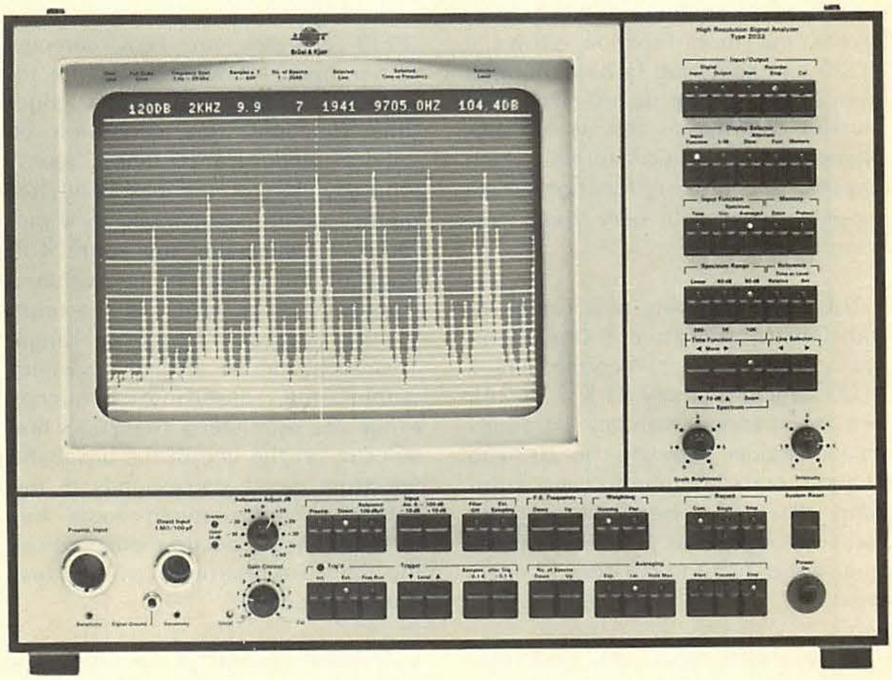
type 2033

High Resolution Signal Analyzer



USES:

- High resolution analysis of acoustical and vibrational signals
- Analysis of non-stationary signals such as speech, rapid machine run-ups and run-downs, etc.
- Measurement and analysis of shock and transient signals
- Analysis of vibration from both rotating and cyclic machines
- Measurement of 4000-line spectra
- Order Analysis

FEATURES:

- Constant bandwidth baseband frequency analysis in 400 frequency lines
- Eleven selectable baseband frequency ranges from 0 — 10 Hz through 0 — 20 kHz
- 10 K sample input memory with internal, external or free running trigger and adjustable after trigger recording giving exceptional transient analysis possibilities
- 1 K sample window can be moved along 10 K sample recorded time function to permit automatic "slow motion" analysis
- Built-in 10 x zoom to allow measurement of high resolution spectra with zoom frequency range controlled by line selector
- Display of spectrum over 80 dB, 40 dB or linear display range with variable display gain
- Memory allows storage of spectrum for comparison with later data
- Alphanumeric read-outs directly from display screen using line selector
- Major control settings displayed on display screen
- Output of displayed data via analog output
- Connection to IEC 625-1/ IEEE Std. 488 interface bus
- Digital input and output of data and front panel control settings via IEC interface
- Display of time signal, instantaneous spectrum, averaged spectrum and spectrum ratio on 11" display screen
- Greater than 70 dB dynamic range
- Built-in antialiasing filters
- Overlap processing where calculation time allows it
- Exponential and linear averaging over 1 to 2048 spectra and hold max. facility
- Scan averaging for analysis of 10 K transient signals
- Flat or Hanning weighting selectable before or after recording
- Read-out of amplitude in relative or engineering units

Introduction

The High Resolution Signal Analyzer Type 2033 represents a significant innovation in the world of real-time FFT analysis. An input memory which has been considerably enlarged with respect to that found in a conventional FFT analyzer greatly enhances the capability of the 2033 in the analysis of transient and non-stationary signals. Further, a unique zoom feature which preserves the time function allows a 4000-line spectrum to be generated from a single time record. This is in marked contrast to the usually implemented zoom transforms which require that the time function be re-recorded for each new zoom frequency range.

The 2033 consists of a combined transient recorder and Fourier analyzer. The transient recorder has a 10 K sample memory, (1 K = 1024), and is equipped with an extremely flexible trigger allowing the 2033 to analyze both continuous and transient data. The transient recorder combines with the Fourier analyzer to give the 2033 two modes of operation.

In **baseband** mode, the 2033 operates like a conventional 400-line FFT analyzer by sampling the input signal and transforming it, 1 K samples at a time, into the frequency domain. The spectrum produced by each transformation is a constant bandwidth spectrum measured at 400 equally spaced frequency intervals, (or lines), across a frequency range which is selectable in a 1-2-5 sequence from 0 Hz (nominal) to 10 Hz through 0 Hz (nominal) to 20 kHz. The selected frequency range is referred to as the **baseband** of the 2033, and spectra measured using baseband mode as referred to as baseband spectra. The sampling frequency used in the 2033 is always, (in both baseband and high resolution modes), 2,56 times the selected baseband frequency range.

In **high resolution** mode, the 2033 operates on 10 K samples rather than 1 K samples of the input signal, i.e., a 10 times longer time function. This can then be used to produce a 10 times "zoom" whereby part of the baseband frequency range is expanded by a factor of 10 such that the entire 400 lines of the spectrum lie within a frequency range which is one tenth of the baseband frequency range. This zoom can be applied anywhere within the baseband frequency range, by positioning the 2033 line selector on the line of the baseband spectrum which corresponds to the centre of the required zoom frequency range. Spectra measured using zoom are referred to as **high resolution** spectra.

Another method of analysis is a "**scan**" analysis. Here, 10 K samples of the input signal are recorded and stored in the 2033 input memory. A time window 1 K samples long can then be automatically or manually stepped along the 10 K sample time function, the 1 K samples of the time function selected by the window with each step being analyzed. The frequency range and resolution of each of the spectra will be the same as of the baseband spectrum. This method of analysis gives the possibility of "scanning through" the 10 K sample time function to give a "slow motion" analysis, allowing any changes in the baseband spectrum to be observed as the time window is stepped along the 10 K samples.

The spectra produced by the 2033 in both baseband and high resolution mode can be linearly or exponentially averaged, or their maxima can be stored. These results as well as the instantaneous spectrum and the time function can then be displayed on an 11" calibrated display screen, and the displayed values read via a line selector. The 2033 incorporates a memory where a spectrum can be stored and then recalled to the display screen allowing, e.g. the comparison of baseband and zoomed data. The amplitude ratio between the input data and the memory can also be displayed.

Output of displayed data can be made to an X-Y or level recorder. The 2033 is also equipped with an extremely sophisticated IEC 625-1 standard/IEEE Std. 488 compatible interface.

The analysis modes and other features described above allow the 2033 to be used in a wide range of applications in the analysis of both stationary and non-stationary signals. The use of these modes and features is further described in the section "Features and Uses".

Features and Uses

Use of zoom in the analysis of vibration

One of the major applications of real-time narrow band spectrum analysis is in the study of vibration from rotating machines. Such analysis can be instrumental in pin--pointing faults as they occur, enabling repairs to be made before catastrophic failure takes place. In many measurements, e.g., the vibration from rotating shafts, the baseband spectrum gives sufficient resolution to enable the speedy identification of key components in the vibration spectrum. In some measurements, however, and in particular in the analysis of sideband structures typical of gearbox vibrations, a greater resolution can be beneficial.

It is here that the high resolution mode of the 2033 can be used. Pressing the zoom pushkey, shown in Fig.1, causes that part of the baseband spectrum centered around the line selector to be expanded by a factor of 10, hence

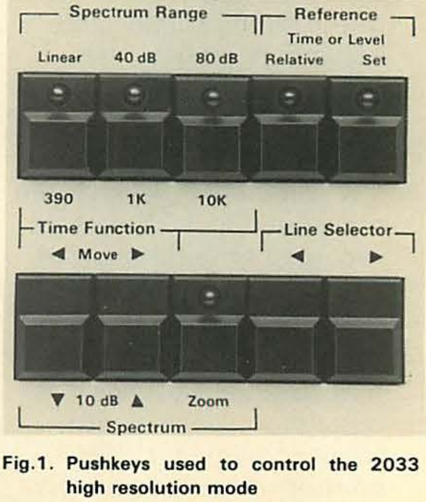


Fig.1. Pushkeys used to control the 2033 high resolution mode

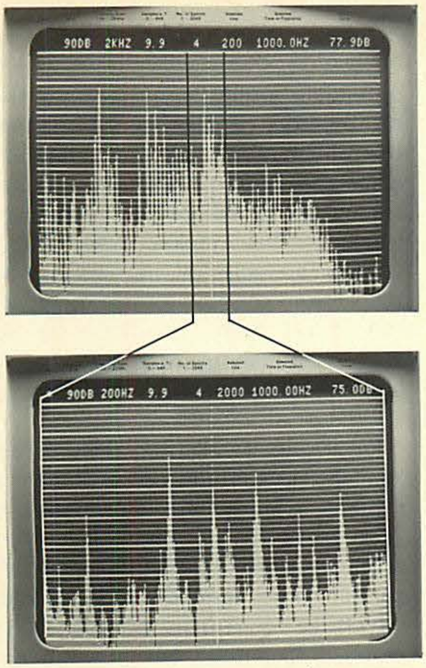


Fig.2. Example of the use of zoom to expand spectra data. The upper spectrum is the baseband spectrum. In the lower spectrum, the range from 900 to 1100 Hz has been expanded to fill the entire zoom

giving 10 times improved resolution. This is illustrated in Fig.2, where the baseband and high resolution vibration spectra from a large gearbox are compared. The 400-line baseband spectrum shows a frequency range of 0—2 kHz, while in the high resolution spectrum, the 400 lines are centered around the third harmonic of the toothmeshing frequency in a frequency range of 900 Hz to 1100 Hz. In the high resolution spectrum, a sideband structure around the third harmonic which is indicative of faulty gears becomes clearly apparent.

It is interesting to note here the optimal nature of the zoom factor 10 in this type of measurement, in that it is sufficient to bring out the required information. Higher zoom factors, on the other hand, would cause increased "smearing" of the spectral peaks, this arising from small variations in machine speed.

Measurement of 4000 line spectra

A feature of the 2033 is that when it is switched to its high resolution mode, once 10 K samples of the input signal have been recorded, multiple zoom transforms may be made on the same 10 K samples. Each zoom transform takes approximately 1 s. This allows, for instance, 10 contiguous 400-line high resolution spectra to be generated from the same 10 K samples, allowing a 4000-line spectrum of a single time record to be obtained. This spectrum will extend across the entire 2033 baseband frequency range.

High speed zoom

The feature described above, i.e., that the 2033 can process multiple zoom transforms from the same 10 K time record, can make the 2033 considerably faster than an analyzer processing conventional zoom transforms in obtaining high resolution spectra. With conventional zoom transforms, the zoom frequency range must be selected before the time function is recorded, and hence the time function must be re-recorded each time a new zoom frequency range is required. This is in contrast to the 2033 zoom transform, where the zoom frequency range need not be chosen until after the time function has been recorded, allowing repeated zoom transforms to be performed on the same data.

An indication of the possible differences in processing times may be had by comparing the two transforms in a 10 times zoom on a 0 to 10 Hz baseband frequency range. Both will require 400 s of time domain data, (assuming a 400 line high resolution spectrum). Thereafter, the 2033 can make as many zoom transforms as are required from the same 400 s of data, each taking about 1 s. A conventional zoom transform, however, requires a new 400 s of data for each new zoom transform, making it in this case about 400 times slower.

Use of scan in the analysis of non-stationary signals

The scan function is of exceptional value in the analysis of non-stationary signals such as speech, fast machine run-ups and run-downs, music, etc. It has the effect of producing a "slow motion" analysis such that rapid changes in the spectrum of, e.g., a word of speech can be seen and understood directly from the 2033 display screen. Otherwise, as in for instance a real-time analysis, these changes might occur so rapidly as to make their visual comprehension impossible.

In operation of a scan analysis, 10240 samples of the input signal are recorded and stored in the 2033 input memory. The scan function then allows a 1 K sample time window to be stepped along the 10 K samples, while producing a new 400-line spectrum for each step. Either a flat (rectangular) or a Hanning weighting can be applied as the window function. The process is illustrated in Fig.3. The scan is non-destructive, allowing repeated scans on the same 10 K samples, e.g., with a changed weighting function, etc..

The scan can be controlled automatically or manually. In an **automatic scan** the window is stepped across the entire 10 K samples, producing and displaying a new spectrum for each step. The number of steps is selectable in a sequence of 8 values from 10 to 1153, (these values corresponding to a step size selectable in a binary sequence of from 1024 to 8 samples), the duration of each step being approximately 110 ms. The effect is to produce a "live" display of the spectrum changes which occur as the time window moves along the 10 K samples. The total time taken for the scan varies from about 1 s to about 2 min. depending on the number of steps.

In a **manual scan**, the time window is chosen by manually positioning the required 1 K samples on the 2033 display screen, and then selecting instantaneous spectrum display to show the spectrum. (An example is shown in Fig.4). In a manual scan, the step size from window to window is in multiples of 30 samples.

Signals from 200 ms to 400 s duration can be analyzed in the above manner, depending on the baseband frequency range selected. With a 5 kHz baseband frequency range, for instance, the 10 K samples would correspond to 800 ms of time domain data, and the minimum step size from one window to the next would be about 1 ms for an automatic scan and about 2,5 ms for a manual scan. The time window would in this case correspond to 80 ms with rectangular weighting selected, and about 40 ms with Hanning weighting se-

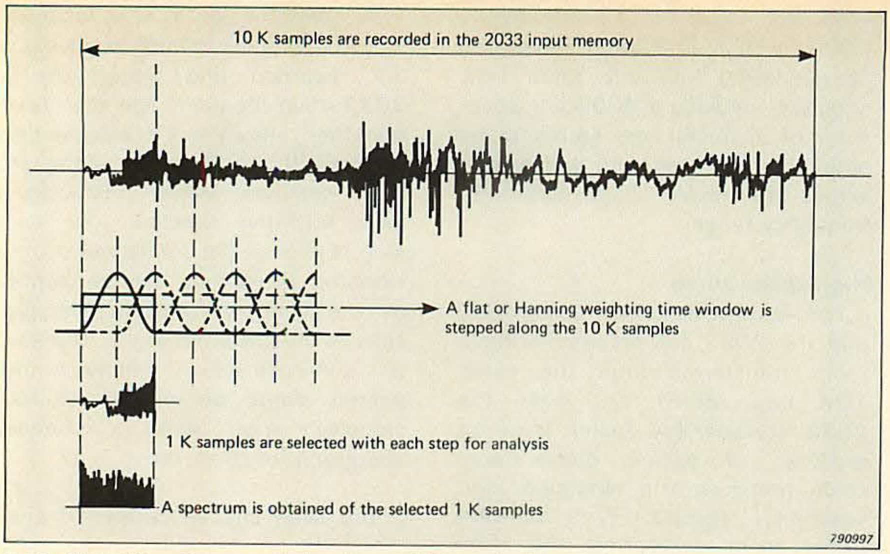


Fig.3. Illustration of scan analysis, where a 1 K sample time window is stepped along the 10 K sample time function to give a "slow motion" analysis

lected, (use of Hanning weighting reduces the effective time window by approximately 50%).

Triggering facilities

The 2033 incorporates very advanced and flexible triggering facilities. In the **free running** trigger mode, the 2033 analyzes data at a rate which is only limited by the calculation procedures. In the lower baseband frequency ranges, (0 to 2 kHz and less), this gives overlap processing whereby overlapping time records are analyzed to update the instantaneous spectrum at least 5 times a second, making it easier to follow changing spectral components. Use of a free running trigger is principally associated with the analysis of continuous signals.

Internal trigger mode is primarily applied in the analysis of transient signals. Here, the input signal itself is used to trigger the analysis, the trigger level being adjustable in 200 steps across the maximum input voltage swing. The trigger level set is displayed when the 2033 display screen is set to show a time function. In **external** trigger mode, an externally applied pulse is used to control the recording. The major use of this is to synchronise the analysis with a repetitive process.

After trigger recording

Associated with internal and external triggering is an adjustable delay called after trigger recording. It is used to select precisely which part of the input signal is analyzed with respect to the time when the trigger occurs. It operates by allowing the 2033 to continue recording new samples after it has been triggered until a preset number has been reached. Then, the recording process is stopped, and the 2033 operates on whichever time function is standing in its memory at that time. The after trigger recording enables the 2033 to analyze events occurring both before and after the trigger, (an example of its use is given in the section "Analysis of machine cycles").

Up to a further 64 K samples, adjustable in steps of 0,1 K samples, can be recorded after the 2033 is triggered. This allows the 2033 to analyze events occurring from 10 K samples before the trigger, (after trigger recording set to 0,0 K), up to 64 K samples after the trigger, (after trigger recording set to 64 K). For instance, with a baseband frequency range of 10 kHz this represents a timespan of 0,4 s before the trigger up to 2,56 s after it. (The sampling frequency is 2,56 times the baseband frequency range). On the 2 kHz range, the corresponding figures would be 2 s and 12,8 s respectively.

Transient analysis

The trigger and after trigger recording facilities described in the previous two sections make the 2033 an extremely flexible system in the analysis of transient signals. The range of adjustment of the internal trigger level reduces the likelihood of a false trigger, while where a suitable trigger signal is available, an external trigger can be used. Use of the after trigger recording enables the 2033 to analyze data occurring both before and after the trigger. This makes the 2033 equally suitable in analysis across the entire range of transient signals from short, highly impulsive signals such as gunshots, to long, low frequency signals like seismic waves.

Fig.4 illustrates the possibilities available in the analysis of transient signals. It shows an analysis in the 10 kHz baseband frequency range of punch press noise. First the 10 K sample time function is displayed, which is of 400 ms duration, this being sufficient to describe the entire punch press cycle. Next, a 1 K sample section of the 10 K time function is displayed, this having been selected using a manual scan from that part of the time function where the amplitude was at a maximum, (as indicated by the line selector in Fig.4(a)). The next display shows an analysis in the baseband frequency range of those 1 K samples. Finally, a scan average, (see the section "Scan averaging"), across the entire transient is shown. A further possibility, not illustrated, would be to measure the 4000 line spectrum of the transient.

Averaging

Spectrum averaging is performed in signal analysis in order to reduce the effects of random variations and to produce a statistically reliable result. The 2033 has three averaging modes, the first two of which, namely **exponential averaging** and **linear averaging** give a true RMS average. From 1 to 2048 baseband or (400 line) high resolution spectra can be averaged coming from both continuous and transient data. The third averaging mode is a **maximum hold**, where the maximum level occurring in each line of the spectrum is held. Maximum hold can operate on an unlimited number of spectra.

When the 2033 is in its baseband mode, and Hanning weighting is selected, the effective time window is reduced by about 50%. The 2033 takes advantage of this to re-

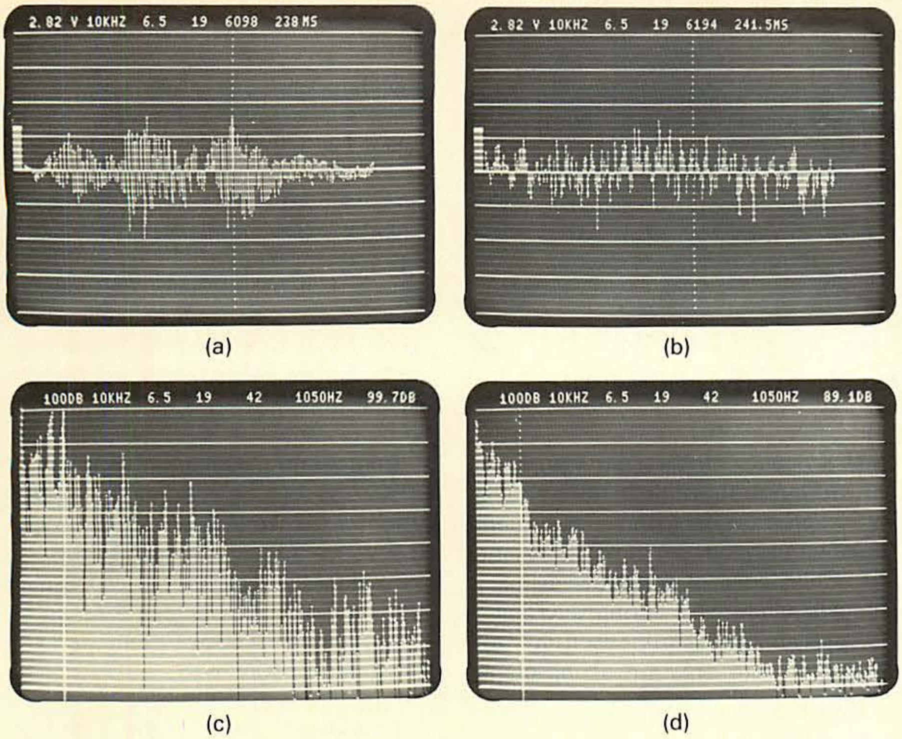


Fig.4. Illustration of transient analysis possibilities with the 2033, a) 10 K sample time function, b) 1 K samples selected using manual scan, c) analysis of the 1 K samples, d) scan average of the 10 K samples

duce the time required to produce a statistically reliable result, by averaging spectra which come from 50% overlapping time records. Hence, the time required, for instance to linearly average 64 spectra with a 1 kHz full scale frequency is reduced from 25,6 s to 12,8 s but with the relative error remaining at approximately ± 0,5 dB. Averaging with flat weighting in the baseband mode or with flat or Hanning weighting in the high resolution mode is carried out without overlap.

Scan averaging

When the 2033 makes an automatic scan analysis of a 10 K sample time function, it simultaneously produces a scan average. This is a linear average of the spectra generated by the scan, and it can be seen by setting the 2033 display screen to show the averaged spectrum.

Scan averaging is used to obtain a 400-line averaged baseband spectrum from a 10 K sample time function. In this respect it can be used with both stationary and non-stationary signals and both transient and continuous signals.

Analysis of machine cycles

The application of the 2033 to the analysis of machine cycles, mentioned previously, can be extended by appropriate use of the trigger, after trigger recording, and averaging facilities. Fig.5 shows a typical result, this being a three dimensional plot of the vibration at the cylinder head covering one cycle of a 4-cylinder 4-stroke diesel engine, operating at 1500 rpm with delayed injection. Each spectrum in the plot represents about 4 ms of the entire 80 ms cycle, (8 ms of record weighted with a Hanning weighting), and is an average over 64 cycles. Synchronisation between the 2033 analysis window and the engine was obtained using a once-per-cycle tachometer pulse as an external trigger, the analysis window being stepped in 1,6 ms steps along the engine cycle by incrementing the after trigger recording. The various events in the cycle can be clearly seen.

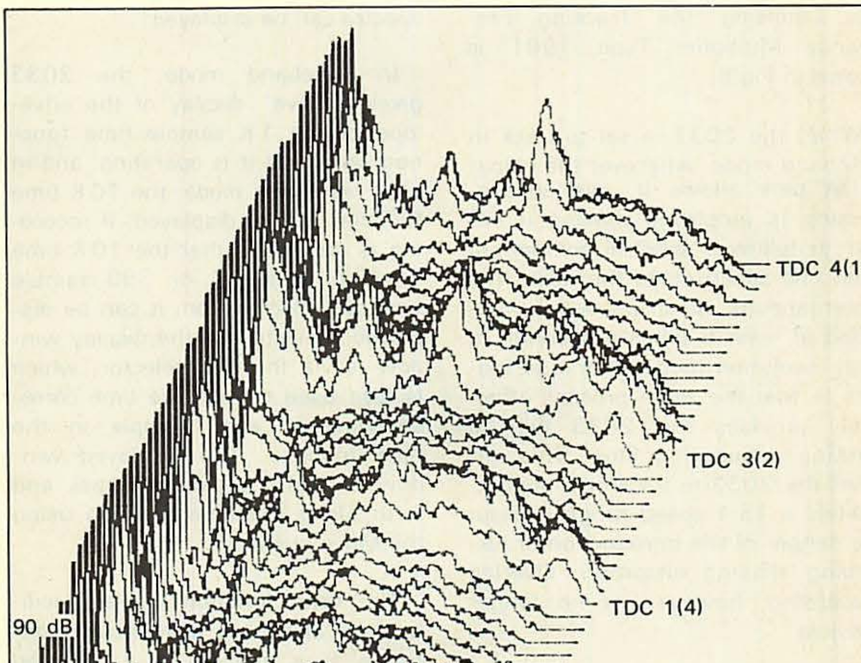


Fig.5. Analysis of one cycle of a 4-cylinder diesel engine

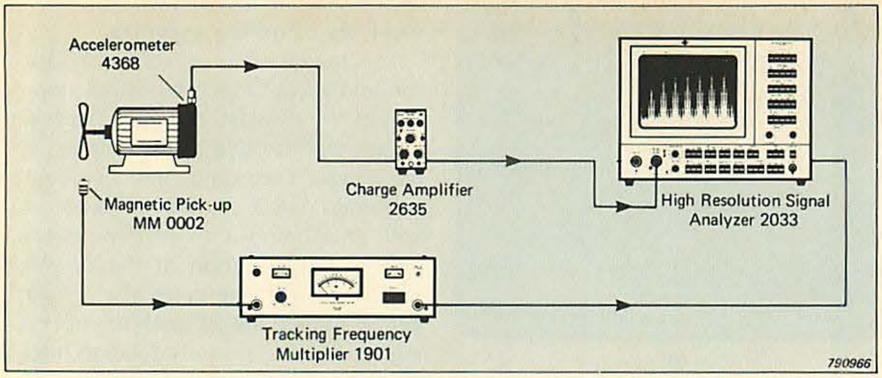


Fig.6. Use of the Tracking Frequency Multiplier Type 1901 with the 2033

Tracking and order analysis

The frequency range of the 2033 can also be controlled, both in baseband and high resolution mode, from an external sampling frequency. By deriving this external sampling frequency from the rotational speed of a machine, order analysis whereby the 2033 tracks the machine speed can be carried out. In such an analysis, the frequency range displayed varies in sympathy with the machine speed such that the rotationally related components stay in fixed positions on the 2033 display screen. A suitable set-up for this, utilising the Tracking Frequency Multiplier Type 1901 is shown in Fig.6.

When the 2033 is set to track in baseband mode, wherever the calculation time allows it, overlap processing is employed making it easier to follow a spectral component from one spectrum to the next, (the instantaneous spectrum will be updated at least 5 times a second). In high resolution mode, a unique feature is that the zoom process effectively provides the 2033 with a tracking antialiasing filter. This enables the 2033 to track over approximately a 15:1 speed range without the danger of the introduction of disturbing aliasing distortion. Overlap processing, however, is no longer possible.

Data Input

The 2033 input is designed to ensure the integrity of analyzed data. A full B & K measuring amplifier input is built in, allowing the connection of signals from most B & K microphone preamplifiers and other signal sources. Detection of overload takes place at two points, namely before the antialiasing filter to guard against undetected saturation of the input amplifier, and at analog to digital conversion to guard against clipping of samples at the ADC. Evidence of saturation or clipping is later used during averaging to prevent data influenced by an overload from entering an on-going average.

Data Display

The 2033 utilises an 11" calibrated raster scan display screen enabling important details in displayed data to be quickly and precisely identified. Both time functions and spectra can be displayed.

In baseband mode, the 2033 gives a "live" display of the envelope of the 1 K sample time function on which it is operating, and in high resolution mode, the 10 K time function can be displayed. If recording is stopped, either the 10 K time function or a 1 K or 390 sample window selected from it can be displayed. Selection of the display window is via the line selector, which is also used to read the time corresponding to each sample in the time function. The displayed window can also be moved back and forth along the time function using the Move pushkeys.

The **time function** display facilities are also used to manually control a scan analysis of a recorded 10 K time function. The 1 K samples required for analysis are first positioned on the 2033 display screen. Selecting instantaneous spectrum display gives their spectrum.

Display of the **instantaneous** or **averaged spectrum** is in terms of linear or logarithmic amplitude, (logarithmic amplitude display range selectable between 40 dB and 80 dB), with variable display gain, against linear frequency. The line selector may now be used to read the frequency in Hz and the amplitude in dB or V of any line in the spectrum. Any line in the spectrum can be set to read 0 dB or 1 unit, (as can any sample of the time function be set to read 0 s). The line selector is also used to select the zoom frequency range in high resolution mode. An example of a linear spectrum display is given in Fig.7.

Engineering Units calibration of the 2033 can be obtained using the internal 100 mV reference with the Reference Adjust dB and Gain Control potentiometers. The calibration level is adjustable across a range of approximately 100 μV/unit to approximately 30 V/unit.

Associated with the display screen is a memory, where a spectrum can be stored for its later recall, allowing, e.g., the comparison of baseband and high resolution spectra. The **amplitude ratio** between the input spectrum and the memory contents can also be displayed allowing the estimate of the magnitude of a system frequency response.

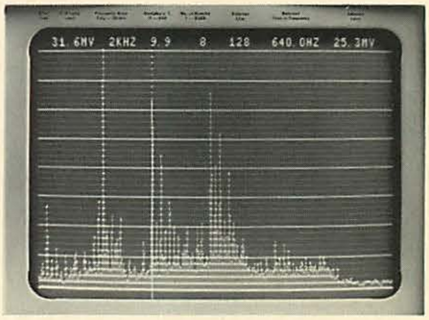


Fig.7. Example of a linear spectrum display. The amplitude of the selected line can be read in volts, engineering units, or in linear units referred to any line of the spectrum

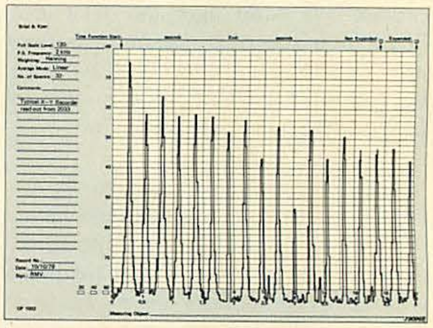


Fig.8. Example of a 2033 spectrum recorded using an X-Y Recorder Type 2308

Data Output

Analog outputs can be made to a B & K Level Recorder Type 2307 or to an X-Y Recorder Type 2308, (specify which output is required when ordering). Any function which is displayed can be output, the recording being made on graduated paper. Fig.8 shows a spectrum recorded using an X-Y Recorder Type 2308.

IEC Interface

A further unique feature of the 2033 is an extremely flexible and sophisticated interface which allows total access to the 2033 controls and data memory. This interface, which conforms to the IEC 625-1 standard (compatible with IEEE Std. 488), allows simple connection of a calculator to the 2033, to form a powerful system. So connected, a calculator has access to, amongst other things:

All the 2033 pushkeys and the line selector.
The time function.
The complex spectrum.
The instantaneous power spectrum.
The averaged power spectrum.
The stored spectrum.
The display screen alphanumeric text line.

Examples of more complex processing which can then take place include:

Automatic spectrum comparison.
Inverse Fourier Transform.
Cepstrum.
Hilbert Transform.

An interesting combination is the 2033 with the **Digital Cassette Recorder Type 7400**, (shown in Fig.10). The 7400 connects directly to the 2033, and as well as being able to record spectra, the 7400 can record the time function, (1 K or 10 K), held by the 2033. This allows the total documentation of results, in that everything generated from that time function can be exactly reconstructed by reading the recorded time function back to the 2033.

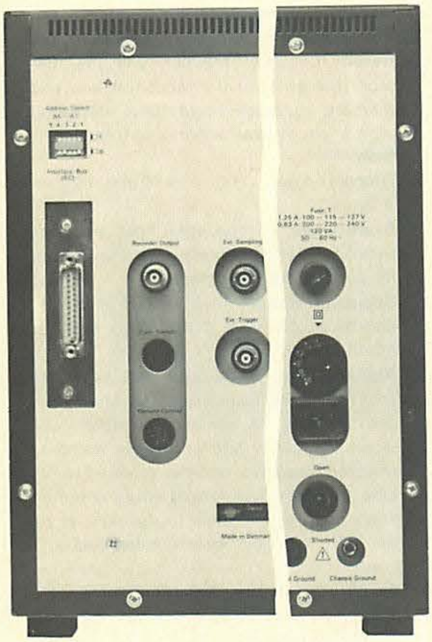


Fig.9. Rear Panel of the 2033

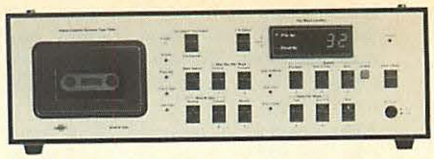


Fig.10. Digital Cassette Recorder Type 7400

Graphics Recorder Type 2313 (see Fig. 11), is a fast digital graphics printer, which, when fitted with Application Package BZ 7002, can not only plot or list measurement results, but also store approx. 30 spectra or 20 × 1 K (or 2 × 10 K) time functions, produce 1/3 octave and 1/1 spectra, re-format time functions and a number of spectra, plus perform integration and differentiation of spectra. The measurement results can then be stored on the 7400 Digital Cassette Recorder. A range of application packages are available for interface with other B & K instruments, see your B & K representative for details.

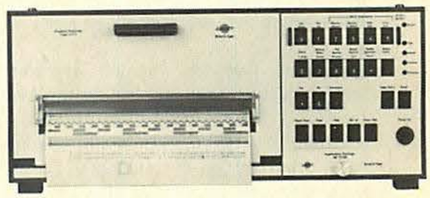


Fig.11. Graphics Recorder Type 2313

Specifications 2033

Input Characteristics:

Input: either "Direct Input" or standard B & K 7 pin "Preamplifier Input"

Input Impedance: "Direct Input" 1 MΩ//100 pF

Maximum Input Voltage: 2033 is a Safety Class II instrument (IEC 348). For safe operation in accordance with IEC 348, the voltage of the signal or signal ground relative to earth must not exceed 42 V RMS (sine). To ensure safe operation within IEC 348 at higher voltages, the user must limit all input currents to 0,7 mA peak

Sensitivity: 11 full scale sensitivity ranges (overload limit of ADC), 10 dB steps from 66 dB to 166 dB RMS re 1 μV (sine)

Input Attenuator: 0 to 100 dB in 10 dB steps, accurate to ± 0,1 dB

Gain Control: 0 to 10 dB

Sensitivity Adjustment (Direct): + 4,7 dB to —10 dB

Sensitivity Adjustment (Preamp.): +4,7 dB to —10 dB

Amplitude Reference: 100 dB referred to 1 μV. Frequency, 64% of selected baseband full scale frequency

Antialiasing Filters: 11 filters automatically selected with baseband frequency range. Max. ± 0,2 dB ripple in the passband, 113 dB/oct roll off. Provide at least 70 dB attenuation of any components in the input signal having frequencies higher than 1,56 the baseband full scale frequency. The filters can be bypassed, if required

Sampling: 2,56 × baseband full scale frequency, automatically selected with the baseband frequency range for internal sampling. External sampling sets the baseband full scale frequency to 1/2,56 of the external sampling rate

Analog to Digital Conversion: 12-bit two's complement, quantizing error maximum ± 1/2 LSB

Overload Indicator: indicates overload in either the input amplifier or the ADC

Upper 10 dB Indicator: indicates when either the input amplifier or the ADC is operating in the upper 10 dB of its dynamic range

Analysis Characteristics:

Baseband Mode:

Full Scale Frequency: 10 Hz to 20 kHz selectable in a 1 - 2 - 5 sequence

Real Time Frequency Range: > 2 kHz

Number of Synthesised Filters: 400, generated from 1024 input samples

Filter Spacing, β: reciprocal of the input time function duration, or the full scale frequency/400

Overlap: with free running trigger selected the instantaneous spectrum is updated at least 5 times a second

High Resolution Mode:

Frequency Span: one tenth of the selected baseband full scale frequency, 1 Hz to 2 kHz selectable in a 1 - 2 - 5 sequence. Frequency span centre frequency is selectable in steps of 1/400 th of the baseband full scale frequency within the baseband frequency range, via the line selector

Number of Synthesised Filters: 400 generated from 10240 input samples, i.e. 4000 filters within the baseband frequency range

Filter Spacing, β: reciprocal of the input time function duration, or the baseband full scale frequency/4000

Baseband and High Resolution Mode:

Weighting: flat (rectangular) or Hanning, selectable before or after the time function has been recorded

3 dB Bandwidth: 0,88 β for Flat Weighting, 1,44 β for Hanning Weighting

Noise Bandwidth: β for Flat Weighting, 1,5 β for Hanning Weighting

Amplitude Linearity: (for 32 spectra average) ± 0,1 dB or ± 0,01% of full scale at overload, whichever is greater (no adjustment necessary)

System Frequency Response: ± 0,2 dB with antialiasing filters bypassed, or ± 0,3 dB otherwise, 2 Hz to 20 kHz

Noise Level: (for 32 spectra average) less than 0 dB re 1 μV or 76 dB below overload, whichever is greater

Transient Analysis:

Trigger Modes: Internal, External or Free-run

Trigger Level: adjustable in 200 steps across the input voltage range. Trigger level indicated on the display screen

Trigger Slope: positive for positive trigger level, negative for negative trigger level

After Trigger Recording: adjustable in steps of 0,1 K samples from 0,0 to 64 K samples

Memory Period: equal to in seconds 4000/baseband full scale frequency in Hz

Recording Control: manual transient capture or automatic capture on the next trigger

Transient Averaging: automatic averaging of a succession of transients or averaging with manual control after verification of data

Scan Analysis: Automatic; 1 K time window is stepped across entire 10 K time function producing new analysis with each step, number of steps selectable in a sequence of 8 values from 10 to 1153
Manual; 1 K time window placed manually, step size in multiples of 30 samples

Averaging:

Linear: linear average of a preset number of spectra producing a true power average. A true average is always displayed and the number of spectra averaged is indicated on the display

Exponential: the number of spectra indicated on the display gives the effective averaging time

No. of Spectra: 1 — 2048 in 12 binary related ranges

Hold Max.: the maximum level occurring in each line is held

Overlap: Hanning weighting selected, 50% where calculation time allows it. Rectangular weighting selected, no overlap. High resolution mode selected, no overlap

Controls: Start, Proceed and Stop

Overload Protection: data influenced by an overload is automatically excluded from an average

Scan Averaging: linear average of an automatic scan analysis

Memory:

"Store": stores the instantaneous or averaged spectrum and corresponding alphanumerics shown on the display

"Protect": prevents further updating of the memory

Display:

The display screen shows the input function, (i.e., time function, instantaneous spectrum, or averaged spectrum), the memory contents, the amplitude ratio between the input function and the memory contents, or the input function and memory contents alternatively displayed with a fast or slow alternating frequency

Size: 11"

Display Area: 150 × 210 mm (6 in × 8,25 in)

Scale Lines: 41 horizontal lines are electrically generated directly on the screen for parallax free readings

Spectrum Range: linear, 40 dB or 80 dB

Spectrum Gain: in 10 dB steps over an 80 dB range

Alphanumeric Read-outs: full scale level, frequency span, samples after trigger, number of spectra averaged, selected frequency line or sample number, selected frequency or time, selected level

Line Selector: line moved either continuously or in single steps to the right or to the left, indicated by an intensified column

Amplitude at Line Selector: shown on display in V, or in dB referenced to 1 μV, or dB referenced to 1 μV ± 50 dB, or dB referenced to the RMS level in any channel of the spectrum, or linear units referenced to any channel of the spectrum

Time at Line Selector: shown on display referenced to first sample or relative to any sample in the record

Time Function Display: envelope of 10 K samples or 1 K samples, or 390 contiguous samples

Level Recorder Output:

Output Impedance: 1 kΩ

Maximum Output Voltage: + 15 V (nominal 12 V)

Digital Input and Output:

Interface: conforms to IEC 625-1 standard, compatible with IEEE Std. 488

Functions: SH1, AH1, T5, L3, SR1, RLØ, PPØ, DC2 and DTØ

Data: functions selected by Display Selector, or with controller, any main memory block

Code: ISO 7-bit code or binary, selected from controller

Remote Control: front panel settings can be input and output via digital interface

Miscellaneous:

Power Supply: 100, 115, 125, 200, 220, 240 V AC, ± 10%, 50 to 60 Hz, consumption approx. 120 VA. Complies with IEC 348 Safety Class II

Environment: temperature range (for operation within specifications), + 5°C to + 40°C

Electromagnetic Compatibility: Complies with American FCC requirements for Class A computing device

Storage Temperature: −25°C to + 75°C

Cabinet: Supplied as model A (lightweight metal cabinet) or C (as A but with flanges for standard 19" racks)

Dimensions and Weight: (A-cabinet with feet)
Height: 310,4 mm (12,2 in)
Width: 430 mm (16,9 in)
Depth: 500 mm (19,7 in)
Weight: 22 kg (48,5 lb)

X-Y Recorder Output ZN 0204 (optional):
(replaces Level Recorder Output)

X-Deflection:

Read-out time: switch selectable 45, 118, or 263 s

Output Voltage: staircase 0 to + 10 V 400 steps, (linearity better than 0,1%), full scale deflection in "Cal." mode

Output Impedance: 100 Ω

Y-Deflection:

Output Voltage: 0 to + 10 V, in 256 steps (accuracy better than ±10 mV), full scale deflection in "Cal." mode

Output Impedance: 100 Ω

Accessories Included:

Mains cable	AN 0020
IEC Bus Connector Kit	UA 0793
1 B & K plug	JP 0101
1 BNC plug	JP 0035
Cam disc for 2307	OD 0253
Remote control cable for 2307	AQ 0035
Cam switch cable for 2307 and Remote 1 cable for 2308	AQ 0034
Signal cable for 2307	AO 0064
Signal cable for 2308	AO 0087
Spare fuses 0,63 A	VF 0032
Spare fuses 1,25 A	VF 0027

Accessories Available:

IEC 625–1 interface cable (2m)	AO 0194
IEC (male, slide-lock) to IEC 625–1	AO 0184
Adaptor to convert IEEE instrument to IEC 625–1	AO 0195
Preprinted Level Recorder paper	QP 1103
Preprinted X-Y Recorder paper	QP 1002

Display/Documentation Program BZ 0013 for operation in an HP 9825 calculator when it is connected to a 2033