USER MANUAL

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

for use with
Hand-held Analyzer Types 2250 and 2270

BE 1778 – 19
English

Brüel & Kjær

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

For use with
Hand-held Analyzer Types 2270 and 2250

Valid for all hardware versions and from software versions 4.7

User Manual

BE 1778–19
February 2020

www.bksv.com

Health and Safety Considerations

This apparatus has been designed and tested in accordance with IEC/EN 61010 – 1 and ANSI/UL 61010 – 1 *Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use*. This manual contains information and warnings which must be followed to ensure safe operation and to retain the apparatus in safe condition.

Safety Symbols and Signal Words Used

The apparatus will be marked with this symbol when it is important that you refer to the associated danger or warning statement given in this manual

The manual uses this symbol when a danger or warning statement is applicable

Hazardous Voltage/Electricity. Both the apparatus and manual use this symbol when there is a risk for shock or electrocution

Hot Surface. This manual will use this symbol when there is a risk for burning or scolding

Earth (Ground) Terminal. The apparatus will be marked with this symbol when applicable

Protective Conductor Terminal. The apparatus will be marked with this symbol when applicable

Alternating Current. The apparatus will be marked with this symbol when applicable

Danger Signals an imminent hazardous situation, which, if not avoided, will result in death or serious injury

Warning Signals a possibly hazardous situation, which, if not avoided, will result in death or serious injury

Caution Signals a hazardous situation, which, if not avoided, could result in minor or moderate injury or damage to the apparatus

Notice Signals a situation or practice that requires attention, but does not directly result in personal injury if ignored

Risks and Hazards

Explosion Hazards

Danger: The apparatus is not designed to be used in potentially explosive environments. It should not be operated in the presence of flammable liquids or gases

Electrical Hazards

Warning: Any adjustment, maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be carried out only by trained service

Caution: Switch off all power to equipment before connecting or disconnecting their digital interface. Failure to do so could damage the equipment

Mechanical Hazards

Caution: Whenever it is likely that the correct function or operating safety of the apparatus has been impaired, it must be made inoperative and be secured against unintended operation

Waste Handling

Brüel & Kjær complies with the EU’s Waste Electrical and Electronic Equipment (WEEE) Directive, which issues the following waste handling instructions:

- Do not dispose of electronic equipment or batteries as unsorted municipal waste
- It is your responsibility to contribute to a clean and healthy environment by using the appropriate local return and collection systems
- Hazardous substances in electronic equipment or batteries may have detrimental effects on the environment and human health
- The symbol shown to the left indicates that separate collection systems must be used for any discarded equipment or batteries marked with that symbol
- Waste electrical and electronic equipment or batteries may be returned to your local Brüel & Kjær representative or to Brüel & Kjær Headquarters for disposal

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Contents

Chapter 1

Introduction

1.1 Welcome

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

If you are newcomer to the world of Type 2250 or 2270, you are strongly advised to study Hand-held Analyzer Types 2250 and 2270 user manual (BE 1713) before reading this manual. Doing so will give you 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 analyzers in general.

This manual instructs you on how to set up your analyzer for FFT measurements, how to measure, and how to look at your results. Anything that is independent of BZ-7230 or BZ-7231 can be found in Hand-held Analyzer Types 2250 and 2270 user manual (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 How to Use this Manual

1.2.1 Conventions Used in this Manual

"Analyzer" refers to Type 2250 or Type 2270 if the description is valid for both types.

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

Icons, Buttons and Tabs Used on the Screen

Indicated by bold type face (for example, on the **Full** tab ...).

Parameter Values, Text and Variables

Parameter values, instructions, descriptions appearing on the screen and variables are indicated by italics (for example, *Internal Disk*).

Menu, Parameters and Screen Navigation

Indicated by bold type face (for example, **Setup** > **Frequency Settings** > **Span**).

Keyboard Entries

Keyboard entries and combinations are indicated by bold type face within angle brackets (for example, **<Ctrl+b>** means you should press the **Ctrl** key and **b** key at the same time).

1.2.2 Beginners

Before you read the rest of this manual, read Brüel & Kjær's primer on Measuring Sound (BR 0047). This will give you a basic idea of acoustic measurements. It can be found on the www.bksv.com website, by typing "Primer" in the search window. The website also contains lots of other information you might find useful.

Further information is available in the online help installed on your analyzer.

1.2.3 Experienced Users of Acoustic Measurement Equipment

The manual is designed so that you don't have to read all of it to be able to use the analyzer. It is built around the most frequently used operations, which are as follows:

- Getting Started (Chapter 2) – a general description of FFT signal analysis and a tutorial
- Using Accelerometers for Vibration Measurement (Chapter 3) – a guide to choosing and mounting your accelerometer, configuring the analyzer's input and calibration
- Measuring Random Signals (Chapter 4) – a brief description of random signals and how to prepare for measurement, measure random signals and fine tune
- Measuring Transient and Continuous Signals (Chapter 5) – a brief description of transient and continuous signals and how to prepare for measurement and measure transient and continuous signals
- Measuring Deterministic Signals (Chapter 6) – a brief description of deterministic signals, and how to prepare for measurement, measure deterministic signals and use reference spectra and tolerance windows
- Tone Assessment Option BZ-7231 (Chapter 7) – how to perform FFT-based tone assessment measurements, set up and measure with your analyzer and view and recall your measurements
- Specifications (Chapter 8) – technical specifications for FFT Analysis Software BZ-7230 and FFT-based Tone Assessment Software BZ-7231
- Setup Parameters (Appendix A) – parameters for performing FFT measurements
- Measurement Parameters (Appendix B) – parameters for viewing FFT measurements
- Glossary (Appendix C)

However, it is recommended that you read the entire manual for appropriate procedures on how to use the analyzer to obtain accurate sound level measurement results.

Chapter 2

Getting Started

This chapter starts with an introduction to Fast Fourier Transform (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 familiarize 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 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 (CPB) analysis. CPB analysis can be implemented with analogue or digital signal processing, while CB analysis is usually implemented using the digital FFT technique.

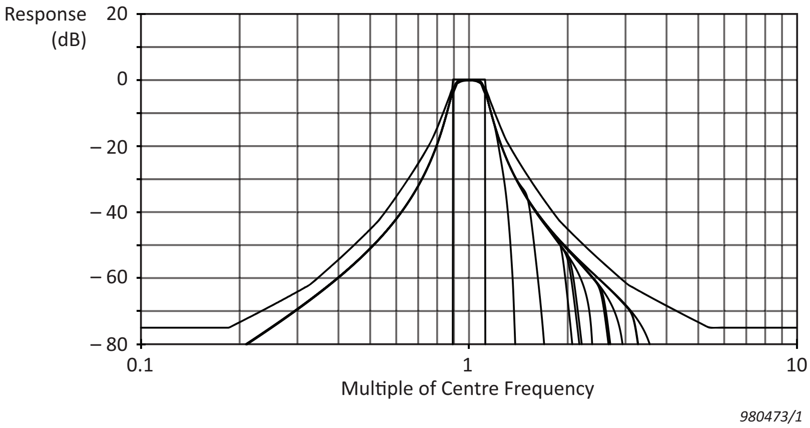
Constant Percentage Bandwidth Analysis

Traditionally frequency analysis of sound, and occasionally vibration, is made using 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.

CPB 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 analyzer's 1/3-octave filters used in Frequency Analysis Software BZ-7223. 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 characterized by a continuous stream of results, with averaging controlled exponentially (for example, Fast or Slow) or linearly (L_{eq}). Frequency Analysis Software BZ-7223 is an example of a 1/3- or 1/1-octave real-time analyzer capable of simultaneous linear and exponential averaging.

CB Analysis

CB 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 characterized 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 0 Hz, 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 analyzer's FFT Analysis Software, you can select frequency spans from 100 Hz to 20000 Hz in a 1-2-5 sequence, while selecting the number of lines of analysis from 100 to 6400 in a doubling 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 (Hz) available in FFT Analysis Software BZ-7230*

		Frequency Span (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* 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.

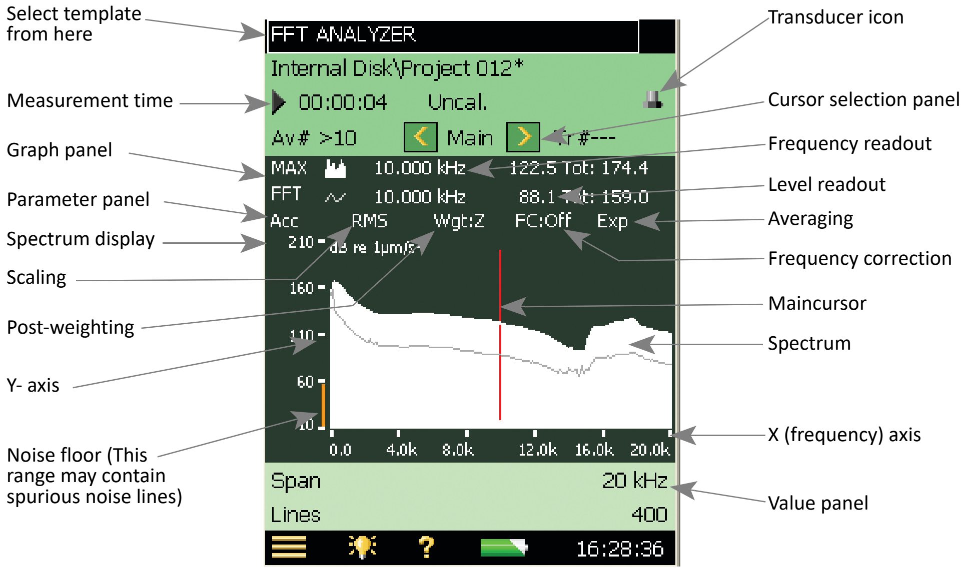
A maximum hold display (sometimes called peak averaging) is also available when using FFT Analysis Software BZ-7230, to capture the highest value in any frequency band during the measurement.

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.

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

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:

Analyzer with:

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

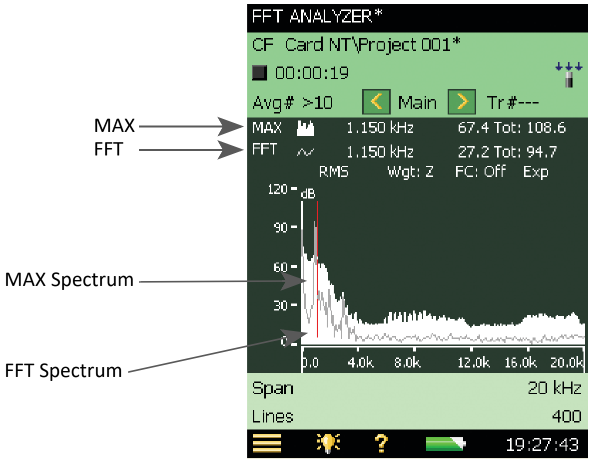
This tutorial provides a step-by-step guide on how to perform FFT measurements on a stationary source, including familiarization with the important features of BZ-7230.

Please note: If you do not have the Signal Recording option BZ-7226 installed, please skip section 2.3.7.

1) Fit the supplied microphone onto the 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** .
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 is 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 that 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.

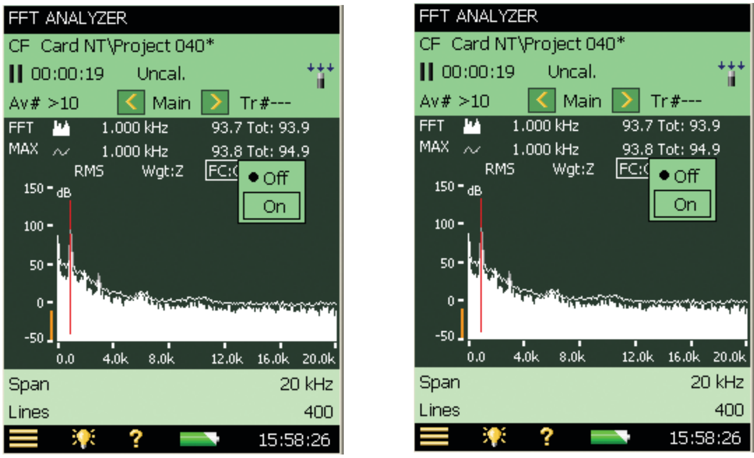


Fig. 2.4
Setting frequency correction:
Left: *Before*
Right: *After*

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 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 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.

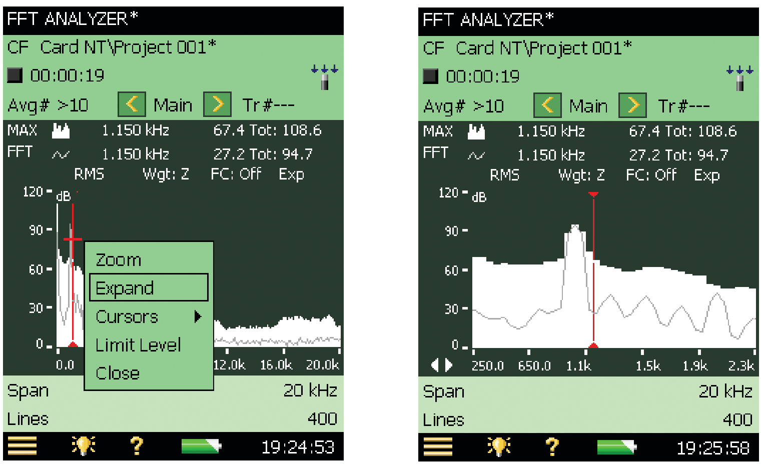


Fig. 2.5
Expanding the display:
Left: *Before*
Right: *After*

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

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.

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

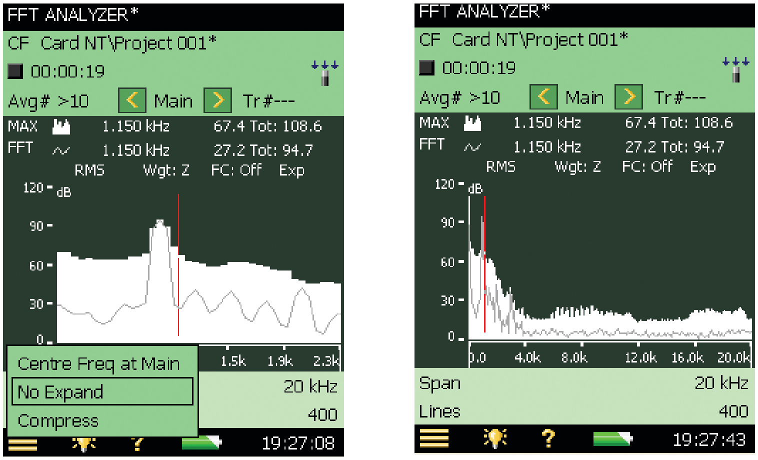


Fig. 2.6
Performing a ‘No Expand’ operation:
Left: *Before*
Right: *After*

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).

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

17) Select *Zoom Measurement* from the resulting drop-down menu (Fig. 2.7).

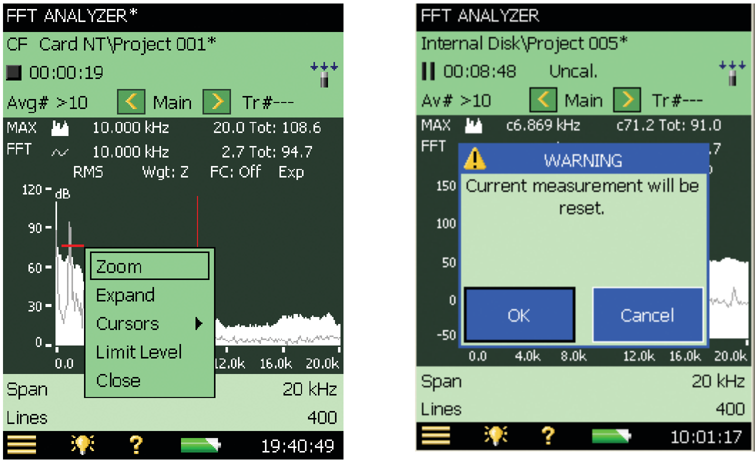


Fig. 2.7
Left: Spectrum before 'zoom' operation
Right: Message box for measurement reset

18) 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.

    The axis now has a new span and centre frequency, see Fig. 2.8.

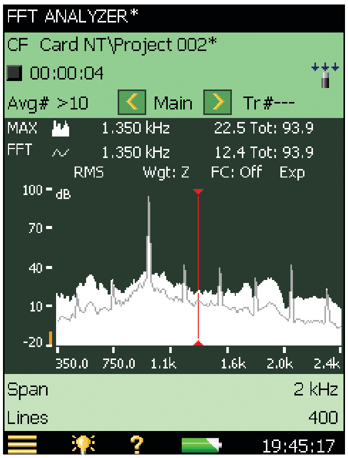


Fig. 2.8
Spectrum after 'zoom' operation

19) Tap > **Setup**.
20) On the Quick tab, locate **Centre Freq.** and **Span**.
21) Change the frequency span to *20 kHz*, see Fig. 2.9. This will automatically set your centre frequency to *10 kHz*.

Hint: It is also possible to unzoom by tapping the frequency axis and selecting *Unzoom* from the drop-down menu, see Fig. 2.9.

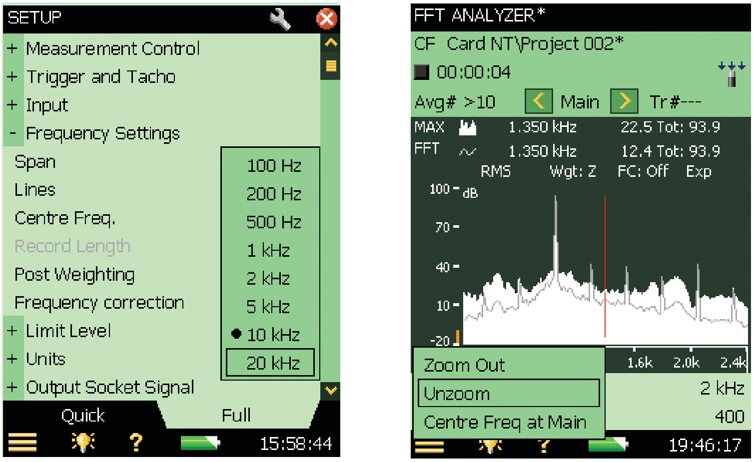


Fig. 2.9
Left: *Drop-down list showing selectable frequency spans.*
Right: *Alternative method of unzooming*

22) Return to the measurement display: the frequency axis now covers the full 0 Hz to 20 kHz range again and the measurement has restarted.

23) Instead of a linear X-axis (frequency axis), you can select a logarithmic X-axis by tapping on the frequency axis and selecting *Logarithmic X-axis* (Fig. 2.10). A logarithmic X-axis can be useful for sound measurements. Tap the frequency axis again to reselect *Linear X-axis*.

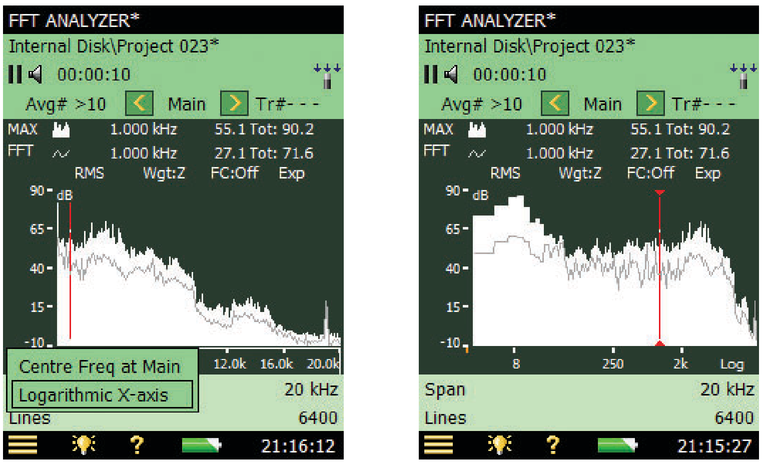


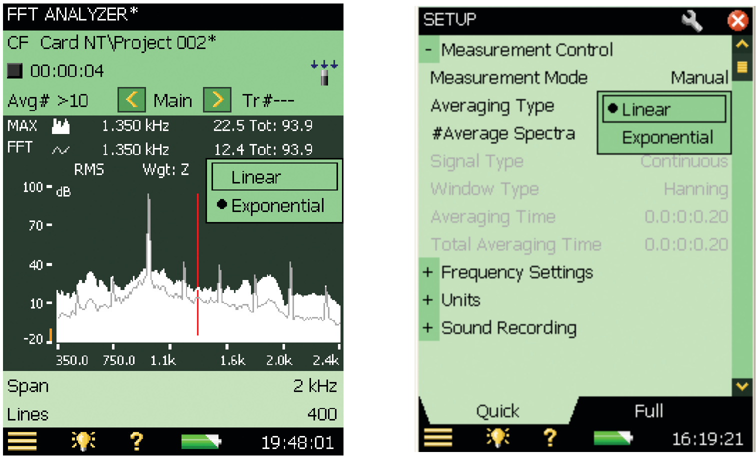
Fig. 2.10
Left: *Drop-down list showing the Logarithmic X-axis option.*
Right: *The logarithmic X-axis displayed*

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*.

24) Select *Linear* averaging by tapping directly in the Averaging field (Fig. 2.2) of the measurement display, see Fig. 2.11.

Fig. 2.11
***Left:** Setting linear averaging directly.*
***Right:** Setting Linear averaging via the Setup menu*



25) 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).
26) Observe the spectrum, the number of averages display and the elapsed time. Observe that the measurement automatically goes to the paused state || after the preconfigured number of averages has been reached (default setup is 10 averages).
27) You can also select averaging from the setup page, see Fig. 2.11.
28) To set the measurement in free run mode again, select *Exponential* averaging by tapping directly on the measurement display.

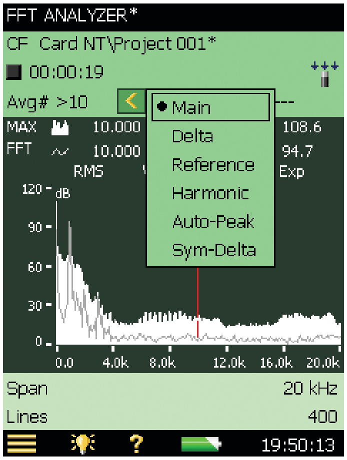
2.3.5 Cursors

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

29) Tap the cursor selector (between the < and > buttons). Select *Delta* cursor from the cursor selection drop-down.
30) Use the pushbutton to navigate down until the main cursor is active.

Fig. 2.12
The cursor selection drop-down menu



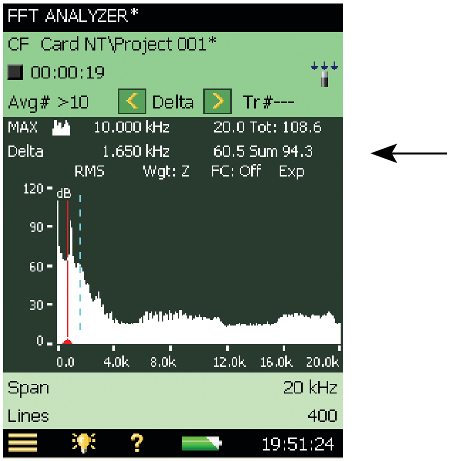
31) Use the ◄ or ► pushbuttons to place the main cursor (together with the delta cursor) at a position to the left of the calibrator tone.

32) Use the < or > buttons to move the delta cursor to a position to the right of the calibrator tone.

33) Observe the cursor reading (Fig. 2.13).

Please 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. 2.13
Delta cursor reading



Reference Cursor and Auto Peak Find

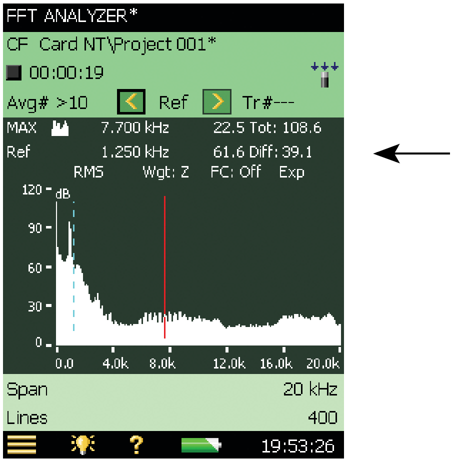
34) Tap the cursor selector again. Select *Reference* cursor from the cursor selection drop-down.

35) Use the < or > buttons to navigate the reference cursor to a position close to the calibrator tone.

36) Observe the cursor readout (Fig. 2.14).

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

Fig. 2.14
Reference cursor reading



37) 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

38) Tap the cursor selector again. Select the *Harmonic* cursor from the cursor selection drop-down. This cursor assists in identifying harmonics, see Fig. 2.15.
39) Use the < or > buttons to navigate to the third harmonic.
40) Use the ▼ pushbutton to navigate down until the main cursor is active.
41) Use the ◄ or ► pushbuttons to move the third harmonic.

Please 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.

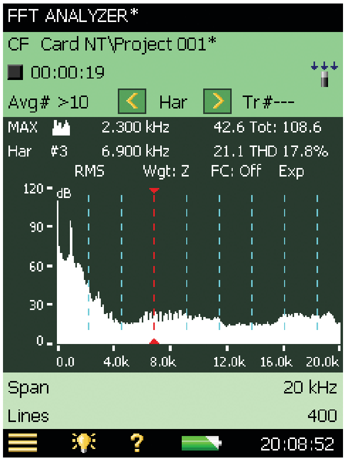


Fig. 2.15
Harmonic cursor reading

Symmetric Delta Cursor

42) Tap the cursor selector and 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 way 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.

43) Use the < and > buttons to decrease and increase the delta span.

44) Observe the spectrum and cursor reading (Fig. 2.16).

Please 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.

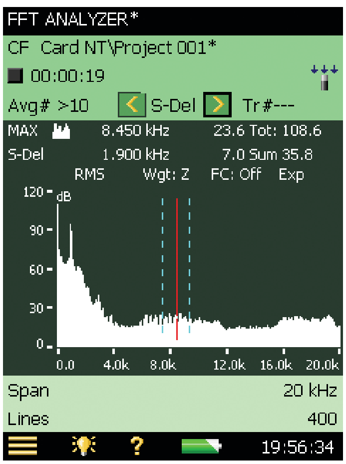


Fig. 2.16
Symmetric delta cursor reading

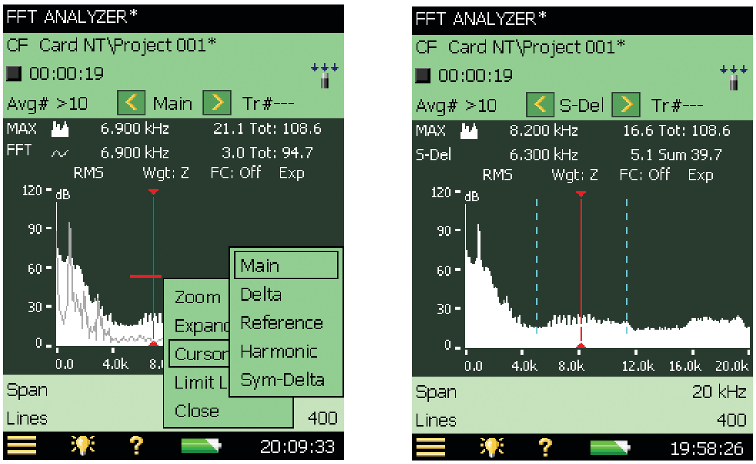
Selecting Cursors by Dragging the Stylus Over the Spectrum

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. 2.17
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 Tolerance Windows

When you need an indication that your measured level is above or below a certain value in particular frequency ranges of your choice, use the Tolerance Windows feature. You can set the values on the setup page, as well as the measurement display. Then either the FFT lines within the specified frequency range are all checked against the limits or the Delta Sum of the lines within the specified frequency range is checked (See "Delta Sum" on page 20). In addition to tolerance windows on the FFT spectrum, you can specify tolerances for the single values L_{AF}, L_{Aeq}, instantaneous rpm and averaged rpm. The system can also be configured to start recording automatically when data are beyond the tolerances.

Check FFT Lines

45) Using your stylus, drag-and-release a rectangle somewhere between the noise floor and the calibrator tone's maximum level.

46) Select **Tolerance Window** > **TolWin1** > **FFT Lines** from the resulting drop-down menu, see Fig. 2.18.

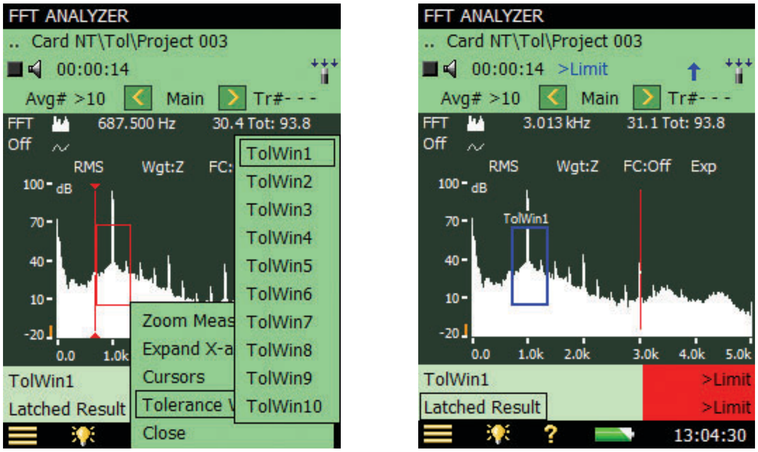
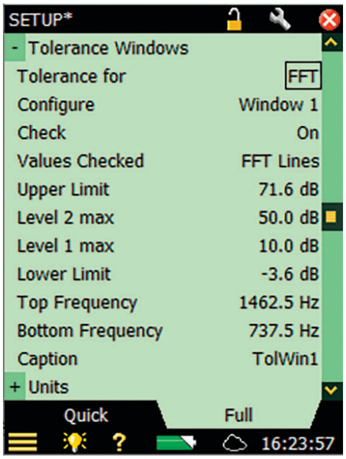


Fig. 2.18
Left: *Selecting the tolerance window.*
Right: *Tolerance window indications – overall result, instantaneous, (blue >Limit) or latched result (blue arrow)*

Please note:

- In addition to the tolerances for the single values, you can have up to 10 tolerance windows active at the same time (per template)
- Under **Setup** > **Tolerance Windows** you can fine tune the settings for upper and lower limit Level 1 max. and Level 2 max., and for top and bottom frequency for each tolerance window. You can also define a name (*Caption*) for each tolerance window. See Fig. 2.19
- Under **Setup** > **Tolerance Windows** you can also define tolerances for four single values; two instantaneous values: L_{AF} and *Instantaneous RPM*, and two average values: L_{Aeq} and *Average RPM*
- The FFT Spectrum and single values are compared to the set limits, with an indication of:
  – 'above *Upper Limit*'
  – 'within limits'
  – 'below *Lower Limit*'
  – 'above and below limits'
  – 'Passed' when *Level 1 max* and *Level 2 max* are set below *Lower Limit*, otherwise 'Level 3' (for levels between *Level 2 max* and *Upper Limit*), 'Level 2' (for levels between *Level 1 max* and *Level 2 max*) and 'Level 1' (for levels between *Lower Limit* and *Level 1 max*)
- The background colours for the displayed results differ depending on the result

Fig. 2.19
Tolerance Window settings

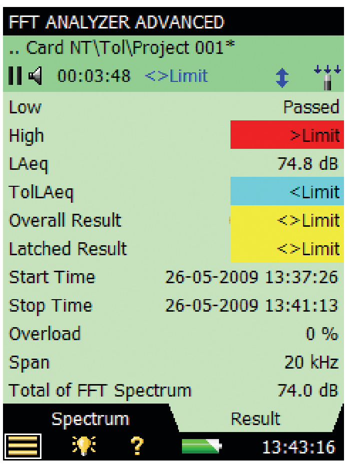


47) Make a measurement and observe the spectrum and the status field, see Fig. 2.18.

Please note:

- The tolerance window indication is visible on the display
- Two indicators are displayed in the status field: 1) 'Overall Result' for instantaneous tolerance window exceedance (blue text indicating that there is a tolerance window exceedance now) and 2) 'Latched Result' for latched tolerance window exceedance (a blue icon indicating that there has been at least one tolerance window exceedance during the measurement)
- The status of one of the indicators may be selected as a signal at the Output Socket, please refer to the Specifications for information
- The status indicators, or the result for each single tolerance window, can be selected and displayed in the two value panels below the graph. By selecting the FFT ANALYZER ADVANCED template, an extra **Result** tab is available, which displays all your results and status indications, useful for checking a number of results, see Fig. 2.20

Fig. 2.20
Advanced FFT Analyzer – Result tab



48) Start the calibrator again.
49) Observe the spectrum and the status field (Fig. 2.18).
50) Turn off the calibrator again.
51) Observe the spectrum.

    The indication for instantaneous tolerance window exceedance disappears while the indicator for latched tolerance window exceedance remains.
52) Turn the indication of tolerance window off by clicking on the Y-axis, and selecting *Tolerance Window Off* (Fig. 2.21).

    This will not turn off the feature that checks for limits; this is done by setting **Setup** > **Tolerance Windows** > **Check** to *Off* (Fig. 2.19).
53) With a saved measurement you may adjust the tolerance windows and see the corresponding results. However, the latched indicator remains unchanged.

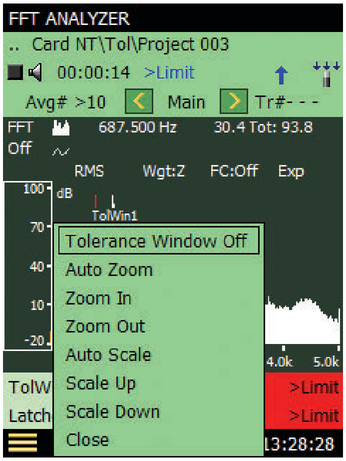


Fig. 2.21
Setting tolerance window indication

Delta Sum

Rather than checking all FFT lines against the top and bottom frequencies of the tolerance window for upper and lower limit compliance, you can check the sum of FFT lines for limit compliance. Set **Setup** > **Tolerance Windows** > **Values Checked** to *Delta Sum*.

Delta sum is based on the measured FFT lines; however, it takes spectrum display and post-weighting into account. The summation principle is as described in Table 4.1. The Delta Sum parameter is displayed using the same units as the FFT spectrum.

In linear averaging, the calculation and check of delta sum (and FFT Lines) are made on the available FFT spectrum. You can change the frequency range and limits for the tolerance windows before, during and after the measurement – the tolerance results are recalculated (except the latched result, which is updated during measurement only).

In exponential averaging, the delta sum is calculated periodically (for example, every 100 ms) during the measurement and checked against the limits. In addition to the Tolerance Result parameters a number of other parameters are updated:

- Delta Sum
- Max Delta Sum
- RPM at time for Max Delta Sum (requires Tacho set to On)
- LAF at time for Max Delta Sum
- FFT Spectrum at time for Max Delta Sum

Refer to section 6.4 for details regarding the use of Delta Sum and exponential averaging.

2.3.7 (Signal) Recording

Please note: This section is only applicable if you have Signal Recording Option BZ-7226. If not, please proceed directly to section 2.3.8.

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

54) Tap ☰ > **Setup**.

55) On the **Quick** tab, set **Signal Recording** > **Recording Control** to *Tol. Exceed* (Fig. 2.22).

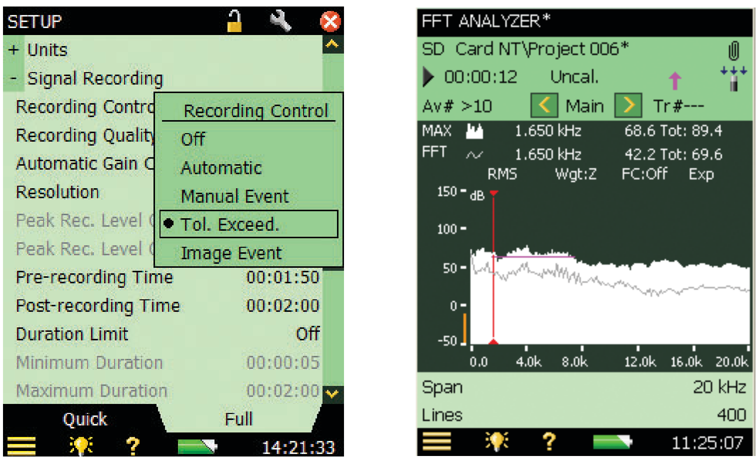


Fig. 2.22
Left: *Selecting Tol. Exceed. in Signal Recording.*
Right: *Tolerance indications*

56) Repeat the measurement described in the previous 'Tolerance Windows' section – steps 45) to 52).

57) Observe the display.

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

58) Tap the paper clip icon and play back the recording.

Please 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)*.

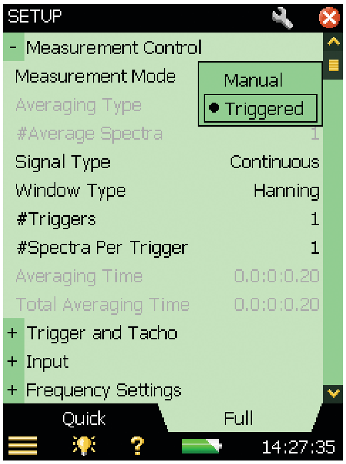
2.3.8 Triggering

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 pot of tea/coffee.

59) Tap ☰ > **Setup**.

60) On the **Full** tab, set **Measurement Control** > **Measurement Mode** to *Triggered* (Fig. 2.23).

Fig. 2.23
Setting Triggered mode



61) Set **Measurement Control** > **Signal Type** to *Transient*.

62) Open the keyboard panel for configuring the Trigger Level by tapping on the value next to **Trigger and Tacho** > **Internal Level**, see Fig. 2.24. (If **Internal Level** is greyed-out, check that **Trigger Type** 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.)

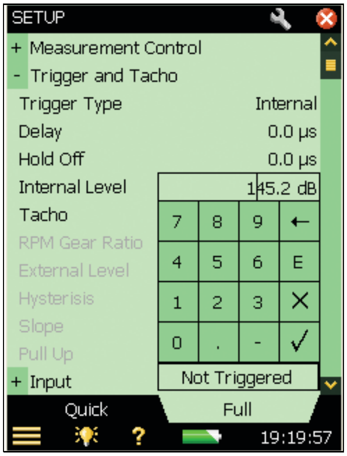


Fig. 2.24
Setting the Trigger level

63) Keep the keyboard panel open. Hold the cup 10 cm from your microphone and hit the rim of the cup with your pencil.
64) If the keyboard panel indicates a trigger (see Fig. 2.25) then all is fine and you have successfully set your analyzer up for a triggered measurement. If not, try to adjust the level downwards in 3 dB steps until you get a trigger when hitting the rim.

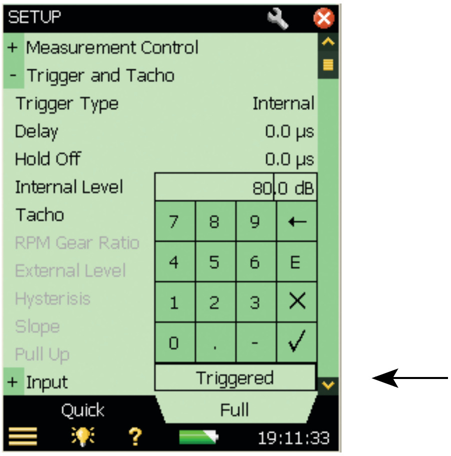
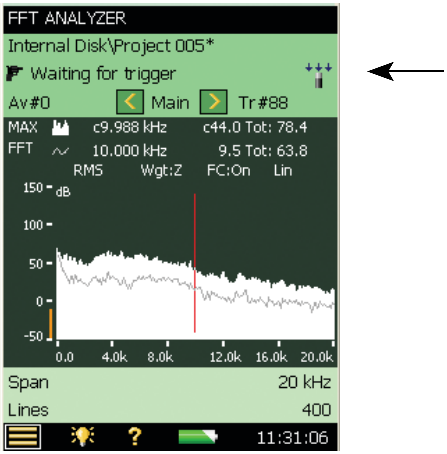


Fig. 2.25
Successful setup of the trigger level

65) Return to the measurement display – tap on the ✕ button on the screen, or outside the number keyboard to close the keyboard.
66) Press **Start/Pause** to start a measurement.
67) The analyzer should indicate *Waiting for Trigger*, see Fig. 2.26.

Fig. 2.26
Waiting for trigger indication on the measurement display



68) Tap the rim of the cup with your pencil.
    The 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 analyzer (with BZ-7230) provides a quick and easy way to do this through the reference spectrum.

69) Tap *FFT* on the primary cursor line and select *Set as Ref* from the drop-down list to save the current spectrum (from the cup) and use it as a reference.
70) Now fill the cup with tea/coffee and repeat the measurement described in section 2.3.8, steps 64) to 67).
    The display now shows the spectrum for the full cup on the primary cursor line.
71) Select *Ref* on the secondary cursor line.
72) Observe the spectrum. Note the two spectra, one for a full cup and one for an empty cup.

2.3.10 Y-axis Operations

By clicking on the Y-axis you can perform the operations listed in Table 2.2.

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).

Table 2.2 *Y-axis operations*

Operation	Principal Function
Zoom In*	The range of the Y-axis is reduced each time you zoom in, so you get a zoomed in view of your data. See “Zoom In” below
Zoom Out*	This is the exact reverse of Zoom In. You can zoom out only up to the maximum range, however.
Auto Zoom	This 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 moves the area currently displayed on the Y-axis up by a fixed value, up to the maximum limit. (This is only possible after zooming in.)
Scale Down	This moves the area currently displayed on the Y-axis down by a fixed value, up to the maximum limit. (This is only possible after zooming in.)
Auto Scale	This 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.

* Zoom In and Zoom Out should not be confused with the zoom operations available for the frequency, or x-axis, covered in section 2.3.3.

Zoom In

This operation works differently when using the ‘dB’ scale or ‘engineering’ scale for the Y-axis (select these scales by setting **Setup** > **Units** > **Engineering Unit** to *Yes* or *No*).

To zoom in:

73) Tap on the Y-axis.
74) Select **Zoom In** from the resulting drop-down menu and observe the display.

Zoom in for ‘dB’ Scale

On zooming in, the range of the Y-axis is reduced by changing both maximum and minimum values displayed. For example, if you zoom in with the default range of the Y-axis (range 200 dB, from –160 dB to 40 dB), the range changes to –150 dB to 30 dB, and has reduced to 180 dB, see Fig. 2.27.

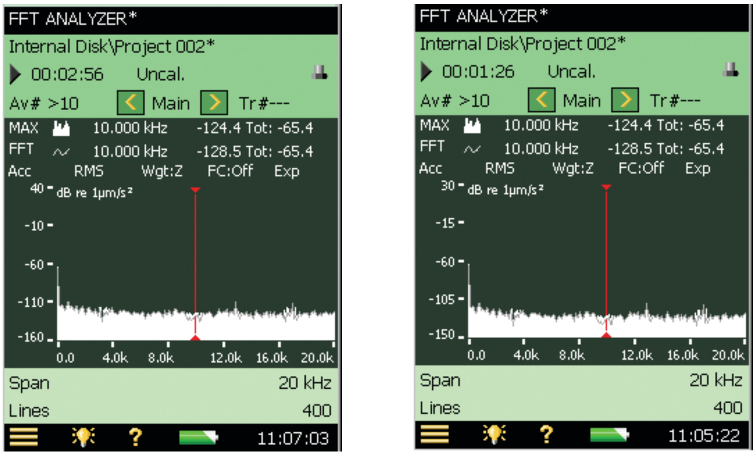


Fig. 2.27
Left: *Performing a zoom-in operation on the 'dB' scale, before zoom-in.*
Right: *After zoom-in*

Zoom in for 'Engineering' Scale

On zooming in, the range of the Y-axis is reduced from the top of the scale only. For example, if you zoom in on the default range of the Y-axis (range 100 $\mu m/s^2$, with a scale from 0 to 100 $\mu m/s^2$), the range reduces to 50 $\mu m/s^2$ with a scale from 0 to 50 $\mu m/s^2$ (Fig. 2.28).

Fig. 2.28
Left: *Performing a zoom-in operation on the 'engineering' scale, before zoom-in.*
Right: *After zoom-in*

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" (BB 0694).

The piezoelectric accelerometer is the standard vibration transducer for most general purpose vibration measurement situations because it 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.

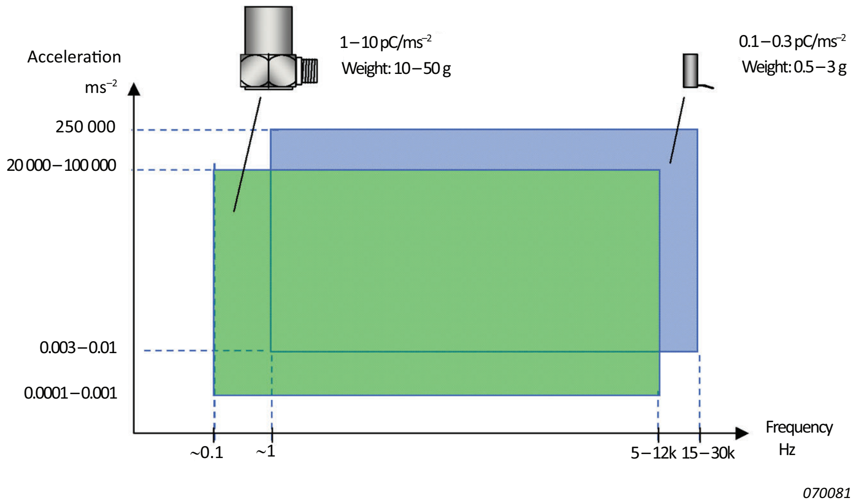
The circuit is powered from an input with constant-current line drive (CCLD) power supply. The analyzer is able to deliver such a power supply on its rear input socket when CCLD is selected. The analyzer then receives an input signal, in the form of a modulated voltage on the input, which is proportional to the acceleration measured.

We recommend that CCLD accelerometers be used with FFT Analysis Software BZ-7230, and that 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 ferromagnetic 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 ferromagnetic 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 (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 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 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, you can use a mechanical filter, which is mounted between the accelerometer and the test object. Mechanical filters prevent energy from exciting the resonance, protecting the whole measurement chain. A mechanical filter can also provide electrical isolation between the accelerometer base and the mounting point. Note that the attenuation achieved depends on 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.

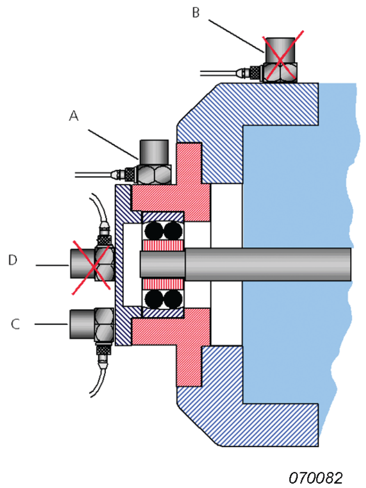


Fig. 3.2
Examples of different accelerometer mounting positions on the bearing of a drive shaft

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 CCLD accelerometers**

Type	Description	Frequency Range (Hz)	Nominal Sensitivity
4397-A	Miniature	1 – 25000	1 mV/ms^{-2}
4533-B/4534-B	General Purpose	0.5 – 12800	1 mV/ms^{-2}
4533-B-001/ 4534-B-001	General Purpose	0.5 – 12800	10 mV/ms^{-2}
4533-B-002/ 4534-B-002	General Purpose	0.5 – 12800	50 mV/ms^{-2}
8341	Industrial	0.3 – 10000	10 mV/ms^{-2}
8344	Low Level	0.5 – 3000	250 mV/ms^{-2}

3.2 Configuring the Input

CCLD accelerometers should be connected to the analyzer’s rear input socket, which 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 analyzer’s rear input socket. For accelerometers with a smaller M3 connector, use Cable AO-0701-D-030. For Type 8341 use Cable AO-0722-D-050.

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-CCLD Converter (1 mV/pC)
- Type 2647-B: Charge-to-CCLD Converter (10 mV/pC)

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

* See relevant accelerometer data sheet for complete specifications.

Recommended charge accelerometer: Type 8324 for industrial use:

- Frequency range: 1 – 10000 Hz
- Nominal sensitivity: 1 pC/ms^{-2}

Use Charge-to-CCLD Converter Type 2647-D-004 (1 mV/pC) for direct connection to the rear input socket.

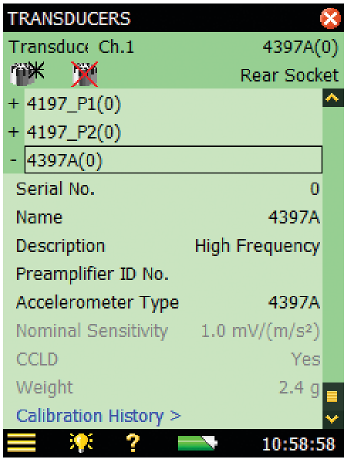
3.2.1 Transducer Database

Any transducer used by the 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 Hand-held Analyzer Types 2250 and 2270 user manual (BE 1713). Instructions for adding an accelerometer are described in the next section.

3.2.2 Adding an Accelerometer

1) Tap > **Transducers**.
2) Tap the **Add New Transducer** icon then **Accelerometer**. (The entry defaults to general purpose CCLD Accelerometer Type 4397-A, although other accelerometer names and Types can be used.) The transducer you have chosen now appears as the transducer used in the status field. When you choose an accelerometer, the field below automatically changes to *Rear Socket*.
3) Select the type number of the accelerometer you are using under the **Accelerometer Type** parameter, or select **Unknown** if you do not 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 ten characters can be used. (The name of the accelerometer will be displayed in the status field, appended with the serial number of the accelerometer.)
5) You can also enter the **Serial No.**, 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 analyzer.

The calibration procedure is very similar to that for acoustically calibrating a microphone using Sound Calibrator Type 4231 – please refer to Hand-held Analyzer Types 2250 and 2270 user manual (BE 1713), Chapter 5, 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  > **Calibration** to display the initial calibration screen.
2) Mount* Calibration Exciter Type 4294 onto the accelerometer, turn on Type 4294 and tap *Start Calibration*.

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

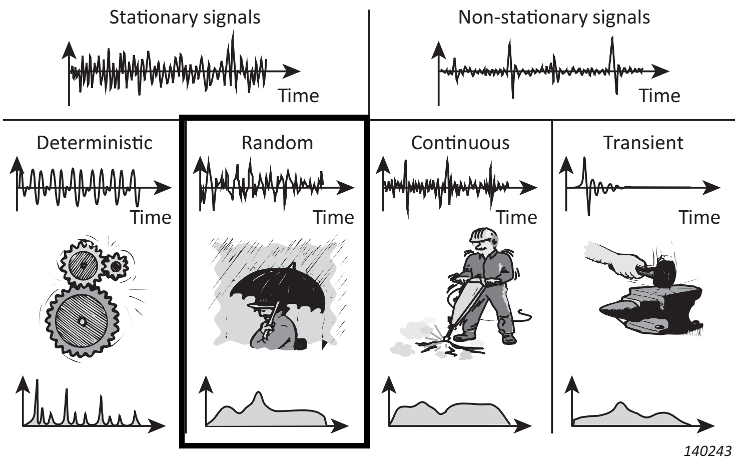
* Various mountings are available, depending on the type of accelerometer you are using, please refer to the user manual for Calibration Exciters Types 4294 and 4294-002 (BE 0739).

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 cavitation 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

Tap > **Setup** > **Measurement Control**. Set **Measurement Mode** to *Manual*, and **Averaging Type** to *Exponential* (Fig. 4.2).

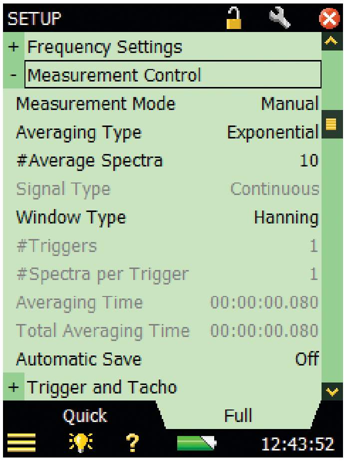


Fig. 4.2
Setting Measurement Control parameters

Averaged Spectra

If you enter a value of *10* for the **# Average Spectra** parameter, the analyzer will smooth 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.

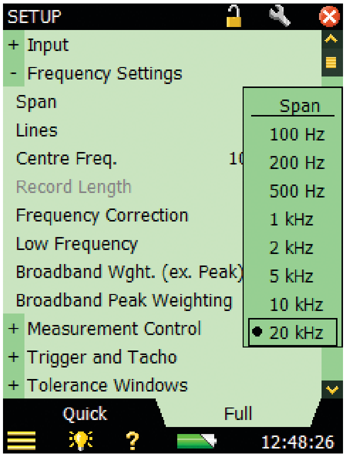
4.2.4 Frequency Resolution / Span

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. To adjust span parameters, tap > **Setup** > **Frequency Settings** – set the required **Span**, **Lines** or **Centre Freq.** (Fig. 4.3).

Fig. 4.3
Setting the frequency span



Please 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, tap ☰ > **Setup** > **Frequency Settings**.

Number of Lines

The FFT Analyzer allows you to perform up to 6400 line measurements. Because there is not enough space to display all of the lines at the same time, the FFT analyzer displays the line with maximum amplitude in a group. 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 minimize 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* always corresponds to *Rectangular* window *Continuous* always corresponds to *Hanning*, see example displays in Fig. 4.4.

Perform the following steps:

1) Set **Measurement Mode** to *Triggered*.
2) Set **Window Type** to *Rectangular*.
   Signal Type changes to *Transient*.
3) Observe the spectra.
4) Change **Signal Type** to *Continuous*.
   Window Type changes to *Hanning*.
5) Observe the spectra.

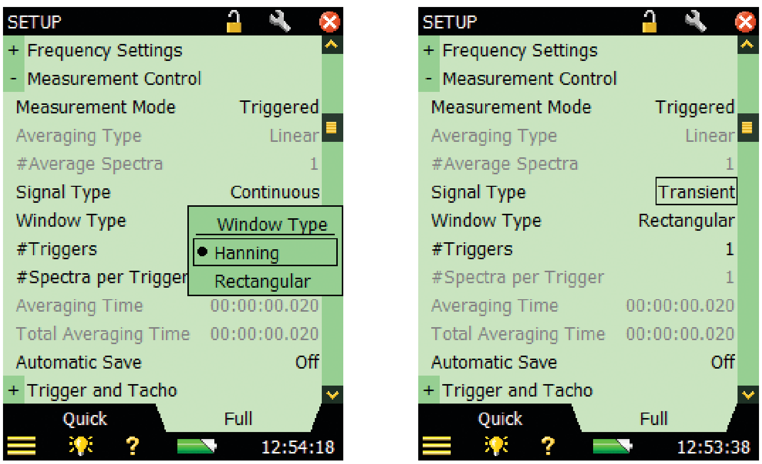


Fig. 4.4
Left:
Selecting Window Type from Setup
Right:
Selecting Signal Type from the Setup

4.2.6 Post-weighting

When measuring acceleration signals or voltage from direct input, the weighting of the input signal is always linear (unweighted).

When measuring sound, there are two available post-weighting parameters: A and Z.

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

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

1) Tap > **Setup**.
2) On the **Full** tab, select **Frequency Settings** > **Post Weighting**.

Please note: If a microphone is not currently selected, select **Input** > **Transducer** and *4189* (or other microphone type).

3) Select *A* or *Z* (Fig. 4.5).

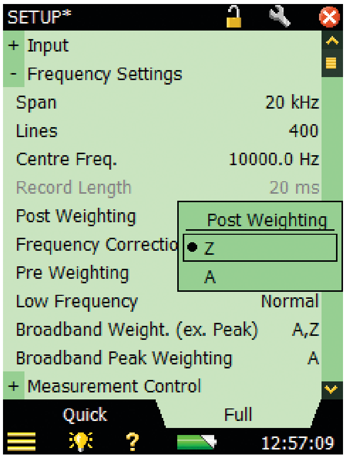


Fig. 4.5 *Selecting* ***Post Weighting*** *from* ***Setup***

Please note:

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

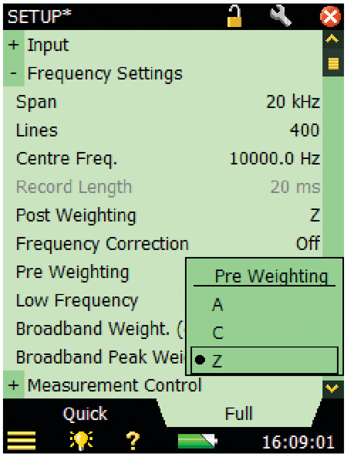
4.2.7 Pre-weighting

When measuring sound, there are four available pre-weighting parameters that can be used: A, B, C and Z.

1) Tap > **Setup**.
2) On the **Full** tab select **Frequency Settings** > **Pre Weighting**.
3) Select *A, B*, *C* or *Z* (Fig. 4.5; A/B-weighting is determined when you set the **Broadband Weight (ex. Peak)** parameter).

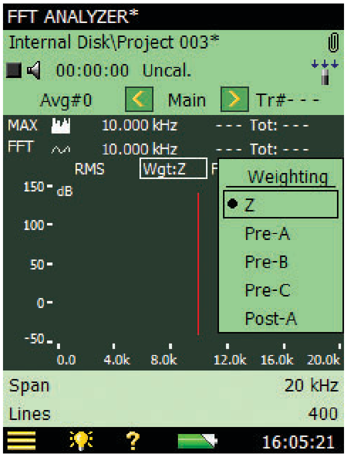
Please note: Setting the post-weighting will disable the pre-weighting.

Fig. 4.6
Selecting Pre-weighting from Setup



Please 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 (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 × √2)
- Peak-Peak (rms value × 2√2)
- PWR, Power (rms value^2)
- PSD, Power Spectral Density (rms value^2/NBW)

- ESD, Energy Spectral Density (rms value^2/NBW × observation time)

The observation time for manual and continuous measurements is the elapsed averaging time; 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 × observation time

Please 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 Principles

Table 4.1 summarizes 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

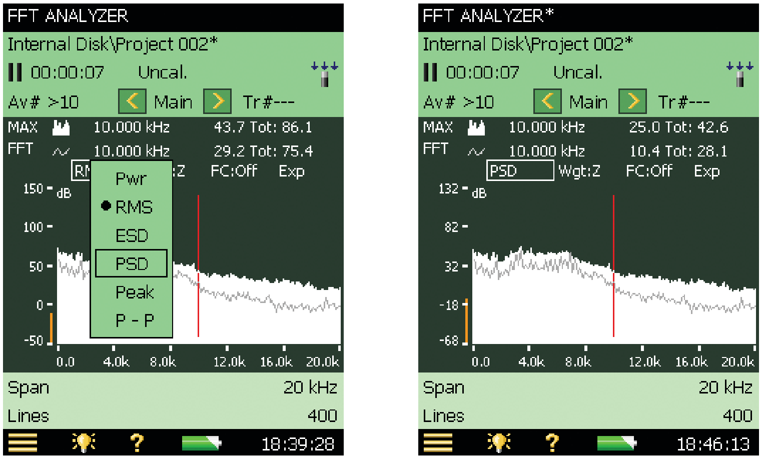
Total Level (or Sum for Delta Cursors)		
Scaling	**Hanning Window**	**Rectangular Window**
RMS	$\sqrt{(\Sigma_i p_i^2/1.5)}$	$\sqrt{(\Sigma_i p_i^2)}$
PWR	$\Sigma_i p_i^2/1.5$	$\Sigma_i p_i^2$
PSD	$\Sigma_i p_i^2/1.5$	$\Sigma_i p_i^2$
ESD	$(\Sigma_i p_i^2/1.5) \times T$	$(\Sigma_i p_i^2) \times T$
Peak	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.

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

1) Click the *RMS* parameter on the measurement display (Fig. 4.8).
2) Select *PSD* from the drop-down list.

Fig. 4.8
Left: *Changing scaling from measurement display.*
Right: *Resulting measurement display*



Please note: Alternatively, on the **Quick** tab of the **Setup** menu, select **Units** > **Scaling** > **PSD**.

Frequency Correction

The use of frequency correction was covered in section 2.3.1 For the initial measurement, set **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 any the other screen and view the measurement display.
2) Press **Start/Pause** to start the measurement.

Please note: This clears the measurement buffer – any spectrum shown will be erased.

3) If you do not 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 shown 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 exponential averaging uses the full energy only 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 **Setup** > **Measurement Control**. Change **Averaging Type** to *Linear*, and set **#Average spectra** to the number you require.

Please note:

- Set the value of **#Average 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 **Averaging Time** 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 **Averaging Type** will reset the measurement buffer and start a new measurement.

4.4 Fine Tuning – Zooming In

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.

However, whether you are using exponential or linear averaging, you may see parts of the measured spectra that require closer inspection (a finer resolution) in order to make more qualified measurements. You can 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 (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

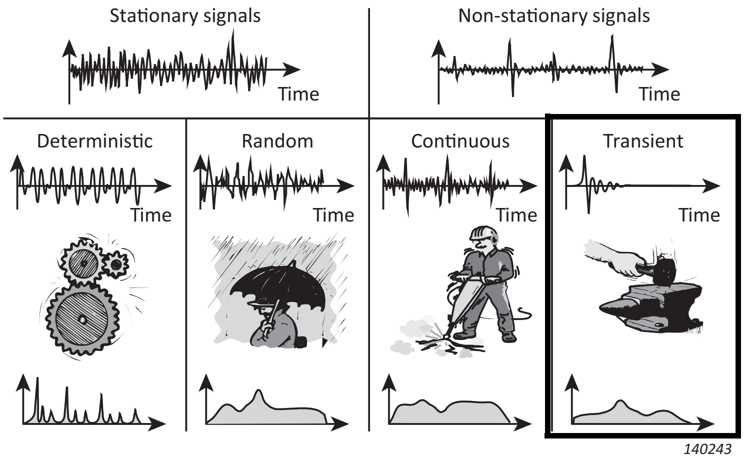


Fig. 5.1
Transient signals

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.

Please note: If the transient cannot be captured within the length of a single FFT record, the technique for measuring continuous signals described in section 5.3 can be used.

5.2 Preparing for Measurement

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

5.2.1 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.

5.2.2 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

5.2.3 Measurement Control

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

1) Tap > **Setup**.
2) On the **Quick** tab, tap **Measurement Control** > **Measurement Mode** > **Triggered** (Fig. 5.2).

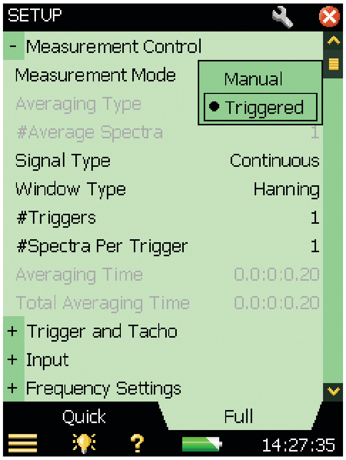
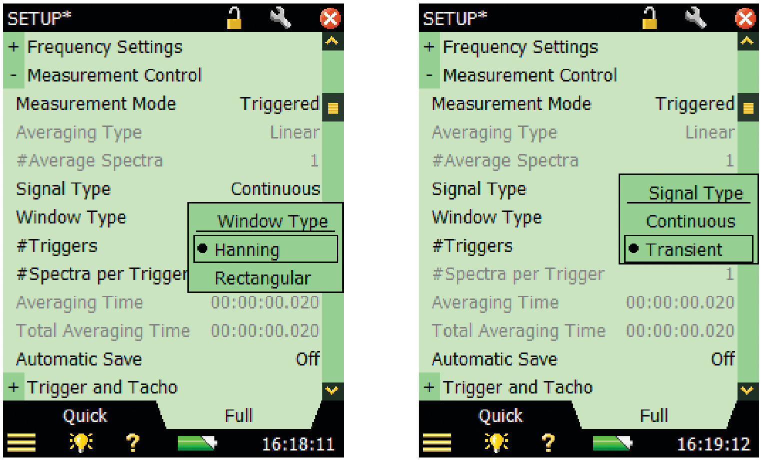


Fig. 5.2
Setting Triggered mode

Time Windows

The purpose of a time window is to minimize the effects of the discontinuity that occurs when only a section of a continuous signal is measured. When measurement is manual, **Window Type** is always set to *Hanning*. In triggered mode, you can change **Window Type** from *Hanning* to *Rectangular*, and vice versa. You can also change the window type by changing **Signal Type** (Fig. 5.3).

Fig. 5.3
Left:
Selecting Hanning as the Window Type from Setup.
Right:
Selecting Transient as Signal Type from Setup



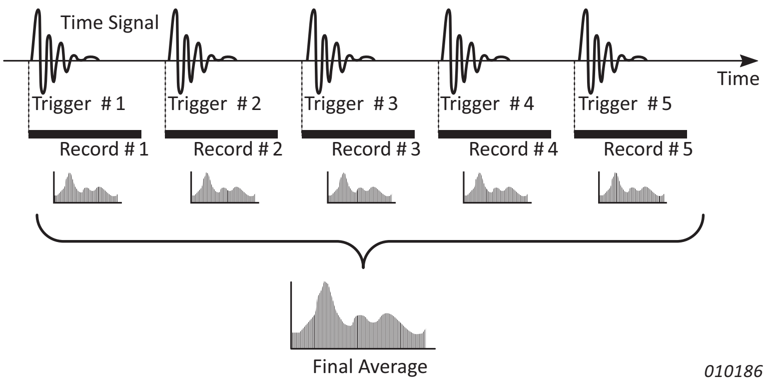
1) Set **Measurement Mode** to *Triggered*.
2) Set **Signal Type** to *Transient* – **Window Type** automatically changes to *Rectangular*.
3) Observe the spectra.

Please 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.

5.2.4 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 vibration unit system used (SI, US/UK)
  To change the units used, tap ☰ > **Preferences** > **Regional**
- How the vibration is displayed (acceleration, velocity or displacement)

The displayed Y-axis can also be scaled in terms of the display range.See section 2.3.10.

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 re 1 $\mu m/s^2$)	g (dB re 1 μg)
Velocity	m/s (dB re 1 nm/s)	nm/s (dB re 10 nm/s)*
Displacement	m (dB re 1 pm)	mil (dB re 1 μmil†)
Sound	dB (dB re 20 μPa)	dB (dB re 20 μPa)
Direct	volts (dB re 1 μV)	volts (dB re 1 μV)

* These units are traditionally used in the US and UK.
† 1 mil = 0.001 inch

5.2.5 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. This is obtained from the measured power by multiplying it with the observation time. The measurement should be normalized with respect to the filter bandwidth since transients have continuous spectra resulting in energy spectral density (ESD). ESD is measured in $units^2$ seconds/Hz.

Therefore, for transient signals, use ESD scaling.

5.2.6 Y-axis Unit Display

To change the Y-axis units from dB to Engineering, tap ☰ > **Setup** > **Units** > **Engineering Unit** > **Yes** (Fig. 5.5 and Fig. 5.6).

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

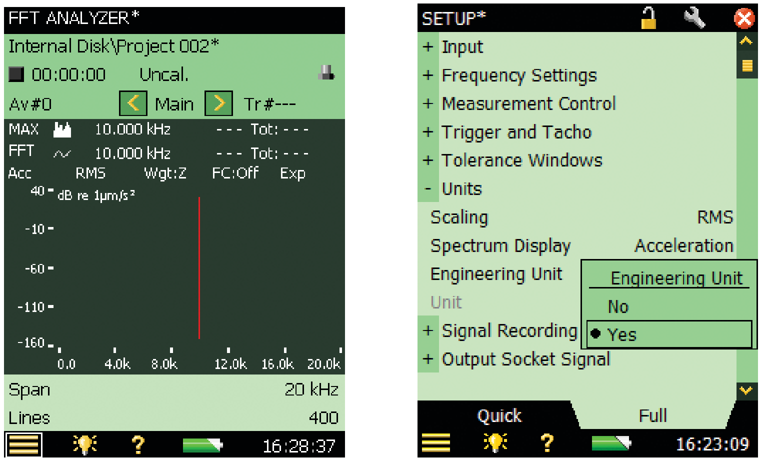
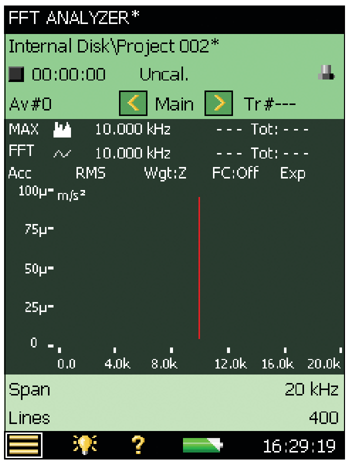


Fig. 5.6
The Y-axis with engineering units displayed



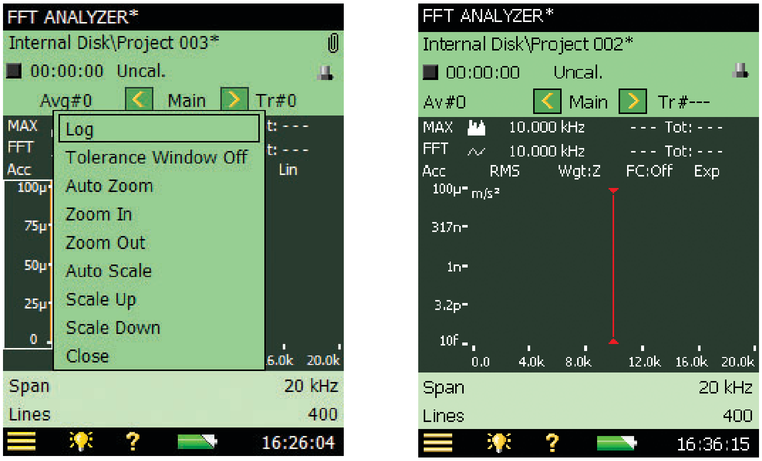
5.2.7 Linear to Log Conversion

When Y-axis displays an engineering scale, the scale can be 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* (Fig. 5.7).

Fig. 5.7
Left:
Switching between linear and log scale.
Right:
Log scale displayed



5.2.8 Unit System

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

To change the units, tap > **Preferences** > **Regional** > **Vibration Unit** > **US/UK** (Fig. 5.8 and Fig. 5.9).

Fig. 5.8
Left:
SI units displayed.
Right:
*Changing to US/UK units from **Preferences***

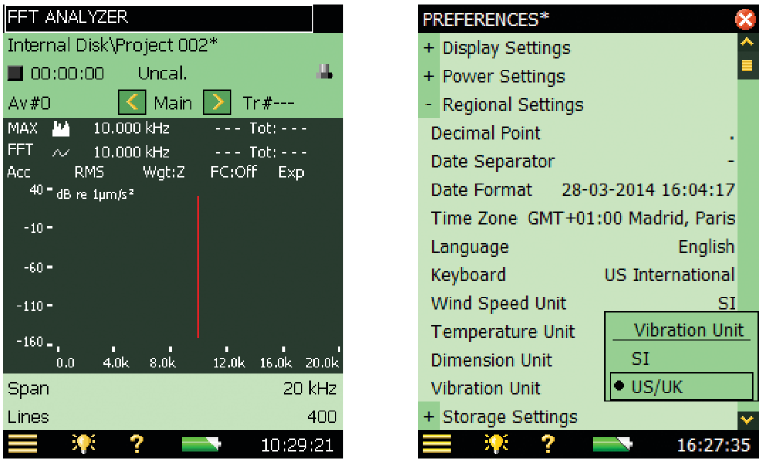
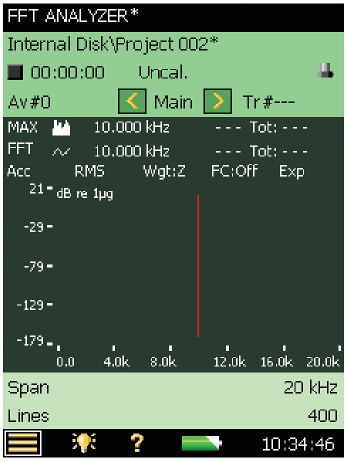


Fig. 5.9
US/UK units displayed



5.2.9 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 spectra are usually 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* (Fig. 5.10).

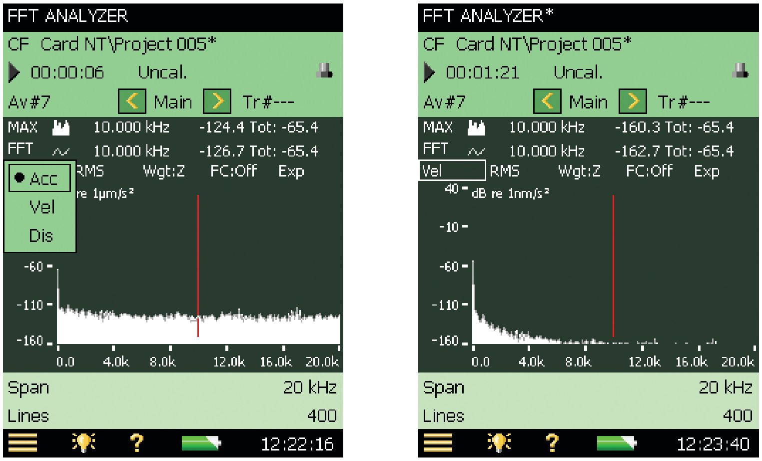


Fig. 5.10
Left:
Changing spectrum display from measurement screen.
Right:
Resulting measurement screen

Alternatively, you can select **Setup** > **Units** > **Spectrum Display** (Fig. 5.11).

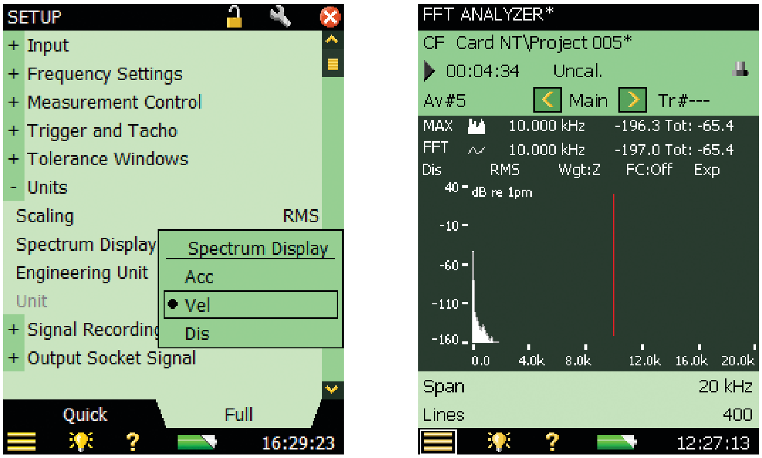


Fig. 5.11
Left:
Changing spectrum display from Setup.
Right:
Resulting measurement screen

5.2.10 Averaging

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

5.2.11 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 **Setup** > **Trigger and Tacho**, see Fig. 5.12.

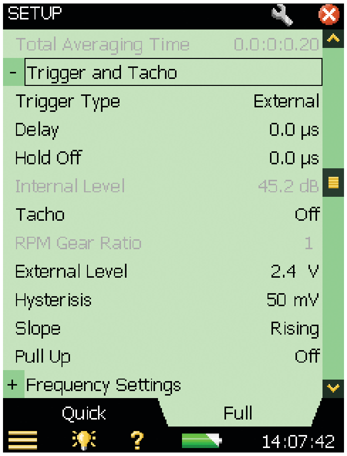


Fig. 5.12
Setting the trigger and tacho parameters

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.

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 retriggering 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.

CCLD / Pull Up

For instruments with serial number 2630266 and above, this parameter is named **CCLD**. Use this parameter to switch on or off a CCLD power supply, depending on the requirements of the equipment connecting to the trigger input.

Please note: Laser Tachometer Probe Type 2981/MM-0360 requires **CCLD** set to *On*.

For instruments with serial numbers below 2630266 the parameter is named **Pull Up**. Use this parameter to 'pull up' the external trigger input to + 5 V (via a 7.5 kΩ resistor).

CCLD or **Pull Up** 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 –20 V to +20 V. By default it is set to 18.2 V, which suits Laser Tachometer Probe Type 2981/MM-0360. When setting the trigger level, please take a small offset at the trigger input into account. Typical values for the offset are between –70 mV and 200 mV.

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 **Setup** > **Trigger and Tacho**) and enter the required value.
2) Tap ✓ 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 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 ✕.

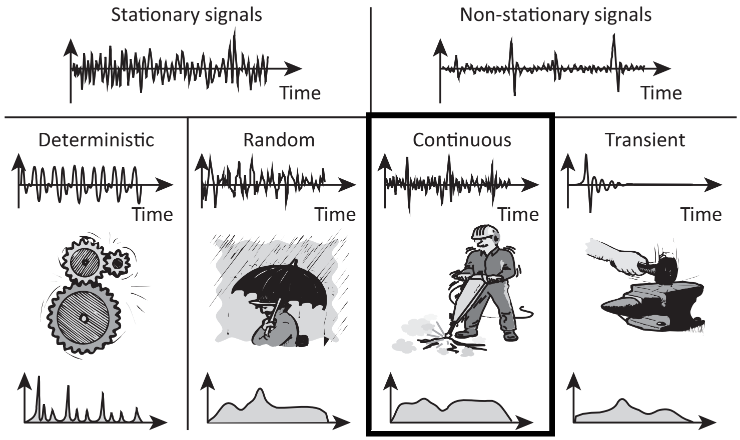
Signal Recording

If a valid license for the Signal Recording Option is present, it is possible to record the signal while measuring the FFT spectrum. Refer to the Hand-held Analyzer Types 2250 and 2270 user manual, Chapter 13, for information about the Signal Recording Option.

Please 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 **Recording Quality** to *High (20 kHz)*.

5.3 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.

5.3.1 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

5.3.2 Measurement Control

To measure continuous signals you need to set the analyzer, initially, for a triggered measurement start with continuous signals. Tap > **Setup** > **Measurement Control** then check the following parameters.

Time Window

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

Triggers

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

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 Trigger**) 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.

Set the value of **#Spectra per Trigger** 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. 5.14
Graphical explanation of what happens to records when measuring triggered, continuous signals using the set up described in section 5.3.2

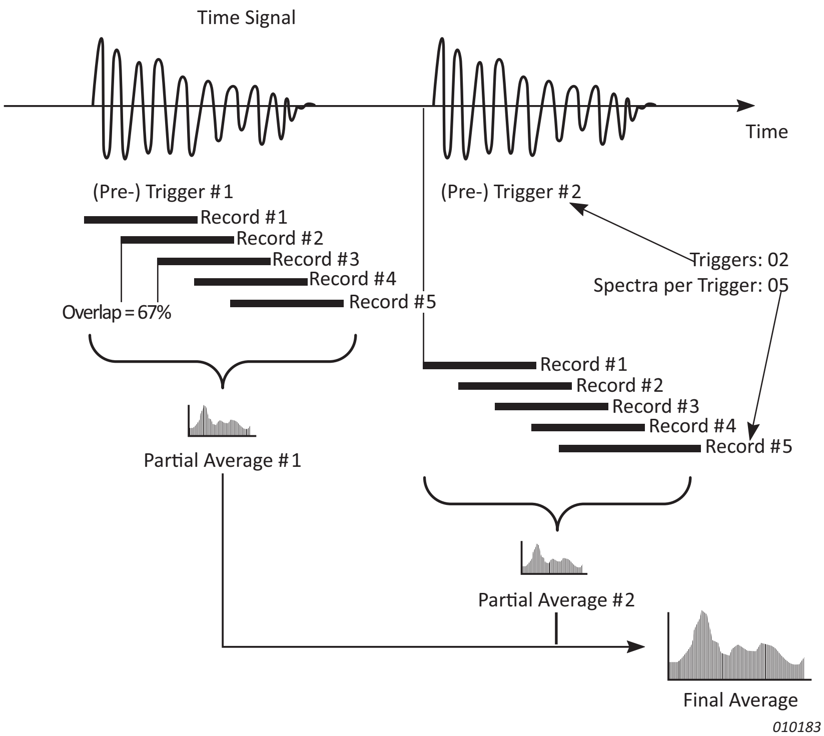
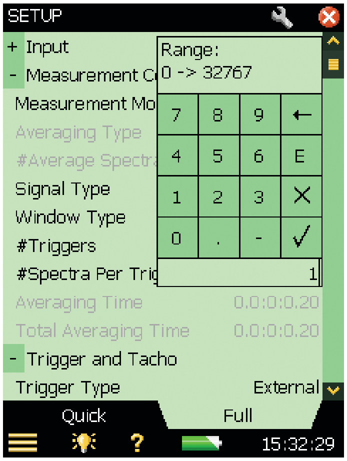


Fig. 5.15
Entering the number of spectra per trigger for a triggered measurement



Measuring

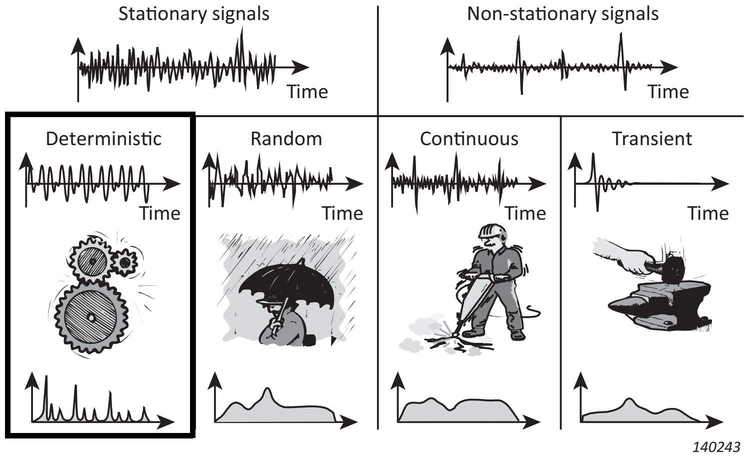
See “Measuring” on page 43.

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. Tap > **Setup** > **Measurement Control**, set **Measurement Mode** to *Manual*, **Averaging Type** to *Exponential*. Then set the following parameters.

Time Window

Window Type 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 **Setup** > **Trigger and Tacho** > **RPM Gear Ratio** 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 units squared.

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: Set ☰ > **Setup** > **Frequency Settings** > **Frequency Correction** to *On* or *Off*. Frequency correction will work with any measurement mode: 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 **Tacho** 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 <u>and stored</u> together with each spectrum result. It is an average over the same time as the spectrum, if **Averaging Type** is set to *Linear*. If *Exponential* is selected, no averaging is done and the result is the last measured rpm.

Signal Recording

If a valid license for the Signal Recording Option is present, it is possible to record the signal while measuring the FFT spectrum. Refer to the Hand-held Analyzer Types 2250 and 2270 user manual, Chapter 13, for information about the Signal Recording Option.

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

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.

Please note: The reference spectrum can only be displayed if the parameters (frequency) **Span**, **Centre Freq.**, (number of) **Lines**, and (input) **Transducer** match the currently displayed measurement. See "Align" below.

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).

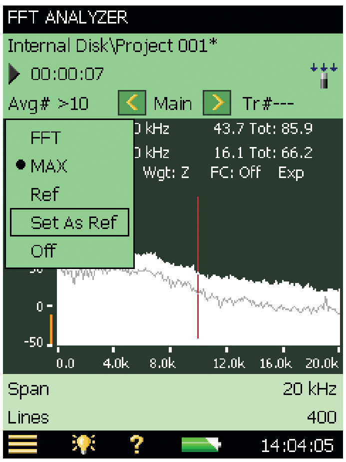


Fig. 6.2
Saving the reference spectrum

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, left.

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

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

6.4 Tolerance Windows

6.4.1 Exponential Averaging

During a measurement using exponential averaging you can use tolerance windows to calculate whether the delta sum complies with limits (see “Delta Sum” on page 20). The delta sum is based on the measured FFT lines within the specified frequency range; however, it takes Spectrum Display, Scaling and Post-weighting into account. The summation principle is as described in Table 4.1.

The delta sum is calculated periodically (every 100 ms for up to 1600 lines and every 1 s for more than 1600 lines) during the measurement and checked against the limits. In addition to the Tolerance Result parameters a number of other parameters are updated:

- Delta Sum
- Max Delta Sum
- RPM at time for Max Delta Sum (requires **Tacho** set to *On*)
- LAF at time for Max Delta Sum
- FFT Spectrum at time for Max Delta Sum

To ensure the integrity of the measured parameters listed above, changing frequency range or limits for the tolerance windows during or after the measurement cannot be done without resetting the measurement. This also applies to changing some of the display parameters (Scaling, Spectrum Display, Unit System, Y-axis and Post-weighting).

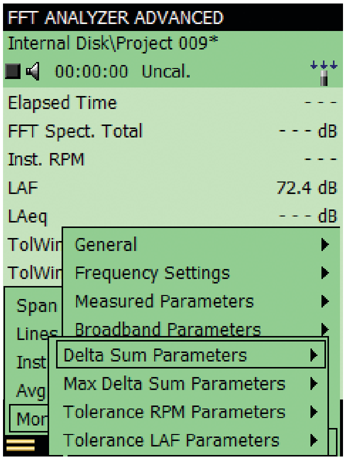
One example of usage is checking if the vibration level (within a specified frequency range) exceeds a certain limit during a run-up of an engine:

1) Set **Span**, **Lines** and **Centre Freq.** as required.
2) Set **Averaging Type** to *Exponential*, **#Average Spectra** to *1*.
3) Tap > **Setup** > **Tolerance Windows** and set:
   - **Tolerance for** = *FFT*
   - **Check** = *On*
   - **Values Checked** = *Delta Sum*
   - **Upper Limit**, **Level 2 max.**, **Level 1 max.**, **Lower Limit**, **Top Frequency** and **Bottom Frequency** as required
4) Start the measurement when you speed up the engine.
5) Stop the measurement when the engine has reached the required speed.

During the measurement a max delta sum will have been measured together with the spectrum present at the time for the max delta sum.

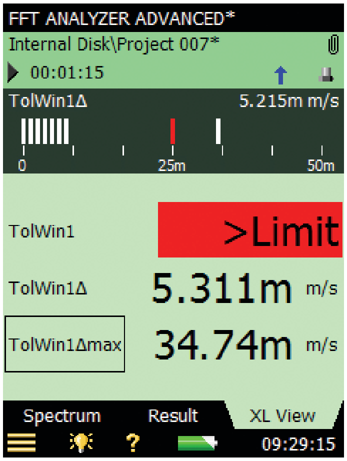
The parameters for display can be selected in the Tolerance Delta Sum group: tap any parameter then **More** > **Tolerance Delta Sum** > **Delta Sum Parameters**.

Fig.6.4
Delta Sum Parameters sub-menu



The parameters can also be displayed in the bar graph on the **XL View** tab (Fig.6.5).

Fig. 6.5
XL View tab



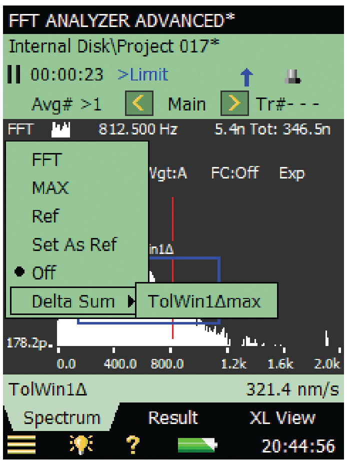
The Delta Sum parameters can be selected for display in the bar graph (tap on the parameter in first line within the bar graph). The upper limit is indicated (red line) on the bar graph together with the Max Delta Sum (a single white line). The Delta Sum parameter is displayed with the same units as the FFT spectrum.

When **Setup** > **Units** > **Engineering Unit** is set to *Yes*, the scaling of the bar graph can be Log or Lin and you can zoom in, out or move the scale by tapping on the bar graph axis.

Instead of the Delta Sum parameter you can select the Total of the FFT Spectrum or *LAF* or *LZF* in the bar graph.

The FFT spectrum at time for the Max Delta Sum can be selected for display from the **Delta Sum** group in the graph selector (see Fig. 6.6).

Fig. 6.6
Graph selector Delta Sum parameters



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 1996-2:2007 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”
- Assess tones in a measured FFT spectrum according to “Denmark 1984/1991: Vejledning nr. 6, 1984 fra miljøstyrelsen: Måling af ekstern støj fra virksomheder, Orientering nr 13, 1991 fra miljøstyrelsens referencelaboratorium for støjmålinger: Måling af hørbare toner i støj”.
- Use the ‘Generate tone at cursor’ feature to generate a pure tone on the headphone output of the 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 1996-2. The L_{Aeq} and other broadband parameters are measured simultaneously by the 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 Signal 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 done using Measurement Partner Suite BZ-5503.

Check the About screen to see whether you have the license to run the Tone Assessment option. (To access the About screen, tap the **Help** icon then tap **About**.)

If you have purchased an 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 analyzer, then you have to install the license on the instrument. This is done using Measurement Partner Suite 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 recognized 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 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 Noise" booklet (BR 1626).

Tone Standard = *Denmark 1984/1991* is identical to *ISO 1996-2:2007*, except for a few details, mentioned in the following sections.

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.

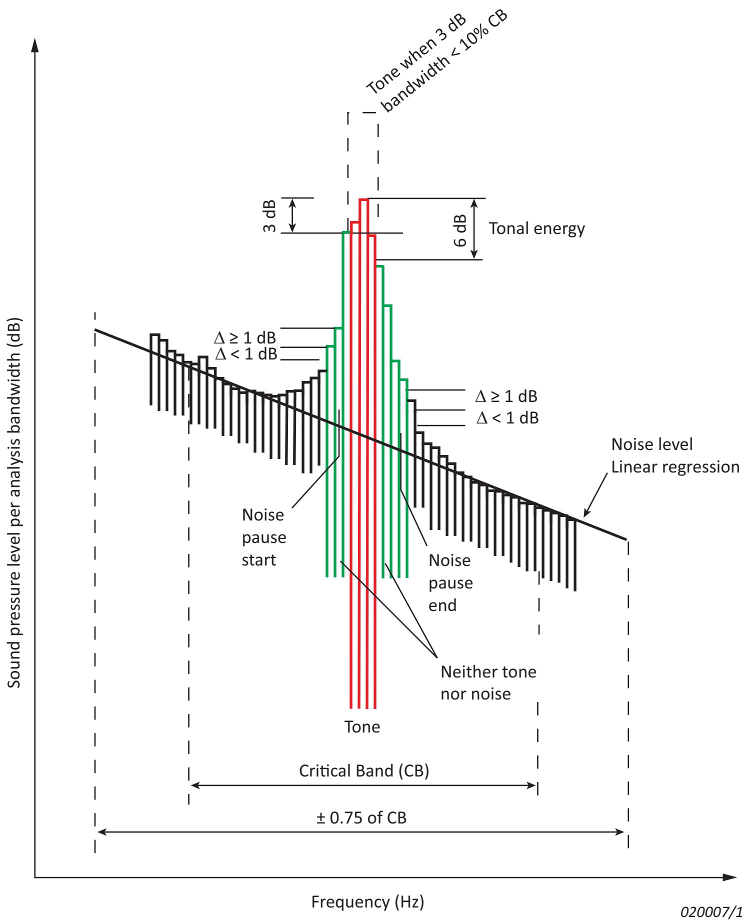


Fig. 7.1
Overview of terms related to FFT-based tone assessment

Detecting the Tone Candidates

First, the calculation algorithm looks for noise pauses in the measured FFT-spectrum. **Tone Standard** = *ISO 1996-2:2007* requires the A-weighted spectrum, **Tone Standard** = *Denmark 1984/1991* requires the Z-weighted spectrum. A noise pause is a local maximum in the spectrum with a probability of containing a tone.

Setup > **Tone Assessment** > **Tone Seek Criterion** is the threshold for the algorithm that looks for noise pauses in the spectrum (differences between successive line levels). The criterion may be interpreted as the maximum variation in levels between neighbouring 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. The tone level is calculated using the corrected frequencies of the lines when only two lines are within 6 dB of the local maximum level.

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 midpoint of the 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

The frequency of a pure tone rarely coincides with a line in the FFT spectrum, and even when it does, its energy is spread over a few lines. This is called the “picket fence effect”. If only two FFT lines are within 6 dB of the local maximum level (indicating a pure tone), the tone level and tone frequency are corrected for the picket fence effect. If a narrow band of noise is indicated (no pure tone), the tone level is calculated as the energy sum of all lines within 6 dB of the local maximum level, corrected for the influence of the Hanning window (spread of energy).

Please note: Corrections for the picket fence effect are introduced in section 2.3.1.

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 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).

Adjustment (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 adjustment, K_t is referring to the total analysed 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 level.

Adjustment for **Tone Standard** = *ISO 1996-2:2007* is determined from the audibility as:

- 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.

Please note: The adjustment is not restricted to integer values.

For **Tone Standard** = *Denmark 1984/1991*, $\Delta L_{ts} = L_{p,tone} - L_{p,crit.band}$ is calculated.

- If ΔL_{ts} is greater than or equal to the frequency dependant $\Delta L_{ts,Kriterie}$, then an adjustment of 5 dB should be added, otherwise none.

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 analyzer may include spurious signal noise that will cause the calculation to give an adjustment (K_t) greater than 0 dB. On the 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 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 μPa). Refer to Chapter 5 of Hand-held Analyzer Types 2250 and 2270 user manual (BE 1713) for more information about acoustic calibration.

7.4 Setting up the Instrument

7.4.1 Setting up the Tone Assessment Option

Tap > **Setup** > **Full** > **Tone Assessment** > **Tone Assessment** and select *On*, see Fig. 7.2.

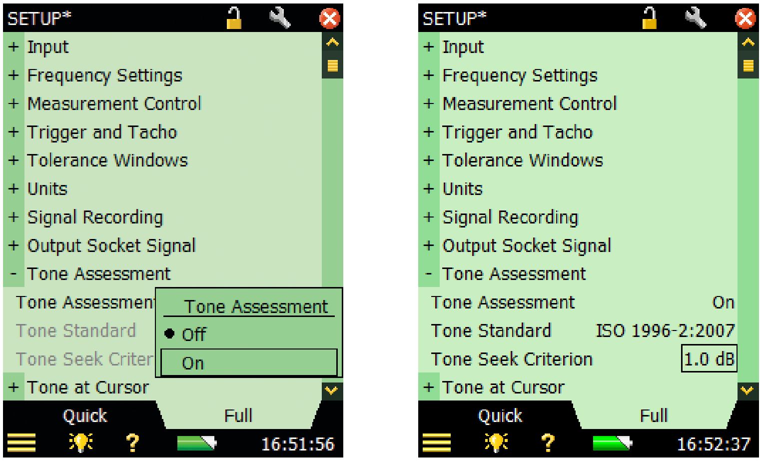


Fig. 7.2
Left: *Selecting the Tone Assessment option.*
Right: *Setting the Tone Seek Criterion*

Select the **Tone Standard** as required. 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 the selected **Tone Standard**, the pop-up window in Fig. 7.3 will be displayed.

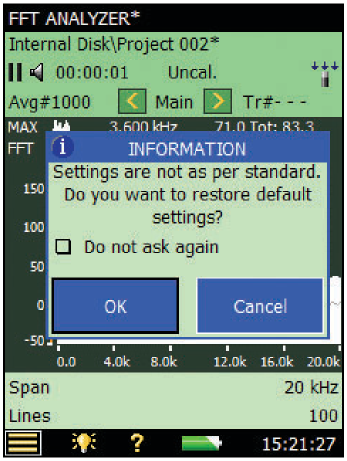


Fig. 7.3
Pop-up window for the Measurement Setup Check

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 the selected **Tone Standard**. 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 **Tone Assessment** is set to *Off*.

Table 7.1 *Default parameters used by the Measurement Setup Check*

Default 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:	±0.75 × CB*	Lines:	6400	#Average Spectra:	600		
		Centre Freq.:	10 kHz	Window Type:	Hanning		
		Pre-weighting:	A or Z†	Total Averaging Time:	00:01:04.213‡		

* Cannot be controlled by the user.
† A-weighting for Tone Standard = ISO 1996-2:2007, Z-weighting for **Tone Standard** = *Denmark 1984/1991*
‡ Calculated by the 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 the selected tone standard.

While using the 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 Hand-held Analyzer Types 2250 and 2270 user manual (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 – these parameters are found under **Setup** > **Frequency Settings**. 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).

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 **Frequency Correction** to *On* or *Off* only affects the results read from the main cursor; the tone assessment calculation is not affected.

Pre- and Post-weighting of the Frequency

In the default setup the pre-weighting is set to *A* in accordance with ISO 1996-2:2007 or to *Z* in accordance with Denmark 1984/1991. The 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 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 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 Signal Recording

If a valid license for the Signal Recording Option is present, it is possible to record the signal while measuring the FFT spectrum. Refer to the Hand-held Analyzer Types 2250 and 2270 user manual (BE 1713), Chapter 13, for information about the Signal Recording Option.

Please note:

- When analyzer recordings are to be used for reanalysis on a PC, set **Automatic Gain Control** to *Off* under the **Signal Recording** parameters, and set the **Recording Quality** to *High*
- You may find the Template Explorer (accessed from) useful to save your own measurement setup. Please find more information about using templates in the Hand-held Analyzer Types 2250 and 2270 user manual (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 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. 7.4.

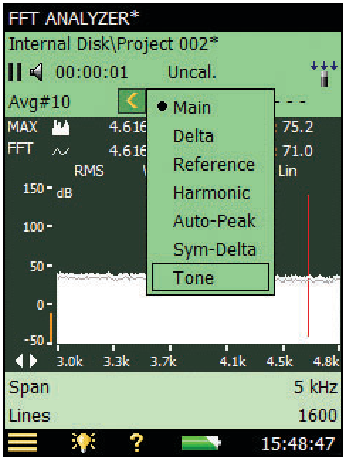
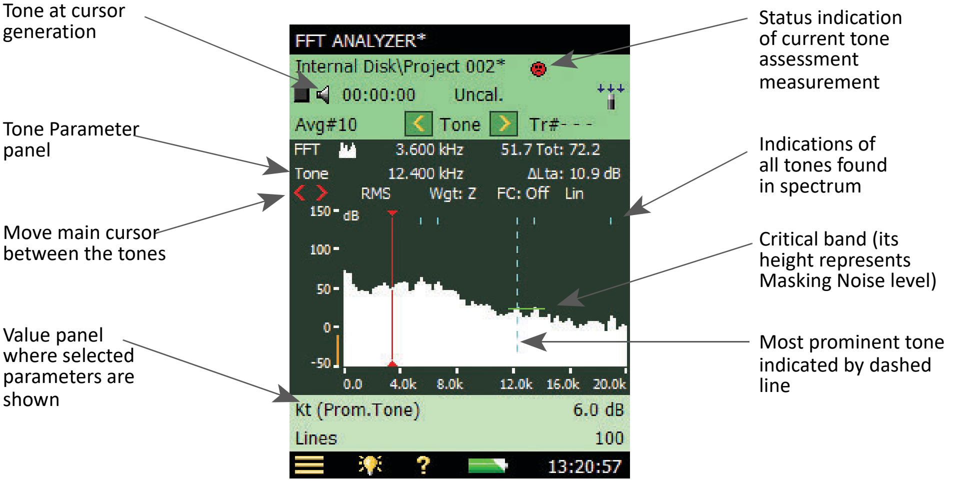


Fig. 7.4
Selecting the Tone cursor

The results from the tone assessment calculation can only be displayed on the analyzer's display when the Tone Cursor is selected, see Fig. 7.5. After finishing the tone assessment calculation, the tone cursor jumps to the most prominent tone. If no tones are detected in the analysed 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. 7.5 *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.
- 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. 7.5. Two selectable parameters are displayed and the parameters shown may be changed by tapping on them.

By 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. 7.6.

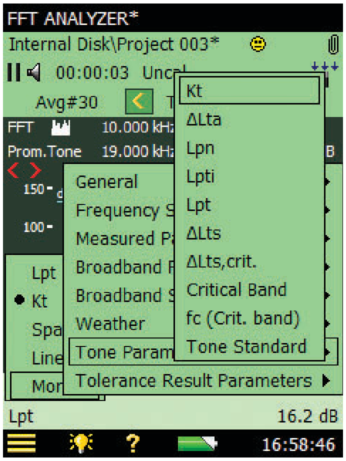


Fig. 7.6
Selecting different tone parameters

Select between the following parameters from the drop-down list (the parameter in brackets used with the Danish standard):

- K_t (K) – the size of the adjustment in dB. The adjustment is calculated from the decisive band and refers to the total spectrum
- ΔL_{ta} (ΔL_{ta}) – the audibility of all tones found in the same critical band as the selected tone
- L_{pn} ($L_{p,crit.band}$) – the Total level of the masking noise in the band containing the selected tone
- L_{pti} ($L_{p,tone(i)}$) – the Level of the selected tone
- L_{pt} ($L_{p,tone}$) – the Level of all tones in the critical band containing the selected tone
- ΔL_{ts} – the difference between $L_{p,tone}$ and $L_{p,crit.band}$ (Danish standard only)
- $\Delta L_{ts,crit.}$ – kriterieværdien is a frequency-dependent threshold for the tone audibility (Danish standard only)
- Critical Band (Critical Band) – the start and end of the critical band containing the selected tone
- $f_{c(Crit.band)}$ ($f_{c,crit.}$) – the centre frequency of the critical band
- Tone Standard – the standard used for tone assessment

7.6.4 Broadband Parameters

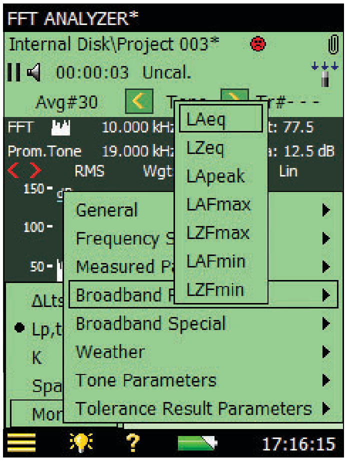
The result of the FFT-based tone assessment is the adjustment K_t, which should be added to the L_{Aeq} measurement to calculate the rating level, L_r according to ISO 1996-2. The tone corrected rating level is calculated from the following equation:

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

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 (BR 1626) for more detailed information about the rating level.

While using the 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 (Fig. 7.7). Tap the panel and select the parameter to be displayed.

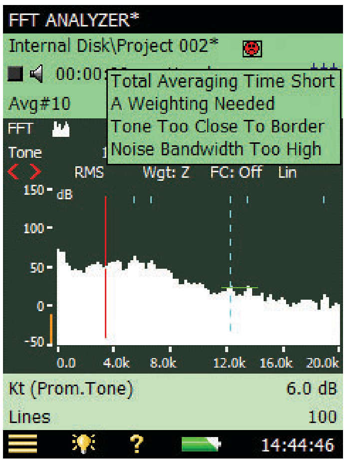
Fig. 7.7
Selecting broadband parameters



7.6.5 Status Codes (Smileys)

When the 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. 7.8.

Fig. 7.8
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 <5% of minimal critical bandwidth. Increase the number of lines or reduce the analysed frequency span
	Red	A-weighting needed	Set **Pre-weighting** to *A* (for **Tone Standard** = *ISO 1996-2:2007*)
	Red	Z-weighting needed	Set **Pre-weighting** and **Post-weighting** to *Z* (for **Tone Standard** = *Denmark 1984/1991*)
	Red	Hanning window needed	Select *Hanning* window
	Yellow	Total Averaging Time too short	Increase total average time to >1 min
	Yellow	Linear averaging missing	Set *Linear* averaging
	Yellow	Closely spaced Tones	Need better frequency resolution: refer to ISO 1996-2 Annex C: Note 3, page 27
	Yellow	Tone too close to frequency span limits	Adjust the analysed frequency span
	Yellow	Assessment is performed on MAX spectrum	Reselect tone cursor, or change the graph manually to *FFT*
	Yellow	Assessment is performed on Reference spectrum	Reselect tone cursor, or change the graph manually to *FFT*
	Yellow	No masking noise found in critical band	Increase the tone seek criterion or zoom in. Relevant for very prominent tones, for example calibration tone.

Please 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 73.

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. 7.9. 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.

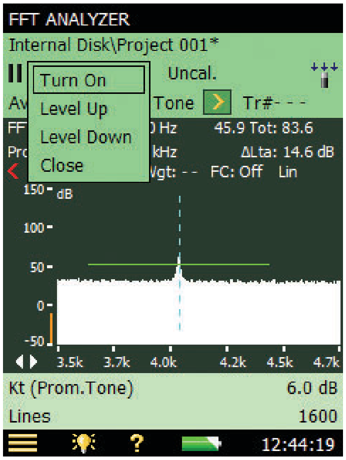


Fig. 7.9
Generation of a tone at the cursor

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. 7.9. Tap on **Level Up** or **Level Down** or control the level using **Setup** > **Tone at Cursor** > **Level.**

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 set **Preferences** > **Headphones** > **Listen to Signal** to *Input A-weighted*, *Input C-weighted* or *Input Z-weighted*. If **Tone At Cursor** is enabled, the 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 Hand-held Analyzer Types 2250 and 2270 user manual (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.

Hardware Interface

PUSHBUTTONS
11 buttons with backlight, optimized 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

STATUS INDICATORS
LEDs: Red, yellow and green

DISPLAY
Type: Transflective back-lit colour touchscreen 240 × 320 dot matrix
Colour Schemes: Five different – optimized for different usage scenarios (day, night, etc.)
Backlight: Adjustable level and time

USER INTERFACE
Measurement Control: Using pushbuttons
Set-up and Display of Results: Using stylus on touchscreen or pushbuttons
Lock: Pushbuttons and touchscreen can be locked and unlocked

USB INTERFACE
Hardware G1 – 3: USB 1.1 OTG Mini B socket
Hardware G4: USB 2.0 OTG Micro AB and USB 2.0 Standard A sockets for Wireless USB-A Adapter UL-1050, printer or weather station

MODEM INTERFACE
Connection to Internet through GPRS/EDGE/HSPA modem connected through the CompactFlash slot (hardware G1 – 3) or the USB Standard A Socket (hardware G4).
Supports DynDNS for automatic update of IP address of host name

PRINTER INTERFACE
PCL printers, Mobile Pro Spectrum thermal printer or Seiko DPU S245/S445 thermal printers can be connected to USB socket

MICROPHONE FOR COMMENTARY
Microphone, which utilizes automatic gain control (AGC), is incorporated in underside of analyzer. Used to create voice annotations for attaching to measurements

CAMERA (TYPE 2270 ONLY)
Camera with fixed focus and automatic exposure is incorporated in underside of analyzer.
Used to create image annotations for attaching to measurements
Image Size: Hardware G1 – 3: 640 × 480 pixels or hardware G4: 2048 × 1536 pixels
Viewfinder Size: 212 × 160 pixels
Format: jpg with exif information

COMPACTFLASH SOCKET (Hardware G1 – 3 only)
Connection of CF memory card, CF modem, CF to serial interface, CF Ethernet interface or CF WLAN interface

SECURE DIGITAL SOCKET
1 × SD socket for hardware G1 – 3 or 2 × SD sockets for hardware G4
Connect SD and SDHC memory cards

LAN INTERFACE SOCKET
Hardware G1 – 3 (Type 2270 only):
- Connector: RJ45 MDI
- Speed: 10 Mbps
- Protocol: TCP/IP

Hardware G4 (Types 2250 and 2270):
- Connector: RJ45 Auto-MDIX
- Speed: 100 Mbps
- Protocol: TCP/IP

INPUT SOCKET
One socket with Type 2250; two with Type 2270
Connector: Triaxial LEMO. Used for Direct input as well as input with constant current line drive (CCLD) power supply
Input Impedance: ≥1 MΩ
Direct Input: Max. input voltage: ±14.14 V_{peak}, 10 V_{RMS} for sinusoidal input signals, no damage for signals up to ±20 V_{peak}, Source impedance ≤1 kΩ

CCLD Input: Max. input voltage: ±7.07 V_{peak}, (no indication for violation of this level), no damage for signals in the range –10 to +25 V_{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: ±20 V_{peak}, no damage for signals up to +50 V_{peak}
Input Impedance: >47 kΩ
CCLD Current/Voltage: 4 mA/25 V

OUTPUT SOCKET
Connector: Triaxial LEMO
Max. Peak Output Level: ±4.46 V
Output Impedance: 50 Ω

HEADPHONE SOCKET
Connector: 3.5 mm Minijack stereo socket
Max. Peak Output Level: ±1.4 V
Output Impedance: 32 Ω in each channel, short-circuit proof without affecting the measurement results
Sources: Input conditioned (gain adjustment –60 to +60 dB), playback of voice annotations and signal recordings (gain adjustment –60 to 0 dB) and playback of recordings (gain adjustment –60 to +60 dB); however, max. gain is 0 dB for 16-bit wave files

Storage

INTERNAL FLASH-RAM (NON-VOLATILE)
For hardware G1 – 3: 20 MB or hardware G4: 512 MB for user set-ups and measurement data

EXTERNAL MEMORY CARD
SD and SDHC Card: For store/recall of measurement data
CompactFlash (CF) Card: Hardware G1 – 3 only. For store/recall of measurement data

USB MEMORY STICK (Hardware G4 only)
For store/recall of measurement data

Power

EXTERNAL DC POWER SUPPLY REQUIREMENTS
Used to charge the battery pack in the analyzer
Voltage: 8 – 24 V DC, ripple voltage <20 mV
Current Requirement: min. 1.5 A
Power Consumption: <2.5 W, without battery charging, <10 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 V AC; 47 – 63 Hz
Connector: 2-pin IEC 320

BATTERY PACK
Rechargeable Li-Ion battery
Part No.: QB-0061
Voltage: 3.7 V
Capacity: 5200 mAh nominal
Typical Operating Time:
Single-channel: >11 h (screen backlight dimmed); >10 h (full screen backlight)
Dual-channel: >7.5 h(full screen backlight)
Battery Cycle Life: >500 complete charge/discharge cycles
Battery Aging: Approximately 20% loss in capacity per year
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 analyzer, typically 10 hours from empty at ambient temperatures below 30 °C (86 °F). To protect the battery, charging will be terminated completely at ambient temperatures above 40 °C (104 °F). 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 (32 °F) or over 50 °C (122 °F). Doing this will reduce battery lifetime

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

Environmental

WARM-UP TIME
From Power Off: <2 min
From Standby: <10 s for prepolarized microphones

WEIGHT AND DIMENSIONS
650 g (23 oz) including rechargeable battery
300 × 93 × 50 mm (11.8 × 3.7 × 1.9″) including preamplifier and microphone

Wireless Connection to Mobile Device

Specifications apply to Wireless USB-A Adapter UL-1050
Operating Frequency: 2.4 GHz
Data Rate:
- IEEE 802.11n: up to 150 Mbps
- IEEE 802.11g: up to 54 Mbps
- IEEE 802.11b: up to 11 Mbps

Encryption/Authentication:
- 64/128-bit WEP
- WPA-PSK
- WPA2-PSK

Range: The range is similar to a standard WLAN unit, typically from 10 to 50 m (33 to 164′), depending on the environment and the number of other WLAN transmitters in the area (smartphones, Wi-Fi, etc.)
Power Requirements: Power Consumption: <1 W

Software Interface

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 (People's Republic of China), Chinese (Taiwan), Croatian, Czech, Danish, English, Flemish, French, German, Hungarian, Japanese, Italian, Korean, Polish, Portuguese, Romanian, Russian, Serbian, Slovenian, Spanish, Swedish, Turkish and Ukrainian

HELP
Concise context-sensitive help in Chinese (People's Republic of China), English, French, German, Italian, Japanese, Polish, Romanian, Serbian, Slovenian, Spanish and Ukrainian

UPDATE OF SOFTWARE
Update to any version using BZ-5503 through USB or update via Internet

REMOTE ACCESS
Connect to the analyzer using:
- Measurement Partner Suite BZ-5503
- the 2250/2270 SDK (software development kit)
- a REST interface through HTTP
- an Internet browser supporting JavaScript

The connection is password protected with two levels of protection:
- Guest level: for viewing only
- Administrator level: for viewing and full control of the analyzer

CLOUD
Connect to Measurement Partner Cloud on cloud.bksv.com for transferring data to an archive in the cloud for storage or easy synchronization with Measurement Partner Suite BZ-5503

Input

DUAL CHANNELS (Type 2270 only)
All measurements are made from either Ch. 1 or Ch. 2
Two independent measurement channels are available on Type 2270 to enable you to measure various parameters, subject to having a dual-channel application license

TRANSDUCER DATABASE
Transducers are described in a transducer database with information on Serial Number, Preamplifier ID, Nominal Sensitivity, CCLD Required and Weight.
The analogue hardware is set up automatically in accordance with the selected transducer

Calibration

Initial calibration for each transducer is stored for comparison with later calibrations For accelerometer Types 4397-A, 4513, 4513-001, 4513-002, 4514, 4514-001, 4514-002, 4533-B, 4533-B-001, 4533-B-002, 4534-B, 4534-B-001, 4534-B-002, 8324, 8341, 8344 and 8347-C + 2647-C, the lower frequency limit will be optimized to match the specifications for the accelerometer.

ELECTRICAL
Uses internally generated electrical signal combined with a typed-in value of microphone sensitivity

MECHANICAL
Using Calibrator Exciter Type 4294 or custom calibrator

DIRECT ELECTRICAL
Using an external voltage reference

CALIBRATION HISTORY
Up to 20 of the last calibrations made are listed and can be viewed on the analyzer

Data Management

METADATA
Up to 30 metadata annotations can be set per project (text from keyboard or text from pick list, number from keyboard or auto-generated number)

PROJECT TEMPLATE
Defines the display and measurement set-ups. Set-ups can be locked and password-protected

PROJECT
Measurement data stored with the project template

JOB
Projects are organized in jobs.
Explorer facilities for easy management of data (copy, cut, paste, delete, rename, open project, create job, set default project name)

Measurement Control

MANUAL
Manually controlled single measurement

AUTOMATIC
Preset measurement time from 1 s to 24 h in 1 s steps

MANUAL CONTROLS
Reset, Start, Pause, Back-erase, Continue and Store the measurement manually

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

BACK-ERASE
The last 5 s of data can be erased without resetting the measurement

Measurement Status

ON SCREEN
Information such as overload and running/paused are displayed on screen as icons

TRAFFIC LIGHTS
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 calibration signal
- Green LED on constantly = measuring
- Yellow LED flashing slowly = paused, measurement not stored
- Red LED flashing quickly = intermittent overload, calibration failed

NOTIFICATIONS
Sends an SMS or email daily at a specified time or if an alarm condition is fulfilled
Alarm Conditions:
- Disk Space below set value
- Trig. Input Voltage below set value
- Internal Battery enters set state
- Change in Measurement State
- Reboot of analyzer

Annotations

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 +60 dB

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

GPS ANNOTATIONS
A text annotation with GPS information can be attached (Latitude, Longitude, Altitude and position error). Requires connection to a GPS receiver

IMAGE ANNOTATIONS (TYPE 2270 ONLY)
Image annotations can be attached to measurements. Images can be viewed on the screen

Software Specifications – Sound Level Meter Software BZ-7222

Conforms with the following National and International Standards:
- IEC 61672–1 (2013) 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)
- ANSI S1.4–1983 plus ANSI S1.4A–1985 Amendment, Type 1
- ANSI/ASA S1.4–2014, Class 1
- ANSI S1.43–1997, 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. Type 2250/2270 also conforms to these EN Standards

Input

CHANNELS (Type 2270 only)
All measurements are made from either Ch. 1 or Ch. 2

TRANSDUCERS
Transducers are described in a transducer database with information on Serial Number, Nominal Sensitivity, Polarization Voltage, Free-field Type, CCLD required, Capacitance and additional information.
The analogue hardware is set up automatically in accordance with the selected transducer

CORRECTION FILTERS
For Microphone Types 4189, 4190, 4191, 4192, 4193, 4193 + UC-0211, 4950, 4952, 4952+EH-2152, 4955-A, 4964, 4964 + UC-0211, 4966 and 4184-A, BZ-7222 is able to correct the frequency response to compensate for sound field and accessories:
Sound Field: Free-field, diffuse-field or pressure-field (Type 4192 only). For Types 4952 and 4184-A only: 0° (Top) reference direction and 90° (Side) reference direction
Accessories:
- Types 4189, 4190, 4964 and 4964 + UC-0211 only: None, Windscreen UA-1650 or Outdoor Microphone Kit UA-1404
- Types 4191, 4192, 4193, 4193 + UC-0211, 4966 and 4955-A only: None or Windscreen UA-1650
- Type 4950 only: None or Windscreen UA-0237

For Accelerometer Types 4397-A, 4513, 4513-001, 4513-002, 4514, 4514-001, 4514-002, 4533-B, 4533-B-001, 4533-B-002, 4534-B, 4534-B-001, 4534-B-002, 8324, 8341, 8344, 8347-C + 2647-D the lower frequency limit will be optimized to match the specifications for the accelerometer

Analysis

DETECTORS

Parallel detectors on every measurement:

- **A- or B-weighted (switchable):** Broadband detector channel with three exponential time weightings (Fast, Slow, Impulse), 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 FOR SOUND INPUT

X = frequency weightings A or B
Y = frequency weightings C or Z
V = frequency weightings A, B, C or Z
U = time weightings F or S
Q = exchange rate 4, 5 or 6 dB
N = number between 0.1 and 99.9

For Display and Storage:

Start Time	Stop Time	Overload %
Elapsed Time	L_{Xeq}	L_{Yeq}
L_{XE}	L_{YE}	$L_{Ceq}–L_{Aeq}$
L_{XSmax}	L_{XFmax}	L_{XImax}
L_{YSmax}	L_{YFmax}	L_{YImax}
L_{XSmin}	L_{XFmin}	L_{XImin}
L_{YSmin}	L_{YFmin}	L_{YImin}
L_{XIeq}	L_{YIeq}	$L_{AIeq}–L_{Aeq}$
L_{AFTeq}	$L_{AFTeq}–L_{Aeq}$	Time Remaining
$L_{ep,d}$	$L_{ep,dv}$	E
Dose	Proj. Dose	L_{vpeak}
#VPeaks (>NNNdB)	#VPeaks (>137dB)	#VPeaks (>135dB)
T_{Vpeak}	L_{avUQ}	TWA
TWAv	DoseUQ	Proj. DoseUQ
$L_{Aeq,T1,mov,max}$	$L_{Aeq,T2,mov,max}$	$L_{Ceq,T1,mov,max}$
$L_{Ceq,T2,mov,max}$	$\Delta L_{eq,T1,mov,max}$	$\Delta L_{eq,T2,mov,max}$
Avg. RPM		

Weather Data (requires weather station):

Wind Dir. avg.	Wind Dir. min.	Wind Dir. max.
Wind Speed avg.	Wind Speed min.	Wind Speed max.
Amb. Temp.	Amb. Humidity	Amb. Pressure
Rainfall		

Only for Display as Numbers or Quasi-analog Bars:

L_{XS}	L_{XF}	L_{XI}
L_{YS}	L_{YF}	L_{YI}
$L_{XS(SPL)}$	$L_{XF(SPL)}$	$L_{XI(SPL)}$
$L_{YS(SPL)}$	$L_{YF(SPL)}$	$L_{YI(SPL)}$
L_{XN1} or L_{XUN1}	L_{XN2} or L_{XUN2}	L_{XN3} or L_{XUN3}
L_{XN4} or L_{XUN4}	L_{XN5} or L_{XUN5}	L_{XN6} or L_{XUN6}
L_{XN7} or L_{XUN7}	LVpeak,1s	Trig. Input Voltage
Std.Dev.	$L_{Aeq,T1,mov}$	$L_{Aeq,T2,mov}$
$L_{Ceq,T1,mov}$	$L_{Ceq,T2,mov}$	$\Delta L_{eq,T1,mov}$
$\Delta L_{eq,T2,mov}$	Inst. RPM	

Instantaneous Weather Data:

Wind Dir.	Wind Speed

Instantaneous GPS Data:

Latitude	Longitude

MEASUREMENTS FOR VIBRATION INPUT

For Display and Storage:

Start Time	Stop Time	Overload %
Elapsed Time	Time Remaining	
aLinear	aLin(1k–20kHz)	
aFast max	aF max(1k–20kHz)	
aSlow max	aS max(1k–20kHz)	
aFast min	aF min(1k–20kHz)	
aPeak	aT_{Peak}	
Crest Factor	Avg. RPM	

Only for Display as Numbers or Quasi-analog Bars:

aFast Inst	aF Inst(1k–20kHz)
aSlow Inst	aS Inst(1k–20kHz)
Inst RPM	Trig. Input Voltage

Instantaneous GPS Data:

Latitude	Longitude

MEASUREMENTS FOR DIRECT INPUT

For Display and Storage:

Start Time	Stop Time	Overload %
Elapsed Time	Time Remaining	
Linear	Fast max	Slow max
Fast min	Slow min	Peak
T_{Peak}	Crest Factor	Avg. RPM

Only for Display as Numbers or Quasi-analog Bars:

Fast Inst	Slow Inst
Inst RPM	Trig. Input Voltage

Instantaneous GPS Data:

Latitude	Longitude

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 122.3 dB
Linearity Range: In accordance with IEC 60804: A-weighted: 21.4 dB to 140.8 dB
Linear Operating Range: In accordance with IEC 61672:
- A-weighted: 1 kHz: 24.8 dB to 139.7 dB
- C-weighted: 25.5 dB to 139.7 dB
- Z-weighted: 30.6 dB to 139.7 dB

Peak C Range: In accordance with IEC 61672: 1 kHz: 42.3 dB to 142.7 dB

SAMPLING FOR STATISTICS
The Statistics can be based on either L_{XF}, L_{XS} or L_{Xeq}:
- Statistics L_{XFN1-7} or L_{XSN1-7} are based on sampling L_{XF} or L_{XS}, resp., every 10 ms into 0.2 dB wide classes over 130 dB
- Statistics L_{XN1-7} are based on sampling L_{Xeq} every second into 0.2 dB wide classes over 130 dB

Full distribution saved with measurement
The Std.Dev. (Standard Deviation) parameter is calculated from the statistics

RPM MEASUREMENT
RPM is measured on the signal connected to Trigger input when Tacho is set to *On*
Range: 1 to 6 000 000 RPM
Gear Ratio: 10^{-5} to 10^{38}. The displayed RPM is the measured RPM divided by the RPM gear ratio

Measurement Display and Control

MEASUREMENT DISPLAYS
SLM: Measurement data displayed as numbers of various sizes and one quasi-analog bar
Measured sound data are displayed as dB values, vibration data as dB values or in physical units (SI units (m/s^2) or US/UK units (g)), direct data as voltage in dB or V, housekeeping data as numbers in relevant format.
Instantaneous measurement L_{XF} or Fast Inst is displayed as a quasi-analog bar

MEASUREMENT CONTROL
Manual: Manually controlled single measurement
Automatic: Preset measurement time from 1 s to 24 hr in 1 s steps
Manual Controls: Reset, Start, Pause, Back-erase, Continue and Store the measurement manually
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

BACK-ERASE
The last 5 s of data can be erased without resetting the measurement

Measurement Status

ON SCREEN
Information such as overload and running/paused are displayed on screen as icons

TRAFFIC LIGHTS
Red, yellow and green LEDs show measurement status and instantaneous overload as follows:
- Yellow LED flash every 5 s = stopped, ready to measure
- Green LED flashing slowly = awaiting calibration signal
- Green LED on constantly = measuring
- Yellow LED flashing slowly = paused, measurement not stored
- Red LED flashing quickly = intermittent overload, calibration failed

NOTIFICATIONS
Sends an SMS or email daily at a specified time or if an alarm condition is fulfilled
Alarm Conditions:
- Disk Space below set value
- Trig. Input Voltage below set value
- Internal Battery enters set state
- Change in Measurement State
- Reboot of analyzer

Signal Monitoring

The input signal can be monitored using an earphone/headphones connected to the headphone socket, or it can be fed to the output socket

OUTPUT SIGNAL
Input Conditioned: A-, B-, C- or Z-weighted
Gain Adjustment: –60 dB to 60 dB
L_{XF} output (every ms) as a DC voltage between 0 V and 4 V
DC output for calibration purposes: 0 dB ~ 0 V and 200 dB ~ 4 V

HEADPHONE SIGNAL
Input signal can be monitored using this socket with headphones/earphones
Gain Adjustment: –60 dB to 60 dB

Annotations

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 +60 dB

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

GPS ANNOTATIONS
A text annotation with GPS information can be attached (Latitude, Longitude, Altitude and position error). Requires connection to a GPS receiver

IMAGE ANNOTATIONS (TYPE 2270 ONLY)
Image annotations can be attached to measurements. Images can be viewed on the screen

Calibration

Initial calibration is 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

ELECTRICAL
Uses internally generated electrical signal combined with a typed-in value of microphone sensitivity

CALIBRATION HISTORY
Up to 20 of the last calibrations made are listed and can be viewed on the analyzer

Data Management

METADATA
Up to 30 metadata annotations can be set per project (text from keyboard or text from pick list, number from keyboard or auto generated number)

PROJECT TEMPLATE
Defines the display and measurement setups. Setups can be locked and password protected

PROJECT
Measurement data stored with the project template

JOB
Projects are organized in jobs
Explorer facilities for easy management of data (copy, cut, paste, delete, rename, open project, create job, set default project name)

Software Specifications – Frequency Analysis Software BZ-7223

The specifications for BZ-7223 also include the specifications for Sound Level Meter Software BZ-7222.

Standards

Conforms with the following National and International Standards:
- IEC 61260–1 (2014), 1/1-octave Bands and 1/3-octave Bands, Class 1
- IEC 61260 (1995–07) plus Amendment 1 (2001–09), 1/1-octave Bands and 1/3-octave Bands, Class 0
- ANSI S1.11–1986, 1/1-octave Bands and 1/3-octave Bands, Order 3, Type 0–C
- ANSI S1.11–2004, 1/1-octave Bands and 1/3-octave Bands, Class 0
- ANSI/ASA S1.11–2014 Part 1, 1/1-octave Bands and 1/3-octave Bands, Class 1

Input

CHANNELS (TYPE 2270 ONLY)
All measurements are made from either Ch. 1 or Ch. 2

Frequency Analysis

CENTRE FREQUENCIES
1/1-oct. Band Centre Frequencies: 8 Hz to 16 kHz
1/3-oct. Band Centre Frequencies: 6.3 Hz to 20 kHz

MEASUREMENTS FOR SOUND INPUT
X = frequency weightings A, B, C or Z, Y = time weightings F or S
Data for Storage
Full Spectral Statistics

Spectra for Display and Storage:

L_{Xeq}	L_{XSmax}	L_{XFmax}
L_{XSmin}	L_{XFmin}	

Spectra for Display Only:

L_{XS}	L_{XF}	L_{XYN1}
L_{XYN2}	L_{XYN3}	L_{XYN4}
L_{XYN5}	L_{XYN6}	L_{XYN7}

Single Values:

SIL	PSIL	SIL3
L_{Xeq}(f1-f2)*		
NR	NR Decisive Band	
RC	RC Classification	
NCB	NCB Classification	
NC	NC Decisive Band	
Loudness	Loudness Level	

* where f1 and f2 are frequency bands in the spectrum

MEASUREMENTS FOR VIBRATION AND DIRECT INPUT

Spectra for Display and Storage:

Linear	Fast max	Slow max
Fast min	Slow min	

Spectra for Display Only:

Fast Inst	Slow Inst

Single Values:

Linear (f1 – f2)*

* where f1 and f2 are frequency bands in the spectrum

MEASURING RANGES
When using Microphone Type 4189:
Dynamic Range: From typical noise floor to max. level for a pure tone signal at 1 kHz 1/3-octave: 1.1 to 140 dB
Linear Operating Range: In accordance with IEC 61260, 1/3-octave: ≤20.5 to 140 dB

SAMPLING FOR OCTAVE OR 1/3-OCTAVE STATISTICS
X = frequency weightings A or B
The Statistics can be based on either L_{XF} or L_{XS}:
- Statistics L_{XFN1-7} or L_{XSN1-7} are based on sampling L_{XF} or L_{XS}, respectively, every T ms into 1 dB wide classes over 150 dB;

T = 100 for frequency range set to 12.5 – 20 kHz
T = 200 for frequency range set to 6.3 – 20 kHz
Full distribution can be saved with measurement

Displays

MEASUREMENT DISPLAYS
Spectrum: One or two spectra superimposed + A/B and C/Z broadband bars
Table: One or two spectra in tabular form
Y-axis: Range: 5, 10, 20, 40, 60, 80, 100, 120, 140, 160 or 200 dB. Auto zoom or auto scale available. Sound data are displayed as dB values, vibration data as dB values or in physical units (SI units (m/s^2) or US/UK units (g)), direct data as voltage in dB or V
Cursor: Readout of selected band

Generator

INTERNAL GENERATOR
Built-in pseudo-random noise generator
Spectrum: Selectable between Pink and White
Crest Factor:
- Pink Noise: 4.4 (13 dB)
- White Noise: 3.6 (11 dB)

Bandwidth: Selectable:
- Lower Limit: 50 Hz (1/3-oct.) or 63 Hz (oct.)
- Upper Limit: 10 kHz (1/3-oct.) or 8 kHz (oct.)

Output Level: Independent of bandwidth
- Max.: 1 V_{rms} (0 dB)
- Gain Adjustment: –60 to 0 dB

When bandwidth is changed, the level for all bands is automatically adjusted to comply with the set output level
Correction Filters: For Sound sources Type 4292, Type 4295 and Type 4296: Flat or Optimum
Repetition Period: 175 s
Output Connector: Output socket

EXTERNAL GENERATOR
Selectable as alternative to Internal Generator (for microphone input only)
To control external noise generator, set:
- **Levels:** 0 V (Generator off), 4.5 V (Generator on)
- **Rise-time and Fall-time:** 10 μs

The noise generator is turned on and off automatically during the measurement
Escape Time: 0 to 60 s
Build-up Time: 1 to 10 s
The generator can be turned on and off manually for checking equipment and sound levels

Software Specifications – Logging Software BZ-7224

The specifications for BZ-7224 include the specifications for Sound Level Meter Software BZ-7222. BZ-7224 adds:

Logging

MEASUREMENTS

Logging: Measurement data logged at preset periods into files on:
- SD Card: All hardware versions
- CF Card: G1 – 3
- USB Memory Stick: G4

Logging Period: From 1 s to 24 hr with 1 s resolution
Fast Logging: L_{AF}, L_{AS} and L_{Aeq} (sound input) or Fast Inst, Slow Inst and Linear (vibration and Direct input) can be logged every 100 ms, irrespective of logging period. For sound input you can also log LAF every 10 ms. One spectrum (L_{eq}, LF or LS) can be logged every 100 ms. The 10 ms LAF and the 100 ms spectrum can only be stored and not displayed on the analyzer; it can be displayed on Measurement Partner Suite BZ-5503
Broadband Data Stored at each Logging Interval: All, or up to 10 selectable broadband sound data incl. Trig. Input Voltage, Avg. RPM, Weather data, and $L_{Aeq,T,mov}$ (for vibration and direct input: up to 5 parameters)
Broadband Statistics Stored at each Logging Interval: Full distribution, or none (sound input only)
Spectrum Data Stored at each Logging Interval: All, or up to three selectable spectra (license for BZ-7223 required)
Spectral Statistics Stored at each Logging Interval: Full distribution, or none (sound input only, license for BZ-7223 required)
Logging Time: From 1 s to 31 days with 1 s resolution
Measurement Total: For the logging time, in parallel with logging: All broadband data, statistics and spectra (license for BZ-7223 required)

MARKERS
One data exclusion marker and four user-definable markers for on-line marking of sound categories heard during the measurement
Events can be set manually

TRIGGERS
Markers can be set and signal recordings can be started (license for BZ-7226 required) when a broadband level is above or below a specified level

ANNOTATIONS
On-line annotations with spoken comments, written notes or images (Type 2270 only)

Calibration

CHARGE INJECTION CALIBRATION (CIC)
Injects an internally generated electrical signal in parallel with the microphone diaphragm. A manual CIC can be performed whenever there is no measurement in progress
An automatic CIC can be performed at the start and end of a logging measurement

Measurement Displays

Profile: Graphical display of selectable measurement data versus time. Fast display of next or previous marker, profile overview of entire measurement
Y-axis: Range: 5, 10, 20, 40, 60, 80, 100, 120, 140, 160 or 200 dB. Auto zoom or auto scale available. Sound data are displayed as dB values, vibration data as dB values or in physical units (SI units (m/s^2) or US/UK units (g)), direct data as voltage in dB or V.
X-axis: Scroll facilities
Cursor: Readout of measurement data at selected time

Notifications

Alarm Conditions (in addition to those specified for BZ-7222):
- CIC failed
- Trigger Level exceeded

Software Specifications – Signal Recording Option BZ-7226

Signal Recording Option BZ-7226 is enabled with a separate license.
For data storage, signal recording requires:
- SD Card: All hardware versions
- CF Card: Hardware G1 – 3
- USB Memory Stick: Hardware G4

RECORDED SIGNAL
A-, B-, C- or Z-weighted sound signal from the microphone or acceleration signal from the accelerometer

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 the signal. This allows the beginning of events to be recorded even if they are only detected later

Sampling Rate (kHz)		8	16	24	48
Maximum Pre-recording (s) 16-bit	G1 – 3	110	50	30	10
	G4	470	230	150	70
Maximum Pre-recording (s) 24-bit	G1 – 3	70	30	16	3
	G4	310	150	96	43
Memory (kB/s) 16-bit		16	32	48	96
Memory (kB/s) 24-bit		24	48	72	144

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

RECORDING FORMAT
The recording format is either 24- or 16-bit wave files (extension .wav) attached to the data in the project, easily played back afterwards on a PC using BZ-5503, Type 7820 or 7825. Calibration information and possible tacho trigger information are stored in the .wav file allowing BZ-5503 and BK Connect to analyse the recordings

Functions

Manual Control of Recording: Recording can be manually started and stopped during a measurement using a pushbutton or an external signal
Automatic Control of Recording: Start of recording when measurement is started. Minimum and Maximum recording time can be preset

Software Specifications – FFT Analysis Software BZ-7230

Specifications for FFT analysis are given for the 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*
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 (microphone input only)

MEASUREMENT CONTROL
Manual Start
Measurements can be manually started and stopped using a pushbutton or an external signal
Exponential Averaging: With an averaging time of up to 999 spectra, measured with Hanning window and 67% overlap
Linear Averaging: Up to 8 388 607 spectra measured with Hanning window and 67% overlap
Triggered Start
Transient Signal Type: Linear averaging of up to 32 767 triggered spectra measured with rectangular window and 0% overlap
Continuous Signal Type: Linear averaging of up to 32 767 spectra measured with Hanning window and 67% overlap. Up to 32 767 spectra are averaged on each trigger

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

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 16 383 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 –20 to 20 V
Offset at Trigger Input: Typically between –70 mV and 200 mV
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 between 2 479 653 and 2 630 265, the Trigger Input is pulled up to +5 V through a 7.5 kΩ resistor when this parameter field is set to *On.* For instruments with serial number 2 630 266 and above the Pull-up has been changed to a CCLD power supply

MEASUREMENT RANGE
(See Table 8.1)
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).

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 Low Frequency: Extended/Normal
Direct Input	1 V/V	3 µV – 14.1 V_{Peak}	300 nV – 75 mV_{Peak}	1.5/6.3 Hz – 20 kHz
4184-A	10.9 mV/Pa	23 dB – 153 dB_{Peak}	3 dB – 111 dB_{Peak}	3.6/6.6 Hz – 15 kHz
4189	50 mV/Pa	10 dB – 143 dB_{Peak}	–10 dB – 98 dB_{Peak}	6.8/7.8 Hz – 20 kHz
4190	50 mV/Pa	10 dB – 143 dB_{Peak}	–10 dB – 98 dB_{Peak}	4.0/6.7 Hz – 20 kHz
4191	12.5 mV/Pa	22 dB – 155 dB_{Peak}	2 dB – 110 dB_{Peak}	3.6/6.6 Hz – 20 kHz
4192	12.5 mV/pa	22 dB – 155 dB_{Peak}	2 dB – 110 dB_{Peak}	3.6/6.6 Hz – 20 kHz
4193	12.5 mV/Pa	22 dB – 155 dB_{Peak}	2 dB – 110 dB_{Peak}	0.56/6.3 Hz – 20 kHz
4193 + UC-0211	1.9 mV/Pa	38 dB – 145 dB_{Peak}	18 dB – 126 dB_{Peak}	0.38/6.3 Hz – 20 kHz
4950	50 mV/Pa	10 dB – 143 dB_{Peak}	–10 dB – 98 dB_{Peak}	4.3/6.3 Hz – 19 kHz
4952	31.6 mV/Pa	14 dB – 144 dB_{Peak}	–6 dB – 101 dB_{Peak}	4.3/6.3 Hz – 14 kHz
4952+EH-2152	31.6 mV/Pa	14 dB – 144 dB_{Peak}	–6 dB – 101 dB_{Peak}	4.3/6.3 Hz – 12.7 kHz
4955-A	1100 mV/Pa	–17 dB – 98 dB_{Peak}	–37 dB – 71 dB_{Peak}	9.2/9.2 Hz – 19 kHz
4964	50 mV/Pa	10 dB – 143 dB_{Peak}	–10 dB – 98 dB_{Peak}	0.6/6.0 Hz – 20 kHz
4964 +UC-0211	6.1 mV/Pa	28 dB – 133 dB_{Peak}	8 dB – 116 dB_{Peak}	0.35/6.0 Hz – 20 kHz
4966	50 mV/Pa	10 dB – 143 dB_{Peak}	–10 dB – 98 dB_{Peak}	4.0/6.7 Hz – 20 kHz
4397-A	1 mV/(m/s^2)	3 mm/s^2 – 5 km/s$^2_{Peak}$	300 µm/s^2 – 75 m/s$^2_{Peak}$	1.25/6.3 Hz – 20 kHz
4513, 4514	1 mV/(m/s^2)	3 mm/s^2 – 5 km/s$^2_{Peak}$	300 µm/s^2 – 75 m/s$^2_{Peak}$	1.25/6.3 Hz – 10 kHz
4513-001, 4514-001	10 mV/(m/s^2)	300 µm/s^2 – 500 m/s$^2_{Peak}$	30 µm/s^2 – 7.5 m/s$^2_{Peak}$	1.25/6.3 Hz – 10 kHz
4513-002, 4514-002	50 mV/(m/s^2)	60 µm/s^2 – 100 m/s$^2_{Peak}$	6 µm/s^2 – 1.5 m/s$^2_{Peak}$	1.25/6.3 Hz – 10 kHz
4533-B, 4534-B	1 mV/(m/s^2)	3 mm/s^2 – 5 km/s$^2_{Peak}$	300 µm/s^2 – 75 m/s$^2_{Peak}$	0.2/6.3 Hz – 12.8 kHz
4533-B-001, 4534-B-001	10 mV/(m/s^2)	300 µm/s^2 – 500 m/s$^2_{Peak}$	30 µm/s^2 – 7.5 m/s$^2_{Peak}$	0.2/6.3 Hz – 12.8 kHz
4533-B-002, 4534-B-002	50 mV/(m/s^2)	60 µm/s^2 – 100 m/s$^2_{Peak}$	6 µm/s^2 – 1.5 m/s$^2_{Peak}$	0.2/6.3 Hz – 12.8 kHz
6233-C-10 + 2647-D	1 mV/(m/s^2)	3 mm/s^2 – 7 km/s$^2_{Peak}$	300 µm/s^2 – 75 m/s$^2_{Peak}$	1.25/6.3 Hz – 8 kHz
8324 + 2647-D	1 mV/(m/s^2)	3 mm/s^2 – 7 km/s$^2_{Peak}$	300 µm/s^2 – 75 m/s$^2_{Peak}$	1.25/6.3 Hz – 10 kHz
8341	10 mV/(m/s^2)	300 µm/s^2 – 500 m/s$^2_{Peak}$	30 µm/s^2 – 7.5 m/s$^2_{Peak}$	0.7/6.3 Hz – 10 kHz
8344	250 mV/(m/s^2)	12 µm/s^2 – 20 m/s$^2_{Peak}$	1.2 µm/s^2 – 300 mm/s$^2_{Peak}$	0.2/6.3 Hz – 3 kHz
8347-C + 2647-D	1 mV/(m/s^2)	3 mm/s^2 – 7 km/s$^2_{Peak}$	300 µm/s^2 – 75 m/s$^2_{Peak}$	1.25/6.3 Hz – 12.8 kHz

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 are the measured RPM 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 or Linear Y-axis, Logarithmic or 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† (THD)

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

TOLERANCE CHECK

Tolerance Window: Determines the upper and lower levels and the top and bottom frequency at which the spectrum is checked. The check can either be made on all the FFT Lines within the specified range or on the Delta Sum of the lines. The following parameters are measured for check on Delta Sum with exponential averaging:

- Delta Sum
- Max Delta Sum
- RPM at time for Max Delta Sum
- LAF at time for Max Delta Sum‡
- FFT Spectrum at time for Max Delta Sum
- Fast Inst at time for Max Delta Sum**

Up to 10 tolerance windows can be specified per template.

Single Values Check: Tolerances can be set for the parameters: L_{AF}*, Fast Inst†, Instantaneous RPM, L_{Aeq}*, Linear† and Average RPM.

Indication: Results for each tolerance window and for the four single values can be displayed. An Overall Result (combination of all results) and a Latched Result (latched during measurement) can be displayed and are indicated in the status panel.

When tolerance limits are violated, a recording can be started (license for BZ-7226 required) and a 3.3 V DC signal (above upper limit), a –3.3 V DC (below lower limit), a 3 V DC signal (Level 3), a 2 V DC signal (Level 2), a 1 V DC signal (Level 1), or a signal alternating between 3.3 V and –3.3 V (both above and below limits) can be output to the Output Socket

BAR GRAPH

LAF*, LZF*, Fast Inst†, Total of Spectrum and Delta Sum can be displayed on a bar graph with indication of Max Delta Sum and Upper, Level 2 max, Level 1 max, and Lower Limits

For engineering units, the axis on Bar Graph can be logarithmic or linear and can be zoomed

Broadband Parameters

Sound level meter (broadband) parameters are measured simultaneously with the FFT parameters, however, their measurement starts when 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 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

Conforms with the following National and International Standards:

- IEC 61672–1 (2002–05) Class 1

* Microphone input only.

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

‡ Microphone input only.

** Accelerometer and Direct input only.

- 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)
- ANSI S1.4–1983 plus ANSI S1.4A–1985 Amendment, Type 1
- ANSI S1.43–1997, 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)* or Linear† 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_{Xeq}	L_{Yeq}
L_{XFmax}	L_{YFmax}	L_{XFmin}
L_{YFmin}	L_{XIeq}	L_{YIeq}
L_{AFTeq}	L_{Vpeak}	

Only for Display as Numbers

L_{XF} L_{YF}

Weather Data (requires connection to a weather station):

Wind Dir. avg.	Wind Speed avg.
Wind Dir. min.	Wind Speed min.
Wind Dir. max.	Wind Speed max.
Amb. Temperature	Amb. Humidity
Amb. Pressure	Amb. Rain Gauge

Instantaneous Weather Data:

Wind Dir. Wind Speed

Instantaneous GPS Data:

Latitude Longitude

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

MEASUREMENTS*

For Display and Storage

Start Time	Stop Time	Overload %
Elapsed Time	Linear	
$Fast_{max}$	$Fast_{min}$	
Peak	Crest Factor	

Only for Display as Numbers

Fast Inst

Instantaneous GPS Data:

LatitudeLongitude

* Accelerometer and direct input only.

Software Specifications – Tone Assessment Option BZ-7231

LICENSE

Tone Assessment Option BZ-7231 is a standard application included with all new Type 2250/2270 analyzers. The option can be used with the FFT template (BZ-7230) or with 1/3-octave and logging template (BZ-7223, BZ-7224 and BZ-7225)1/3-octave and logging template (BZ-7132 and BZ-7133)

FFT Based Tone Assessment (with BZ-7230 Only)

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 CD (informative) Objective method for assessing the audibility of tones in noise – ReferenceSimplified method

SPECTRA ASSESSED

Any displayed sound FFT1/3-octave spectrum (FFT, Ref or $MaxL_{eq}$) may be assessed
Assessment is made as post-processing, that is, when measurement is paused or stopped

SETUP ACCORDING TO STANDARD

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. For tone assessment according to ISO 1996–2, Annex D, you can set the division between the low and middle frequency range, the division between the middle and high frequency range, and the limits for the level differences between adjacent bands

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 can be mixed with the input signal

TONE ASSESSMENT CURSOR

All tones found are indicated in the display.

The Tone cursor is initially placed at the most prominent tone, and can 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, Tone vs. Noise Level difference ΔL_{ts}, Audibility criterion $\Delta L_{ts,krit}$

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

QUALITY INDICATORS

On 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

1/3-octave Based Tone Assessment (with BZ-7223/24/25 Only)

Tone assessment is based on the measured 1/3-octave spectrum in accordance with either the international 'ISO 1996:2007 Acoustics – Description, assessment and measurement of environmental noise – part 2: Determination of environmental noise levels. Annex D (informative) Objective method for assessing the audibility of tones in noise – Simplified method' or the Italian law 'DM 16-03-1998: Ministero dell'ambiente, Decreto 16 marzo 1998'

SPECTRA ASSESSED

The displayed 1/3-octave spectrum (L_{eq}, L_{max} or L_{min}) may be assessed. Assessment is made as post-processing, that is, when measurement is paused or stopped

SETUP ACCORDING TO STANDARD

Setups in violation of the standard are indicated as such on the display. You can then accept to apply the default setup. Tone assessment will be made if possible, in spite of standard violations. For tone assessment according to ISO 1996-2, Annex D, you can set the division between the Low and Middle frequency range, the division between the Middle and High frequency range, and the limits for the level differences between adjacent bands.

For tone assessment according to DM 16-03-1998, the tones are tested against loudness contours. Select between ISO 226: 1987 Free-field, 1987 Diffuse-field and 2003 Free-field

RESULTS

Tones are indicated above the spectrum when *Tone* is selected as spectrum parameter. The resulting adjustment can be viewed on the Value panel. It is not saved with the measurement

Software Specifications – Enhanced Vibration and Low Frequency Option BZ-7234

Enhanced Vibration and Low Frequency Option BZ-7234 is enabled with a separate license. It adds human vibration parameters, and integration and double integration of the acceleration signal for vibration and displacement parameters to Sound Level Meter, Frequency Analysis, Logging and Enhanced Logging Software and adds low frequency 1/1- and 1/3-octave analysis to Frequency Analysis, Logging and Enhanced Logging Software

General Vibration

Specifications for General Vibration parameters apply to Type 2250/2270 fitted with an accelerometer

Analysis

Conforms with the following International standards:

- ISO 2954
- ISO 10816 series

Analysis

DETECTORS

Addition to the Acc Linear and Acc 1k-20kHz settings for the two broadband detectors:

Vel 3 – 20 000 Hz	Vel 0.3 – 1000 Hz	Vel 10 – 1000 Hz
Vel 1 – 100 Hz	Dis 10 – 1000 Hz	Dis 30 – 300 Hz
Dis 1 – 100 Hz		

The weighting for the peak detector can be set to one of the settings chosen for the broadband detectors or Acc Linear
The weighting for the spectrum detectors can be set to Acc Linear or Vel 3 – 20000 Hz, Vel 0.3 – 1000 Hz, Vel 10 – 1000 Hz or Vel 1 – 100 Hz

Single Values for Display and Storage: Peak-Peak for displacement

Human Vibration

Specifications for Human Vibration parameters apply to Type 2250/2270 fitted with an accelerometer.

Standards

Conforms with the following International Standards:

- ISO 8041:2005
- ISO 5349–1
- ISO 2631 series
- DIN 45669-1:2010–09

Analysis

DETECTORS

Two broadband detectors can each be set to one of the weightings:

Acc Linear	Vel 0.3 – 1000 Hz	Vel 1 – 100 Hz
W_b	W_c	W_d
W_e	W_j	W_h
W_k	W_m	W_{xb}
W_{hb}	W_{mb}	

W_{mb} is the band limiting part of W_m. W_{hb} is the band limiting part of W_h and W_{xb} is the band limiting part of W_b, W_c, W_d, W_e, W_j and W_k
The weighting for the peak detector can be set to one of the settings chosen for the broadband detectors or Acc Linear.
The weighting for the spectrum detectors can be set to Acc Linear or Vel 0.3 – 1000 Hz or Vel 1 – 100 Hz

MEASUREMENTS

Single Values for Display and Storage:

MTVV	KBF_{max}	KBF_{Tm}
Peak-Peak		

Single Values for Display Only:

aW,1s	KBF

Low Frequency 1/1- and 1/3-octave Analysis

Frequency Analysis

CENTRE FREQUENCIES

1/1-oct. Band Centre Frequencies: 1 Hz to 16 kHz
1/3-oct. Band Centre Frequencies: 0.8 Hz to 20 kHz

Standards

Conforms with the following National and International Standards:

- IEC 61260–1 (2014), 1/1-octave Bands and 1/3-octave Bands, Class 1
- IEC 61260 (1995–07) plus Amendment 1 (2001–09), 1/1-octave Bands and 1/3-octave Bands, Class 0
- ANSI S1.11–1986, 1/1-octave Bands and 1/3-octave Bands, Order 3, Type 0–C
- ANSI S1.11–2004, 1/1-octave Bands and 1/3-octave Bands, Class 0
- ANSI/ASA S1.11–2014 Part 1, 1/1-octave Bands and 1/3-octave Bands, Class 1

Vibration Measurements

Brüel & Kjær recommends Low-level Accelerometer Type 8344 for low frequency vibration measurements

Specifications – Measurement Partner Suite BZ-5503

BZ-5503 is included with Types 2250 and 2270Type 2250-LTypes 2250, 2250-L and 2270 for easy synchronization of setups and data between the PC and hand-held analyzer. BZ-5503 is supplied on ENV DVD BZ-5298

PC REQUIREMENTS

Operating System: Windows® 7, 8.1 or 10 (all in 32-bit or 64-bit versions)
Recommended PC:

- Intel® Core™ i3
- Microsoft®.NET 4.5
- 2 GB of memory
- Sound card
- DVD drive
- At least one available USB port
- Solid State Drive

ONLINE DISPLAY OF TYPE 2250/22702250-L2250/2250-L/ 2270 DATA
Measurements on the analyzer can be controlled from the PC and displayed online with the PC, using the same user interface on the PC as on the analyzer
Display: 1024 × 768 (1280 × 800 recommended)

DATA MANAGEMENT
Explorer: Facilities for easy management of analyzers, users, jobs, projects and project templates (copy, cut, paste, delete, rename, create)
Data Viewer: View measurement data (content of projects)
Synchronization: Project templates and projects for a specific user can be synchronized between PC and analyzer and between local and cloud archives

USERS
Users of Type 2250/2270 can be created or deleted

EXPORT FACILITIES
Excel®: Projects (or user-specified parts) can be exported to Microsoft® Excel® (Excel 2003 – 2016 supported)
Brüel & Kjær Software: Projects can be exported* to BK Connect

* Not all data are available in all exports. The data exported are dependent on the type and target of the export.

POST-PROCESSING
With the post-processing module licence, Measurement Partner Suite includes a range of post-processing tools for data acquired with Type 2250-LType 2250/2270Type 2250/ 2250-L/2270. These tools help to assess logging data and measured spectra, such as calculating contribution from markers on a logging profile, or correcting spectra for background noise

HAND-HELD ANALYZER SOFTWARE UPGRADES AND LICENSES
The software controls analyzer software upgrades and licensing of the analyzer applications

INTERFACE TO HAND-HELD ANALYZER
USB, LAN or Internet connection

LICENSE MOVER
To move a license from one analyzer to another use BZ-5503 together with License Mover VP-0647

LANGUAGE
User interface in Chinese (People's Republic of China), Chinese (Taiwan), Croatian, Czech, Danish, English, Flemish, French, German, Hungarian, Japanese, Italian, Korean, Polish, Portuguese, Romanian, Russian, Serbian, Slovenian, Spanish, Swedish, Turkish and Ukrainian

HELP
Concise context-sensitive help in English

Ordering Information

To measure vibration, order these analyzer and software module combinations:

Single-Channel Measurements

Type 2250-W	**Hand-held Analyzer**
with one or both of:	
BZ-7230	FFT Analysis Software
BZ-7234	Enhanced Vibration and Low Frequency Option

Dual-Channel Measurements

Type 2270-W	**Hand-held Analyzer (two-channel)**
with one or both of:	
BZ-7230	FFT Analysis Software
BZ-7234	Enhanced Vibration and Low Frequency Option

Both Types 2250-W and 2270-W include the following as standard:
Software:
- BZ-7222: Sound Level Meter Software
- BZ-7223: Frequency Analysis Software
- BZ-7231: Tone Assessment Option
- BZ-7232: Noise Monitoring Software
- BZ-7229: 2-channel Option (Type 2270-W only)

Accessories:
- FB-0679: Hinged Cover (Type 2250 only)
- FB-0699: Hinged Cover (Type 2270 only)
- QB-0061: Battery Pack
- ZG-0426: Mains Power Supply
- Accessory Kit UA-1710-D01 including:
  - KE-0441: Protective Cover for Hand-held Analyzer
  - UL-1050:Wireless USB-A (M) Adapter
  - UA-1651: Tripod Extension for Hand-held Analyzer
  - UA-1654: 5 Extra Styli
  - UA-1673: Adapter for Standard Tripod Mount
  - DH-0696: Wrist Strap
  - DD-0594: Protection Plug for Hand-held Analyzer without Preamplifier
  - AO-1494: Cable, USB 2.0, USB-A (M) to USB-micro-B (M) black, 1.8 m (5.9 ft), max. +70 °C (158 °F)
  - BZ-5298: Software, Environmental Software DVD

These accessories are also available separately

Software and Accessories Available Separately

SOFTWARE MODULES

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	Signal Recording Option
BZ-7229	2-channel Option (Type 2270 only)

MEASUREMENT PARTNER SUITE SOFTWARE

BZ-5503-012	Post-processing Module, 1-year subscription for one instrument
BZ-5503-036	Post-processing Module, 3-year subscription for one instrument
BZ-5503-060	Post-processing Module, 5-year subscription for one instrument
BZ-5503-N36	Post-processing Module, 3-year subscription for any instrument (dongle)
BZ-5503-N60	Post-processing Module, 5-year subscription for any instrument (dongle)
BZ-5503-ND	Post-processing Module, permanent license for any instrument (dongle)
BZ-5503-NI	Post-processing Module, permanent license for one instrument

MEASUREMENT ACCESSORIES

Type 4397-A	Accelerometer, with 1 mV/ms^{-2} sensitivity, suitable for high-frequency and high-level measurement, with M3 connection
Type 4533-B	Accelerometer, general purpose, with 1 mV/ms^{-2} sensitivity and 10–32 UNF, side connection
Type 4533-B-001	Accelerometer, suitable for low-level measurement, 10 mV/ms^{-2} and 10–32 UNF, side connection
Type 4533-B-002	Accelerometer, suitable for very low-level measurement, 50 mV/ms^{-2} and 10–32 UNF, side connection
Type 4534-B	Accelerometer, general purpose, with 1 mV/ms^{-2} sensitivity and 10–32 UNF, top connection
Type 4534-B-001	Accelerometer, suitable for low-level measurement, 10 mV/ms^{-2} and 10–32 UNF, top connection
Type 4534-B-002	Accelerometer, suitable for very low-level measurement, 50 mV/ms^{-2} and 10–32 UNF, top connection
Type 8324	Piezoelectric Charge Accelerometer, industrial, with 1 pC/ms^{-2} sensitivity and 2-pin 7/16-27 UNS connection
Type 8341	Accelerometer, industrial, with 10.2 mV/ms^{-2} sensitivity and MIL-C-5015 top connection
Type 8344	High-sensitivity Accelerometer, with 250 mV/ms^{-2} sensitivity and 10–32 UNF side connection
Type 2647-D-004	Charge-to-CCLD Converter with integrated cable and connectors for Accelerometer Type 8324 and Type 2250/2270; 80 Hz – 10 kHz

MISCELLANEOUS

Type 2981	Laser Tachometer Probe
Type 4294	Calibration Exciter
UA-0588	Tripod Adaptor for ½″ Microphone/ Preamplifier Assemblies
UA-0801	Small Tripod
UL-1009	SD Memory Card
UL-1017	SDHC Memory Card
ZG-0444	Charger for QB-0061 Battery Pack
QS-0007	Tube of Cyanoacrylate Adhesive
UA-0642	Mounting Magnet for accelerometer 10–32 UNF mounting
UA-1077	Mounting Magnet for accelerometer M3 mounting
YJ-0216	Beeswax for mounting accelerometer
KE-0440	Travel Bag
KE-0459	Shoulder Bag

CABLES

AO-0440-D-015	Signal Cable, LEMO to BNC, 1.5 m (5 ft)
AO-0701-D-030	Accelerometer Cable, LEMO to M3, 3 m (10 ft)
AO-0702-D-030	Accelerometer Cable, LEMO to 10–32 UNF, 3 m (10 ft)
AO-0722-D-050	Accelerometer Cable, LEMO to MIL-C-5015, 5 m (16 ft)
AO-0726-D-030	Cable for Laser Tachometer Probe, LEMO to SMB, 3 m (10 ft)
AO-0726-D-050	Cable for Laser Tachometer Probe, LEMO to SMB, 5 m (16 ft)
AO-0727-D-015	Signal Cable, LEMO to BNC Female, 1.5 m (5 ft)

Service Products

SLM-ADV-CAF	SLM Advanced, Accredited Calibration incl. microphone
SLM-ADV-CAI	SLM Advanced, Initial Accredited Calibration incl. microphone

VM-CAF	Vibration Meter, Accredited Calibration incl. accelerometer	VM-CAI	Vibration Meter, Initial Accredited Calibration incl. accelerometer

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

Parameter	Values	Comment
Input	*Top Socket* *Rear Socket*	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.
Transducer	*Direct* *Accelerometer* *Microphone*	Determines which transducer is currently connected to the analyzer and once selected, the hardware of the analyzer will be automatically set up to fit the transducer. If *Direct* is selected, it means voltage is being measured from the input socket – this can be either *Top Socket* or *Rear Socket*, whichever is selected. This parameter is part of the instrument setup and is common to all setups. It can also be set using > **Transducers**.
Sound Field Correction	*Free-field* *Diffuse-field*	Select a correction matching the sound field conditions of your measurements. If your sound source can be positioned facing the microphone (exactly), that is, its sound comes mainly from one direction, then use the Free-field correction, otherwise use the Diffuse-field correction*
Windscreen Auto Detect	*On* *Off*	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. **Please note:** • The preamplifier should be connected to the top socket, if necessary using a microphone extension cable. • Windscreen detection cannot be performed while measuring, so if the instrument detects a change in windscreen status (that is., 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 **OK**. If you want to save the measurement, tap **Cancel** and save the measurement as usual.*
Windscreen Correction	*None* *UA-1650* *UA-1404*	If **Windscreen Auto Detect** is set to *None*, you can manually select a windscreen correction suitable for the windscreen in use.*

Parameter	Values	Comment
Trigger Input		This parameter should be set to match the equipment connected to the Trigger Input Socket on the connector panel of the analyzer.
	Tacho/Trigger	Set it to *Tacho/Trigger* if it is not used, if External Triggering is used, or if a Tacho is connected to the Trigger Input. **Please note:** Set **CCLD/Pull Up** as required by the equipment.
	MATRON Handswitch	Set it to *MATRON Handswitch* if you want to start or stop the measurement using a MATRON Handswitch. Please contact your local Brüel & Kjær representative for further information.
	Voltage Level	Set it to *Voltage Level* if you want to start/stop a measurement by a voltage level generated by external equipment. The voltage level should generate at least 2 V for a start and less than 1 V for a stop. The duration of the steady level should be at least 1 s, so it can be recognized by the analyzer. **Please note:** Start/Stop of measurement using Trigger Input cannot be combined with using it for tacho or trigger signal.

* Available for microphone input only.

A.2 Frequency Setting Parameters

Parameter	Values	Comment
Span	*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.
Lines	*100* *200* *400* *800* *1600* *3200* *6400*	Determines the number of FFT lines to be measured and displayed on the screen.
Centre Freq.	Span from *50 Hz* to *19950 Hz*	Determines the frequency around which the selected frequency span is equally divided.
Record Length	–	Determines the inverse of frequency resolution. This field cannot be edited. It is calculated internally and then displayed.
Post Weighting	*Z* *A*	Determines the weighting to be applied to the FFT spectrum. In the case of sound measurements, use A-weighting to emphasize frequencies audible to the human ear.*
Frequency Correction	*On* *Off*	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 **Frequency Correction** parameter is set to *Off*. 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*.
Pre Weighting	*X* *C* *Z*	Determines the weighting to be applied to the input signal. In the case of sound measurements, use A-weighting to emphasize frequencies audible to the human ear. **Please note:** *X* = frequency weighting *A* or *B*. *A* requires that **Broadband Weight. (ex. Peak)** is set to *A,C* or *A,Z*. *B* requires that it is set to *B,C* or *B,Z*.*

Parameter	Values	Comment
Low Frequency	*Normal* *Extended*	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.
Broadband Weight. (ex. Peak)	*A,C* *A,Z* *B,C* *B,Z*	All broadband parameters (except L_{peak}) are measured simultaneously with two different frequency weightings – select the weightings here.*
Broadband Peak Weighting	*X* *C* *Z*	One broadband peak parameter L_{peak} is measured, select the frequency weighting here. **Please note:** *X* = frequency weighting *A* or *B*. *A* requires that **Broadband Weight. (ex. Peak)** is set to *A,C* or *A,Z*. *B* requires that it is set to *B,C* or *B,Z**

* Available for microphone input only.

A.3 Measurement Control Parameters

Parameter	Values	Comment
Measurement Mode	*Manual* *Triggered*	Determines whether the measurement is manual or triggered.
Averaging Type	*Linear* *Exponential*	Determines the way in which the spectra are averaged. **Please note:** **Averaging Type** is automatically set to *Linear* when measurement mode is set to *Triggered*, and cannot be changed.
#Average Spectra	*1* to *8388607* (Linear) *1* to *999* (Exponential)	Determines the number of spectra to be averaged. **Please note:** If triggered mode is selected, this parameter is set to the number of spectra resulting from the setting of **#Triggers** and **#Spectra per Trigger**.
Signal Type	*Continuous* *Transient*	Determines the type of signal to be measured. **Please note:** If manual mode is selected, **Signal Type** is automatically set to *Continuous*.
Window Type	*Hanning* *Rectangular*	Determines the type of Time Window to be applied on the measured signal. **Please note:** If manual mode is selected, **Window Type** is automatically set to *Hanning*.
#Triggers	*1* to *32767*	Determines the number of triggers for which the measurement will run. **Please note:** This parameter is disabled in manual mode.
#Spectra per Trigger	*1* to *32767*	Determines the number of spectra that will be averaged per trigger. **Please note:**This parameter is disabled in the manual measurement mode.
Automatic Save	*On* *Off*	Choose *On* to save the measurement automatically when the measurement pauses (either automatically or manually).

A.4 Trigger and Tacho Parameters

Parameter	Values	Comment
Trigger Type	*Internal* *External*	Determines whether the trigger input is internal or external. *Internal* is used to trigger on the incoming time signal. *External* is used to trigger on a signal applied through the trigger input.

Parameter	Values	Comment
Delay	Permissible delays for the respective spans: 20kHz: *−0.64 s* to *300 s* 10kHz: *−1.28 s* to *300 s* 5kHz: *−2.56 s* to *300 s* 2kHz: *−6.4 s* to *300 s* 1kHz: *−12.8 s* to *300 s* 500Hz: *−25.6 s* to *300 s* 200Hz: *−64 s* to *300 s* 100Hz: *−128 s* to *300 s*	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 **Trigger Type** is set to *Internal*.
Tacho	*On* *Off*	When **Tacho** is *On*, rpm measurements are done on the signal connected to Trigger input. The parameters for **External Level**, **Hysteresis**, **Slope** and **CCLD/Pull Up** are used for finding the tacho pulses – these are used to measure the rpm. When **Tacho** is *Off*, no rpm is measured.
RPM Gear Ratio	10^{-5} to 10^{38}	The displayed rpm are the measured rpm divided by the RPM Gear Ratio.
External Level	*−20 V* to *20 V*	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*. When setting the trigger level, please take a small offset at the trigger input into account. Typical values for the offset are between −70 mV and 200 mV.
Hysteresis	*0 V* to *10 V*	Determines the hysteresis on the external trigger. This parameter is enabled when **Trigger Type** is set to *External* or **Tacho** is set to *On*.
Slope	*Rising* *Falling*	Determines the trigger slope on the external trigger. This parameter is enabled when **Trigger Type** is set to *External* or **Tacho** is set to *On*.

Parameter	Values	Comment
CCLD/Pull Up	*On* *Off*	For instruments with serial number 2630266 and above, this parameter is named CCLD. Use this parameter to switch on or off a CCLD power supply, depending on the requirements of the equipment you connect to the Trigger Input. **Please note:** Laser Tachometer Probe Type 2981/ MM-0360 requires **CCLD** set to *On*. For instruments with serial number below 2630266 the parameter is named Pull Up. Use this parameter to 'pull up' the trigger input to +5 V (via a 7.5 kΩ resistor). The CCLD/Pull Up parameter is enabled when **Trigger Type** is set to *External* or **Tacho** is set to *On*.

A.5 Tolerance Window Parameters

Parameter	Values	Comment
Tolerances For	*FFT* *LAeq* *LAF* *Average RPM* *Instantaneous RPM*	Select *FFT* to display settings for one of the tolerance windows. Select *LAeq* to display tolerances for L_{Aeq}. Select *LAF* to display tolerances for L_{AF}. Select *Average RPM* to display tolerances for average rpm. Select *Instantaneous RPM* to display tolerances for instantaneous rpm.
Configure	*Window 1* to *Window 10*	Select which of the ten windows to display the tolerances for. **Please note:** Only selectable if **Tolerances For** is set to *FFT*.
Check	*Off* *On*	Determines whether the tolerance check is made for the selected window/parameter or not.
Values Checked	*FFT Lines* *Delta Sum*	Select *FFT Lines* to check whether all the FFT lines within Bottom and Top Frequencies of the window are within the Upper and Lower Limits of the window. Select *Delta Sum* to check whether the sum of the FFT lines within Bottom and Top Frequencies of the window are within the Upper and Lower Limits of the window. Delta Sum is based on the measured FFT lines; however, it takes Spectrum Display and Post-weighting into account. The summation principle is as described in Table 4.1. The Delta Sum parameter is displayed using the same units as the FFT spectrum. In Linear averaging the calculation and check of Delta Sum (and FFT Lines) are made on the available FFT spectrum. You can change the frequency range and limits for the tolerance windows before, during and after the measurement – the tolerance results are recalculated (except the Latched Result, which is updated during measurement only). In Exponential averaging the Delta Sum is calculated periodically (for example, every 100 ms) during the measurement and checked against the limits. In addition to the Tolerance Result parameters a number of other parameters are updated: • Delta Sum • Max Delta Sum • RPM at time for Max Delta Sum (requires **Tacho** set to *On*) • LAF at time for Max Delta Sum • FFT Spectrum at time for Max Delta Sum
Upper Limit	*Lower Limit* to full scale	Determines the upper limit for the selected window or parameter.
Level 2 max	*Level 1 max* to *Upper Limit*	Determines the upper limit for Level 2 (and lower limit for Level 3) **Please note:** To disable, set below *Lower Limit*

Parameter	Values	Comment
Level 1 max	*Lower Limit* to *Level 2 max*	Determines the upper limit for Level 1 (and upper limit for Level 2) **Please note:** To disable, set below *Lower Limit*
Lower Limit	Lowest Y-value to *Upper Limit*	Determines the lower limit for the selected window or parameter.
Top Frequency	*0.0 Hz* to *20000 Hz*	Determines the upper limit of the tolerance window.
Bottom Frequency	*0.0 Hz* to *20000 Hz*	Determines the lower limit of the tolerance window.
Caption	1 to 10 characters	A name (caption) for the selected tolerance window or parameter.

A.6 Parameters Related to Units

Parameter	Values	Comment
Scaling	*Pwr* *RMS* *ESD* *PSD* *Peak* *Peak-Peak*	Determines the scaling to be applied to the measured signal, and accordingly modifies the Y-axis range, the spectrum and the units of measurement.
Spectrum Display	*Acceleration* *Velocity* *Displacement* *Sound* *Voltage*	If a microphone is selected under **Transducer**, this parameter is set by default to *Sound* and cannot be changed. If an accelerometer is selected, this parameter determines whether the measured signal is displayed in terms of acceleration, velocity, or displacement. If *Direct* is selected under **Transducer**, this parameter is set by default to *Voltage* and cannot be changed.
Engineering Unit	*No* *Yes*	Determines whether the Y-axis will be displayed in decibel values (dB) or Engineering units.*
Unit	–	Determines the current unit of measurement. It is dependent on all the above parameters.

* Available for direct and accelerometer input only.

Please note: You can choose unit system at **Preferences** > **Regional** > **Vibration Unit**.

A.7 Signal Recording Parameters

<table>
<tr><th>Parameter</th><th>Values</th><th>Comment</th></tr>
<tr><td>Recording Control</td><td>Off

Automatic

Manual Event

Tol. Exceed.</td><td>Determines how recording of the measured signal is controlled.
Set to Automatic to start the recording when the measurement starts and record throughout the measurement, only limited by the Maximum Duration.
Set to Manual Event to enable manual recording. Start and stop recording by pressing the Manual Event pushbutton during a measurement. Maximum Duration and Minimum Duration are still in effect.
Set to Tol. Exceed. to start recording whenever the signal exceeds one of the set upper limits or gets below one of the set lower limits, and stop when the signal is within all tolerance limits.</td></tr>
<tr><td>Recording Quality</td><td>Low (3.3 kHz)
Fair (6.6 kHz)
Medium (10 kHz)
High (20 kHz)</td><td>This setup determines the quality of the recording by adjusting the sampling rate.
The amount of space required for the recording will depend on the selected quality:
<table>
<tr><th><u>Quality</u></th><th><u>Sampling freq.</u></th><th><u>Upper freq.</u></th><th><u>Memory 16-bit</u></th><th><u>Memory 24-bit</u></th></tr>
<tr><td>Low</td><td>8 kHz</td><td>3 kHz</td><td>16 KB/s</td><td>24 KB/s</td></tr>
<tr><td>Fair</td><td>16 kHz</td><td>6 kHz</td><td>32 KB/s</td><td>48 KB/s</td></tr>
<tr><td>Medium</td><td>24 kHz</td><td>10 kHz</td><td>48 KB/s</td><td>72 KB/s</td></tr>
<tr><td>High</td><td>48 kHz</td><td>20 kHz</td><td>96 KB/s</td><td>144 KB/s</td></tr>
</table>
Please note: Recording Quality needs to be High (20 kHz) if you want trigger or tacho trigger encoded in the wav-file for later analysis in BK Connect</td></tr>
<tr><td>Automatic Gain Control</td><td>

On

Off</td><td>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.
Set Automatic Gain Control to On to convert the recorded signal. The recorded signal is stored as a 16-bit wav-file.
Set Automatic Gain Control to Off for recording the signal with a fixed gain – then set Resolution = 24 bit (recommended) to cover the full 120 dB dynamic range (from max. input level and down) or select Resolution = 16 bit and specify the Peak Recording Level to fit the signal.
Please note: If the sound contains very high levels at low frequency, then a fixed gain is recommended.</td></tr>
</table>

Parameter	Values	Comment
Resolution	*24 bit* *16 bit*	Set **Resolution** to *24 bit* to cover the full dynamic range. Set **Resolution** to *16 bit* to cover up to 96 dB from **Peak Recording Level** and down. **Please note:** You will only be warned about overload in the recorded signal if **Automatic Gain Control** is *On*, or **Resolution** is *24 bit*, or **Peak Recording Level** is set to its maximum value.
Peak Recording Level	Depends on the current transducer type selected	For **Automatic Gain Control** = *Off* and **Resolution** = *16 bit* the recorded wave file has a dynamic range of up to 96 dB. When playing back on the analyzer, the dynamic range of the output is approx. 75 dB. When playing back on a PC it might be even lower. Set **Peak Recording Level** to fit the signal. The values for **Peak Recording Level** take the sensitivity of the attached transducer into account. **Please note:** This parameter is enabled only if **Automatic Gain Control** is set to *Off*.
Pre-recording Time	*0* to *470 s*	Recording is started the **Pre-recording Time** before the trigger conditions are fulfilled (for example, 5 s means the recording will be started 5 s before you hit 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 **Pre-recording Time** is limited by this buffer size, and the **Recording Quality** and **Resolution**: Quality Pre-recording Pre-recording Time limit 16-bitTime Limit 24-bit HW 1 – 3 HW 4HW 1 – 3HW 4 *Low* 110 s 470 s70 s 310 s *Fair* 50 s 230 s30 s 150 s *Medium* 30 s 150 s 16 s 96 s *High* 10 s 70 s 3 s 43 s
Post-recording Time	*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.
Duration Limit	*On* *Off*	Use this parameter to enable the **Minimum Duration** and **Maximum Duration** parameters for overruling the duration of the signal recording determined by the trigger condition parameters. **Please note:** This parameter is enabled only if **Recording Control** is set to *Manual Event* or *Limit Level*.
Minimum Duration	*00:00:00* to *01:00:00*	When **Duration Limit** is *On*, **Minimum Duration** will determine the minimum recording time regardless of the trigger conditions. The total record length will then (as a minimum) be the sum of **Minimum Duration**, **Pre-recording Time** and **Post-recording Time**.

Parameter	Values	Comment
Maximum Duration	*00:00:00* to *01:00:00*	When **Duration Limit** is *On*, then **Maximum Duration** will determine the maximum recording time regardless of the trigger conditions. The total record length will then (as a maximum) be the sum of **Maximum Duration**, **Pre-recording Time** and **Post-recording Time**. **Please note:** If **Maximum Duration** = *00:00:00*, then it is disabled and does not limit the duration.

A.8 Output Socket Signal Parameters

Parameter	Values	Comment
Source	*Off* *Input* *Overall Tolerance Result* *Latched Tolerance Result*	Determines the source of the input signal for the output socket of the analyzer. Select between *Off* and *Input* signal for monitoring purposes. Choose between *Overall Tolerance Result* and *Latched Tolerance Result* to get 3.3 V DC out if an upper limit is exceeded, –3.3 V DC out if signal is below one of the lower limits, 3 V DC out for result = Level 3, .2 V DC out for result = Level 2, 1 V DC out for result = Level 1, or alternating between 3.3 V and –3.3 V if signal is both above and below. **Please note:** If you do not want to output the signal, then set this parameter to *Off* to save power
Gain	*–60 dB* to *60 dB*	Enter a gain value (0.1 dB resolution) for the input signal. Tap ✓ to accept the setting. Tap ✕ to close the keyboard without applying the setting Tap *@* 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. **Please note:** • 0 dB means 1 V output for 1 V input. • This parameter is enabled only if the **Source** parameter is set to *Input*.

A.9 Tone Assessment Parameters

Parameter	Values	Comment
Tone Assessment	*On* *Off*	Turn this parameter *On* to enable Tone Assessment **Please note:** Tone Assessment is enabled if a valid BZ-7231 license is available
Tone Standard	*ISO 1996:2-2007* *Denmark 1984/1991*	Determines the standard on which tone assessment is based
Tone Seek Criterion	*0.1 dB* to *4.0 dB*	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.10 Tone at Cursor Parameters

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

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 Hand-held Analyzer Types 2250 and 2270 user manual (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 Settings** > **Broadband Peak Weighting** parameter)

  X = frequency weightings A or B (controlled by **Setup** > **Frequency Settings** > **Broadband Weight. (ex. Peak)** parameter)

  Y = frequency weightings C or Z (controlled by **Setup** > **Frequency Settings** > **Broadband Weight. (ex. Peak)** 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}*
- Linear†

Peak Sound Level

- L_{Vpeak}*
- Peak†

Maximum Time-weighted Sound Levels

- L_{XFmax}*
- L_{YFmax}*
- $Fast_{max}$†

Minimum Time-weighted Sound Levels

- L_{XFmin}*
- L_{YFmin}*
- $Fast_{min}$†

General Parameters

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

Special Parameters‡

- L_{XIeq}
- L_{YIeq}
- L_{AFTeq} (also called L_{AFTm5})
- Crest Factor

Weather Data (Requires connection to a weather station)*

- Wind Dir. avg.
- Wind Dir. min.

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* Microphone input only.
† Accelerometer and Direct input only.
‡ Microphone input only.

- Wind Dir. max.
- Wind Speed avg.
- Wind Speed min.
- Wind Speed max.
- Amb. Temperature
- Amb. Humidity
- Amb. Pressure
- Amb. Rain Gauge

Tolerance Results

- Tolerance Window 1
- Tolerance Window 2
- Tolerance Window 3
- Tolerance Window 4
- Tolerance Window 5
- Tolerance Window 6
- Tolerance Window 7
- Tolerance Window 8
- Tolerance Window 9
- Tolerance Window 10
- Tolerance L_{AF}*
- Tolerance L_{Aeq}*
- Tolerance Lin*
- Tolerance Fast†
- Tolerance Instantaneous RPM
- Tolerance Average RPM
- Overall Tolerance Result
- Latched Tolerance Result

B.1.2 Parameters for Tolerance Windows with Check on Delta Sum

Delta Sum Parameters

- Delta Sum for Tolerance Window 1
- Delta Sum for Tolerance Window 2
- Delta Sum for Tolerance Window 3
- Delta Sum for Tolerance Window 4

---

* Accelerometer and Direct input only.

- Delta Sum for Tolerance Window 5
- Delta Sum for Tolerance Window 6
- Delta Sum for Tolerance Window 7
- Delta Sum for Tolerance Window 8
- Delta Sum for Tolerance Window 9
- Delta Sum for Tolerance Window 10

Max Delta Sum Parameters (Exponential Averaging Only)

- Max Delta Sum for Tolerance Window 1
- Max Delta Sum for Tolerance Window 2
- Max Delta Sum for Tolerance Window 3
- Max Delta Sum for Tolerance Window 4
- Max Delta Sum for Tolerance Window 5
- Max Delta Sum for Tolerance Window 6
- Max Delta Sum for Tolerance Window 7
- Max Delta Sum for Tolerance Window 8
- Max Delta Sum for Tolerance Window 9
- Max Delta Sum for Tolerance Window 10

Tolerance RPM Parameters (Exponential Averaging Only)

- RPM at time for Max Delta Sum for Tolerance Window 1
- RPM at time for Max Delta Sum for Tolerance Window 2
- RPM at time for Max Delta Sum for Tolerance Window 3
- RPM at time for Max Delta Sum for Tolerance Window 4
- RPM at time for Max Delta Sum for Tolerance Window 5
- RPM at time for Max Delta Sum for Tolerance Window 6
- RPM at time for Max Delta Sum for Tolerance Window 7
- RPM at time for Max Delta Sum for Tolerance Window 8
- RPM at time for Max Delta Sum for Tolerance Window 9
- RPM at time for Max Delta Sum for Tolerance Window 10

Tolerance LAF Parameters (Exponential Averaging Only)*

- LXF at time for Max Delta Sum for Tolerance Window 1
- LXF at time for Max Delta Sum for Tolerance Window 2
- LXF at time for Max Delta Sum for Tolerance Window 3
- LXF at time for Max Delta Sum for Tolerance Window 4

* Microphone input only.

- LXF at time for Max Delta Sum for Tolerance Window 5
- LXF at time for Max Delta Sum for Tolerance Window 6
- LXF at time for Max Delta Sum for Tolerance Window 7
- LXF at time for Max Delta Sum for Tolerance Window 8
- LXF at time for Max Delta Sum for Tolerance Window 9
- LXF at time for Max Delta Sum for Tolerance Window 10

Tolerance Inst Parameters (Exponential Averaging Only)*

- Inst at time for Max Delta Sum for Tolerance Window 1
- Inst at time for Max Delta Sum for Tolerance Window 2
- Inst at time for Max Delta Sum for Tolerance Window 3
- Inst at time for Max Delta Sum for Tolerance Window 4
- Inst at time for Max Delta Sum for Tolerance Window 5
- Inst at time for Max Delta Sum for Tolerance Window 6
- Inst at time for Max Delta Sum for Tolerance Window 7
- Inst at time for Max Delta Sum for Tolerance Window 8
- Inst at time for Max Delta Sum for Tolerance Window 9
- Inst at time for Max Delta Sum for Tolerance Window 10

Spectra at Time for Max Delta Sum (Exponential Averaging Only)

- FFT Spectrum at time for Max Delta Sum for Tolerance Window 1
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 2
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 3
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 4
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 5
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 6
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 7
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 8
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 9
- FFT Spectrum at time for Max Delta Sum for Tolerance Window 10

B.1.3 For Tone Assessment Option BZ-7231†

Parameters for **Tone Standard** = *ISO 1996-2:2007*

- K_t
- ΔL_{ta}

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* Accelerometer and Direct input only.
† Microphone input only.

- L_{pn}
- L_{pti}
- L_{pt}
- Critical Band
- $f_{c(Crit.band)}$

B.1.4 For Tone Assessment Option BZ-7231*

Parameters for **Tone Standard** = *Denmark 1984/1991*

- K
- ΔL_{ta}
- $L_{p,crit.band}$
- $L_{p,tone(i)}$
- $L_{p,tone}$
- ΔL_{ts}
- $\Delta L_{ts,crit.}$
- Critical Band
- $f_{c,crit.}$

B.1.5 Instantaneous Measured Parameters (Not Stored with Measurement)

Instantaneous Time-weighted Sound Levels

- L_{XF}*
- L_{YF}*
- $\text{Fast}_{\text{Inst}}$†

Instantaneous Weather Data*

- Wind Dir.
- Wind Speed

Instantaneous GPS Data

- Latitude
- Longitude

* Accelerometer and Direct input only.

Appendix C

Glossary

This Appendix is a continuation of the Glossary in Appendix E of Hand-held Analyzer Types 2250 and 2270 user manual (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 Broadband Parameters

F, S or I Time Weighting:

A time weighting (sometimes called a time constant) defines how the exponential averaging in root mean square (RMS) measurement is done. It defines how heavily fluctuating sound pressure variations are smoothed or averaged to allow useful readings.
The standards define three time weightings: F (Fast), S (Slow) and I (Impulse). Most measurements are carried out using the F time weighting, which uses a 125 ms time constant.

With Microphone selected as Input

LAeq

A widely used noise parameter that calculates a constant level of noise with the same energy content as the varying acoustic noise signal being measured. The letter 'A' denotes that the A-weighting has been included and 'eq' indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous noise level.

LAFmax

Maximum time-weighted sound level measured with A-frequency weighting and Fast time weighting. It is the highest level of environmental noise occurring during the measurement time. It is often used in conjunction with another noise parameter (for example L_{Aeq}) to ensure a single noise event does not exceed a limit.

LAFmin

Minimum time-weighted sound level measured with A-frequency weighting and Fast time weighting. It is the lowest level of environmental noise occurring during the measurement time (time resolution is 1 s).

LAFTeq

Taktmaximal Mittelungspegel as defined by DIN 45641. L_{AFTeq} has also been called L_{AFTm5} or L_{ATm5F}.

LCpeak

Maximum peak sound level during a measurement. 'C' denotes that the C frequency weighting is used. Used for assessing possible damage to human hearing caused by very high, short-duration noise levels.

LAF The instantaneous time-weighted sound level, L_p, is available at any time. ‘A’ denotes that the A-frequency weighting is used. ‘F’ denotes that the Fast time-weighting is used.

With Accelerometer or Direct selected as Input

aLinear/Linear Time-averaged (rms) weighted acceleration (or voltage) value, averaged over the entire measurement period with frequency weighting Linear.

aFast max/Fast max Maximum time-weighted acceleration or voltage level measured with Linear frequency weighting and Fast time weighting. It is the highest level occurring during the measurement time.

aFast min/Fast min Minimum time-weighted acceleration or voltage level measured with Linear frequency weighting and Fast time weighting. It is the lowest level occurring during the measurement time.

aPeak/Peak Maximum peak of the acceleration signal or voltage input with frequency weighting Linear.

Crest Factor Crest Factor given by aPeak/aLinear (based on absolute acceleration values) over the entire measurement period.

aFast Inst/Fast Inst The instantaneous acceleration or voltage level measured with Linear frequency weighting and Fast time weighting. The parameter is available at any time.

C.3 Tone Assessment Parameters

Tone Level (L_{pt}): Level of all tones in the critical band containing the selected tone ($L_{p,tone}$ for **Tone Standard** = *Denmark 1984/1991*).

Level (L_{pti}): Level of the selected tone ($L_{p,tone(i)}$ for **Tone Standard** = *Denmark 1984/1991*).

Masking Noise Level (L_{pn}):	Masking noise is the sound that does not belong to the tone and that limits (masks) the audibility of the tone. It is the total level of the masking noise in the band containing the selected tone ($L_{p,crit.band}$ for **Tone Standard** = *Denmark 1984/1991*).
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.
$f_{c(Crit.band)}$	Centre frequency 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 (K for **Tone Standard** = *Denmark 1984/1991*).
Kriteriestørrelsen (ΔL_{ts})	The difference between the tone level and masking noise level within the critical band $L_{p,tone} - L_{p,crit.band}$
Kriterieværdien ($\Delta L_{ts,crit.}$)	A frequency dependant threshold for tone audibility

Index

BE 1778 – 19