibrating the system.

These steps are covered in detail in Chapter 3, and should be done before proceeding.

4.2.2 Measurement Control

To measure random signals, you initially need to set the analyzer up for a manual measurement start, with exponential averaging, see “Setting the Measurement Control Parameters” on page 36.

Because of their nature, triggered measurements with random signals are not suitable since there is no specific event to trigger on.

Selecting exponential averaging in the first instance allows you to judge if the random signal is truly random, or if it varies with time (a continuous signal). Linear averaging will mask time variations.

Setting the Measurement Control Parameters


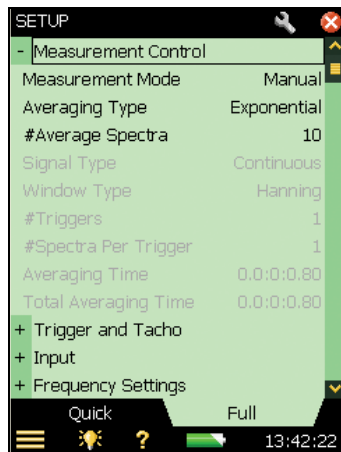
The measurement control parameters are found under *Measurement Control* – tap the Main Menu icon  and select **Setup** from the list of options. Set *Measurement Mode* to *Manual*, and *Averaging Type* to *Exponential*, see Fig. 4.2.

Fig. 4.2
Setting the measurement control parameters



Averaged Spectra

If you enter a value of 10 for the *#Average Spectra* parameter, the analyzer will iron out any very short-term changes in the random signal, but is still fast enough for you to see the general trend of the signal.

Averaging Time

The *Averaging Time* readout is computed by the FFT software. The value depends upon the frequency span (see section 2.3.3 and section 4.2.4) and the number of spectra to be averaged.

4.2.3 Full Scale Value

The full scale value is the maximum signal level that the analyzer will accept before overload occurs with the current input type setting. This is specific to the transducer used, and cannot be changed.

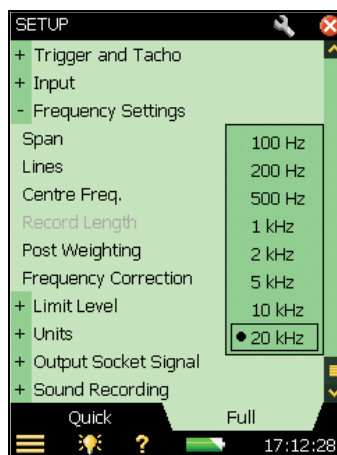
4.2.4 Frequency Resolution/Span

Frequency Span

For sound measurements in the audio range, a span of 20 kHz centred on 10 kHz and 400 lines, gives a good overview. This enables you to “see” the sound in almost real-time.

The frequency resolution is set by the frequency span and the number of FFT lines, which in turn governs the record length for each captured spectrum and the effective noise bandwidth of each FFT line. Therefore, you need to initially set these parameters to values that suit the signal type you are testing. The Frequency Span is set to a value that you expect will encompass the frequency range of your signal. The centre frequency decides the frequency around which the frequency span will be distributed equally. The span parameters are found under *Frequency Settings* (**Setup** menu) – set the required *Span*, *Lines* or *Centre Freq.* value by selecting them in the *Frequency Settings* parameters – see Fig. 4.3.

Fig. 4.3
Setting the frequency span



Note: The frequency span can also be set by dragging the stylus across the desired frequency range on the display. It's up to you which method you choose. However, to set the precise frequency range more accurately, use the Measurement Control parameters (from the **Setup** menu).

Number of Lines

The FFT Analyzer allows you to perform up to 6400 line measurements. Since there isn't enough space to display all of them at a time, the FFT analyzer displays a group of them in 1 pixel, with the value of the one with the maximum amplitude being displayed. The greater the number of lines, the more precise the frequency resolution becomes, but the longer it takes to get a result.

4.2.5 Time Windows

The purpose of a time window is to minimise the effects of the discontinuity that occurs when a section of continuous signal is measured. When the measurement is manual, the *Window Type* is always set to *Hanning*. In the *Triggered* mode, you can change the *Window Type* from *Hanning* to *Rectangular*, and vice versa. You can also change the *Window Type* by changing the *Signal Type*. *Transient Signal Type* always corresponds to rectangular window. *Continuous Signal Type* always corresponds to *Hanning Window*, see example displays in Fig. 4.4.

Perform the following steps:

- 1) Set the *Measurement Mode* to *Triggered*.
- 2) Select *Rectangular* as the *Window Type*.
- 3) *Signal Type* changes to *Transient*.
- 4) Observe the spectra.
- 5) Change *Signal Type* to *Continuous*.
- 6) *Window Type* changes to *Hanning*.
- 7) Observe the spectra.
- 8) Change *Window Type* to *Rectangular*.
- 9) *Signal Type* changes to *Transient*.
- 10) Observe the spectra.

Fig. 4.4
Left: Selecting Window Type from the Setup Page
Right: Selecting signal type from the Setup Page




4.2.6 Post-weighting

BZ-7230 has two kinds of post-weighting, A-Weighting and Z-Weighting.

A-weighting attenuates frequencies where the human ear is less sensitive.

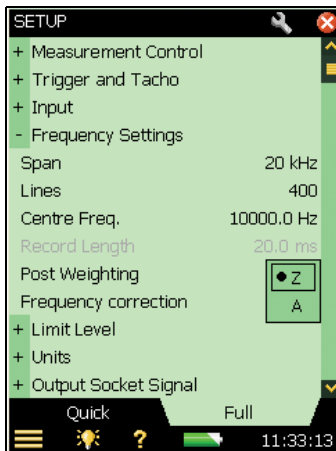
Note: Although A-weighting was designed to be used during the measurement of sound, you can also apply it when using vibration or direct transducers.

Z-weighting (Zero-weighting) means that no frequency weighting is applied.

- 1) Tap the Main Menu icon  and select **Setup** from the list of options.
- 2) On the **Full** view tab select *Frequency Settings*, and then *Post Weighting*
- 3) Select *A* or *Z*, see Fig. 4.5.

Note: Setting the post-weighting will disable the pre-weighting.


Fig. 4.5
Selecting Post-weighting from the Setup menu



Note: Another way to select Post-weighting is to tap on the *Wgt* parameter label on the measurement screen and select *Post-A* or *Z* from the drop-down list that appears, see Fig. 4.7.

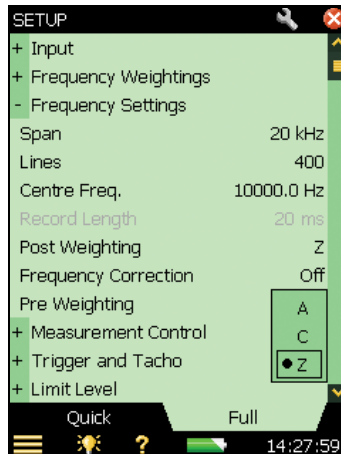
4.2.7 Pre-weighting

There are four different pre-weighting parameters that can be used: A, B, C or Z.

- 1) Tap the Main Menu icon  and select **Setup** from the list of options.
- 2) On the **Full** view tab select *Frequency Settings*, and then *Pre Weighting*.
- 3) Select *A*, *B*, *C* or *Z*, see Fig. 4.5 (A/B-weighting is determined when you set the *Broadband (excl. Peak)* parameter under Frequency Weightings in the **Setup** menu).

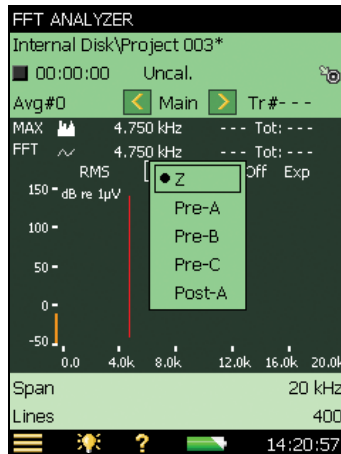
Note: Setting the post-weighting will disable the pre-weighting.

Fig. 4.6
Selecting Pre-weighting
from the Setup menu



Note: Another way to select Pre-weighting is to tap on the *Wgt* parameter label on the measurement screen and select *Pre-A*, *Pre-B*, *Pre-C* or *Z* from the drop-down list that appears, see Fig. 4.7.

Fig. 4.7
Selecting Pre-weighting by tapping on the 'Wgt' parameter



4.2.8 Scaling

Scaling the Level in the FFT Graph

You can select from the following scales that are available with FFT Analysis Software BZ-7230 for amplitude measurement::

- RMS (root mean square value of the FFT line/spectrum)
- Peak (RMS value $\times \sqrt{2}$)
- Peak-Peak (RMS value $\times 2\sqrt{2}$)
- PWR, Power (RMS value²)
- PSD, Power Spectral Density (RMS value²/NBW)
- ESD, Energy Spectral Density (RMS value²/NBW \times observation time)

The observation time for manual and continuous measurements is the elapsed averaging time, and for transient measurements it is the record length.

Scaling for Different Signals

When considering amplitude scaling:

- For deterministic signals, use the Power scaling: $PWR = RMS^2$
- For random signals, use Power Spectral Density scaling: $PSD = PWR/Bandwidth$
- For transient signals, use Energy Spectral Density scaling:
 $ESD = PSD \times observation\ time$

Note: Your choice of scaling will not affect the appearance of the displayed spectrum. It is the units and values in the display that will reflect your choice.

Summation Principle

Table 4.1 summarises the summation principle for each type of scaling relative to the total level (or sum for Delta Cursors).

Table 4.1
Summation principles

i = included FFT lines
 T = observation time

Total Level (or sum for Delta cursors)		
Scaling	Hanning Window	Rectangular Window
RMS	$\sqrt{(\sum_i p_i^2 / 1.5)}$	$\sqrt{(\sum_i p_i^2)}$
PWR	$\sum_i p_i^2 / 1.5$	$\sum_i p_i^2$
PSD	$\sum_i p_i^2 / 1.5$	$\sum_i p_i^2$
ESD	$(\sum_i p_i^2 / 1.5) \times T$	$(\sum_i p_i^2) \times T$
Peak	N/A	N/A
Peak - Peak	N/A	N/A

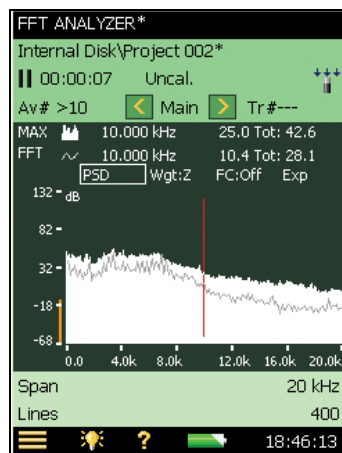
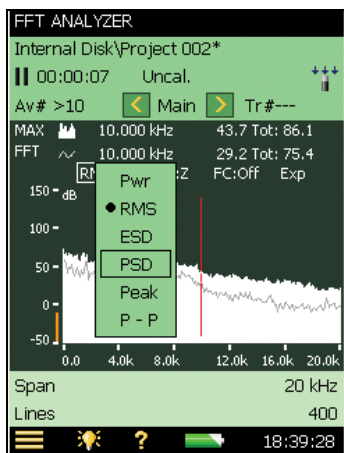
The default scaling for FFT Analysis Software BZ-7230 is RMS. Changing the scaling will result in change in units and values on the display. Different levels of scaling can be used for different signals, for example, for random signals, use PSD (Power Spectral Density) scaling.

Note: Depending upon which scaling is selected, the relevant values of Total level and sum are modified.

- 1) Click the **RMS** parameter label on the measurement display.
- 2) Select **PSD** from the dropdown list that is displayed, see Fig. 4.8.

Fig. 4.8

Left: Changing scaling from measurement display
Right: Resulting measurement display



Note: Alternatively, on the **Quick** view tab of the **Setup** menu, select **Units**, then **Scaling**, and then **PSD**.

Frequency Correction

The use of frequency correction was covered earlier, section 2.3.1 For the initial measurement, set the *Frequency Correction* parameter to *Off*.

Spectrum Compress/Expand

If you want to view the signal in more detail, expand the display to the range of your choice.


Reference Spectrum Display

If you have stored a reference spectrum (see section 2.3.9), you can show or hide it on the measurement display by clicking the graph selection panel.


4.3 Measuring

If you have been through the screens mentioned in section 4.2, you should be in a position to make an initial exploratory measurement. The parameters should have been set to allow you to quickly find out what parts of the spectrum you are interested in analysing further. When you have found what you really want to measure, then you can fine-tune the setup.

4.3.1 Measurement Start

- 1) Close all the other screens and view the measurement display.
- 2) Press **Start/Pause**  to start the measurement. Pressing this clears the measurement buffer – any spectrum shown will be erased.
- 3) If you don't see the proper signal, apply the Y-axis operations (section 2.3.10) to view the signal clearly.

4.3.2 Overload Indication


During measurements you may see the instantaneous *Overload* warning  (or the textual feedback on the overload situation) on the status panel. These indicate that the input signal amplitude is (or has been) too high.

4.3.3 Cable Break/Short Detection

Cable breaks and shorts are detected at the start and the end of a measurement – and indicated by a message box. Intermittent cable breaks and shorts during a measurement **will not** be detected.

4.3.4 Measurement Pause/Continue/Save


Pause

When using exponential averaging, the analyzer will continue to measure until you press **Start/Pause** . This pauses the measurement and displays the last spectrum in the measurement buffer.

Continue

Since pausing the measurement does not clear the measurement buffer, pressing the key again continues a measurement from where it left off.

Save





When you have completed your measurement, you need to save it. Check that the data path at the top of the screen displays the project where you want to save the measurement and press the **Save** pushbutton .

Average Number, Elapsed Time, Current Averaging Time and Total Averaging Time

For exponential averaging, you set a number of spectra to be averaged together. Until this number of spectra have been recorded, the software will display the current record number, in the form *Avg#n*, on the status panel. When the set number has been exceeded, you will see *Avg#>n*.

Similarly, the elapsed measurement time is shown on the status panel. The current and total averaging time can be seen on the value panel on the bottom of the screen.

4.3.5 Main Cursor

Whether the measurement is running or paused, the frequency and amplitude of the FFT line at the main cursor for both graphs is shown on the respective graph panels, if applicable. You can scroll the main cursor using the   pushbuttons (or the   buttons).

4.3.6 Total Reading

The cursor gives the frequency and amplitude value of the FFT line it is aligned with. However, if you wish to know the total level of the displayed spectra, you should read the displayed total at the right-hand end of the graph panel.

4.3.7 Linear Averaging

The initial exploratory measurement used exponential averaging. This was chosen to allow you to see any changes in the average signal. For detailed analysis and qualified measurement of a random signal, you should choose linear averaging.

The main difference between exponential and linear averaging is that with linear averaging, all the energy gathered during the averaging time is used to build up the final spectrum, whereas for exponential averaging only the full energy from the latest record is used. Previous records only partially contribute to the total – with the penultimate record being given a lot more emphasis than the very first one.

The duration of the measurement is set by you, but should be long enough to build up a good representation of the random signal.

Setting Linear Averaging Parameters

The values used for Linear averaging are set using the *Meas. Ctrl.* parameters on the **Setup** menu. Change averaging to linear, and set the # *Average spectra* parameter to the number you require.

Notes:

- Set the value of *Avg. Spectra* to give an average time (measurement period) that is long enough to be sure that the signal you are measuring is fully represented. For example, when measuring environmental noise, some standards require that you measure for at least two minutes to be sure that a good representative sample is taken.
- The *Avg. Time* field is computed by the FFT software. The value depends upon the frequency span (see section 4.2.4) and the number of spectra to be averaged.
- Changing the *Averaging Type* parameter will reset the measurement buffer and start a new measurement.

4.4 Fine Tuning

In section 4.3, the initial exploratory measurement was dealt with. The setup was designed to allow you to quickly home in on the general characteristics of the random signal. This section deals with how to make more qualified measurements on the signal as a whole, or on specific parts of the signal.

4.4.1 Zooming In

Whether you are using exponential or linear averaging, you may see parts of the measured spectra that require closer inspection (a finer resolution). You may do this by changing the span, centre frequency and the x-axis scaling.

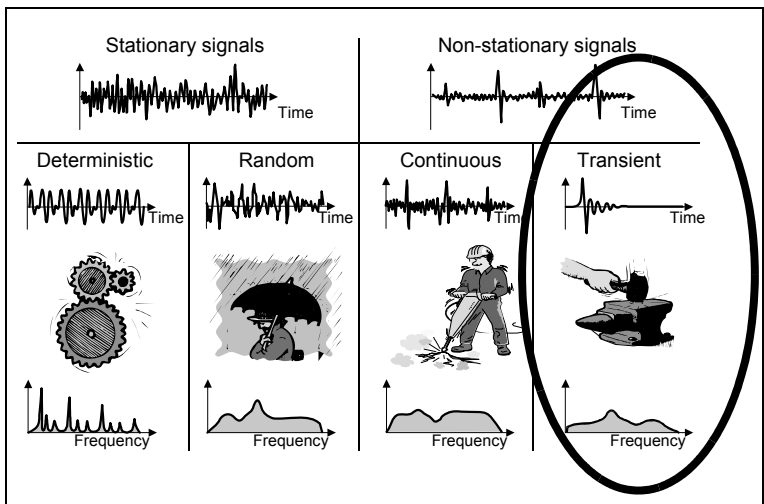
The initial span and centre frequency were entered as part of the measurement set up (see section 4.2.4). The x-axis scaling was set to be in *Compress* mode.

Chapter 5

Measuring Transient and Continuous Signals

5.1 Transient Signals

Fig. 5.1
Transient signals



A transient signal is a signal which only exists for a short period of time. Examples of transient signals are impacts caused at industrial sites, combustion in a reciprocating machine, or the opening or closing of a valve. A transient signal produces continuous spectra.

To measure transient signals you need to be able to trigger at (or just before) the start of the signal, and be sure to capture the transient within the length of a single FFT record.

Note: If the transient cannot be captured within the length of a single FFT record, the technique for measuring continuous signals described in section 5.2 can be used.

5.1.1 Preparing for Measurement

This section will guide you in choosing suitable start values for the measurement of transient signals.

5.1.2 Configuring the Input

Configuring the input is a two step process:

- 1) Choosing the correct transducer
- 2) Calibrating the system using Calibrator Type 4294.

These steps are covered in detail in Chapter 3, and should be done before proceeding.

5.1.3 Configuring the Analyzer

The following parameters, discussed in Chapter 2, are also applicable for transient measurements. You should check each one in turn before you begin measurements to make sure they are set correctly in relation to your expected input signal:

- Frequency Resolution and Span
- X-axis scaling – compress/expand
- Corrected Frequency

5.1.4 Measurement Control

To measure transient signals, you need initially to set the analyzer to triggered mode:


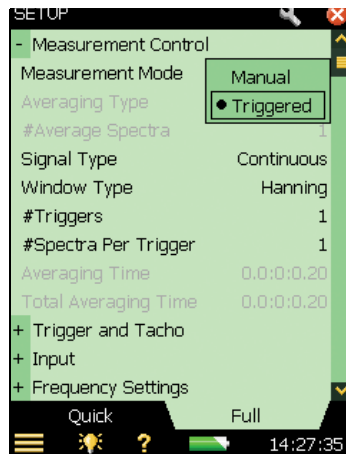
- 3) Tap the Main Menu icon  and select **Setup** from the list of options.
- 4) On the **Quick** setup tab, locate the *Measurement Control* group and change the *Measurement Mode* to *Triggered*, see Fig. 5.2.

Fig. 5.2
Setting Triggered mode

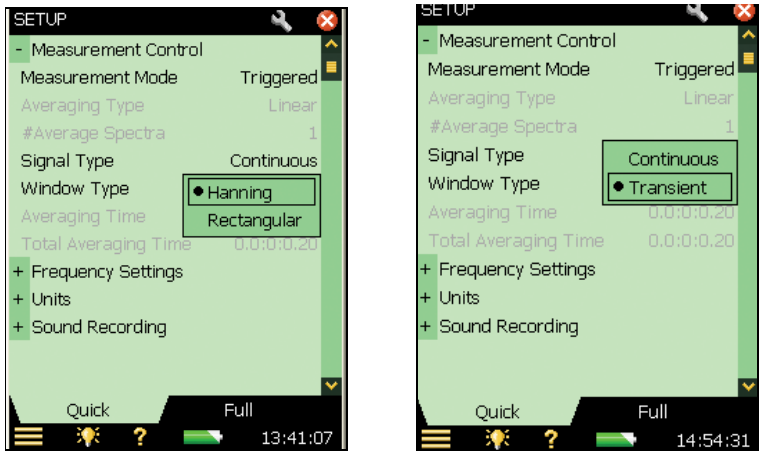


Time Windows

The purpose of a time window is to minimise the effects of the discontinuity which occurs when only a section of a continuous signal is measured. When measurement is manual, the Time window parameter is always set to Hanning. In the triggered mode, you can change

the Window Type from Hanning to Rectangular, and vice versa. You can also change the Window Type by changing the Signal Type, see Fig. 5.3.

Fig. 5.3
Left: Selecting Hanning as the window type from Setup menu
Right: Selecting Transient as signal type from Setup menu



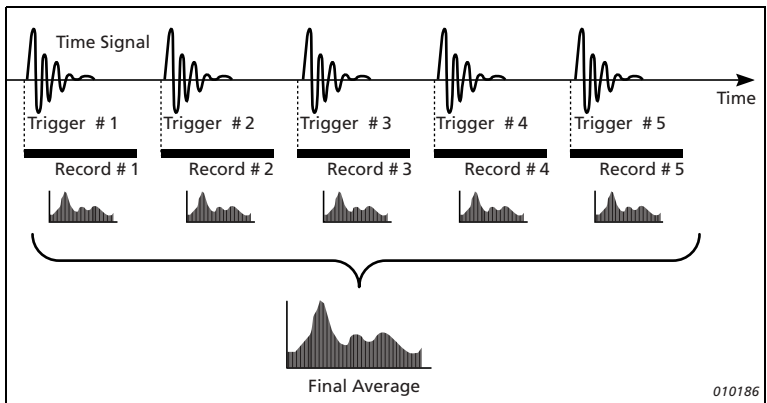
- 1) Set the *Measurement Mode* to *Triggered*.
- 2) Set *Signal Type* to *Transient* – *Window Type* automatically changes to *Rectangular*.
- 3) Observe the spectra.

Note: Transient signals always correspond to rectangular windows and continuous signals always correspond to Hanning windows.

Triggers

The number of triggers that you set determines how many records will be averaged together to make the final result – see Fig. 5.4. You can get a statistical average of several occurrences when measuring if you trigger more than once.

Fig. 5.4
How spectra are averaged in triggered mode, when signal is transient



One consequence of increasing the number of triggers is that the duration of the measurement increases – you need to wait longer to get the final result. Another consequence is that random components in the measurement will also be averaged.

5.1.5 Setting Up the Y-axis

The Y-axis can be set up by selecting the scaling and the units for display.

Setting the units for the Y-axis depends on the following factors:

- The type of Y-axis scaling selected (Linear or Logarithmic)
- The type of transducer selected (Microphone/Accelerometer/Direct)
- The Unit System used (SI, US/UK)
- How the Vibration is displayed (Acceleration, Velocity or Displacement)

The displayed Y-axis can also be scaled in terms of the display range. We shall cover this in the Y-axis operations section.

Table 5.1 shows the physical units that are available when an accelerometer is selected.

Table 5.1 Physical units available for display

	SI	US/UK
Acceleration	m/s ² (dB ref: 1 μm/s ²)	g (dB ref: 1 μg)
Velocity	m/s (dB ref: 1 nm/s)	nm/s (dB ref: 10 nm/s) ^a
Displacement	m (dB ref: 1pm)	mil (dB ref: 1 μmil ^b)
Sound	dB (dB ref: 20 μPa)	dB (dB ref: 20 μPa)
Direct	Volts (dB ref: 1 μV)	Volts (dB ref: 1 μV)

a. These units are traditionally used in the US and UK.

b. 1 mil = 0.001 inch

5.1.6 Scaling of Transient Signals

Power has no meaning in relation to transient signals, since the signal only exists for a short period of time. What is of interest for a transient signal is the energy. The energy is the main factor to take into consideration for a transient signal. This is obtained from the measured power by multiplying it with the observation time. The measurement should be normalised with respect to the filter bandwidth, since transients have continuous spectra resulting in energy spectral density (ESD). ESD is measured in units² seconds/Hz.

Therefore, for transient signals, use ESD scaling.

5.1.7 Y-axis Unit Display

Change the units of the Y-axis from the ‘dB’ to the ‘engineering’ scale by:

- 1) Selecting *Units* and then *Y-axis* from the **Setup** menu.

- 2) Select *Engineering*, see Fig. 5.5 and Fig. 5.6.

Fig. 5.5
Left: The Y-axis with 'dB' units displayed
Right: Selecting 'engineering' units from the Setup menu

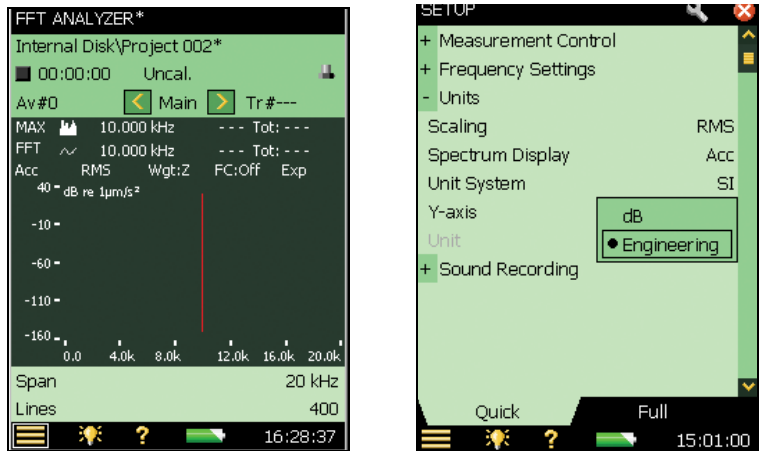
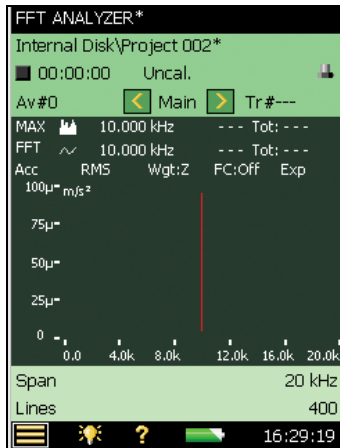


Fig. 5.6
The Y-axis with 'engineering' units displayed



5.1.8 Linear to Log Conversion

When Y-axis displays an engineering scale, the scale can be chosen to be either linear or logarithmic.

On a linear scale, the selection values on the Y-axis are divided linearly, while on a logarithmic scale, they are divided exponentially. Also, while measuring vibrations the structural responses vary over a wide dynamic range, so, select logarithmic scaling. To change from Linear to Logarithmic:

- 1) Tap on the Y-axis.
- 2) Select **Log** from the drop-down list that appears, see Fig. 5.7.

Fig. 5.7

Left: Switching between linear and log scale
Right: Log scale displayed



5.1.9 Unit System

With FFT Analysis Software BZ-7230 you can view the acceleration in SI units or in US/UK units. To change the unit system:

- 1) Click *Units* on the **Setup** menu, and then *Unit System*.
- 2) Select *US/UK*, see Fig. 5.8 and Fig. 5.9.

Fig. 5.8

Left: SI units displayed
Right: Changing to US/UK units from Setup menu

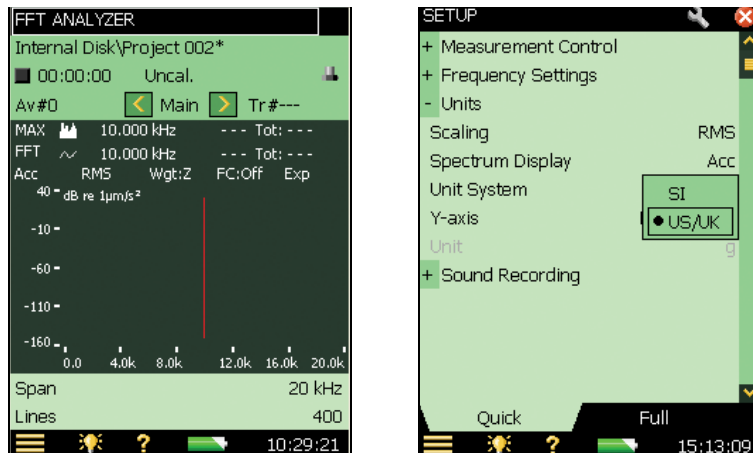
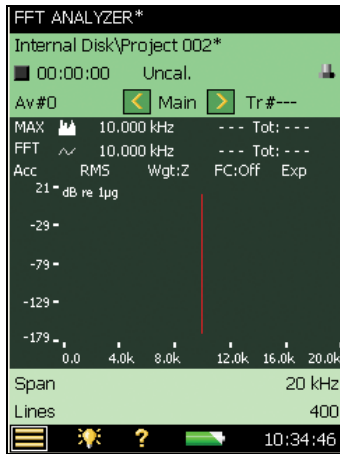


Fig. 5.9
US/UK units displayed



5.1.10 Spectrum Display

The vibration spectrum can be displayed in terms of Acceleration, Velocity or Displacement.

Acceleration Displays

These are used where forces, loads, and stresses must be analysed, and where force is proportional to acceleration

Velocity Displays

These are used

- Where vibration measurements are to be correlated with acoustic measurements, since sound pressure is proportional to the velocity of the vibrating surface
- In measurements on machinery where velocity spectrum usually is more uniform than either displacement or acceleration spectra

Displacement Displays

These are used:

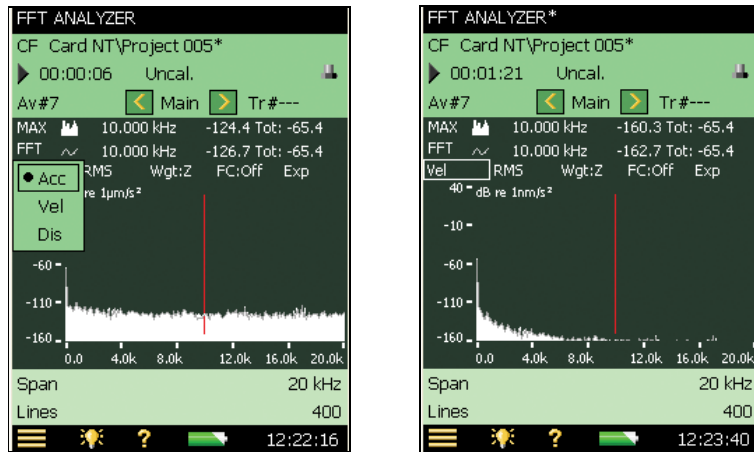
- Where amplitude of displacement is particularly important – for example, where vibrating parts must not touch, or where displacement beyond a given value results in equipment damage
- Where the magnitude of displacement may be an indication of stresses to be analysed

To change the display of the spectrum, use one of the two following methods.

- 1) Tap on the spectrum display on the measurement screen.
- 2) Select **Acc**, **Vel** or **Dis** from the drop-down list that appears, see Fig. 5.10.

Fig. 5.10

Left: Changing spectrum display from measurement page
 Right: Resulting measurement page



Alternatively, you can select *Units*, and then *Spectrum Display* from the **Setup** menu.

Fig. 5.11

Left: Changing spectrum display from Setup menu
 Right: Resulting measurement page



5.1.11 Averaging

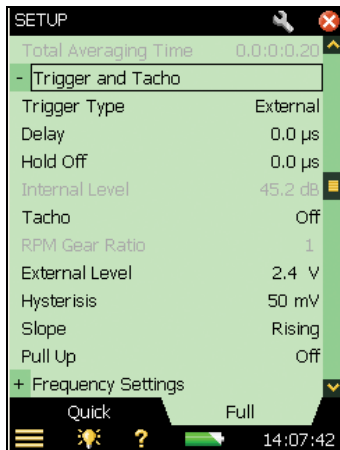
You cannot switch between linear and exponential averaging in triggered mode. Averaging is set to Linear, and cannot be toggled.

5.1.12 Trigger Values

When *Measurement Mode* is set to *Triggered*, the BZ-7230 software will only begin a measurement when either an internal or an external trigger has occurred. However, you must still prime the analyzer by pressing **Start/Pause** (⏸).

To set the trigger state use the *Trigger and Tacho* parameters on the **Setup** menu, see Fig. 5.12.

Fig. 5.12
Setting the trigger and
tacho parameters



Trigger Type

This parameter determines whether the trigger input is internal or external. Choose *Internal* to trigger on the incoming time signal (applied through the ‘Rear Input’ or ‘Top’ socket) and *External* to trigger on an external signal applied through the ‘Trigger Input’ socket.

Delay

The delay parameter determines the delay from the trigger point to the start of the record. When the delay is positive, the record starts the specified duration after the occurrence of the trigger point. When the delay is negative, the record starts the specified duration before the occurrence of the trigger point.

Hold Off

The hold off value determines the time that the trigger circuit is held off after the occurrence of a trigger. A new trigger is only accepted after this time. You can use this to prevent false triggering:

- If a transient/trigger condition you are not interested in occurs shortly after the one you are interested in
- If your transient is longer than the record length and energy in the signal causes re-triggering before the transient has decayed (records will be overlaid incoherently). If the repetition rate of the transient signal allows, it is wise to set a hold-off time longer than two record lengths

Hysteresis

This parameter determines the ‘hysteresis’ on the external trigger. (Hysteresis refers to the ‘safety margin’ you should take into account when setting the trigger level and will stop interference from noise signals around that level.) The parameter is enabled when *Trigger Type* is set to *External* or *Tacho* is set to *On*.

Slope

The slope parameter determines the trigger slope on the external trigger. It is enabled when *Trigger Type* is set to *External* or *Tacho* is set to *On*. You can choose to trigger on the Rising or Falling slope of the external trigger signal.

Pull Up

Use this parameter to ‘pull up’ the external trigger input to +5 V (via a 7.5 kΩ resistor). This parameter is enabled when *Trigger Type* is set to *External* or *Tacho* is set to *On*.

Internal/External Level

The *Internal Level* parameter determines the level of the incoming measurement signal that will cause a trigger. This parameter is enabled when *Trigger Type* is set to *Internal*. The maximum value you can enter depends on the full-scale level.

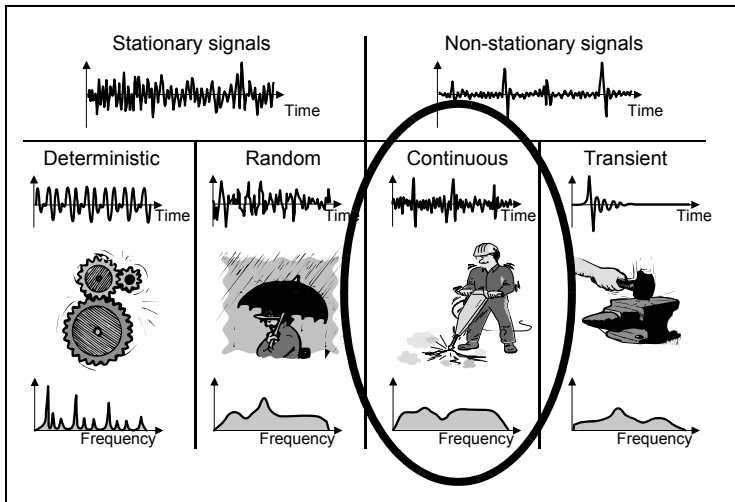
The *External Level* parameter determines the level of the signal applied on the trigger input that will cause a trigger. This parameter is enabled when *Trigger Type* is set to *External* or *Tacho* is set to *On*. It can be set to any value from –18 V to +18 V. By default it is set to +2.4 V.

In practice, a good way to set the trigger level and to avoid false triggering is to:

- 1) Open the keyboard panel for configuring the Trigger Level by tapping on the value next to the *Internal Level* or *External level* parameter (under *Trigger and Tacho* in the **Setup** menu). See Fig. 2.22. Type in the required value.
- 2) Tap the button on the keyboard panel to apply the value. You can now check whether triggering occurs (or not) by watching the keyboard panel. It will display *Triggered* (or *Not Triggered*) depending on the situation.
- 3) Set the trigger level so that no triggers occur when only the background noise is present.
- 4) Check that triggering occurs when the signal and background are present.
- 5) To confirm the level you’ve set, click outside the keyboard panel or tap on the button.

5.2 Continuous Signals

Fig. 5.13
Continuous signals



Continuous (non-stationary) signals have some similarities with both transient and stationary signals. During analysis continuous non-stationary signals should normally be treated as random signals (see Chapter 4), or separated into their individual transients and treated as transients (see section 5.1). An example of a continuous signal is a pneumatic drill where there are random components from the air supplied by the compressor, and the transients are produced when the drill-bit is applied to a material.

Continuous signals normally need to be measured over a period of time that is longer than one record, but starting with some form of trigger. Thus, you can consider them to be an extended measurement of a transient signal (which is measured one record at a time). You should note that the transient signal is measured with a rectangular window in BZ-7230, while continuous signals use Hanning windows with overlap.

5.2.1 Configuring the Analyzer

The following parameters, discussed in previous sections, are also applicable for continuous measurements. You should check each one in turn before you begin measurements to make sure they are set correctly in relation to your expected input signal:

- Frequency Resolution and Span
- Y-axis
- X-axis Scaling – compress/expand
- Corrected Frequency
- Trigger Values

5.2.2 Measurement Control

To measure continuous signals you need to set the analyzer, initially, for a triggered measurement start with continuous signals. Select *Measurement Control* from the **Setup** menu, and then the following parameters:

Time Window

The time window is automatically set to *Hanning* when you set the *Signal Type* parameter to *Continuous*.

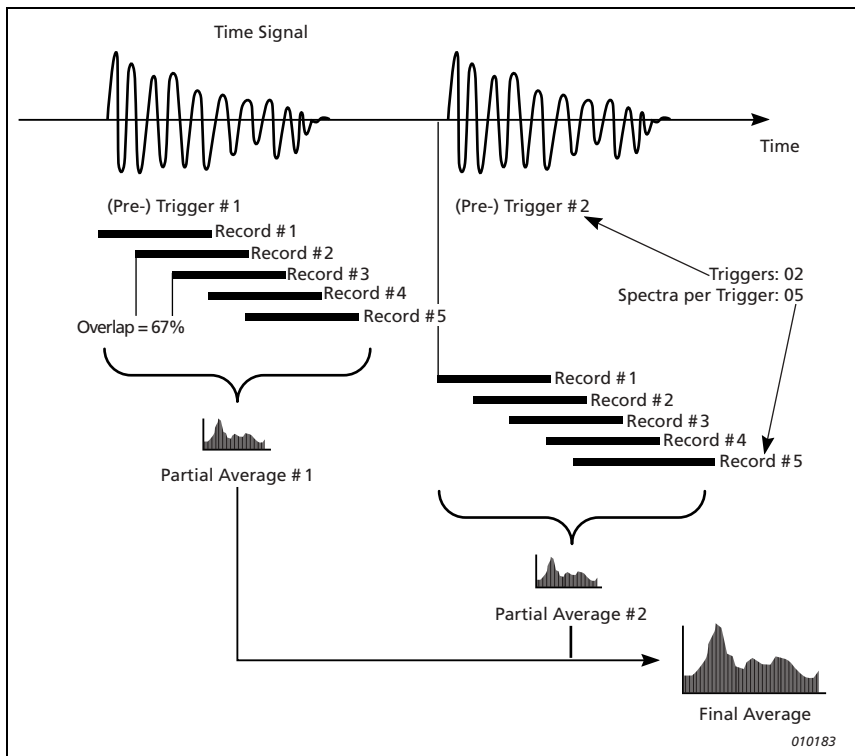
Triggers

The number of triggers that you set determines how many batches of records will be averaged together to make the final result (*#Triggers* parameter).

Spectra per Trigger

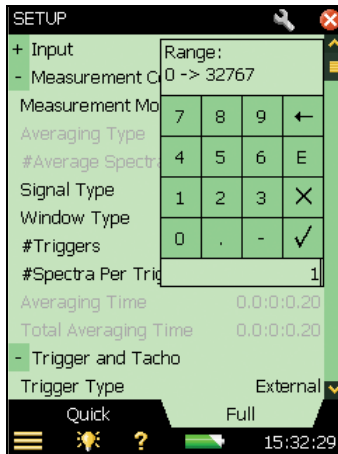
For continuous measurements, each time a trigger occurs the software will linearly average together the number of spectra per trigger (*#Spectra per Trig* parameter) that you have set – see Fig. 5.14 and Fig. 5.15. You can consider this number to be the number of records in a batch.

Fig. 5.14 Graphical explanation of what happens to records when measuring triggered, continuous signals using the set up described in section 5.2.2



Set the value of *#Spectra per Trig* to give an average time (measurement period) that is long enough to be sure that the signal you are measuring is fully captured in each batch of records.

Fig. 5.15
Entering the number of spectra per trigger for a triggered measurement



Measuring

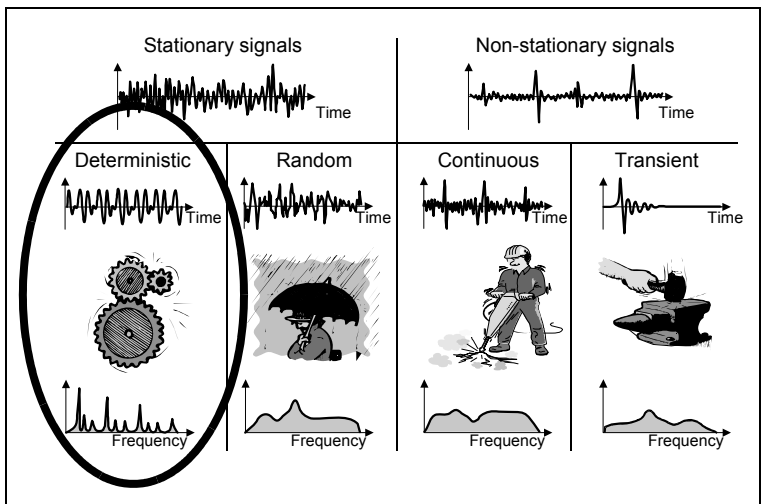
See “Measuring” on page 43.

Chapter 6

Measuring Deterministic Signals

6.1 Deterministic Signals

Fig. 6.1
Deterministic signals



Deterministic signals are made up entirely of sinusoidal components at discrete frequencies. When the spectral lines show a harmonic relationship, the signal is described as being periodic. Examples of a periodic signals are vibration from a rotating shaft, the sound/vibration from meshing gearwheels, or more theoretically a square wave.

To measure deterministic signals successfully you need to use multiple cursors to explore the relationships of the discrete frequencies.

For machine diagnostics, it is also useful to be able to compare two spectra – for example a known reference generated by measuring an optimally set up machine compared to the current state of the machine.

6.2 Preparing for Measurement

This section will guide you in choosing suitable start values for measurement of deterministic signals.

6.2.1 Configuring the Input

Configuring the input is a three step process:

- 1) Choosing the correct transducer.
- 2) Setting the signal source and type.
- 3) Calibrating the system.

These steps are covered in detail in Chapter 3, and should be done before proceeding.

6.2.2 Configuring the Analyzer

The following parameters, discussed in Chapter 4, are also applicable for deterministic measurements. You should check each one in turn before you begin measurements to make sure they are set correctly in relation to your expected input signal:

- X-axis Scaling – compress/expand
- Corrected Frequency

6.2.3 Measurement Control

To measure deterministic signals you need to set the analyzer, initially, for a manual measurement start with exponential averaging. (Select *Measurement Control* from the **Setup** menu, set *Measurement Mode* to *Manual*, *Averaging Type* to *Exponential*, and then check the following parameters:

Time Window

The time window (*Window Type* parameter) is automatically set to *Hanning* when you set *Measurement Mode* to *Manual*.

Frequency Resolution/Span

Deterministic signals will, in general, be generated by rotating machinery. There is likely to be a fundamental frequency related to the base rpm. In a system involving gears (meshed or chain driven), there will also be harmonics related to the fundamental. The gearing ratio and number of teeth involved give frequencies related to the fundamental. So, you should choose the frequency resolution and span to encompass what you expect to be in the signal.

For vibration measurements, a span of 10 times the fundamental frequency is suitable. Then you will be able to see harmonics up to the ninth. If the fundamental frequency is above 2 kHz, then you must set the span to maximum. Similarly, if you cannot guess what the fundamental frequency is, or if there are many, then maximum span can be used to get an overview. Remember, you can always zoom in later.

For example, consider a 1:2 gear system running at 600 rpm (input) with 40 teeth on the input gear and 20 on the output gear, set the *RPM Gear Ratio* parameter to 2. This will give frequencies of 10 Hz, 20 Hz, and 400 Hz – so you might set the initial span to 1 kHz and centre frequency close to 500 Hz.

6.2.4 Correct Scaling of Deterministic Signals

Deterministic signals are normally described in terms of their mean square or their root mean square amplitude (RMS), as a function of frequency. The RMS value, U , is the square root of the mean square. RMS is measured in the appropriate units. Mean square is measured in units².

Mean square is often also called power (U^2), which strictly speaking is not correct since impedance is missing, so it is assumed that the impedance has a numerical value of unity.

For Deterministic Signals

Measure Power (PWR in U^2) or RMS amplitude (RMS in U)

6.2.5 Turning Frequency Correction On/Off

You can turn the frequency correction algorithm on and off at any time – select *Measurement Control* from the **Setup** menu, then under *Frequency Settings* set the *Frequency Correction* parameter to ‘On’ or ‘Off’ as required. Frequency correction will work with any measurement mode, that is, manual, transient or continuous.

6.2.6 RPM Measurement

RPM is measured on the signal that is connected to the trigger input. To measure RPM the *Tacho* parameter should be set to *On*.

Two types of RPM can be displayed, either instantaneous or average RPM.

Instantaneous RPM is only displayed, as it is being measured, at the trigger input, whereas Average RPM is displayed and stored together with each spectrum result. It is an average over the same time as the spectrum, if *Linear Averaging* is selected as *Averaging Type*. If *Exponential* is selected, no averaging is done. The result is the last measured RPM.

6.3 Reference Spectra

FFT Analysis Software BZ-7230 has a buffer to store a reference spectrum. The spectrum saved in this buffer can be the current measurement, or it can be a recalled measurement. In the case of turbines, a perfectly balanced turbine’s vibrations can be used as the reference spectrum.

Volatile Memory

Data in the reference spectrum buffer is not saved and is therefore lost during power-off. The only way to save a spectrum that you can use in the future as a reference spectrum is to

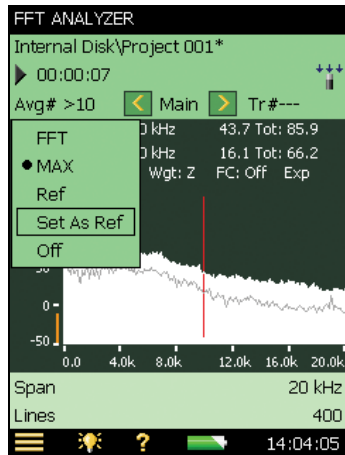
save it from the measurement screen. This means that either you need to plan in advance which spectra you want to use as a reference, or save every measurement.

Note: The reference spectrum can only be displayed if the parameters (frequency) *Span*, *Centre Freq.*, (number of) *Lines*, and *Trans. Used* match the currently displayed measurement.

Set as Ref

Use the ‘Set as Ref’ option to save the currently displayed spectrum in the measurement buffer as a reference spectrum (you do this by tapping *FFT* on the primary cursor line and selecting *Set as Ref* from the drop-down list, see Fig. 6.2).

Fig. 6.2
Saving the reference spectrum



Show/Hide

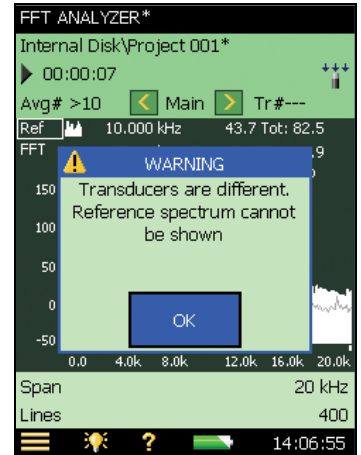
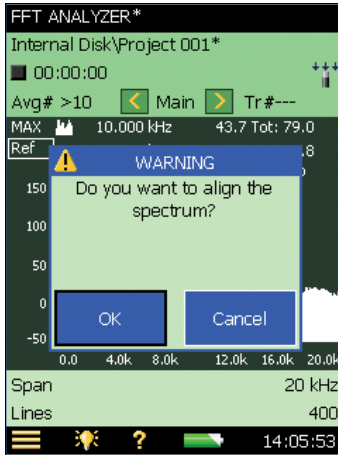
You can show or hide the reference spectrum using the Graph Panel (see Fig. 2.2). The reference spectrum can be shown as a line graph or a bar graph depending on whether you select it from the first or second line of the Graph Panel.

Align

When the current setup, with respect to *Span*, *Centre Frequency*, and (number of) *Lines*, is different from the setup in which the reference spectrum is stored, you will be asked if you want to ‘align’ the measurement (this means aligning the current measurement setup to that of the reference spectrum setup), see Fig. 6.3.

However, if the transducer used is different, you cannot display the reference spectrum, even if the above three parameters are the same, also see Fig. 6.3.

Fig. 6.3
 Message boxes that appear:
 Left: when parameters of spectrum are different
 Right: when the transducers are different



Chapter 7

Tone Assessment Option BZ-7231

7.1 General


Tone Assessment Option BZ-7231 works with sound spectra and allows you to:

- Assess tones in a measured FFT spectrum according to “ISO 1996:2007 Acoustics – Description, assessment and measurement of environmental noise – part 2: Determination of environmental noise levels. Annex C (informative) Objective method for assessing the audibility of tones in noise – Reference method”
- Use the ‘Generate tone at cursor’ feature to generate a pure tone on the headphone output of the Hand-held Analyzer, for comparison to the actual noise

BZ-7231 works as an ‘add-on’ to BZ-7230, and allows assessment of tones on-site. The result of the tone assessment is the adjustment ‘ K_t ’ to the rating level as described in ISO 1996. The L_{Aeq} and other broadband parameters are measured simultaneously by the Hand-held Analyzer and the tone corrected rating level can be calculated on-site. Additionally, the ‘Generate tone at cursor’ feature is a useful tool that can be used in dialogue for identifying a tonal noise source.

BZ-7231 works with Sound Recording Option BZ-7226 and, together with BZ-7230, provides the complete solution for on-site objective FFT-based tone assessment and recording.

BZ-7231 gives you results on-site as well as preparing for post-processing and reporting back at the office. Documentation can be prepared using Utility Software for Hand-held Analyzers BZ-5503 or the measured data can be exported for post-processing by Evaluator Type 7820 or other post-processing software such as Microsoft® Excel®.

Check the **About** Menu to see whether you have the right license to run the Tone Assessment Option. (The **About** Menu is accessed from built-in help – tap  on the shortcut bar, then select **About**.)

If you have purchased a Hand-held Analyzer together with the software application(s), then the relevant license(s) comes pre-installed on the instrument.

If you purchased a separate software application for your Hand-held Analyzer, then you have to install the license on the instrument. This is done using Utility Software for Hand-held Analyzers, BZ-5503. Please consult the on-line help included with the BZ-5503 software for instructions on how to install a license.

7.2 Introduction to Tone Assessment

When assessing noise, it is generally recognised that noise containing audible pure tones is more annoying than noise with the same A-weighted broadband level that does not contain audible tones. The first evaluation of audible tones in noise is most often carried out by the human ear. But for comparative analysis results, and documentation, an objective analysis may be needed.

Tone Assessment may be performed using either a 1/3-octave method or an FFT-based method. “ISO 1996-2:2007 Determination of environmental noise levels” includes two informative annexes dealing with objective Tone Assessment:

- Annex C: “Objective method for assessing the audibility of tones in noise – Reference method”. This method uses FFT analysed measurements.
- Annex D: “Objective method for assessing the audibility of tones in noise – Simplified method”. This method uses 1/3-octave analysed measurements.

The selection of the method to be used when assessing tones in noise is dependent on local legislation. The local legislation may refer to ISO 1996-2 or some local method.

The ISO 1996-2 Annex C method provides measurement procedures that are used to verify the presence of audible tones. The method is based on the psychoacoustic concept of critical bands. The definition of a critical band is that noise outside the band does not contribute significantly to the audibility of the tones inside the critical band.

The implementation of the ISO 1996-2 Annex C method in Hand-held Analyzer FFT-based Tone Assessment, BZ-7231, includes procedures for steady tones, narrow-band noise, low frequency tones and the result is a graduated adjustment, K_t , to the rating level calculated from L_{Aeq} . The tone-corrected rating level is obtained by adding the adjustment K_t to the L_{Aeq} level.

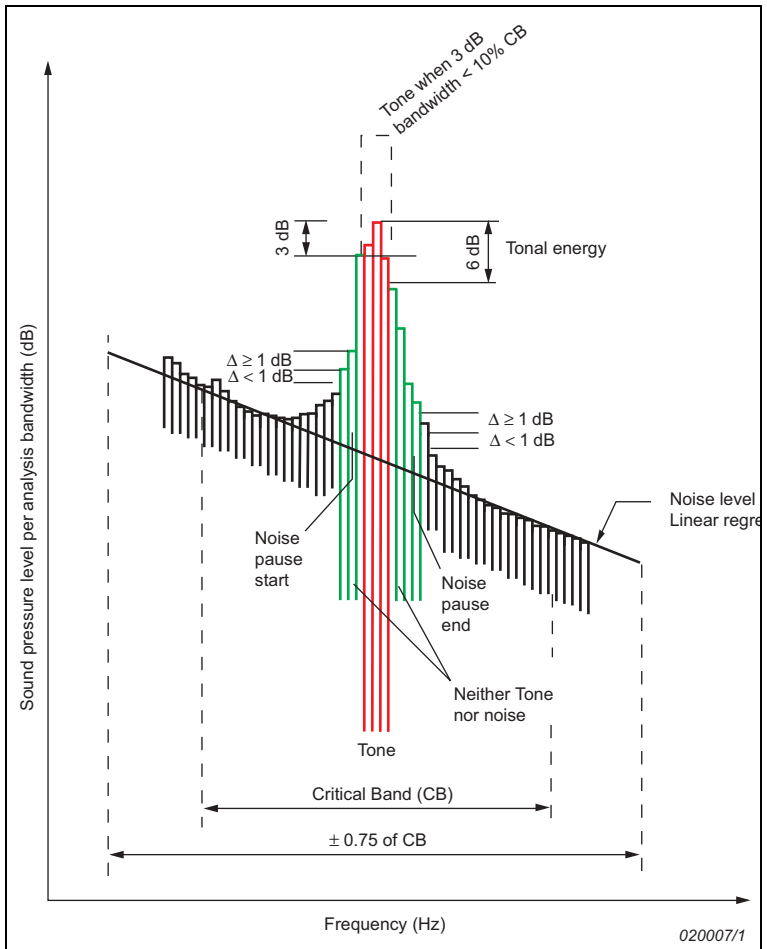
ISO 1996-2 Annex C describes how to deal with time-varying tones. Tones may be varying either in level or in frequency. Tone Assessment Option BZ-7231, does not support automatic features for dealing with time-varying tones.

Find more information about rating level and assessment of environmental noise in ISO 1996-2 and in Brüel & Kjær’s Environmental Booklet.

7.2.1 Tone Assessment Calculations

BZ-7231 follows the rules given in ISO 1996-2 Annex C. Please refer to Fig. 7.1 for a graphical overview of terms and definitions explained in this section.

Fig. 7.1
Graphic overview of terms related to FFT-based tone assessment



Detecting the Tone Candidates

First, the calculation algorithm looks for noise pauses in the measured FFT-spectrum. A noise pause is a local maximum in the spectrum with a probability of containing a tone.

The *Tone Seek Criterion* in the **Setup** menu is the threshold for the algorithm that looks for noise pauses in the spectrum, i.e., differences between successive line levels. The criterion may be interpreted as the maximum variation in levels between neighboring lines in the parts of the FFT-spectrum where no tone candidate is present. In general this criterion should be set to 1 dB. For irregular spectra (mainly spectra with short averaging time) values up to 4 dB may give better results.

When a noise pause is detected, the tone-seek algorithm seeks for tones (or narrow bands of noise) at local maxima inside the noise pauses. A tone (or narrow band of noise) is a local maximum with a 3 dB bandwidth smaller than 10% of the bandwidth of the critical band. The tone level is the energy sum of all lines within 6 dB of the local maximum level, corrected for the influence of the Hanning window.

Critical Bands

The critical band (the frequency range that can mask the tone) is centred on the tone, and its width is 100 Hz below 500 Hz, and 20% of the tone frequency above 500 Hz. Note that above 500 Hz this is close to the bandwidth of 1/3-octave filters (23%), while it is progressively wider at lower frequencies.

If more than one tone is found within a critical band, the critical band is placed symmetrically around the tones in the critical band, centring on the sum of frequencies divided by the number of tones. Only tones with levels within 10 dB of the highest tone level are included in the positioning of the critical band. If not all tones can be included in the critical band, that placement of the critical band is selected, which yields the highest difference between tone level and masking noise level.

Tone Level and Noise Level

Usually, the frequency of a tone does not coincide precisely with one line in the FFT spectrum. Instead, its energy is spread over two or more lines. In such cases the tone level is the level sum of all lines within 6.0 dB of the local maximum corrected for the applied Hanning window function.

Several tones may be found within one critical band. The resulting level for every tone (see above) is added on an energy basis. The tone assessment evaluates all the tones found and the possible associated critical bands. The decisive critical band that yields the highest audibility is reported as the final result. The most prominent tone is the tone with the highest audibility within the decisive critical band.

The results for tones in other bands are also shown. In some special spectra you might find a tone with higher audibility than that of the decisive critical band – this is because the tone level is very low; a tone can be disregarded if its level is more than 10 dB below the tone with the highest level in the critical band.

The noise level in a critical band, L_{pn} is found by linear regression of the spectrum in a range $\pm 0.75 \times$ critical band from the centre of the critical band. When determining the noise level, all maxima resulting from tones are disregarded. The noise level is calculated from the part of the regression line within the critical band placed symmetrically around the tone(s).

Audibility and Penalty

The total audibility ΔL_{ta} is frequency dependent and calculated from the difference between the total tone level, L_{pt} and the masking noise level, L_{pn} in a critical band.

The penalty, K_t is referring to the total analyzed FFT-spectrum and is calculated from the **decisive band**. The decisive band is the critical band giving the highest total audibility.

The most prominent tone is the tone in the decisive band with the highest audibility.

If the audibility is less than 4 dB, no adjustment is incurred.

If the audibility is over 10 dB, the adjustment is 6 dB.

Between 4 and 10 dB, the adjustment is $\Delta L_{ta} - 4$ dB.

Note: the adjustment is not restricted to integer values.

Analysing Very Low Tone Levels

The basic aim for objective tone assessment is to give objective indicators for perceived annoyance from tones in noise. Objective tone assessment must be used with great care when the level of the detected tone(s) is close to either the threshold of hearing or the noise floor in the equipment used for analysing and calculating the objective parameters.

The Noise Floor

The noise floor of the Hand-held Analyzer may include spurious signal noise that will cause the calculation to give an adjustment (K_t) greater than 0 dB. On the Hand-held Analyzer's display, the level of the noise floor in the FFT application is indicated with a red line on the y-axis. This indication may be used as a guide when judging the source of a tone signal. For more details of the noise floor of the Hand-held Analyzer, please refer to the specifications.

The Threshold of Hearing

When tones appear at low levels, it is up to you to check whether the total tone level in the critical band is above the threshold of hearing. If the total tone level in a critical band does not exceed the threshold of hearing, this critical band should be disregarded. Special care has to be taken when tones appear at low frequencies, where the threshold of hearing is elevated.

7.3 Calibration

ISO 1996-2 Annex C recommends that the measurement setup including the frequency analyzer is calibrated for sound pressure measurements (dB re 20 μ Pa). Refer to Chapter 5 of the User Manual for Hand-held Analyzers Types 2270 and 2250, BE 1713, for more information about acoustic calibration.

7.4 Setting up the Instrument

7.4.1 Setting up the Tone Assessment Option


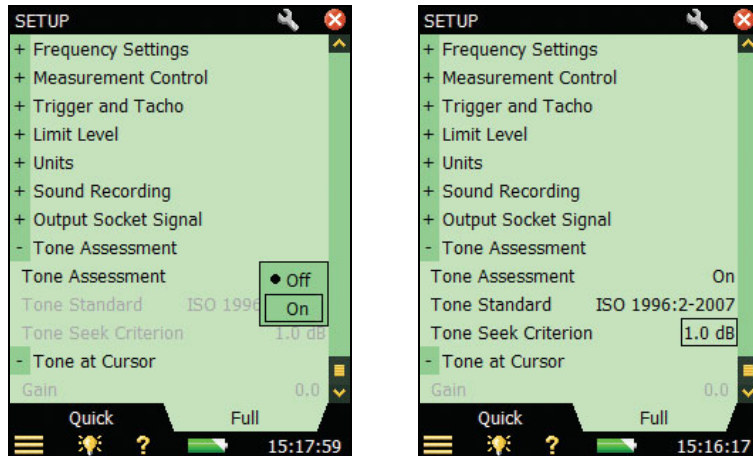
Tap the Main Menu icon  and select **Setup** from the list of options. Under the *Tone Settings* parameters (on the full list of options) tap on the *Tone Assessment* option and select *On*, see Fig. 7.2.

Fig.7.2

Left: Selecting the Tone Assessment option
Right: Setting the Tone Seek Criterion



The *Tone Seek Criterion* is set to 1 dB by default. Increasing the criterion will make the tone seek algorithm less sensitive when searching the FFT spectrum for tone candidates. Increasing the *Tone Seek Criterion* may be relevant for analysing irregular spectra (mainly spectra with short averaging times). The *Tone Seek Criterion* can be varied between 0.5 and 4 dB.

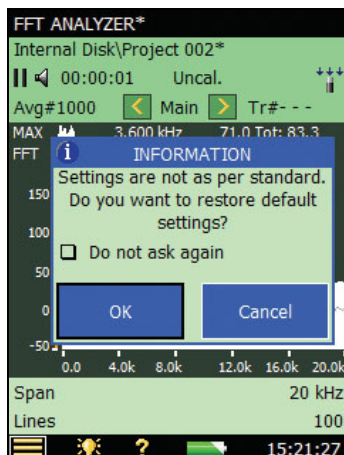
7.4.2 Setting up the Measurement Using the Default Setup

The Tone Assessment option offers two ways of setting up the FFT-measurement for tone assessment calculations. The default method will be covered first. Please refer to section 7.4.3 for a description of how to set up the measurement manually.

Start the FFT measurement by pressing the **Start/Pause** (⏸) Pushbutton. If the selected setup parameters do not comply with the recommendations in ISO 1996-2 Annex C, the following pop-up window will be displayed:

Fig.7.3

Pop-up window for the Measurement Setup Check



From the pop-up window for the measurement setup check (see Fig. 7.3) you can set the parameters relevant for Tone Assessment to a 'default' setup that complies with ISO 1996-2 Annex C. To reset all relevant parameters to the preset defaults described in Table 7.1, tap on the **OK** button. To measure with the manual setup, tap on the **Cancel** button.

The pop-up window can also be deactivated for the rest of the measurement session by checking the *Do not ask again* checkbox. To activate the tone assessment setup check again you will have to restart the FFT ANALYZER template or restart your instrument. The measurement setup check is also deactivated when the *Tone Assessment* parameter is set to *Off* in the **Setup** menu.

Table 7.1 Default Parameters used by the Measurement Setup Check for ISO 1996-2 Annex C

Default ISO 1996-2 Annex C Setup							
Tone Assessment		Frequency Settings		Measurement Control		Units	
Tone Seek Criterion:	1 dB	Span:	20 kHz	Averaging Type:	Linear	Scaling:	RMS
L_{pn} Regression Range:	$\pm 0.75 \times CB_1$	Lines:	6400	# Average Spectra:	600		
		Centre Freq.:	10 kHz	Window Type:	Hanning		
		Pre-weighting:	A-weighting	Total Averaging Time:	00:01:04, 213 ²		

1. Cannot be controlled by the user.
2. Calculated by the Hand-held Analyzer.

7.4.3 Setting up the Measurement Manually

Rating Level

The result of the FFT-based tone assessment is the adjustment K_t , which needs to be added to the L_{Aeq} measurement to calculate the rating level according to ISO 1996-2.

While using the Hand-held Analyzer with FFT Analysis Software BZ-7230 it is possible to access the wide range of broadband parameters (for example, L_{Aeq}) from Sound Level Meter Software, BZ-7222. Please refer to the User Manual for Hand-held Analyzers Types 2270 and 2250 (BE 1713) for more information about broadband parameters.

Frequency Settings

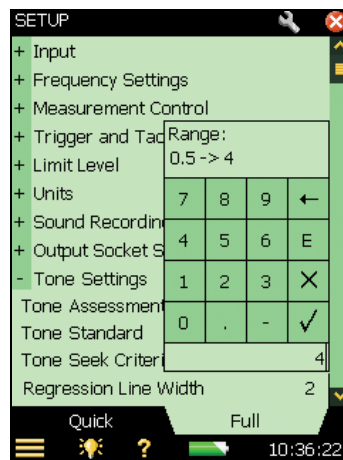
According to ISO 1996-2 Annex C, the effective analysis bandwidth shall be less than 5% of the bandwidth of critical bands with the tonal components. The bandwidth of the critical

bands is 100 Hz if the centre frequency is less than 500 Hz and 20% of the centre frequency if the frequency is more than 500 Hz.

This 5% criterion is fulfilled for the range from 20 Hz to 20 kHz if *Span* is set to *20 kHz*, *Lines* to *6400* and *Centre Freq* to *10000 Hz*. In this case the effective analysis bandwidth is 4.7 Hz.

You are allowed to select other combinations of frequency range and lines (see Fig. 7.4) – these parameters are found in the **Setup** menu, under *Frequency Settings* parameters. Selecting a lower number of lines will make the tone assessment calculation faster. If the 5% bandwidth criterion is violated within the measured frequency range, an error indication will be generated in the status codes (smileys).

Fig. 7.4
Selecting the frequency range



You can speed up the tone assessment calculation without violating the 5% bandwidth criterion by selecting a smaller span and a corresponding smaller number of lines. But be sure that the range with the audible tones is analysed!

In rare cases where a complex tone has many closely spaced components, a finer resolution may be necessary to determine the level of the masking noise correctly.

The setting of frequency correction *FC* to *On* or *Off* only affects the results read from the main cursor, the tone assessment calculation is not affected by the setting of the frequency correction.

Pre- and Post-weighting of the Frequency

In the default setup the pre-weighting is set to 'A' in accordance with ISO 1996-2. The Hand-held Analyzer gives you the freedom to choose pre-weighting as *A*, *B*, *C* or *Z* and the post-weighting as *A* or *Z*. Please note that to avoid errors from double weighting, the Hand-held Analyzer automatically deactivates the post-weighting feature when the pre-weighting differs from *Z*.

Please refer to section 4.2.4 where Frequency Settings are explained.

Measurement Control


According to ISO 1996-2 Annex C, tone assessment must be performed using linear averaging for at least 1 minute. But the Hand-held Analyzer gives you the freedom to choose various combinations of linear averaging time as well as running exponential averaging.

Please refer to section 4.2.2 where Measurement Control is explained.


7.4.4 Sound Recording

If a valid license for the Sound Recording Option is present, it is possible to record the sound while measuring the FFT spectrum. Refer to the User Manual for Hand-held Analyzers Types 2270 and 2250, Chapter 13, for information about the Sound Recording Option.

Note 1: When Hand-held Analyzer recordings are used for re-analysis on a PC, be sure to set *Automatic Gain Control* to *Off* under the *Sound Recording* parameters, and set the *Recording Quality* to *High*.

Note 2: You may find the Template Explorer (accessed from the Main Menu  icon) useful to save your own measurement setup. Please find more information about using templates in the User Manual for Hand-held Analyzers Types 2270 and 2250, BE 1713,.

7.5 Measuring

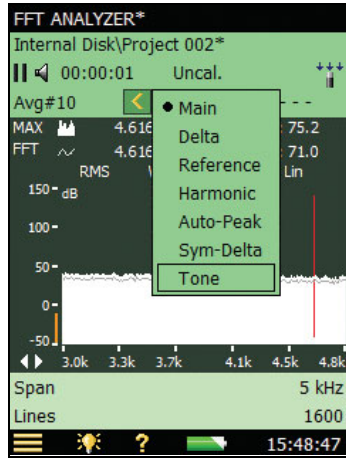
When the measurement is done (the preset measurement time for a linear measurement has finished (or the **Start/Pause**  Pushbutton is pressed) the Hand-held Analyzer carries out the tone assessment calculation.. A typical ISO 1996-2 Annex C calculation, using 6400 lines FFT, will take 4 to 5 seconds.

7.6 Result Display

7.6.1 The Tone Cursor

Choose the *Tone* cursor from the **Cursor** drop-down menu (accessed when you tap on the cursor), see Fig. 7.5.

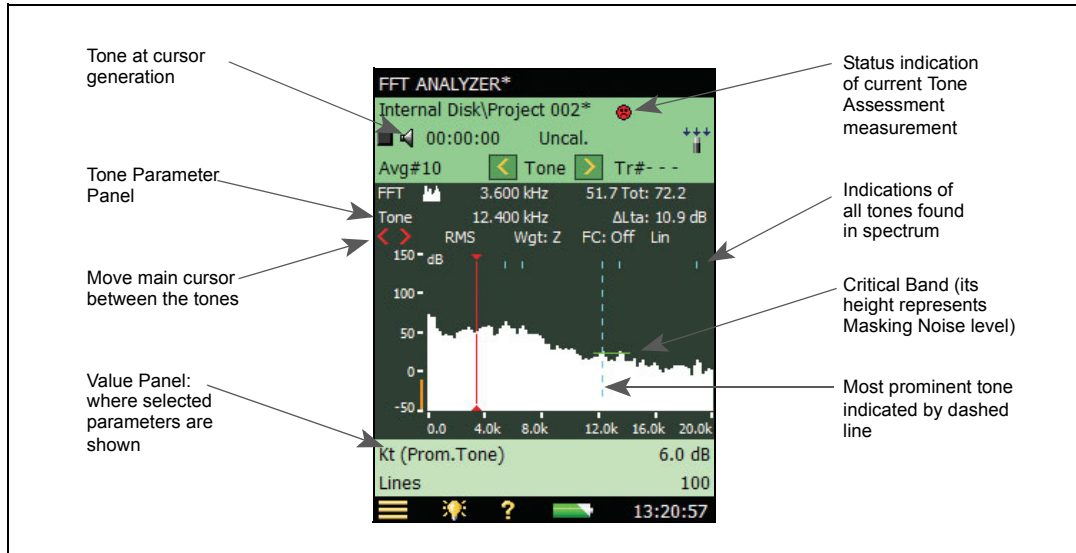
Fig.7.5
Selecting the Tone cursor



The results from the Tone Assessment Calculation can only be displayed on the Hand-held Analyzer's display when the Tone Cursor is selected, see Fig.7.6. After finishing the Tone Assessment Calculation the tone cursor jumps to the most prominent tone. If no tones are detected in the analyzed FFT spectrum, a pop-up message will inform you that no tones have been found.

When the Tone Cursor is selected, the Tone Assessment calculation is performed on the FFT-spectrum on the display. The selected FFT-spectrum may be either the FFT-, MAX- or Ref-spectrum.



Fig.7.6 Typical FFT spectrum display, showing the various fields




7.6.2 The Tone Parameter Panel

The Tone Parameter Panel shows the results for the Tone Assessment Calculation with respect to the position of the tone cursor. The Tone Parameter Panel shows (from left to right)

- *Tone* – the frequency of the selected tone. (*Prom.Tone*), displayed on the Value Panel, marks the most prominent tone in the decisive band. In accordance with ISO 1996-2, the tone frequency is the frequency of the line with the highest level and the tone frequency is not corrected for the influence of the window function. If you want to read the tone frequency corrected for the influence of the window function, please turn Frequency Correction on by tapping directly on *FC:Off* on the Spectrum Display, and choose **On** from the resulting drop-down menu. You can then read the value from the main cursor. Find more information about frequency correction in section 2.3.1 of this manual.
- ΔL_{ta} – the audibility of all tones found in the same critical band as the selected tone. When the selected tone is the ‘Prom.Tone’, ΔL_{ta} is the total audibility of all tones in the decisive band.

To step between the detected tones, tap the  and  buttons.

The  buttons will ‘jump’ the main cursor between the detected tones and in this way you can select the generated frequency.

7.6.3 View Area

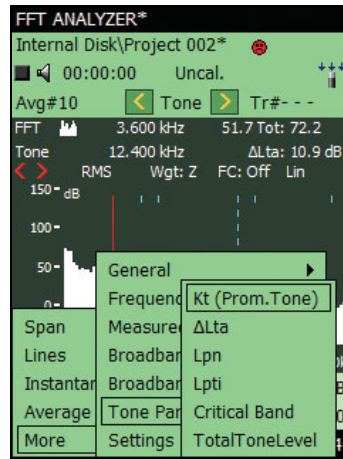
The results that relate to the total FFT analysis are shown on the Value Panel, see Fig. 7.6. Two selectable parameters are displayed and the parameters shown may be changed by tapping on them.

As default, the following parameters will be shown on the Value Panel:

- K_t is the size of the adjustment in dB
- L_{pt} is the total tone level in dB of all tones in the decisive band

By tapping one of the parameters it is possible to access all the detailed parameters that are available for the FFT analysis, Tone Assessment and Broadband Parameters. Tap on *More*, and then *Tone Parameters* on the drop-down, to get the list with the tone parameters, see Fig. 7.7.

Fig.7.7
Selecting different tone parameters



Select between the following parameters from the drop-down list:

- K_t – the size of the adjustment in dB. The adjustment is calculated from the decisive band and refers to the total spectrum
- ΔL_{ta} – the audibility of all tones found in the same critical band as the selected tone
- L_{pn} – the Total level of the masking noise in the band containing the selected tone
- L_{pti} – the Level of the selected tone
- L_{pt} – the Level of all tones in the critical band containing the selected tone
- Critical Band – the start and end of the critical band containing the selected tone

7.6.4 Broadband Parameters

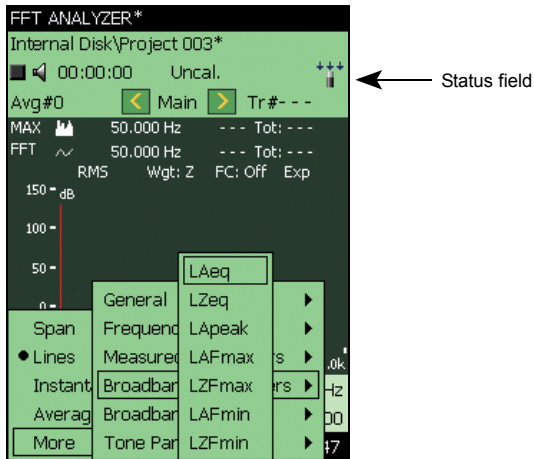
The result of the FFT-based tone assessment is the adjustment K_t , which should be added to the L_{Aeq} measurement to calculate the rating level, L_r according to ISO 1996-2. The tone corrected rating level is calculated from the following equation:

$$L_r = L_{Aeq} + K_t$$

The rating level L_r may be subject to other adjustments (for example, impulsive noise, time of day, etc.) please refer to ISO 1996-2 or Brüel & Kjær's Environmental Noise booklet for more detailed information about the rating level.

While using the Hand-held Analyzer with FFT Analysis Software BZ-7230 it is possible to access the wide range of broadband parameters from Sound Level Meter Software BZ-7222 by selecting them in the Status field, see Fig. 7.8. Tap on the panel and select the parameter to be displayed.

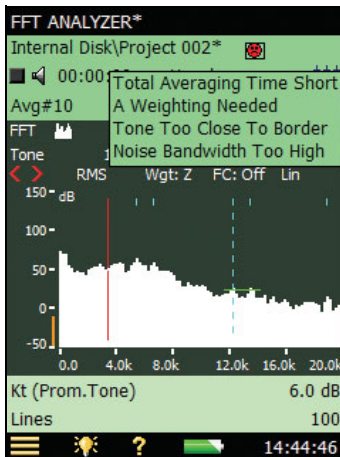
Fig. 7.8
Selecting Broadband parameters



7.6.5 Status Codes (Smileys)










When the Hand-held Analyzer has finished the Tone Assessment Calculation, a quality indicator (or smiley) may appear. Tap on a smiley to get an explanation of the status code, and for a tip on how to remedy or improve the settings on the instrument, see an example in Fig. 7.9.

Fig. 7.9
Explanation of status codes



For an overview of all the remedies associated to the various smileys, please refer to Table 7.2

Table 7.2 Overview of Smiley Indicators and Associated Remedies

Smiley	Colour	Explanation	Remedy – Tip for Solution
	Red	Noise bandwidth too high	Effective analysis bandwidth must be less than 5% of minimal critical bandwidth. Increase the number of lines or reduce the analysed frequency span
	Red	A-weighting needed	Select <i>Frequency Weighting</i> to <i>A</i>
	Red	Hanning window needed	Select <i>Hanning Window</i>
	Yellow	Total Averaging Time short	Increase <i>Total Average Time</i> to a total of more than one minute
	Yellow	Linear averaging missing	Set <i>Linear Averaging</i>
	Yellow	Closely spaced Tones	Need better frequency resolution refer to ISO 1996-2 Annex C: Note 3, page 27
	Yellow	Tone too close to border	Adjust the analysed frequency span
	Yellow	Assessment is performed on MAX spectrum	Reselect <i>Tone Cursor</i> , or change the graph manually to <i>FFT</i>
	Yellow	Assessment is performed on Reference spectrum	Reselect <i>Tone Cursor</i> , or change the graph manually to <i>FFT</i>

Note: Special care has to be taken when assessing tones at low levels. For more information please refer to “Analysing Very Low Tone Levels” on page 71.

7.7 Generation of Tone at Cursor

‘Generation of Tone at Cursor’, is a useful feature for comparing the results of the objective FFT-based tone assessment to the actual noise, and may be used to verify the consistency between the subjective evaluation of the noise and the objective calculation. It is also useful for identifying a tonal noise source and may be used in dialogue with a complainant.


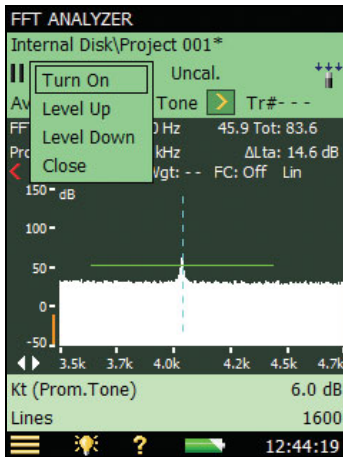



From the Measurement Display tap the loudspeaker icon , and then choose *Turn On* from the drop-down menu, see Fig. 7.10. This activates the generation of a pure tone with a frequency corresponding to the frequency of the main cursor. The tone is generated from the headphone socket. The actual output level in the headphones is dependent of the sensitivity of the headphones used for listening.

Fig. 7.10
Generation of a tone at
the cursor





When tone generation is ‘on’ the display shows the ‘speaker on’  icon. When tone generation is ‘off’, it shows the ‘speaker off’  icon.

7.7.1 Adjusting the Level

When generation of tone at cursor is ‘on’, the level can be controlled from the drop-down menu accessed by tapping on the  icon, see Fig. 7.10. Tap on *Level Up* or *Level Down* or control the level by navigating to the **Setup** menu and setting the *Level* under the *Tone At Cursor* parameters.

7.7.2 Navigating the Frequency

The frequency of the generated tone follows the position of the main cursor.

The   buttons will ‘jump’ the main cursor between the detected tones and in this way you can select the generated frequency.

7.7.3 Listening to a Mixed Signal

‘Tone At Cursor’ generation can be mixed with the signal from the microphone, so if you want to be able to listen to the input signal, then navigate to *Headphone Settings* under *Preferences* and set the *Listen to signal* parameter to *Input*. If the *Tone At Cursor* parameter is enabled, then input signal will now be mixed with the generated tone.

7.8 Recalling Saved Measurements

Saved FFT measurements can be opened and the Tone Assessment can be applied.

Please refer to the User Manual for Hand-held Analyzers Types 2270 and 2250, BE 1713, on how to save and recall FFT-measurements.

Chapter 8

Specifications

Unless otherwise stated, values are given as typical values under Reference Environmental Conditions with nominal sensitivities for the microphones and accelerometers.

Specifications – Type 2270 and 2250 Platforms

These specifications refer to Types 2270 and 2250 unless otherwise stated.

DUAL-CHANNEL MEASUREMENTS (TYPE 2270)

Two independent measurement channels are available on Type 2270 to enable you to measure various acoustic parameters, subject to having a dual-channel application license.

REFERENCE ENVIRONMENTAL CONDITIONS

Air Temperature: 23°C

Static Pressure: 101.325 kPa

Relative Humidity: 50%

SUPPLIED MICROPHONE

Type 4189: Prepolarized Free-field ½" Condenser Microphone

Nominal Open-circuit Sensitivity: 50 mV/Pa (corresponding to –26 dB re 1 V/Pa) ± 1.5 dB

Capacitance: 14 pF (at 250 Hz)

MICROPHONE PREAMPLIFIER ZC-0032

Nominal Preamp Amplifier Attenuation: 0.25 dB

Connector: 10-pin LEMO

Extension Cables: Up to 100 m in length between the microphone preamplifier and the Hand-held Analyzer, without degradation of the specifications

Note: EMC is only tested with a 10 m cable (AO-0441-D-100)

Accessory Detection: Windscreen UA-1650 can be automatically detected when fitted over ZC-0032

MICROPHONE POLARIZATION VOLTAGE

Selectable between 0 V and 200 V

TRANSDUCER DATABASE

Transducers are described in a transducer database with information on Serial Number, Preamplifier ID No., Nominal Sensitivity, and CCLD required.

For microphones, Polarization Voltage, Free-field Type and Capacitance are also included.

For Accelerometers, Weight is also included.

The analogue hardware is set up automatically in accordance with the selected transducer

CORRECTION FILTERS

For Microphone Types 4189, 4191, 4193, 4950 and 4952, BZ-7230 is able to correct the frequency response to compensate for sound field and accessories:

Sound Field: Free-field or Diffuse-field (for Type 4952 only: 0° (Top) reference direction and 90° (Side) reference direction)

Accessories (Type 4189 only): None, Windscreen UA-1650 or Outdoor Microphone Kit UA-1404

Accessories (Types 4191 and 4193 only): None or Windscreen UA-1650

Accessories (Type 4950 only): None or Windscreen UA-0237

CALIBRATION

Initial calibrations for each transducer are stored for comparison with later calibrations

Acoustic: Using Sound Calibrator Type 4231 or custom calibrator. The calibration process automatically detects the calibration level when Sound Calibrator Type 4231 is used

Mechanical: Using Calibrator Exciter Type 4294 or custom calibrator

Direct Electrical: Using an external Voltage Reference

Electrical: Uses internally generated electrical signal combined with a typed-in value of the sensitivity

Calibration History: Up to 20 of the last calibrations made are listed and can be viewed on the instrument

KEYBOARD

Pushbuttons: 11 keys with backlight, optimised for measurement control and screen navigation

ON-OFF BUTTON

Function: Press 1 s to turn on; press 1 s to enter standby; press for more than 5 s to switch off

TRAFFIC LIGHT

Red, yellow and green LEDs show measurement status and instantaneous overload as follows:

- Yellow LED flashing every 5 s = stopped, ready to measure
- Green LED flashing slowly = awaiting trigger or calibration signal
- Green LED on constantly = measuring
- Yellow LED flashing slowly = paused, measurement not stored
- Red LED flashing quickly = intermittent overload, calibration failed

DISPLAY

Type: Transflective back-lit colour touch screen 240 × 320 dot matrix

Colour Schemes: Five different – optimised for different usage scenarios (day, night, etc.)

Backlight: Adjustable level and on-time

USER INTERFACE

Measurement Control: Using pushbuttons on keyboard

Setup and Display of Results: Using stylus on touch screen or pushbuttons on keyboard

Lock: Keyboard and touch screen can be locked and unlocked

VOICE ANNOTATIONS

Voice annotations can be attached to measurements so that verbal comments can be stored together with the measurement

Playback: Playback of voice annotations can be listened to using an earphone/headphones connected to the headphone socket

Gain Adjustment: –60 dB to 0 dB

TEXT ANNOTATIONS

Text annotations can be attached to measurements so that written comments can be stored with the measurement

IMAGE ANNOTATIONS (TYPE 2270 ONLY)

Image annotations can be attached to measurements. Images can be viewed on the screen

DATA MANAGEMENT

Project Template: Defines the display and measurement setups

Project: Measurement data stored with the Project Template

Job: Projects are organised in Jobs
Explorer facilities for easy management of data (copy, cut, paste, delete, rename, view data, open project, create job, set default project name)

USB INTERFACE

USB 1.1 OTG Mini B socket

MODEM INTERFACE

Hayes compatible GSM or standard analogue modems connected through the Compact Flash slot

COMPACT FLASH SOCKET

For connecting CF memory card, CF modem or CF LAN Interface

LAN INTERFACE SOCKET (TYPE 2270 ONLY)

Connector: RJ45

Speed: 10 MB/s

Protocol: TCP/IP

REAR INPUT SOCKET (TYPE 2270 HAS TWO)

Connector: Triaxial LEMO used for Direct input as well as input with Constant-Current Line Drive (CCLD) power supply

Input Impedance: $\geq 1\text{ M}\Omega$

Direct Input: Max. input voltage: $\pm 14.14\text{ V}_{\text{Peak}}$, 10 V_{RMS} for sinusoidal input signals, no damage for signals up to $\pm 20\text{ V}_{\text{Peak}}$. Source Impedance $\leq 1\text{ k}\Omega$

CCLD Input: Max. input voltage: $\pm 7.07\text{ V}_{\text{Peak}}$, (no indication for violation of this level), no damage for signals in the range –10 to $+25\text{ V}_{\text{Peak}}$

CCLD Current/Voltage: 4 mA/25 V

CCLD Cable Break/Short Indication: Checked before and after measurements

TRIGGER SOCKET

Connector: Triaxial LEMO

Max. Input Voltage: $\pm 20\text{ V}_{\text{Peak}}$, no damage for signals up to $\pm 50\text{ V}_{\text{Peak}}$

Input Impedance: $> 47\text{ k}\Omega$

OUTPUT SOCKET

Connector: Triaxial LEMO

Max. Peak Output Level: $\pm 4.46\text{ V}$

Output Impedance: $50\text{ }\Omega$

Load Impedance: $> 15\text{ k}\Omega \parallel < 1\text{ nF}$ for $< 0.2\text{ dB}$ attenuation from DC to 20 kHz, short-circuit proof without affecting the measurement results

Max DC Offset: $\pm 15\text{ mV}$

Source: Input conditioned (gain adjustment –60 dB to 60 dB)

HEADPHONE SOCKET

Connector: 3.5 mm Minijack stereo socket

Max. Peak Output Level: $\pm 1.4\text{ V}$ (no load)

Output Impedance: $32\text{ }\Omega$ in each channel, short-circuit proof without affecting the measurement results

Sources: Input conditioned (gain adjustment –60 dB to 60 dB), playback of voice annotations (gain adjustment –60 dB to 0 dB) and playback of recordings (gain adjustment –60 dB to 0 dB)

MICROPHONE FOR COMMENTARY

Microphone, which utilises Automatic Gain Control (AGC), is incorporated in underside of instrument. Used to create voice annotations for attaching to measurements

CAMERA

Camera with fixed focus and automatic exposure is incorporated in underside of instrument.

Used to create image annotations for attaching to measurements

Image Size: 640×480

Viewfinder Size: 212×160

Format: jpg with exif information

EXTERNAL DC POWER SUPPLY REQUIREMENTS

Used to charge the battery pack in the instrument

Voltage: 8–24 VDC, ripple voltage $< 20\text{ mV}$

Current Requirement: min. 1.5 A

Power Consumption: $< 2.5\text{ W}$, without battery charging, $< 10\text{ W}$ when charging

Cable Connector: LEMO Type FFA.00, positive at centre pin

EXTERNAL AC MAIN SUPPLY ADAPTOR

Part No.: ZG-0426

Supply Voltage: 100 – 120/200 – 240 VAC; 47 – 63 Hz

Connector: 2-pin IEC 320

BATTERY PACK

Part No.: QB-0061 Rechargeable Li-Ion battery

Voltage: 3.7V

Capacity: 4800 mAh nominal

Typical Operating Time: > 8 hours

Battery Cycle Life: > 500 complete charge/discharge cycles

Battery Indicator: Remaining battery capacity and expected working time may be read out in % and in time

Battery Fuel Gauge: The battery is equipped with a built-in fuel gauge, which continuously measures and stores the actual battery capacity in the battery unit

Charge Time: In instrument, typically 10 hours from empty at ambient temperatures below 30°C. To protect the battery, charging will be terminated completely at ambient temperatures above 40°C. At 30 to 40°C charging time will be prolonged. With external charger ZG-0444 (optional accessory), typically 5 hours

Note: It is not recommended to charge the battery at temperatures below 0°C or over 50°C (32°F to 122°F). Doing this will reduce battery lifetime

STORAGE SYSTEM

Internal Flash-RAM (non-volatile): 20 Mbyte for user setups and measurement data

External Secure Digital Memory Card (SD-card):

For store/recall of measurement data

External Compact Flash Memory Card (CF-card):

For store/recall of measurement data

REAL-TIME CLOCK

Back-up battery powered clock. Drift < 0.45 s per 24 hour period

WARM-UP TIME

After reaching equilibrium with the ambient environment and switching on power

From Power Off: < 2 minutes

From Standby: < 10 seconds for prepolarized microphones

TEMPERATURE

IEC 60068–2–1 & IEC 60068–2–2: Environmental Testing. Cold and Dry Heat.

Operating Temperature: –10 to +50°C (14 to 122°F), < 0.1 dB

Storage Temperature: –25 to +70°C (–13 to +158°F)

HUMIDITY

IEC 60068–2–78: Damp Heat: 90% RH (non-condensing at 40°C (104°F)).

Effect of Humidity: < 0.1 dB for 0% < RH < 90% (at 40°C (104°F) and 1 kHz)

MECHANICAL

Environmental Protection: IP44

Non-operating:

IEC 60068–2–6: Vibration: 0.3 mm, 20 m/s², 10–500 Hz

IEC 60068–2–27: Shock: 1000 m/s²

IEC 60068–2–29: Bump: 4000 bumps at 400 m/s²

WEIGHT AND DIMENSIONS

650 g (23 oz.) including rechargeable battery

300 × 93 × 50 mm (11.8 × 3.7 × 1.9") including

preamplifier and microphone

USERS

Multi-user concept with login. Users can have their own settings with jobs and projects totally independent of other users

PREFERENCES

Date, Time and Number formats can be specified per user

LANGUAGE

User Interface in Catalan, Chinese, Croatian, Czech, Danish, English, Flemish, French, German, Hungarian, Japanese, Italian, Polish, Portuguese, Romanian, Serbian, Slovenian, Spanish, Swedish and Turkish

HELP

Concise context-sensitive help in Catalan, Chinese, English, French, German, Italian, Japanese, Polish, Portuguese, Romanian, Serbian, Slovenian and Spanish

Software Specifications – FFT Analysis Software BZ-7230

Specifications for FFT analysis are given for the Hand-held Analyzer with software BZ-7230 installed and fitted with one of the recommended transducers (see Table 8.1)

FFT ANALYSIS

Sampling Frequency: Downsampling from 51.2 kHz

Frequency Span: 100 Hz, 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 20 kHz

Lines: 100, 200, 400, 800, 1600, 3200, 6400^a

Zoom Centre Frequency: Can be set so that the Frequency Span is placed in the range 0 to 20 kHz

Spectrum: Averaged and Maximum

Pre-weighting: Z (none), A, B or C

MEASUREMENT CONTROL

Manual Start

Exponential Averaging: With an averaging time of up to 999 spectra, measured with Hanning window and 67% overlap

Linear Averaging: Up to 8388607 spectra measured with Hanning window and 67% overlap

Triggered Start

Transient Signal Type: Linear averaging of up to 32767 triggered spectra measured with rectangular window and 0% overlap

Continuous Signal Type: Linear averaging of up to 32767 spectra measured with Hanning window and 67% overlap. Up to 32767 spectra are averaged on each trigger

Auto-start: A total of 10 timers allow set up of measurement start times up to a month in advance. Each timer can be repeated. Measurements are automatically stored when completed

TRIGGERS

Delay: From 16383 samples before the trigger time to 300 seconds after

Hold Off: 0 to 300 s

Internal Trigger: Uses the time signal from the measurement transducer. The Internal Level is set in the relevant measurement units

External Trigger: Uses the Trigger Input. The External Level is set in the range -18 to 18 V

Hysteresis (Only for External Trigger): 0 to 10 V

Slope (Only for External Trigger): Rising, Falling

Pull-up (Only for External Trigger): For Type 2250 serial numbers above 2479653 the Trigger Input is pulled up to +5 V through a 7.5 k Ω resistor when this parameter field is set to *On*

MEASUREMENT RANGE

(See Table 8.1)

a. The actual number of lines is one more than stated, to provide symmetry around the centre frequency.

Table 8.1 Measurement ranges with the recommended transducers

Transducer	Nominal Sensitivity	Spurious Free Dynamic Range for High Levels	Spurious Free Dynamic Range for Low Levels	Typical Frequency Response Extended Low Frequency On/Off
Direct Input	1 V/V	3 μ V – 14.1 V _{Peak}	300 nV – 75 mV _{Peak}	1.5/6.3 Hz – 20 kHz
4189	50 mV/Pa	10 dB – 143 dB _{Peak}	-10 dB – 97.5 dB _{Peak}	6.8/7.8 Hz – 20 kHz
4191	12.5 mV/Pa	22 dB – 155 dB _{Peak}	2 dB – 109.5 dB _{Peak}	3.6/6.6 Hz – 20 kHz
4193	12.5 mV/Pa	22 dB – 155 dB _{Peak}	2 dB – 109.5 dB _{Peak}	0.56/6.3 Hz – 20 kHz
4950	50 mV/Pa	10 dB – 143 dB _{Peak}	-10 dB – 97.5 dB _{Peak}	4.3/6.3 Hz – 19 kHz
4952	31.6 mV/Pa	14 dB – 146 dB _{Peak}	-6 dB – 101.5 dB _{Peak}	4.3/6.3 Hz – 14 kHz
4397-A	1 mV/ms ⁻²	3 mm/s ² – 7.1 km/s ² _{Peak}	300 μ m/s ² – 75 m/s ² _{Peak}	1.25/6.3 Hz – 20 kHz
4513	1 mV/ms ⁻²	3 mm/s ² – 7.1 km/s ² _{Peak}	300 μ m/s ² – 75 m/s ² _{Peak}	1.25/6.3 Hz – 10 kHz
4513-001	10 mV/ms ⁻²	300 μ m/s ² – 710 m/s ² _{Peak}	30 μ m/s ² – 7.5 m/s ² _{Peak}	1.25/6.3 Hz – 10 kHz
4513-002	50 mV/ms ⁻²	60 μ m/s ² – 141 m/s ² _{Peak}	6 μ m/s ² – 1.5 m/s ² _{Peak}	1.25/6.3 Hz – 10 kHz

The lower limit of the measurement range is influenced by self-generated random noise and self-generated tones called spurious signals. The influence of the random part can be reduced to a level below the spurious signals by selecting a small analysis bandwidth (small span and many lines). Therefore, the lower limit is specified as the maximum Peak level of the spurious signal lines.

BZ-7230 has only one measuring range but the spurious level depends on the peak level of the signal. Therefore, two specifications are given. One for high levels, where the upper limit is the overload limit, and one for low levels.

The Typical Frequency Response shows the ± 1 dB limits for Direct Input and microphones, and the ± 10 % limits for accelerometers

RPM MEASUREMENT

RPM is measured on the signal connected to Trigger input when Tacho is set to *On*

Range: 1 to 6000000 RPM

Instantaneous RPM: Instantaneous RPM is only displayed (and not stored)

Average RPM: Displayed and stored together with each Spectrum result. In Linear Averaging it is an average over the same time as the spectrum. In Exponential averaging it is the last measured RPM

Gear Ratio: 10^{-5} to 10^{38} . The displayed RPM's are the measured RPM's divided by the RPM Gear Ratio.

OVERLOAD

Instantaneous Overload: Instantaneous Overload is displayed as an icon on the display and is also indicated by the Traffic Light

Spectrum Overload: Displayed and stored together with each Spectrum result

DISPLAY SPECTRA

Two spectra superimposed

Scaling: RMS, Peak, Peak-to-Peak, Power, PSD, ESD

Reference Spectrum: Compare spectrum to stored (measured) reference

Axis: Logarithmic and Linear Y-axis, Linear X-axis

X-axis: Display full frequency range or expand the X-axis until only 20 FFT lines are displayed. Scroll available

Y-axis Display Range: 5, 10, 20, 40, 60, 80, 100, 120, 140, 160, 180 or 200 dB. Auto-zoom or Auto-scale available

Digital Post-weighting: Z (none) or A-weighting

DISPLAY PARAMETERS

Sound: Sound Pressure Level in dB

Vibration: Acceleration, velocity or displacement in dB or physical units. SI units (m/s^2 , m/s or m) or US/UK units (g, m/s or Mil)

Direct: Voltage in dB or V

CURSORS

Readings: Total level within the spectrum.

Frequency Correction: For spectra measured with a Hanning Window, spectral peaks are interpolated to a higher precision

Main: Reads level versus frequency

Symmetrical Delta and Delta: Defines lower and upper frequency limit for any part of the spectrum and calculates the level sum within that frequency range

Harmonic: Identifies fundamental frequency and harmonics in the spectrum and calculates the Total Harmonic Distortion^a (THD)

Reference: Reads the difference between the main cursor Y-value and the reference cursor Y-value

LIMIT LEVEL CHECK

Limit Level: Determines the level at which the spectrum is checked

Limit Range: Determines the frequency range for the limit level check

Indication: two indicators are displayed, latched and instantaneous

When the spectrum exceeds the limit level, a recording can be started (license for BZ-7226 required) and a 3.3VDC signal can be output at the Output Socket

Sound Level Meter Parameters

Sound level meter (broadband) parameters are measured simultaneously with the FFT parameters, however, their measurement starts when the the Start/Pause pushbutton is pressed and it ends at the nearest whole second after the end of the FFT measurement

Specifications for the Sound Level Meter parameters apply to Type 2270/2250 Hand-held Analyzer fitted with Microphone Type 4189 and Microphone Preamplifier ZC-0032

SELF-GENERATED NOISE LEVEL

Typical values at 23°C for nominal microphone open-circuit sensitivity:

Weighting	Microphone	Electrical	Total
"A"	14.6 dB	12.4 dB	16.6 dB
"B"	13.4 dB	11.5 dB	15.6 dB
"C"	13.5 dB	12.9 dB	16.2 dB
"Z" 5 Hz–20 kHz	15.3 dB	18.3 dB	20.1 dB
"Z" 3 Hz–20 kHz	15.3 dB	25.5 dB	25.9 dB

a. Total Harmonic Distortion (THD) is the sum (in %) of all the harmonics relative to the sum of the fundamental and all the harmonics.

Conforms with the following National and International Standards:

- IEC 61672–1 (2002–05) Class 1
- IEC 60651 (1979) plus Amendment 1 (1993–02) and Amendment 2 (2000–10), Type 1
- IEC 60804 (2000–10), Type 1
- DIN 45657 (1997–07)
- ANSIS1.4–1983 plus ANSI S1.4A–1985 Amendment, Type 1
- ANSIS1.43–1997, Type 1

Note: The International IEC Standards are adopted as European standards by CENELEC. When this happens, the letters IEC are replaced with EN and the number is retained. The analyzer also conforms to these EN Standards

DETECTORS

Parallel Detectors on every measurement:

A- or B-weighted (switchable) broadband detector channel with 'Fast' time weighting, one linearly averaging detector and one peak detector

C- or Z-weighted (switchable) as for A- or B-weighted

Overload Detector: Monitors the overload outputs of all the frequency weighted channels

MEASUREMENTS

X = frequency weightings A or B

Y = frequency weightings C or Z

V = frequency weightings A, B, C or Z

For Display and Storage

Start Time	Stop Time	Overload %
Elapsed Time	$L_{Xe q}$	$L_{Ye q}$
L_{XFmax}	L_{YFmax}	L_{XFmin}
L_{YFmin}	L_{Xleq}	L_{Yleq}
L_{AFTeq}		

Only for Display as Numbers or Quasi-analogue Bars

L_{XF} L_{YF}

MEASURING RANGES

When using Microphone Type 4189:

Dynamic Range: From typical noise floor to max. level for a 1 kHz pure tone signal, A-weighted: 16.6 to 140 dB

Primary Indicator Range: In accordance with IEC 60651, A-weighted: 23.5 dB to 123 dB

Linearity Range: In accordance with IEC 60804, A-weighted: 21.4 dB to 140 dB

Linear Operating Range: In accordance with IEC 61672, A-weighted: 1 kHz: 24.8 dB to 140 dB

Peak C Range: In accordance with IEC 61672: 42.3 dB to 143 dB

Software Specifications – Tone Assessment Option BZ-7231

LICENSE

Tone Assessment Option BZ-7231 is enabled with a separate license and can be used with the FFT template

STANDARD

Tone assessment is based on the measured FFT spectrum in accordance with "ISO 1996:2007 Acoustics - Description, assessment and measurement of environmental noise - part 2: Determination of environmental noise levels. Annex C (informative) Objective method for assessing the audibility of tones in noise - Reference method"

SPECTRA ASSESSED

Any displayed sound FFT spectrum (FFT, Ref or MAX) may be assessed

Assessment is made as post-processing, i.e., when measurement is paused or stopped

SETUP ACCORDING TO STANDARD

Default Setup: please refer to Table 7.1

Setups in violation of the standard are indicated as such on the display, you may then accept to apply the default setup

Tone assessment will be made if possible, in spite of standard violations

Tone Seek Criterion: 0.1 to 4.0 dB in 0.1 dB steps

TONE AT CURSOR

A sinusoidal tone is available at the Headphone output, to help confirm identified tones

Frequency: the frequency is selected by the Main cursor

Gain: –70 dB to +10 dB

Options: The generated tone may be mixed with the input signal, please refer to the Preferences/Headphone Settings described in section 7.7.3

TONE ASSESSMENT CURSOR

All tones found are indicated in the display.

The Tone cursor is initially placed at the most prominent tone, and may then be stepped through the tones found

You can also use the Main cursor to step through the tones

RESULTS

Results are displayed in the Tone panel and in the Value panel

They are not saved with the measurement

All Tones: Frequency, Tone level L_{pti} , Masking noise level L_{pn} , Audibility ΔL_{ta} , Critical Band CB

Most Prominent Tone: Tone Level L_{pt} , Adjustment K_t

QUALITY INDICATORS

In the display, a quality indicator (smiley) will indicate that a hint is available for tone assessment quality. Click on the indicator to see the hint (listed in Table 7.2)

Software Specifications – Sound Recording Option

RECORDING

Recording Option BZ-7226 is enabled with a separate license

Recording requires a CF- or SD-Card for data storage

RECORDED SIGNAL

The Z-weighted signal from the measurement transducer

AUTOMATIC GAIN CONTROL

The average level of the signal is kept within a 40 dB range, or the gain can be fixed

SAMPLING RATE AND PRE-RECORDING

The signal is buffered for the pre-recording of sound. This allows the beginnings of events to be recorded even if they are only detected later

Sampling Rate (kHz)	Maximum Pre-recording (s)	Sound Quality	Memory (KB/s)
8	100	Low	16
16	50	Fair	32
24	30	Medium	48
48	10	High	96

Manual Control of Recording: Recording can be manually started and stopped during a measurement using a pushbutton

Automatic Control of Recording: Start of recording when measurement is started. Minimum and Maximum recording time can be preset

Limit Level: Recording is started when the Limit Level is exceeded

PLAYBACK

Playback of sound recordings can be listened to using the earphone/headphones connected to the headphone socket

RECORDING FORMAT

The recording format is 16-bit wave files (extension .wav) attached to the data in the project, easily played-back afterwards on a PC using BZ-5503, Type 7815 or 7820. Calibration information is stored in the wav file, allowing PULSE to analyse the recordings

Software Specifications – Utility Software for Hand-held Analyzers BZ-5503

BZ-5503 is included with the Hand-held Analyzer for easy synchronisation of setups and data between PC and Analyzer. BZ-5503 is supplied on CD-ROM BZ-5298

ON-LINE DISPLAY OF TYPE 2270/2250 DATA

Measurements on the analyzer can be controlled from the PC and displayed on-line with the PC, using the same user interface on the PC as on the analyzer

DATA MANAGEMENT

Explorer: Facilities for easy management of Instruments, Users, Jobs, Projects and Project Templates (copy, cut, paste, delete, rename, create)

Data Viewer: View measurement data (content of projects). Graphics and data can be copied to Windows® clipboard

Template Editor: Editor for changing setups in Project Templates

Synchronisation: Project Templates and Projects for a specific user can be synchronised between PC and analyzer

USERS

Users of the analyzer can be created or deleted

EXPORT FACILITIES

Excel: FFT Projects can be exported to Microsoft® Excel®

Type 7815/20: FFT Projects can be exported to Noise Explorer Type 7815, Evaluator Type 7820

HAND-HELD ANALYZER SOFTWARE UPGRADES AND LICENSES

Utility software controls the analyzer software upgrades and licensing of the analyzer applications

INTERFACE TO HAND-HELD ANALYZER

USB ver. 1.1 or Hayes compatible GSM or standard analogue modem

PC REQUIREMENT

Operating System: Windows® 2000/XP/.NET

Recommended PC: Pentium® III (or equivalent) processor, 512Mbyte RAM, SVGA graphics display/adaptor, sound card, CD ROM drive, mouse, USB, Windows® XP

Ordering Information

2270-H-002 Hand-held Analyzer Type 2270 with BZ-7222 Sound Level Meter and BZ-7230 FFT Analysis Software

2250-H-002 Hand-held Analyzer Type 2250 with BZ-7222 Sound Level Meter and BZ-7230 FFT Analysis Software

Included with 2270-H-002 and 2250-H-002:

- Type 4189: Prepolarized Free-field 1/2" Microphone
- ZC-0032: Microphone Preamplifier
- BZ-7222: Sound Level Meter software
- BZ-7230: FFT Analysis Software
- KE-0440: Travel Bag
- KE-0441: Protective Cover for Type 2250
- DH-0696: Wrist Strap
- UA-1650: 90 mm dia. Windscreen with AutoDetect
- UA-1651: Tripod Extension for Hand-held Analyzer
- UA-1654: 5 Extra Styli
- UA-1673: Adaptor for Standard Tripod Mount
- QB-0061: Battery Pack
- ZG-0426: Mains Power Supply
- AO-1476: USB Standard A to USB Mini B Interface Cable, 1.8 m (6 ft)
- HT-0015: Earphones
- BZ-5298: Environmental Software, including BZ-5503 Utility Software for Hand-held Analyzers
- FB-0679: Hinged Cover for Hand-held Analyzer

2270-H-003 Hand-held Analyzer Type 2270 with BZ-7222 Sound Level Meter Software, BZ-7223 Frequency Analysis Software, BZ-7226 Sound Recording Option and BZ-7230 FFT Analysis Software

2250-H-003 Hand-held Analyzer Type 2250 with BZ-7222 Sound Level Meter Software, BZ-7223 Frequency Analysis Software, BZ-7226 Sound Recording Option and BZ-7230 FFT Analysis Software

Included with 2270-H-003 and 2250-H-003:

- Type 4189: Prepolarized Free-field 1/2" Microphone
- ZC-0032: Microphone Preamplifier
- BZ-7222: Sound Level Meter software
- BZ-7223: 2250 Frequency Analysis Software
- BZ-7226: 2250 Sound Recording Option
- BZ-7230: FFT Analysis Software
- KE-0440: Travel Bag
- KE-0441: Protective Cover for Type 2250
- DH-0696: Wrist Strap
- UA-1650: 90 mm dia. Windscreen with AutoDetect
- UA-1651: Tripod Extension for Hand-held Analyzer
- UA-1654: 5 Extra Styli
- UA-1673: Adaptor for Standard Tripod Mount
- QB-0061: Battery Pack
- ZG-0426: Mains Power Supply
- AO-1476: USB Standard A to USB Mini B Interface Cable, 1.8 m (6 ft)
- HT-0015: Earphones
- BZ-5298: Environmental Software, including BZ-5503 Utility Software for Hand-held Analyzers
- UL-1009: SD Memory Card for Hand-held Analyzers
- FB-0679: Hinged Cover for Hand-held Analyzer

SOFTWARE MODULES AVAILABLE SEPARATELY

BZ-7230	FFT Analysis Software
BZ-7231	Tone Assessment Option
BZ-7223	Frequency Analysis Software
BZ-7224	Logging Software
BZ-7225	Enhanced Logging Software
BZ-7225-UPG	Upgrade from Logging Software BZ-7224 to Enhanced Logging Software BZ-7225 (does not include memory card)
BZ-7226	Sound Recording Option
BZ-7227	Reverberation Time Software

CALIBRATION

Type 4294	Calibration Exciter
Type 4231	Sound Calibrator (fits in KE-0440)
Type 4226	Multifunction Acoustic Calibrator
Type 4228	Pistonphone
2270-CAI	Accredited Initial Calibration of Type 2270
2270-CAF	Accredited Calibration of Type 2270
2270-CTF	Traceable Calibration of Type 2270
2270-TCF	Conformance Test of Type 2270, with certificate
2250-CAI	Accredited Initial Calibration of Type 2250
2250-CAF	Accredited Calibration of Type 2250
2250-CTF	Traceable Calibration of Type 2250
2250-TCF	Conformance Test of Type 2250, with certificate
4513-CAF	IEPE Accelerometer, Accredited Calibration
4513-CTF	IEPE Accelerometer, Traceable Calibration

PC SOFTWARE

BZ-5503	Utility Software for Hand-held Analyzer Type 2250 (supplied as standard with Type 2250)
Type 7815	Noise Explorer – data viewing software

Type 7820	Evaluator – data viewing and calculation software
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MEASUREMENT ACCESSORIES

Type 4513	Accelerometer, general purpose, with 1 mV/ms ⁻² sensitivity and 10–32 UNF connection
Type 4513-001	Accelerometer, suitable for low level measurement, 10 mV/ms ⁻² and 10–32 UNF connection
Type 4513-002	Accelerometer, suitable for very low level measurement, 50 mV/ms ⁻² and 10–32 UNF connection
Type 4397-A	Accelerometer, with 1 mV/ms ⁻² sensitivity, suitable for high frequency and high level measurement, with M3 connection
AO-0701-D-030	Accelerometer cable, LEMO to M3, length 3 m (10 ft)
AO-0702-D-030	Accelerometer cable, LEMO to 10–32 UNF, length 3 m (10 ft)
YJ-0216	Beeswax for mounting accelerometer
QS-0007	Tube of Cyanoacrylate Adhesive
UA-0642	Mounting magnet for accelerometer 10–32 UNF mounting
UA-1077	Mounting magnet for accelerometer M3 mounting
AO-0697-015	Microphone Extension Cable, 10-pin LEMO, length 1.5 m (5 ft)
AO-0697-030	Microphone Extension Cable, 10-pin LEMO, length 3 m (10 ft)
AO-0697-100	Microphone Extension Cable, 10-pin LEMO, length 10 m (33 ft)
UA-0801	Small Tripod
UA-1317	Microphone Holder
UL-1009	SD Memory Card
UL-1013	CF Memory Card
ZG-0444	Charger for QB-0061 Battery Pack

Brüel & Kjær supplies a wide range of accelerometers. Please contact your local Brüel & Kjær office for more information regarding the different types and their use, or visit the website at www.bksv.com.

Brüel & Kjær reserves the right to change specifications and accessories without notice.

Appendix A

Setup Parameters

This appendix lists and explains the various parameters that you can choose when performing FFT and Tone Assessment measurements.

A.1 Input Parameters

Table A.1 *Input parameters*

Parameter	Values	Comment
<i>Input</i>	<i>Top Socket</i> <i>Rear Socket</i>	Determines whether the input is taken from the top socket or the 'Rear Input' socket of the instrument. Connect your transducer to one of these sockets.
<i>Transd. Used</i>	<i>Direct</i> <i>Accelerometer</i> <i>Microphone</i>	Determines which transducer is currently connected to the Hand-held Analyzer and once selected, the hardware of the analyzer will be automatically set up to fit the transducer. If <i>Direct</i> is selected, it means voltage is being measured from the input socket – this can be either <i>Top Socket</i> or <i>Rear Socket</i> , whichever is selected. This parameter is part of the instrument setup and is common to all setups. It can also be set from the Transducers option of the Main Menu.
<i>Sound Field Correction</i>	<i>Free-field</i> <i>Diffuse-field</i>	Select a correction matching the sound field conditions of your measurements. If your sound source can be positioned facing the microphone (exactly), that is, it's sound comes mainly from one direction, then use the Free-field correction, otherwise use the Diffuse-field correction.

Table A.1 (Continued) Input parameters

Parameter	Values	Comment
<i>Windscreen Auto Detect</i>	<i>On</i> <i>Off</i>	Turn this parameter on to automatically detect UA-1650 windscreen when mounted on the ZC-0032 microphone preamplifier, and compensate for the impact on the overall frequency response of the analyzer. Turn this parameter off to enable manual setting of windscreen correction. Note 1: The preamplifier should be connected to the top socket, if necessary using a microphone extension cable. Note 2: Windscreen detection cannot be performed while measuring, so if the instrument detects a change in windscreen status (i.e., the windscreen has been removed, or a windscreen has been fitted during the measurement) a warning message box will appear. This message box gives you the opportunity to reset the measurement, by tapping the <i>OK</i> button. If you want to save the measurement, tap the <i>Cancel</i> button, and then save the measurement as normal.
<i>Windscreen Correction</i>	<i>None</i> <i>UA-1650</i> <i>UA-1404</i>	If <i>Windscreen Auto Detect</i> is set to <i>Off</i> , you can manually select a windscreen correction suitable for the windscreen in use.
<i>Extended Low Frequency</i>	<i>Off</i> <i>On</i>	Use this parameter to extend the low frequency of the measurement down to approximately 1 Hz, determined by the transducer used and the CCLD circuit.

A.2 Frequency Weightings

Table A.2 Frequency weighting parameters

Parameter	Values	Comment
<i>Broadband (excl. Peak)</i>	<i>AC</i> <i>AZ</i> <i>BC</i> <i>BZ</i>	All broadband parameters (except L_{peak}) are measured simultaneously with two different frequency weightings – select the weightings here
<i>Broadband Peak</i>	<i>X</i> <i>C</i> <i>Z</i>	One broadband peak parameter L_{peak} is measured, select the frequency weighting here. Note: X = frequency weighting A or B. 'A' requires that the <i>Broadband (excl. Peak)</i> parameter is set to <i>AC</i> or <i>AZ</i> . 'B' requires that the <i>Broadband (excl. Peak)</i> parameter is set to <i>BC</i> or <i>BZ</i>

A.3 Frequency Setting Parameters

Table A.3 Frequency setting parameters

Parameter	Values	Comment
<i>Span</i>	100 Hz 200 Hz 500 Hz 1 kHz 2 kHz 5 kHz 10 kHz 20 kHz	Determines the frequency span over which the signal will be measured.
<i># Lines</i>	100 200 400 800 1600 3200 6400	Determines the number of FFT lines to be measured and displayed on the screen.
<i>Centre Freq.</i>	Span from: 50 to 19.950 kHz	Determines the frequency around which the selected frequency span is equally divided.
<i>Record Length</i>	–	Determines the inverse of frequency resolution. This field cannot be edited. It is calculated internally and then displayed.
<i>Post Weighting</i>	Z A	Determines the weighting to be applied to the FFT spectrum. In the case of sound measurements, use A-weighting to emphasise frequencies audible to the human ear.
<i>Pre Weighting</i>	X C Z	Determines the weighting to be applied to the input signal. In the case of sound measurements, use A-weighting to emphasise frequencies audible to the human ear. Note: X = frequency weighting A or B. 'A' requires that the <i>Broadband (excl. Peak)</i> parameter is set to AC or AZ. 'B' requires that the <i>Broadband (excl. Peak)</i> parameter is set to BC or BZ

Table A.3 (Continued) Frequency setting parameters

Parameter	Values	Comment
<i>Frequency Correction</i>	<i>On</i> <i>Off</i>	Determines whether the frequency correction is to be applied to the cursor readout. While measuring a pure tone, a peak may lie between two lines. In this case, the energy from that peak will be distributed between these two lines. Therefore, the exact level and frequency will not be shown if the Frequency Correction parameter is set to <i>Off</i> . For a tone that coincides with an FFT line, the corrected and uncorrected values will be very similar. These corrected levels and frequency values are displayed with the prefix "c".

A.4 Measurement Control Parameters

Table A.4 Measurement control parameters

Parameter	Values	Comment
<i>Measurement Mode</i>	<i>Manual</i> <i>Triggered</i>	Determines whether the measurement is manual or triggered.
<i>Averaging Type</i>	<i>Linear</i> <i>Exponential</i>	Determines the way in which the spectra are averaged. Note: <i>Averaging Type</i> is automatically set to <i>Linear</i> when measurement mode is set to <i>Triggered</i> , and cannot be changed.
<i># Average Spectra</i>	1 to 8388607 (Linear) 1 to 999 (Exponential)	Determines the the number of spectra to be averaged. Note: If triggered mode is selected, it is set to the number of spectra resulting from the setting of <i># Triggers</i> and <i># Spectra per Trigger</i> parameters.
<i>Signal Type</i>	<i>Continuous</i> <i>Transient</i>	Determines the type of signal to be measured. Note: If manual mode is selected, <i>Signal Type</i> is automatically set to <i>Continuous</i> by default.
<i>Window Type</i>	<i>Hanning</i> <i>Rectangular</i>	Determines the type of Time Window to be applied on the measured signal. Note: If manual mode is selected, <i>Window Type</i> is automatically set to <i>Hanning</i> by default.
<i># Triggers</i>	1 to 32767	Determines the number of triggers for which the measurement will run. Note: This parameter is disabled in manual mode.

Table A.4 (Continued) Measurement control parameters

Parameter	Values	Comment
# Spectra per Trigger	1 to 32767	Determines the number of spectra that will be averaged per trigger. Note: This parameter is disabled in the manual measurement mode.

A.5 Trigger and Tacho Parameters

Table A.5 Trigger and tacho parameters

Parameter	Values	Comment
Trigger Type	Internal External	Determines whether the trigger input is internal or external. Internal trigger is used to trigger on the incoming time signal. External trigger is used to trigger on a signal applied through the trigger input.
Delay	Permissible delays for the respective spans: 20KHz: $-0.64s$ to $300s$ 10KHz: $-1.28s$ to $300s$ 5KHz: $-2.56s$ to $300s$ 2KHz: $-6.4s$ to $300s$ 1KHz: $-12.8s$ to $300s$ 500Hz: $-25.6s$ to $300s$ 200Hz: $-64s$ to $300s$ 100Hz: $-128s$ to $300s$	Determines the delay from the trigger to the start of the record. When the delay is positive, the record starts the specified duration after the occurrence of the trigger point. When the delay is negative, the record starts the specified duration before the occurrence of the trigger point.
Hold Off	0 to 300 s	Determines the time that the trigger circuit is held off after the occurrence of a trigger. A new trigger is only accepted after this time.
Internal Level	Maximum you can enter depends on full-scale level.	Determines the level of the incoming measurement signal that will cause a trigger. This parameter is enabled when <i>Trigger Type</i> is set to <i>Internal</i> .
Tacho	On Off	When <i>Tacho</i> is <i>On</i> , RPM measurements are done on the signal connected to Trigger input. The parameters for <i>External Level</i> , <i>Hysteresis</i> , <i>Slope</i> and <i>Pull Up</i> are used for finding the tacho pulses – these are used to measure the RPM. When <i>Tacho</i> is <i>Off</i> , no RPM is measured.
RPM Gear Ratio	10^{-5} to 10^{38}	The displayed RPM's are the measured RPM's divided by the RPM Gear Ratio.
External Level	$-18V$ to $+18V$	Determines the level of the signal applied on the trigger input that will cause a trigger. This parameter is enabled when <i>Trigger type</i> is set to <i>External</i> or <i>Tacho</i> is set to <i>On</i> .

Table A.5 (Continued) Trigger and tacho parameters

Parameter	Values	Comment
<i>Hysteresis</i>	<i>0V to 10V</i>	Determines the hysteresis on the external trigger. This parameter is enabled when <i>Trigger Type</i> is set to <i>External</i> or <i>Tacho</i> is set to <i>On</i> .
<i>Slope</i>	<i>Rising</i> <i>Falling</i>	Determines the trigger slope on the external trigger. This parameter is enabled when <i>Trigger Type</i> is set to <i>External</i> or <i>Tacho</i> is set to <i>On</i> .
<i>Pull Up</i>	<i>On</i> <i>Off</i>	Use this parameter to 'pull up' the trigger input to +5V (via a 7.5kΩ resistor). This parameter is enabled when <i>Trigger Type</i> is set to <i>External</i> or <i>Tacho</i> is set to <i>On</i> .

A.6 Limit Level Parameters

Table A.6 Limit level parameters

Parameter	Values	Comment
<i>Limit Level Check</i>	<i>On</i> <i>Off</i>	Determines whether the limit level check is enabled.
<i>Limit Level</i>	<i>-327 dB to 327 dB</i>	Determines the value at which the limit level will be set.
<i>Limit Frequency Range</i>	<i>Full</i> <i>Partial</i>	Determines whether the limit level is to be applied over the entire frequency range or only a part of it.
<i>Bottom Frequency</i>	<i>0.0Hz to 20000Hz</i>	Determines the lower frequency range of the limit level. Note: This parameter is enabled only if <i>Limit Range</i> is set to <i>Partial</i> .
<i>Top Frequency</i>	<i>0.0Hz to 20000Hz</i>	Determines the higher frequency range of the limit level. Note: This parameter is enabled only if <i>Limit Range</i> is set to <i>Partial</i> .

A.7 Parameters Related to Units

Table A.7 Parameters related to units

Parameter	Values	Comment
<i>Scaling</i>	<i>Pwr</i> <i>RMS</i> <i>ESD</i> <i>PSD</i> <i>Peak</i> <i>Peak-Peak</i>	Determines the scaling to be applied to the measured signal, and accordingly modifies the Y-axis range, the spectrum and the units of measurement.
<i>Spectrum Display</i>	<i>Acceleration</i> <i>Velocity</i> <i>Displacement</i> <i>Sound</i> <i>Voltage</i>	If a microphone is selected under <i>Trans. Used</i> , this parameter is set by default to <i>Snd</i> (Sound) and cannot be edited. If an accelerometer is selected, this parameter determines whether the measured signal is displayed in terms of acceleration, velocity, or displacement. If <i>Direct</i> is selected under <i>Trans. Used</i> , this parameter is set by default to <i>Voltage</i> and cannot be edited.
<i>Unit System</i>	<i>SI</i> <i>US/UK</i>	Determines which unit system is used for the measured signal.
<i>Y-axis</i>	<i>dB</i> <i>Engineering</i>	Determines whether the Y-axis will be displayed in decibel values (dB) or Engineering units.
<i>Unit</i>	–	Determines the current unit of measurement. It is dependent on all the above parameters.

A.8 Recording Parameters

Table A.8 Recording parameters^a

Parameter	Values	Comment																				
<i>Recording Control</i>	<p><i>Off</i></p> <p><i>Automatic</i></p> <p><i>Manual Event</i></p> <p><i>Limit Level</i></p>	<p>Determines how recording of the measured signal is controlled.</p> <p>Set to <i>Automatic</i> to start the recording when the measurement starts and record throughout the measurement, only limited by the <i>Maximum Duration</i>.</p> <p>Set to <i>Manual Event</i> to start recording manually while measuring when the Manual Event pushbutton is pressed, and record until pressing the pushbutton again, however, take <i>Maximum</i> and <i>Minimum Duration</i> into account.</p> <p>Set to <i>Limit Level</i> to start recording whenever the signal exceeds the set level limit, and stop when it dips below it.</p>																				
<i>Recording Quality</i>	<p><i>Low (3.3kHz)</i></p> <p><i>Fair (6.6kHz)</i></p> <p><i>Medium (10kHz)</i></p> <p><i>High (20kHz)</i></p>	<p>This setup determines the quality of the recording by adjusting the sampling rate. The amount of space required for the recording on the memory card will depend on the selected quality:</p> <table border="1"> <thead> <tr> <th><u>Quality</u></th> <th><u>Sampling freq.</u></th> <th><u>Upper freq.</u></th> <th><u>Memory</u></th> </tr> </thead> <tbody> <tr> <td>Low</td> <td>8 kHz</td> <td>3 kHz</td> <td>16 KB/s</td> </tr> <tr> <td>Fair</td> <td>16 kHz</td> <td>6 kHz</td> <td>32 KB/s</td> </tr> <tr> <td>Medium</td> <td>24 kHz</td> <td>10 kHz</td> <td>48 KB/s</td> </tr> <tr> <td>High</td> <td>48 kHz</td> <td>20 kHz</td> <td>96 KB/s</td> </tr> </tbody> </table>	<u>Quality</u>	<u>Sampling freq.</u>	<u>Upper freq.</u>	<u>Memory</u>	Low	8 kHz	3 kHz	16 KB/s	Fair	16 kHz	6 kHz	32 KB/s	Medium	24 kHz	10 kHz	48 KB/s	High	48 kHz	20 kHz	96 KB/s
<u>Quality</u>	<u>Sampling freq.</u>	<u>Upper freq.</u>	<u>Memory</u>																			
Low	8 kHz	3 kHz	16 KB/s																			
Fair	16 kHz	6 kHz	32 KB/s																			
Medium	24 kHz	10 kHz	48 KB/s																			
High	48 kHz	20 kHz	96 KB/s																			
<i>Automatic Gain Control</i>	<p><i>On</i></p> <p><i>Off</i></p>	<p>To ease identification of sound sources, the gain can be automatically adjusted to keep the average level within a 40 dB range. When playing back the recorded signal, you will then hear clearly the whole signal content, whether the level has been 20 dB or 140 dB.</p> <p>Set <i>Automatic Gain Control</i> to <i>On</i> to convert the recorded signal.</p> <p>Set <i>Automatic Gain Control</i> to <i>Off</i> for recording the signal with a fixed gain – then set <i>Peak Recording Level</i> to fit the signal.</p> <p>Note: If the sound contains very high levels at low frequency, then a fixed gain is recommended.</p>																				

Table A.8 (Continued) Recording parameters^a

Parameter	Values	Comment
<i>Peak Recording Level</i>	Depends on the current transducer type selected.	The recorded signal is stored as a 16-bit wave file, which has a dynamic range of up to 96 dB. When playing back on the Hand-held Analyzer the dynamic range of the output is approx. 75 dB. When playing back on a PC it might be even lower. Set <i>Peak Recording Level</i> to fit the signal. The values for <i>Peak Recording Level</i> take the sensitivity of the attached transducer into account. Note: This parameter is enabled only if <i>Automatic Gain Control</i> is set to <i>Off</i> .
<i>Pre-recording Time</i>	0 to 110 s	Recording is started the <i>Pre-recording Time</i> before the trigger conditions are fulfilled (e.g., 5 s means the recording will be started 5 s before you press the Manual Event pushbutton). This is possible because the recording is done continuously in an internal buffer, ready to be saved as a wave file. The <i>Pre-recording Time</i> is limited by this buffer size and the <i>Recording Quality</i> : <u>Quality</u> <u>Pre-recording Time Limit</u> Low 110s Fair 50s Medium 30s High 10s
<i>Post-recording Time</i>	0 to 300 s	Use this parameter to specify how much extra you want to be recorded after the trigger conditions are no longer fulfilled.
<i>Duration Limit</i>	On Off	Use this parameter to enable the <i>Minimum Duration</i> and <i>Maximum Duration</i> parameters for overruling the duration of the sound recording determined by the trigger condition parameters. Note: This parameter is enabled only if <i>Recording Control</i> is set to <i>Manual Event</i> or <i>Limit Level</i> .
<i>Minimum Duration</i>	00:00:00 to 01:00:00	When <i>Duration Limit</i> is <i>On</i> , then <i>Minimum Duration</i> will determine the minimum recording time regardless of the trigger conditions. The total record length will then (as a minimum) be the sum of <i>Minimum Duration</i> , <i>Pre-recording Time</i> and <i>Post-recording Time</i> .

Table A.8 (Continued) Recording parameters^a

Parameter	Values	Comment
<i>Maximum Duration</i>	<i>00:00:00 to 01:00:00</i>	When <i>Duration Limit</i> is <i>On</i> , then <i>Maximum Duration</i> will determine the maximum recording time regardless of the trigger conditions. The total record length will then (as a maximum) be the sum of <i>Maximum Duration</i> , <i>Pre-recording Time</i> and <i>Post-recording Time</i> . Note: If <i>Maximum Duration</i> = <i>00:00:00</i> , then it is disabled and doesn't limit the duration.

a. Requires license for Sound Recording Option BZ-7226.

A.9 Output Socket Signal Parameters

Table A.9 Output socket signal parameters

Parameter	Values	Comment
<i>Source</i>	<i>Off</i> <i>Input</i> <i>Instantaneous Limit Level</i> <i>Latched Limit Level</i>	Determines the source of the input signal for the output socket of the Hand-held Analyzer. Select between <i>Off</i> and <i>Input</i> signal for monitoring purposes. Note: If you do not want to output the signal, then select <i>Off</i> to economise on power. Choose between <i>Instantaneous Limit Level</i> or <i>Latched Limit Level</i> to get a TTL output on the Output Socket. Please refer to Fig.2.17 on page 18 of this manual. Note: If you do not want to output the signal, then set this parameter to <i>Off</i> to economise on power
<i>Gain</i>	<i>-60 dB to 60 dB</i>	Key in a gain value (0.1 dB resolution) for the input signal. Use '@' to assign the new value for immediate response at the output – or use the up/down navigation keys to increment/decrement the value in steps of 1 dB. Note 1: 0 dB means 1 V output for 1 V input. Note 2: This parameter is enabled only if the <i>Source</i> parameter is set to <i>Input</i> .

A.10 Tone Assessment Parameters

Table A.10 *Tone assessment parameters^a*

Parameter	Values	Comment
<i>Tone Assessment</i>	<i>On</i> <i>Off</i>	Turn this parameter <i>On</i> to enable Tone Assessment Note: Tone Assessment will be enabled providing a valid BZ-7231 license is available
<i>Tone Standard</i>	<i>ISO 1996:2-2007</i>	Determines the standard on which tone assessment is based. Currently, only ISO 1996:2-2007 is supported
<i>Tone Seek Criterion</i>	<i>0.1 dB to 4.0 dB</i>	Determines if a classified line is a noise pause. A noise line is classified as a noise pause if the difference between its dB level and the dB levels of immediate neighbouring lines is greater than or equal to the Tone Seek Criterion

a. Available for Tone Assessment Option BZ-7231 only.

A.11 Tone at Cursor Parameters

Table A.11 *Tone at cursor parameters^a*

Parameter	Values	Comment
<i>Level [re. 1 V]</i>	<i>-70 dB to +10.0 dB</i>	This sets the level of a tone (sine wave) at the cursor frequency. The tone is output at the headphone socket

a. Available for Tone Assessment Option BZ-7231 only.

Appendix B

Measurement Parameters

This appendix describes the measurement parameters. They are measured in accordance with the setup parameters.

Please refer to the Glossary in Appendix E of the User Manual for Hand-held Analyzers Types 2270 and 2250, BE 1713, and the Glossary in Appendix C of this manual for a description of the parameters.

The following letters are substituted in the parameters that follow to represent the wide range of frequency weightings, time weightings and percentile levels available:

V = frequency weightings A, B, C or Z (controlled by **Setup** – *Frequency Weightings – Broadband Peak* parameter)

X = frequency weightings A or B (controlled by **Setup** – *Frequency Weightings – Broadband (excl. Peak)* parameter)

Y = frequency weightings C or Z (controlled by **Setup** – *Frequency Weightings – Broadband (excl. Peak)* parameter)

W = frequency weightings A, B, C or Z (controlled by **Setup** – *Frequency Weightings – Spectrum* parameter)

B.1 Total Measurement

B.1.1 For FFT Analysis Software BZ-7230

FFT Parameters

Spectrum Parameters

- FFT Spectrum
- MAX Spectrum

FFT Parameters

- Current Average Number
- Current Average Time
- Total Averaging Time
- Total of FFT Spectrum
- Total of MAX Spectrum
- Total of Ref Spectrum
- Instantaneous RPM
- Average RPM

Broadband Parameters

The following parameters are measured within the Elapsed Time:

Equivalent Continuous Sound Levels

- L_{Xeq}
- L_{Yeq}

Maximum Time-weighted Sound Levels

- L_{XFmax}
- L_{YFmax}

Minimum Time-weighted Sound Levels

- L_{XFmin}
- L_{YFmin}

General Parameters

- Overload in %
- Start time
- Stop Time
- Elapsed Time (excl. pauses)

Special Parameters

- L_{XIeq}

- L_{YIeq}
- L_{AFTeq} (also called L_{AFm5})

B.1.2 For Tone Assessment Option BZ-7231

Parameters

- K_t (Prom. Tone)
- ΔL_{ta}
- L_{pn}
- L_{pti}
- L_{pt}
- Critical Band

Appendix C

Glossary

This Appendix is a continuation of the Glossary in Appendix E of User Manual for Hand-held Analyzers Types 2270 and 2250 (BE 1713).

C.1 FFT Parameters

Current Average Number:	When measuring the average of several spectra, the Current Average Number parameter shows the number of spectra averaged so far.
Current Average Time:	When measuring the average of several spectra, the Current Average Time parameter shows the averaging time elapsed so far.
Total Averaging Time:	When measuring the average of several spectra, the Total Averaging Time parameter shows the time for the complete measurement.
Total of FFT Spectrum:	The Total of FFT Spectrum is the sum of the levels of all the lines in the displayed FFT spectrum.
Total of MAX Spectrum:	The Total of MAX Spectrum is the sum of the levels of all the lines in the displayed MAX spectrum.
Total of Ref Spectrum:	The Total of REF Spectrum is the sum of the levels of all the lines in the displayed REF spectrum.
Instantaneous RPM:	The Instantaneous RPM is the current RPM value.
Average RPM:	For Linear averaging, the Average RPM is the average RPM over the Total Averaging Time. For Exponential averaging, it is the latest RPM of the measurement.

C.2 Tone Assessment Parameters

Tone Level (L_{pt}):	Level of all tones in the critical band containing the selected tone.
Level (L_{pti}):	Level of the selected tone.
Masking Noise Level (L_{pn}):	Masking noise is the sound which does not belong to the tone, and which limits (masks) the audibility of the tone. It is the total level of the masking noise in the band containing the selected tone.
Audibility (ΔL_{ta}):	Audibility is difference between the tone level and the masking noise level. It refers to the audibility of all tones found in the same critical band as the selected tone.
Critical Band:	Start of Critical Band and end of Critical Band containing the selected tone.
Adjustment (K_t):	The size of the adjustment in dB. The adjustment is calculated from the decisive band and refers to the total spectrum.

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HEADQUARTERS: DK-2850 Nærum · Denmark · Telephone: +45 4580 0500 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com

Australia (+61) 2 9889-8888 · Austria (+43) 1 865 74 00 · Brazil (+55) 11 5188-8161 · Canada (+1) 514 695-8225
China (+86) 10 680 29906 · Czech Republic (+420) 2 6702 1100 · Finland (+358) 9-755 950 · France (+33) 1 69 90 71 00
Germany (+49) 421 17 87 0 · Hong Kong (+852) 2548 7486 · Hungary (+36) 1 215 83 05 · Ireland (+353) 1 807 4083
Italy (+39) 0257 68061 · Japan (+81) 3 5715 1612 · Republic of Korea (+82) 2 3473 0605 · Netherlands (+31) 318 55 9290
Norway (+47) 66 77 11 55 · Poland (+48) 22 816 75 56 · Portugal (+351) 21 4169 040 · Singapore (+65) 6377 4512
Slovak Republic (+421) 2 5 443 0701 · Spain (+34) 91 659 0820 · Sweden (+46) 33 225 622 · Switzerland (+41) 44 8807 035
Taiwan (+886) 2 2502 7255 · United Kingdom (+44) 14 38 739 000 · USA (+1) 800 332 2040

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