Dual Channel Signal Analyzers

types 2032 and 2034

USES:

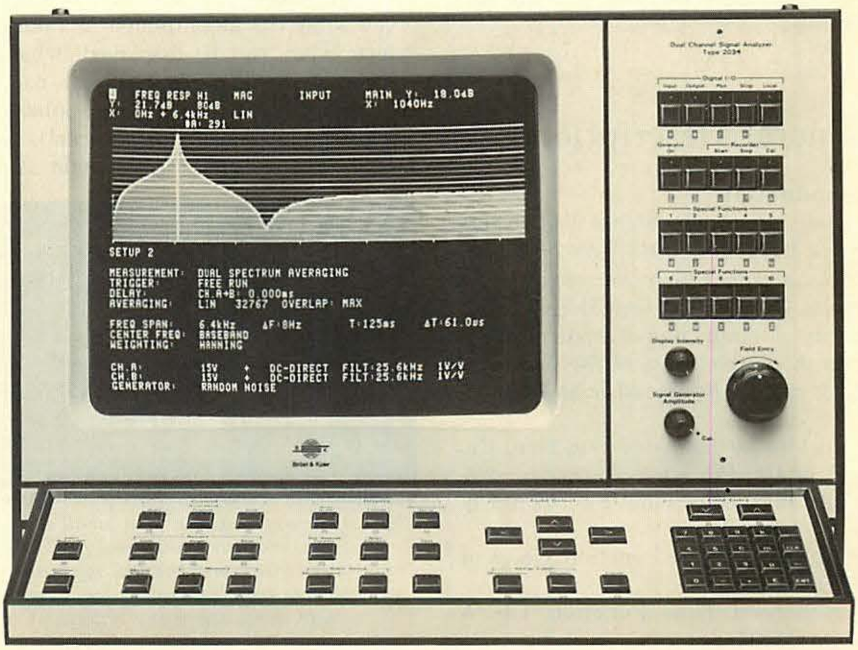
- Analysis of mechanical system responses
- Measurement of sound intensity
- Propagation path identification
- Input/output analysis of electronic and electrical systems and control system analysis

FEATURES:

- Dual-channel signal processing with built-in digital zoom to 25,6kHz
- 801 lines resolution in dual channel operation
- Self-explanatory operation
- Fully instrumented front-end and user-defined calibration
- Hilbert transform for calculation of time envelope functions
- 800 Hz real-time frequency (1,6kHz single channel) and fast fully annotated hard copy via 2313 (2034 only)
- 5,0kHz real-time frequency (10kHz single channel) and fast fully annotated hard copy via 2313 (2032 only)
- Autorange function, also for repeated transients
- Non-volatile memories store 10 user-defined measurement setups and 10 user-defined display setups
- Linear, exponential, or peak averaging of up to 32767 spectra
- Measures Frequency Response, Coherence, Auto and Cross Spectra, Auto and Cross Correlation, Coherent and Non-coherent Output, Impulse Response, Signal to Noise, Sound Intensity, Cepstra, Orbits, and Probability Density and Distribution
- Signal enhancement for time-domain averaging
- Displays real part, imaginary part, magnitude, phase, Nyquist plot, and Nichols plot, on a 12″ display screen, together with the measurement and display setup
- 6 different cursor functions for read-out of results
- Autoscale function optimises display scale
- Extensive post-processing of results
- Flexible and sophisticated trigger
- Built-in zooming signal generator
- Flexible, user-friendly digital interface (IEC 625-1/IEEE 488)
- Modal analysis option
- Graphics Plotter Interface

Introduction

The Dual Channel Signal Analyzers Types 2032 and 2034 are flexible, easy-to-use, and fully self-contained two-channel FFT analysis systems with 801 lines of resolution. The 2032 and 2034 are the same in all aspects of facilities, performance and specifications, with one exception — computation speed. Where the standard Type 2034 has a real-time speed of 800 Hz (1600 Hz in single channel), the high speed Type 2032 has a real-time speed of > 5 kHz (> 10 kHz in single channel). They are flexible because calibration, display scales, post-processing, etc., are user-definable, and that functions such as signal-to-noise ratio, sound intensity, and cepstrum are computed directly without the need for intermediate processing. They are



easy to use because operation is largely self-explanatory with all relevant control settings clearly shown on the display screen, and because complete measurement and display setups can be stored for later recall and use. They are self-contained in that they have a fully instrumented front-end, built-in digital zoom, a built-in zooming signal generator, and a flexible and user-friendly IEC/IEEE interface.

The 2032 and 2034 are used to measure input-output and statistical relationships associated with mechanical, acoustical, and electrical systems. Their 801-line resolution is of special importance with respect to measurements on mechanical systems, since more modes of vibration can be identified and characterised in a single analysis than with a conventional 250 or 400 line analyzer. In addition, they can measure a system's frequency response in two ways: H_1 (= G_{AB}/G_{AA}) and H_2 (= G_{BB}/G_{BA}). H_1 is best when the output noise is high, but H_2 is superior when the input noise is high. Also, measurement of H_2 tends to reduce the bias error at resonance peaks. In acoustical systems, the use of Hilbert Transforms to compute time envelope functions means that the Analyzer can measure the envelope of the system impulse response, also known as the "energy-time curve" from Time Delay Spectrometry. Of further importance is the direct measurement of sound intensity, in combination with the Brüel& Kjær Sound Intensity Probe Type 3519. Finally, the measurement of frequency responses and signal-to-noise ratios allow the 2032 and 2034 to characterise electrical networks in electronic and power engineering.

General Description

Introduction

Dual Channel Signal Analyzers Types 2032 and 2034 are 2-channel FFT analyzers which can measure and display 34 different time domain, frequency domain, and statistical functions. A complete list of the functions which can be measured is as follows:

- Instantaneous Time Function, Ch. A or Ch. B
- Instantaneous Time Function, Ch. A vs. Ch. B
- Enhanced Time Function, Ch. A or Ch. B
- Enhanced Time Function, Ch. A vs. Ch. B
- Probability Density, Ch. A or Ch. B
- Probability Distribution, Ch. A or Ch. B
- Instantaneous Spectrum, Ch. A or Ch. B
- Enhanced Spectrum, Ch. A or Ch. B
- Autospectrum, Ch. A or Ch. B
- Cross Spectrum
- Frequency Response, H_1, H_2
- 1/Frequency Response, H_1, H_2
- Coherence
- Signal-to-noise Ratio
- Coherent Output Power
- Non-coherent Output Power
- Autocorrelation, Ch. A or Ch. B
- Cross Correlation
- Impulse Response
- Sound Intensity
- Cepstrum, Ch. A or Ch. B
- Liftered Spectrum, Ch. A or Ch. B

These functions are measured via six different modes of operation, namely, Single and Dual Channel Spectrum Averaging, Single and Dual Channel Spectrum Averaging Zero Pad (used to avoid the effects of circular folding when measuring correlation functions or impulse responses), Dual Channel Signal Enhancement, and Dual Channel Amplitude Probability mode. The resolution of the Analyzers in the frequency domain is 801 lines, with a frequency span of from 1,56 Hz to 25,6 kHz, selectable in a binary sequence. The selected frequency span can then be placed anywhere in the 0 to 25,6 kHz baseband frequency range of the Analyzers.

All functions related to the selected mode of operation on the 2032 or 2034 are continuously available for display, even while the measurement is taking place. They can be displayed (where relevant) in terms of the real part, imaginary part, magnitude, phase, Nyquist plot (imaginary vs. real), or Nichols plot (log. magnitude vs. phase). The use of Hilbert Transforms allows the complex time function to be displayed and the envelope of the time function (the magnitude) to be calculated. This is of considerable importance when interpreting correlation functions and impulse responses, since peaks become much more readily identifiable in the envelope function than in the conventionally displayed real part (Fig. 1) especially when the log. magnitude is displayed.

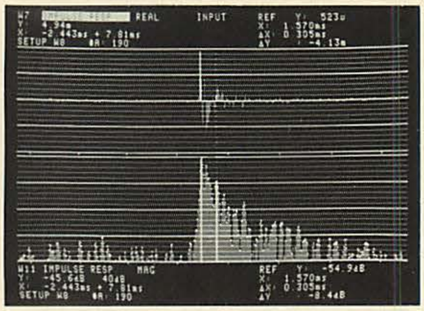


Fig. 1. Impulse response of a small loudspeaker shown as the real part (upper trace), and the log. magnitude (lower trace). Only the log. magnitude shows the many reflections of energy taking place

Control of the 2032 and 2034

The 2032 and 2034 have been designed for ease of operation. All control settings relevant to the measurement in progress (the "measurement setup") can be simultaneously displayed with the current results. The controls are then accessable via a Field Selector. The Field Selector is moved to the required control field (Fig. 2) and a new setting may be selected either by indexing through the allowed settings or by entering it directly as a numerical value (the Analyzer automatically rounds up or down entered values to the nearest allowed setting for numeric fields).

At all times, only those fields relevant to the measurement setup are shown. Some of the control fields are hidden to reduce screen clutter. These fields only become visible when they are relevant to the measurement in progress. Also, should an illegal setting be selected in any field, that field blinks as an automatic warning.

The "display setup" which controls the display of measured results on the 2032 or 2034 display screen is chosen in the same manner as the measurement setup. It controls precisely what is displayed (for example, frequency response, coherence, time, etc.), and how it is displayed (real part, imaginary part, magnitude, etc.). It is independent of the measurement setup.

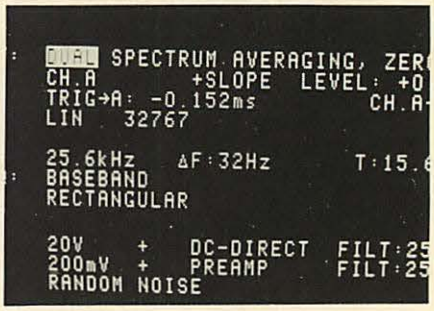
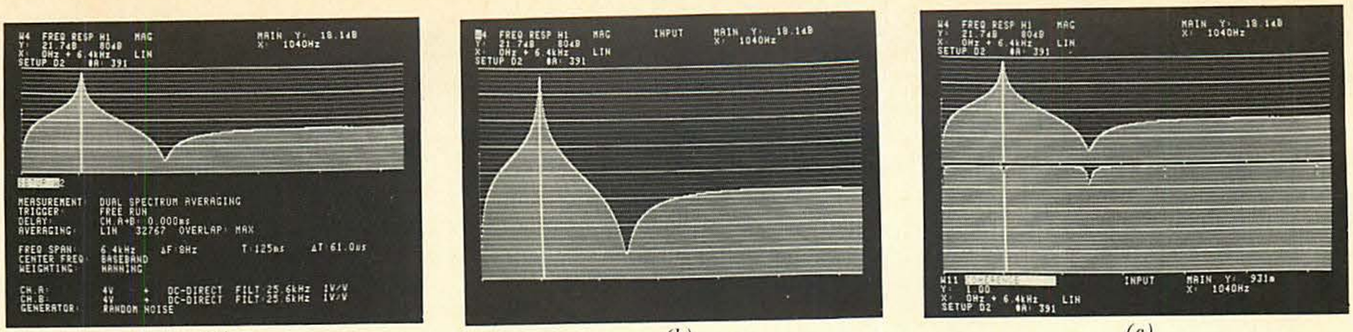


Fig. 2. The Field Selector of the 2032 or 2034. The selected field is highlighted on the display screen



(a) (b) (c)

Fig. 3. (a) Single trace with measurement setup; (b) single trace full screen display; (c) dual trace display in "upper-lower" format

Functions can be displayed as a half screen display with the measurement and display setup, as a full screen display with the display setup, or simultaneous display of two independently selectable functions with their display setups (Fig. 3).

The most frequently used controls on the 2032 and 2034 are incorporated as "hard" controls (Fig. 4). These include the controls used to start a measurement, to store or recall setups and data, for cursor control and field entry, and an autorange and an autoscale control. The autorange control will autorange the inputs and then lock the input attenuators at the optimum level. It can operate on both continuous and transient signals. The autoscale control is used to optimise the scaling of displayed data. (Both controls can also be set manually.) This combination of hard and soft controls makes the Analyzers extremely user-friendly and minimises learning time.

Storage of Measurement and Display Setups

The 2032 and 2034 are equipped with non-volatile memories to store measurement and display setups in order to minimise setup times for frequently repeated measurements. Up to 10 user-defined measurement setups and 10 user-defined display setups can be stored for instant recall. In addition, 10 factory-defined measurement setups and 10 factory-defined display setups are held in read-only memories. All stored measurement and display setups are retained when power to the Analyzer is switched off.

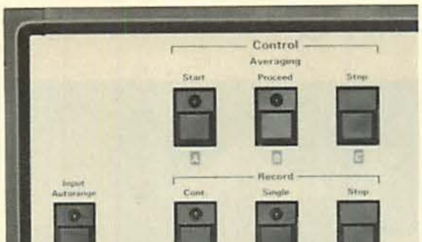


Fig. 4. Some of the hard controls of the 2032 or 2034

Each stored measurement and display setup is identified by a number and is recalled by entering this number into the Analyzer. The measurement and display setups in use are identified on the Analyzer display screen, and working and documentation setups ensure that a measurement is always completely documented. As an aid to selection, the measurement and display setups can be listed on the Analyzer display screen (Fig. 5).

Input to the 2032 and 2034

The 2032 and 2034 have fully instrumented inputs. This means that they can accept signals from most Brüel & Kjær microphone preamplifiers and, via the Line Drive Amplifier Type 2644, most Brüel & Kjær accelerometers in either of their channels without the need for additional amplifiers or preamplifiers. In addition, each channel is equipped with a direct input for the input of electrical signals. The minimum detectable signal level in each channel is 1 μV, and the full-scale level can be selected from 15 mV to 100 V peak in a 1,5–2–4–6–8–10 sequence either manually or by using the autorange control. The preamplifier input of each channel provides a microphone polarization voltage of 0 V, 28 V, or 200 V. The direct input may be DC or AC coupled, with a lower limiting frequency of 3 Hz in AC. The line drive input is AC coupled, with a selectable lower limiting frequency of 3 Hz or 0,2 Hz.

The upper limiting frequency of each channel is selectable between 25,6 kHz (the cut-off frequency of the antialiasing filter), and 6,4 kHz (used to filter out accelerometer resonances). Alternatively, both filters can be used simultaneously or simultaneously switched out. Either input can be inverted or grounded.

Calibration of the 2032 and 2034

Each channel of the 2032 and 2034 can be independently calibrated in user-defined engineering units, with the calibration constant variable from 1×10^{-9} V/unit to 999 kV/unit or in dB with a user-defined reference. Alternatively, it can be directly calibrated in volts. When the Analyzer is calibrated in engineering units, the calibration constant can be entered and displayed as V/unit, V/V, V/Pa, V/ms^{-2}, V/ms^{-1}, V/m, V/N, V/g, V/ins^{-1}, V/mil, or units/V.

Trigger Functions on the 2032 and 2034

The 2032 and 2034 are equipped with an extremely flexible trigger. A free running, internal, or external trigger source can be selected in addition to a generator trigger, where data collection in the Analyzer is synchronised to the sequence of the Analyzer's pseudo-random or impulse generator. With internal triggering, the trigger source may be the input signal in Channel A or Channel B either before or after the signal passes through the digital low-pass filter (i.e. the trigger may be bandlimited to the selected frequency span). The trigger slope can be positive or negative, and the trigger level set from −99% to +99% of the

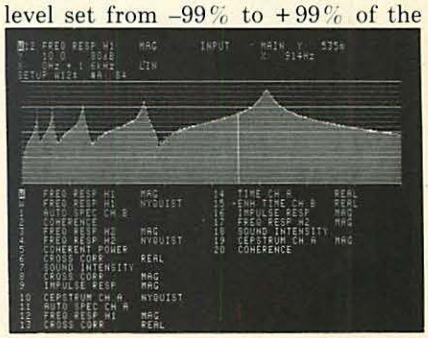


Fig. 5. Listing of the user-defined and factory-defined display setups

peak input voltage. With external triggering, the trigger slope can be positive or negative. There is also provision for a manual trigger.

A trigger delay is selectable in internal, external, and manual triggering. This sets a delay between the trigger and the start of channel A or B, and is adjustable in seconds from $-N \times \Delta t$ (N = number of samples in a record and Δt = sampling interval) to 9999 seconds, with a resolution of Δt. It allows data collection to be offset in time with respect to the trigger. Also, in all trigger modes, the start of Channel B can be offset in time with respect to the start of Channel A by 0 to 9999 seconds (resolution Δt), allowing measurements on systems with delay.

Weighting Functions Available

Each channel of the 2032 and 2034 can be independently set to have a flat, Hanning, transient, or exponential weighting function. Kaiser-Bessel weighting may also be selected, as well as a user-definable weighting function. The Hanning window is used primarily with continuous signals, while the flat, transient, and exponential windows are used with transient signals (the flat or transient window for the transient itself and the exponential window for the system's response). With the transient and exponential windows, the start of the window with respect to the beginning of the record and the window width are user-definable. The resulting windows are displayed on the Analyzer display screen and are superimposed on the recorded data (Fig. 6).

Data Averaging

The 2032 and 2034 can average up to 32767 spectra in exponential, linear, or for single channel operation only, peak (hold max.) averaging mode. Stable averaging algorithms are employed, so that the results displayed are always correctly scaled for read-out; the number of averages can be set to any integer value from 1 through 32767. The amount of overlap between averaged spectra can be selected from 0%, 50%, 75%, or maximum. When the Analyzer cannot achieve the selected overlap (for example, due to its real-time frequency), an automatic warning is given.

The 2032 and 2034 automatically reject data influenced by an input overload from an average. Additionally, a manual accept mode allows data to be visually inspected prior to its entry into an average.

Signal Enhancement Mode

In addition to the averaging functions mentioned previously, the 2032 and 2034 have a signal enhancement mode. This allows successive time-domain records to be averaged on the receipt of a trigger. The result is that signals synchronous with the trigger are enhanced in the averaged record, while asynchronous signals, for example background noise, are averaged out (Fig. 7). Up to 32767 records can be linearly or exponentially averaged with an internal or an external trigger source.

Data Storage on the 2032 and 2034

The 2032 and 2034 are equipped with a memory where one complete set of results, time functions, and the measurement setup can be stored. The stored functions will depend on the mode of operation of the Analyzer, but all functions which can be calculated from the input data can also be calculated from the stored data.

The stored data can be used to "equalize" a frequency response or impulse response. Here the amplitude and phase difference between the two measurement chains entering the Analyzer are analyzed and stored. This information is then used by the Analyzer to correct the transfer function etc., for differences in the measuring chains, with the equalized result being displayed.

Data Display

Data is displayed on the Analyzer's built-in 12″ raster-scan display screen. The display format is selectable between single and dual trace, with single trace formats being further selectable between full screen and half screen with the measurement setup (see Fig. 3). Each trace is fully annotated with the display setup label, the display setup parameters, the number of averages performed, the measurement setup number used, and the cursor values. Further annotation can be added via two text strings, whereby up to 100 characters each of alphanumeric text can be entered onto the display screen (Fig. 8). In a dual trace display, the display setup can be independently chosen for each trace.

When frequency-domain data is displayed, the x-axis may be linear with 401 or 801 lines resolution or logarithmic over 2 decades. For time domain data, the x-axis is linear with a resolution of 512, 1024, or 2048 samples. In the amplitude probability mode, the x-axis is linearly scaled from minus to plus the maximum peak input voltage with 32, 64, 128, 256, or 512 amplitude intervals.

The y-axis can be linearly or logarithmically scaled. With linear scaling, full scale can be set from 1×10^{-24} to 1×10^{24} V, V^2, V^2/Hz, V^2s/Hz, U, U^2, U^2/Hz, U^2s/Hz (where U denotes user-defined engineering units). With logarithmic scaling, full scale can be from –500 to + 500 dB in 0,1 dB steps with a range of 10, 20, 40, 80, or 160 dB. In amplitude probability mode, linear scaling in % is used.

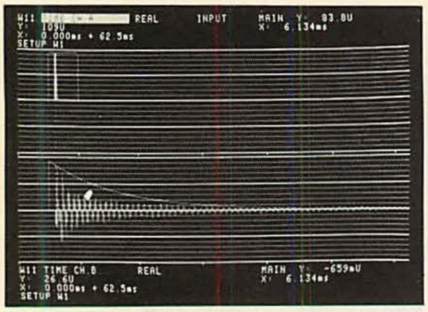


Fig. 6. Examples of transient (upper trace) and exponential (lower trace) windows superimposed on recorded data

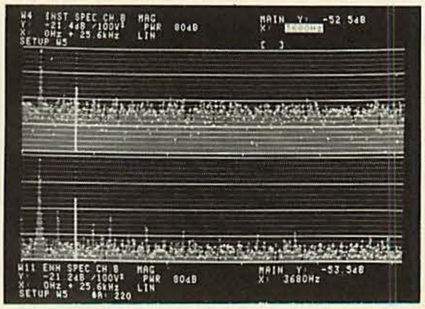


Fig. 7. Instantaneous (upper trace) and enhanced (lower trace) spectrum. The background noise is very much reduced in the enhanced spectrum

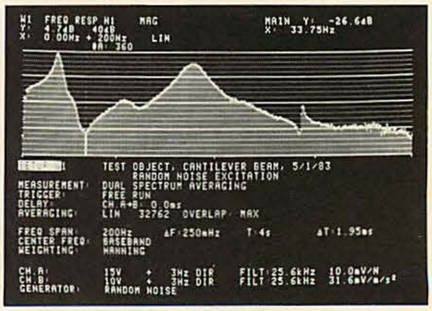
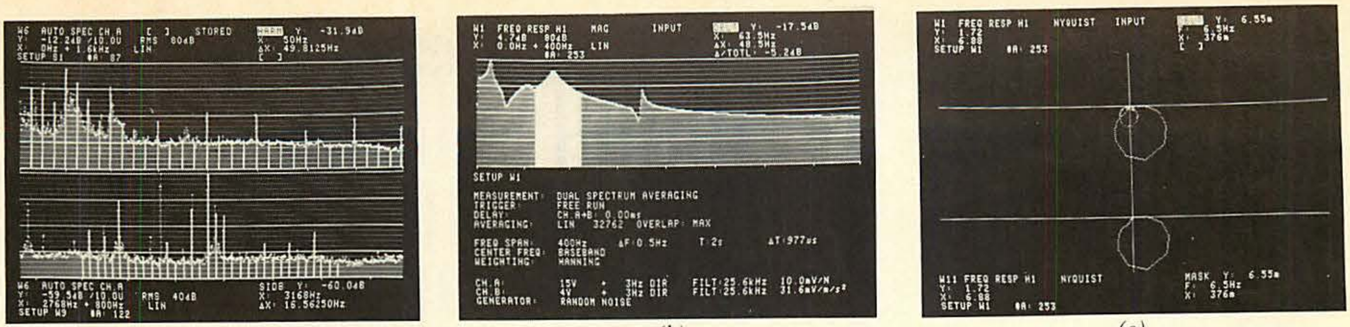


Fig. 8. Example of use of the text line for increased annotation



(a) (b) (c)

Fig. 9. (a) The harmonic (upper trace), and sideband (lower trace) cursors being used to highlight harmonics and sidebands; (b) the delta cursor being used to make measurements across a band of frequencies; (c) use of the mask cursor (lower trace) to remove unnecessary detail from a Nyquist plot

The Cursor Functions

The 2032 and 2034 have six cursor functions: the Main Cursor, used for reading values from the Analyzer display; the Harmonic Cursor, used for identifying harmonics; the Sideband Cursor, used for identifying sidebands; the Delta Cursor, used for measuring across a band of lines or samples; the Mask Cursor, used with Nyquist or Nichols plots to mask unwanted information; and the Reference Cursor, used to reference all readings to one line or sample (see Fig. 9).

The cursor is identified as an intensified column which is movable either continuously or in single steps. In a dual trace display, the cursors on the upper and lower traces can be controlled individually or aligned and moved synchronously.

The cursor is used on the x-axis to read time in sample number or seconds (including compensation for the delay A → B for two channel functions); frequency in Hz, cpm, or orders (cpm and orders are read via the flexible cursor, described later); amplitude level in volts for probability mode; volts or gain for a Nyquist plot; and degrees for a Nichols plot. It is also used to read Δx in terms of Δt or Δf values between harmonics, sidebands, the delta cursor, or reference cursor.

The cursor is used on the y-axis to read time-domain functions in V or engineering units, and frequency-domain functions in V, V^2, V^2/Hz, V^2s/Hz, U, U^2, U^2/Hz, U^2s/Hz, and dB; dB values are referenced to a user-defined reference value. Phase is read in degrees and probability in %, %/V, or %/RMS, with linear scaling.

A special cursor field is used to read (where relevant) the total power of a displayed function. It is also used to read the power between the delta cursors, that power divided by the total power, and Δy between the delta cursors or the reference cursor.

Post-processing functions

The 2032 and 2034 contain a number of other post-processing functions in addition to the "Equalize" function mentioned earlier. Displayed time domain functions can be integrated or differentiated up to two times, and frequency domain functions can be multiplied or divided by $j\omega$ or $j\omega^2$. System delays can be compensated for in phase curves (a simplified form of phase unwrapping), and correlation curves can be displayed with or without the bow-tie correction. A flexible cursor allows cursor readings on the x-axis to be made in user-defined units in both the time and frequency domains, such as distance, cpm, or orders. Any autospectrum, coherent or non-coherent output power spectrum, liftered spectrum, or any sound intensity spectrum can be A-weighted across any frequency span. Finally, cepstra can be short or longpass liftered with selectable lifter length.

Hard Copy from the 2032 or 2034

Four possibilities exist for obtaining a hard copy from the 2032 or 2034. The first is to use the Graphics Recorder Type 2313 with any Application Package. Application Package BZ 7006 produces fully annotated plots of the entire Analyzer display with a wide range of user-definable plot options (Fig. 10). The BZ 7006 also extends the capabilities of the 2034 to include envelope analysis and octave displays of measured data.

The second possibility for hard copy is to use the X-Y Recorder Type 2308. An example of such a hard copy is

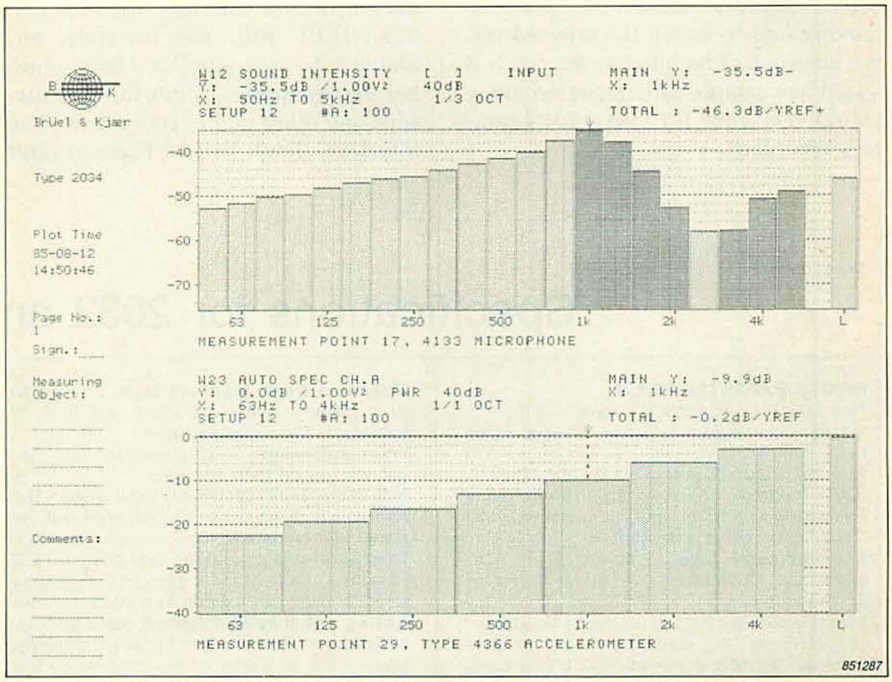


Fig. 10. (a) The Graphics Recorder Type 2313; (b) an example of a hard copy of the display screen obtained using the 2313

shown in Fig. 12. Since the plot includes automatically ruled axes, plain ungraduated paper can be used.

Full-color hard-copy plots may be generated with the Graphics Plotter Type 2319 when the Analyzer is equipped with the Graphics Plotter Interface. The 2319 is an 8-pen, A4 (11 inch) flatbed plotter which provides high-quality plots with a number of user-definable options.

The 2032 and 2034 also have a video output that allows a video plotter or an external monitor to be connected.

The Digital Cassette Recorder Type 7400 provides mass storage of data from the 2032 or 2034. It stores the results and measurement setup from the Analyzer in a format which allows later re-entry into the Analyzer, direct input to a computer, or plots from the 2313. At least 18 complete sets of results can be stored on single cassette, and more can be stored when abbreviated formats are used. The 7400 can also be used to store complete sets of user-defined measurement and display setups for later re-entry into the Analyzer.

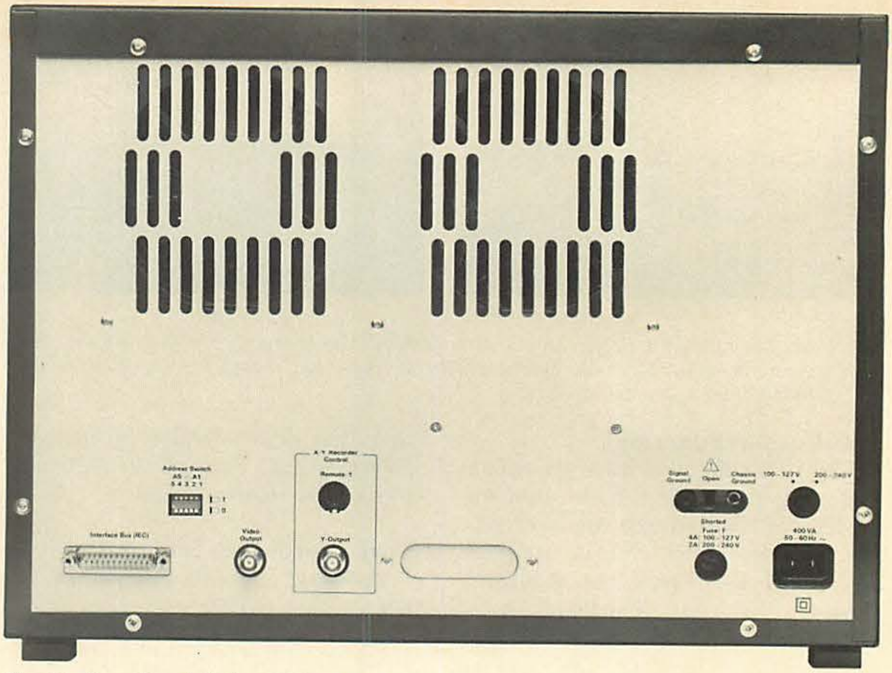


Fig. 11. Rear Panel of the 2032 or 2034

Built-in generator and self-test

The built-in generator of the 2032 and 2034 can supply sine wave, random noise, pseudo-random noise, or impulse signals. The frequency of the sine wave is programmable. The generator is a zooming generator, which means that the spectrum of random or pseudo-random noise outputs are bandlimited to match the selected frequency span. The impulse output is a signal one sample wide repeated every record (i.e. once for every 2048 samples recorded).

The built-in generator is for use as a signal source in system measurements, and also for self-test of the Analyzer. In the latter, the Analyzer checks its functions and indicates whether the self-test has been passed or failed. In the case of failure, error codes are given to help locate the source of the fault. The Analyzer performs a self-test each time it is switched on.

IEC/IEEE Interface

The 2032 and 2034 contain as standard a flexible and user-friendly IEC 625-1/IEEE Std. 488 interface, enabling it be connected to a large number of computers, desk-top calculators, and other digital equipment. The interface allows Brüel & Kjær to offer a state-of-the-art modal analysis package, developed by Structural Measurement Systems, Inc., of San Jose, California as an option to the 2032 or 2034.

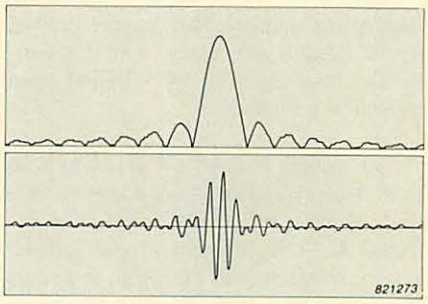


Fig. 12. Example of a hard copy obtained using the X-Y Recorder Type 2308

Specifications for 2032 and 2034

INPUT CHARACTERISTICS:
Two identical channels (Channel A & B)
Inputs: Independent selection of 3 inputs on both channels
Preamp. Input: Standard B & K 7-pin "Preamplifier Input". 0, + 28, or 200 V Microphone Polarization Voltage can be selected. AC Coupling: –3 dB at 3 Hz nominal
Accelerometer Input: Line Drive via TNC connector. Coupling: AC –3 dB at 0,2 Hz or 3 Hz nominal
Direct Input: Via BNC connector. Impedance: 1 MΩ//100 pF. AC Coupling: –3 dB at 3 Hz nominal; DC with automatic DC-offset compensation
Maximum Peak Input Voltage: 28 ranges from 15 mV to 100 V in a 1,5; 2; 3; 4; 6; 8; 10 sequence. Normal or inverted
Input Autorange: Selects optimum peak input voltage on both channels
Maximum Input Voltage: 100 V RMS. The Analyzer is designed to be operated with its signal and chassis ground at earth potential. To ensure safe operation according to IEC 348, the voltage of the signal ground relative to earth must not exceed 42 V RMS
Analog Antialiasing Filters: 2 matched low-pass filters with 25,6 kHz cut-off frequency. Max. ± 0,3 dB ripple in the passband. The filters provide at least 75 dB attenuation of those input frequencies which can cause aliasing. Max. gain difference: 0,3 dB. Max. phase difference: 3° up to 20 kHz, 5° up to 25,6 kHz. The filters can be bypassed
Low Pass Filters: 2 matched low-pass filters with 6,4 kHz cut-off frequency. Max. gain difference: 0,1 dB. Max. phase difference: 1° up to 6,4 kHz. The filters can be bypassed
Input Sampling: Internal: 65,536 kHz. External: Max. 67 kHz. A/D-conversion: 12 bit. Quantization error: Max. ± 1/2 LSB
Calibration: User-defined in engineering units U, or in volts
Calibration Annotation: V/V, V/unit, V/Pa, V/m/s^2, V/m/s, V/m, V/N, V/g, V/in/s, V/mil, unit/V

ANALYSIS CHARACTERISTICS

Measurement Modes

Ch. A Spectrum Averaging
Ch. B Spectrum Averaging
Dual Spectrum Averaging
Ch. A Spectrum Averaging Zero Pad
Ch. B Spectrum Averaging Zero Pad
Dual Spectrum Averaging Zero Pad
Dual Signal Enhancement
Dual Amplitude Probability

Frequency Range: 0 to 25,6 kHz. 15 Frequency spans from 1,56 Hz to 25,6 kHz. Digital zoom giving resolution from 1,95 mHz to 32 Hz anywhere in the frequency range, corresponding to zoom factors from 2 to 16384 in a binary sequence

ANALYSIS PARAMETERS:

Resolution: Samples in time functions: 2048 for each channel. In Zero Pad mode: 1024 for each channel. Resolution elements in frequency functions: 801. Amplitude classes in Probability: 512

Weighting: Rectangular, Hanning, Kaiser-Bessel, Transient, Exponential, or User-definable, selectable independently on each channel. Transient and Exponential window with selectable position and length

Real Time Frequency Range (2032): > 5 kHz in dual spectrum averaging mode > 10 kHz in single spectrum averaging mode

Real Time Frequency Range (2034): 800 Hz in dual spectrum averaging mode 1,6 kHz in single spectrum averaging mode

TRIGGER:

Trigger Input: Free run, internal on channel A or B before or after digital low-pass filtering, external, synchronous with the pseudo-random noise sequence, or manual

Trigger Slope: Positive or negative

Trigger Level: Adjustable in 199 steps across the input voltage range

Delay: Trig → A or Trig → B: delay between trigger and start of channel A or B set in seconds from –T to 9999 s. Resolution: Δt

Ch. A → B: Delay between start of channel A and channel B set in seconds from 0 to 9999 s. Resolution: Δt

AVERAGING:

Exponential: The number of averages indicated in the measurement setup determines the effective averaging time

Linear: Equal weighting. Stops on reaching the selected number of averages. A true average is always displayed and the number of averages is indicated on the display

Peak: (Single channel only), the maximum level occuring in each channel is held

Number of Averages: 1 through 32767. Any integer

Overlap: 0%, 50%, 75%, or maximum

Manual Accept: Data is accepted in the average under manual control

Overload Reject: Any data block related to overloaded data is rejected from an average

DISPLAY:

Type: Built-in 12″ TV raster-scan monitor

Picture Resolution: 290 × 401 or 290 × 512 points

Scale Lines: Horizontal scale lines and *x*-axis check marks are generated electronically directly on the screen to avoid parallax errors

Display Formats: Single or dual trace. Any trace in a dual display can be displayed in a single trace full screen format or in a single trace format with the measurement setup. The display setup and data source are independently selectable for upper and lower trace

Annotation: Identifies each trace with display setup label, measurement setup label, display setup parameters, selected data source number of averages performed, overload and overlap status, and cursor settings and values

Text: Two text strings each containing max. 100 characters of alphanumeric text can be entered. Either of the text strings can be displayed

FUNCTIONS CALCULATED AND DISPLAYED:

For number of datapoints calculated and displayed in each measurement mode, see Table below. All the indicated functions in each measurement mode are available without changing mode or rerunning data

Spectra: Linear Spectrum, RMS Spectrum, Power Spectrum, Power Spectral Density, or Energy Spectral Density

Hilbert Transform: Can be applied on: Time, Enhanced Time, Autocorrelation, Cross Correlation, Impulse Response, and Cepstrum

Coordinates: Real, Imaginary, Magnitude, Phase, Nyquist (Imaginary vs. Real) Nichols (Log. Magnitude vs. Phase), or Orbit (Time A vs. Time B)

y-Axis: Lin: Full scale can be set to any number from 1 E–24 to 1 E24. Units: V, V^2, V^2/Hz, V^2s/Hz, W/m^2, U, U^2, U^2/Hz, U^2s/Hz. Log: Full scale: –500 to + 500 dB in 0,1 dB steps. Ranges: 10, 20, 40, 80, 160 dB. Reference: Can be set to any number from 100 E–15 to 999 E9. Amplitude Probability: %, %/V, %/RMS. Phase: –200 to + 200 Deg.

x-Axis: Spectrum: Lin: 801 lines. Log: 2 decades, 793 lines. Time: 2048 samples. Amplitude Probability: Minus to plus maximum peak input voltage. 32, 64, 128, 256, or 512 amplitude classes. *X*-Axis gain to obtain 512, 1024, 2048 or 4096 points for time and 401 or 801 lines for spectrum. X-start selectable in 1 element

CURSORS:

Intensified column movable either continously or in single steps. Cursors on upper and lower trace can be individually or synchronously controlled

Cursor Types: Main Cursor, Harmonic Cursor, Sideband Cursor, Delta Cursor, Mask Cursor, Reference Cursor

Cursor Readings: For two-channel measurements the time reading includes the selectable delay between Ch. A and Ch. B. Both frequency and time can be read in engineering units e.g. rpm, orders or meters using "flexible" axis

Cursor Δ Readings: Δt or Δf values between harmonics, sidebands, delta cursors, or reference cursor

Special Readings: Total power, power in delta cursor band, delta power/total power, difference between amplitudes at the reference and main cursor, element number

STORED FUNCTIONS:

Single Spectrum Averaging

2048 sample Time Function
1024 line Autospectrum

Single Spectrum Averaging Zero Pad:

1024 sample Time Function
1024 line Autospectrum

Dual Spectrum Averaging:

2 × 2048 sample Time function
2 × 1024 line Autospectrum
1 × 1024 line Cross Spectrum

Dual Spectrum Averaging Zero Pad:

2 × 1024 sample Time Function
2 × 1024 line Autospectrum
1 × 1024 line Cross Spectrum

ANALYSIS PARAMETERS

Frequency Span	Frequency Resolution Δf	Record Length T	Time Resolution Δt	Center Frequency setting resolution
25,6 kHz	32 Hz	31,3 ms	15,3 μs	
12,8 kHz	16 Hz	62,5 ms	30,5 μs	256 Hz
6,4 kHz	8 Hz	125 ms	61,0 μs	128 Hz
3,2 kHz	4 Hz	250 ms	122 μs	64 Hz
1,6 kHz	2 Hz	500 ms	244 μs	32 Hz
800 Hz	1 Hz	1 s	488 μs	16 Hz
400 Hz	500 mHz	2 s	977 μs	8 Hz
200 Hz	250 mHz	4 s	1,95 ms	4 Hz
100 Hz	125 mHz	8 s	3,91 ms	2 Hz
50 Hz	62,5 mHz	16 s	7,81 ms	1 Hz
25 Hz	31,3 mHz	32 s	15,6 ms	500 mHz
12,5 Hz	15,6 mHz	64 s	31,3 ms	250 mHz
6,25 Hz	7,81 mHz	128 s	62,5 ms	125 mHz
3,13 Hz	3,91 mHz	256 s	125 ms	62,5 mHz
1,56 Hz	1,95 mHz	512 s	250 ms	31,3 mHz

In Zero Pad mode the record length is × 0,5
In Zoom the Time Resolution Δt is × 2

FUNCTION	Single ch. Spectrum Averaging	Dual Ch, Spectrum Averaging	Signal Enhancement	Amp. Prob.
Time	1 × 2048	2 × 2048	2 × 2048	2 × 2048
Time A vs. B		2 × 2048	2 × 2048	2 × 2048
Enhanced Time			2 × 2048	
Enhanced Time A vs. B			2 × 2048	
Probability Density				2 × 512
Probability Distribution				2 × 512
Instantaneous Spectrum	1 × 801	2 × 801	2 × 801	2 × 801
Enhanced Spectrum			2 × 801	
Autospectrum	1 × 801	2 × 801		
Cross Spectrum		1 × 801		
Freq. Response H_1, H_2		1 × 801	1 × 801	
1/Freq. Response H_1, H_2		1 × 801	1 × 801	
Coherence		1 × 801		
Signal to Noise Ratio		1 × 801		
Coherent Output Power		1 × 801		
Non-coh. Output Power		1 × 801		
Autocorrelation	1 × 1024	2 × 1024	2 × 2048	
Cross Correlation		1 × 2048	1 × 4096	
Impulse Response		1 × 2048	1 × 4096	
Sound Intensity		1 × 800		
Cepstrum	1 × 1024	2 × 1024		
Liftered Spectrum	1 × 801	2 × 801		

In Zero Pad mode the no. of data points is × 0,5 for Time A vs. B
In Zoom the no. of data points is × 0,5 for Time A vs. B, Enhanced Time and Time A vs. B. H_2 is not measured in Signal Enhancement

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Dual Signal Enhancement:
2 × 2048 sample Time Function
2 × 2048 sample Enhanced Time Function
Dual Amplitude Probability:
2 × 2048 sample Time Function
2 × 512 class Amplitude Probability Density
All functions can be calculated and displayed from the stored basic measurement data. The measurement setup used is stored together with the data

POST-PROCESSING:
Equalize: Calculates the complex ratio of the measured and stored Transfer Function. Applies also to Impulse Response
A-Weighting: Autospectrum, Coherent and Non-coherent Output Power and Sound Intensity can be A-weighted in any frequency span
Integration and Differentiation: Frequency domain functions: Single and double division or multiplication with $j\omega$ can be selected. Time domain functions: Single or double integrated or differentiated functions obtained by inverse transformation from the frequency domain
Delay Compensation: For compensating Frequency Response phase measurements for system delays. Adjustable from –T to T. Resolution $\Delta t/128$
Bow-Tie Correction: Correlation Functions can be displayed with or without bow-tie correction
Cepstrum Liftering: Shortpass or longpass with selectable length

SYSTEM ACCURACY:
Frequency Response: ± 0,4 dB at filter centers with DC coupling
Amplitude Linearity: ± 0,1 dB or ± 0,01% of maximum input voltage, whichever is greater, measured in Autospectrum with at least 32 independent averages, in the presence of another in-band signal not less than 20 dB below max. input
Dynamic Range: > 75 dB for Autospectrum with at least 32 independent averages. Noise, distortion, and spurious signals at least 75 dB below max. input voltage
Minimum Detectable Signal Level: 1 μV
Frequency Accuracy and Stability: 0,01% without warm-up (no adjustment necessary)

OPERATION:
Measurement Setup: 10 complete user-defined measurement setups can be saved and recalled from a non-volatile memory. Measurement setup parameters can be changed before or during a measurement. Additionally 10 factory-defined complete measurement setups are saved in ROM
Display Setup: 10 complete user-defined display setups can be saved and recalled from a non-volatile memory. Display setup parameters can be changed before, during or after a measurement. Additionally 10 factory-defined complete display setups are saved in ROM
Parameter Entry: Via increment/decrement controls, continuously variable speed field entry control, or numeric keypad
Autoscale: Display autoscale to maximize the area of the CRT used. The largest numeric value in the function on the display is automatically selected as new *y*-full scale
Averaging Control: Start, Proceed, Stop
Start: Clears the average accumulator and starts an average
Stop: Stops the averaging process or rejects an estimate in manual accept
Proceed: Continues an average without clearing the average accumulator or accepts an estimate in manual accept

SIGNAL GENERATOR:
Impulse: Length: Δt. Repetition: T. Amplitude: + 5 V
Reference Sine: 5 V RMS. Frequency equals selected centre frequency in zoom mode, and 50% of selected frequency span in baseband mode
Random Noise: Random noise signal band-limited to match the selected frequency span. Power spectrum flat within ± 2 dB in the selected span. Output level: 90 dB $\mu V/\sqrt{\Delta F}$, RMS
Pseudo-Random Noise: Pseudo-random noise signal with spectral line spacing matching the line spacing ΔF for the selected frequency span. The noise spectrum is band-limited to match the selected frequency span. Power spectrum flat within ± 2 dB in the selected span. Output level: 90 dB $\mu V/\sqrt{\Delta F}$, RMS
Variable Sine: 5 V RMS. Frequency range: 15 mHz to 25,6 kHz. Setting resolution: 15 mHz
Output Impedance: 50 Ω
Level: Cal. or 0 to 20 dB attenuation

PLOT:
Graphics Recorder Type 2313: Any display on the Analyzer including graphics and all annotation can be plotted on 2313 in less than 10 seconds with any Application Package in 2313. With Application Package BZ 7006, any screen display can be printed as a fully-annotated plot including cursors and text on axes
Pen Plotter Type 2319: Any display on the Analyzer including graphics and all alphanumerics can be plotted in 8 colors with Graphics Plotter Interface and 2319
X-Y Recorder Type 2308: Plot of single or dual graph with axes. X: 0 to + 10 V. Y: 0 to + 10 V. X and Y outputs are controlled for constant writing speed with a choice of 5 different writing speeds. Pen lift control. Analysis continues during read-out
Video Output: For video hard copy units and recorders. Output impedance: 75 Ω

MASS STORAGE:
Transmission to Digital Cassette Recorder Type 7400 of files containing basic measured data (current or stored), including measurement setup, display setup, cursor setup and text string. Later re-entry to Analyzer allows recalculation of any function. Also storage of user-defined measurement and display setups and of abbreviated read-outs

IEC/IEEE INTERFACE:
Conforms to IEC 625-1 and compatible with IEEE 488 standards. Connection into an IEC interface system is made using Cable AO 0194. Connection into an IEEE 488 interface system is made using Cable AO 0264 or Cable AO 0194 and Adaptor AO 0195
IEC/IEEE Function Implemented:

Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T5
Listener	L3
Service Request	SR1
Remote/Local	RL1
Device Clear	DC1

Data: Any function shown on display, any basic measured data, measurement setup, display setup, cursor setup, text string etc. can be transmitted to and from Analyzer
Remote Control: All functions and instrument settings excl. Signal Generator Amplitude and Microphone Polarization Voltage can be remotely controlled
Command Set: Simple and easy to remember standard engineering English. Resistant to operator error. Syntax errors displayed on screen
Graphics: Display useable for multimode graphics
Code: ASCII (ISO 7-bit) code or Binary
Interface Terminator: Can be defined from the front panel or from a controller
Device Address: Displayable on screen

POWER SUPPLY:
100 – 127 V or 200 – 240 V AC ± 10%, 50 – 60 Hz ± 5%
Consumption approx. 400 VA

GENERAL:
Safety: Complies with IEC 348 Safety Class II
EMI: Complies with U.S. FCC requirement for Class B computing devices
Operating Temperature: 5°C to 40°C (41°F to 104°F)
Storage Temperature: –25°C to + 70°C (–13°F to + 150°F)
Humidity: 0 to 90% RH (5°C to 30°C), non-condensing at 40°C
Cabinet: Supplied as model A (lightweight metal cabinet) or C (as model A but with flanges for standard 19″ racks)
Dimensions: (A-cabinet without feet):
Height: 310,4 mm (12,2 in)
Width: 430 mm (16,9 in)
Depth: 500 mm (19,7 in)
Weight: 35 kg (77 lbs)

ACCESSORIES INCLUDED:
1 Test Unit .... ZZ 0201
1 Mains cable .... AN 0020
3 Signal cables for Test Unit and 2308 .... AO 0087
1 Power cable for Test Unit and Remote control cable for 2308 .... AQ 0034
2 Spare fuses F 2A/250 V .... VF 0057
3 Spare fuses F 4A/250 V .... VF 0058
1 BNC T-connector .... JJ 0152

ACCESSORIES AVAILABLE:
Wide range of microphones and accelerometers
IEC 625-1 interface cable (2 m) .... AO 0194
Adaptor to convert IEEE instrument to IEC 625-1 (25 pin) .... AO 0195
IEC 625–1 to IEEE 488 interface cable (2 m) .... AO 0264
IEEE 488 interface cable (2 m) .... AO 0265
3519 Sound Intensity Probe: For measurement of Sound Intensity
2644 Line-Drive Amplifier: Miniature, charge-type amplifier for mounting directly on top of accelerometers. Can be connected directly to Analyzer Line Drive Input. The 2032 and 2034 include the necessary line-drive supply
2313 Graphics Recorder: Includes BZ 7000 Application Package for direct copying of display screen
BZ 7006 Application Package: For Type 2313. Extends the measurement capabilities of the system to include Envelope Analysis and octave displays. Provides fully documented plots of the display screen.