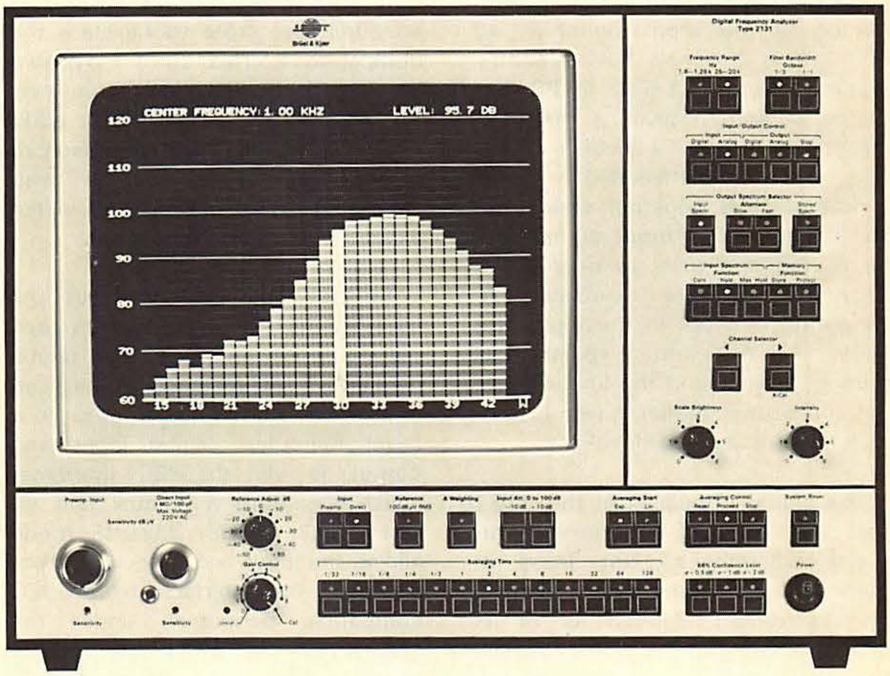
type 2131

Digital Frequency Analyzer



FEATURES:

- Real-time 1/3 octave analysis in 42 channels with centre frequencies from 1,6 Hz to 20 kHz
- Real-time octave analysis in 14 channels with centre frequencies from 2 Hz to 16 kHz
- Almost entirely digital construction gives exceptional operational flexibility
- Digital true RMS detector for wide crest factor capability
- Linear and exponential averaging with selectable averaging time
- Exponential averaging with selectable statistical accuracy
- Both analogue and digital input and output
- Hold facility allows instantaneous spectrum to be held
- Independent memory for storing a spectrum for later recall and comparison with other spectra
- Max. Hold facility allows maximum level in each channel to be held
- Spectrum shown on a calibrated, large screen display with a 60 dB display range
- Alphanumeric read-out of channel level and centre frequency directly from the display
- Pushbutton control for ease of operation
- All major controls externally programmable
- Interface to IEC 625-1/IEEE Std. 488 interface bus
- 1/12 octave analysis

USES:

- Real-time analysis of continuous and impulsive signals
- Provision of data for further computation e.g., in aircraft noise measurement and certification
- On-line production testing in quality control
- Phonetics and speech therapy
- Acoustical research
- Analysis of community noise
- On-line analysis of complex signals

Introduction

The Digital Frequency Analyzer Type 2131 is designed to measure and display octave and 1/3 octave spectra in real-time and may be used in a wide variety of analyses of acoustic, vibration and other signals. It is almost entirely digital in operation, in that it uses digital filtering, RMS detection and averaging techniques. The results obtained are displayed on a calibrated, large screen display, and may be output to a variety of analogue and digital peripherals.

The 2131 has two modes of operation, pushbutton selectable from the front panel. In the first, it gives a real-time measurement of the amplitude of the input signal in 42 1/3 octave channels having centre frequencies from 1,6 Hz to 20 kHz. In the second, it gives a real-time measurement in 14 octave channels having centre frequencies from 2 Hz to 16 kHz, together with a linear channel. The input signal may be A-weighted prior to analysis, if required, using a selectable A-weighting network in the input amplifier. An A-weighted spectrum is then displayed, and the linear channel (in octave mode) gives the A-weighted input signal level.

The digital principles of the 2131 give it a series of important operational advantages. Not least of these is the extreme ease of use of the instrument. Almost all of its functions are pushbutton controlled from an electronic control panel, with LED indicators to show their status. This electronic control in turn allows an extremely wide range of functions to be remotely sensed and controlled over the 2131 IEC interface, by an IEC interface bus controller.

Advantages are also apparent in the display of data, with text being generated in Read Only Memories to give a spectral display which is calibrated in dB and channel number. The amplitude display range is 60 dB, while the frequency display range is pushbutton selectable between 1,6 Hz — 1,25 kHz and 25 Hz — 20 kHz, corresponding to the vibrational and acoustical frequency ranges respectively. Any change in the input attenuation or displayed frequency range is accompanied by an immediate automatic adjustment of the calibration. A channel selector can be used to read-out the centre frequency and amplitude of any of the channels from alphanumeric displays on the display screen.

It is often useful to be able to store a spectrum, and then compare it with another spectrum at a later time. To allow this, the 2131 contains a digital memory. A spectrum may be read into this memory, and then recalled to the display at a later time to allow comparison with new data. The new data may be held in an additional store to facilitate the comparisons. This store may also be used to hold the maximum level occurring in each channel. In addition to facilitating the comparison of spectra, the store may be used independently of the memory in the examination of analyzed data.

Spectra contained in both the memory and the store can be read out to both analogue and digital periherals. An analogue output can be made to an XY Recorder or to a Level Recorder. Digital input and output is via the IEC interface, which has both a manual and an addressable mode. Manual mode allows the input and output of spectra over the interface to an IEC compatible peripheral, under the control of the 2131 front panel controls. When, for example, this peripheral is an IEC compatible digital cassette recorder e.g. B & K Type 7400, this forms a convenient method for the long term storage of reference spectra, which may be reentered into the 2131 at will. Addressable mode allows the input and output of both spectra and remote programming information over the IEC interface bus.

Many of the features mentioned above arise as a direct result of the digital principles of the 2131. However, it should also be mentioned that the techniques themselves add further features and advantages. For instance, a digital filter has a better controlled filter shape and a greater freedom from drift than its analogue equivalent. It requires no special trimming to maintain its properties as components age. Further, it is inherently more flexible. However, probably the most important advantages are that digital filtering techniques greatly simplify the use of a digital detector and a digital averager.

By using a digital detector, the 2131 gives true RMS detection without crest factor limitation, apart from the natural limitations of dynamic range and filter response time. The digital averager, on the other hand, gives a flexibility impossible to acheive by analogue means, in that it can offer both linear and exponential averaging. In linear averaging, the detected data is averaged over a fixed time window, while in exponential averaging a continuous average is made. In both modes, 13 different averaging times from 1/32 s to 128 s in a binary sequence, pushbutton selectable from the front panel, may be used. These give the same averaging time across all channels, to give the same response time in each channel. This is important, e.g., in the analysis of impulses. Additionally exponential averaging may be made with a fixed 68% confidence level, σ. This enables averaging with the same statistical accuracy in each channel, which is important in measurements on random signals. A 68% confidence level of $\sigma < 2$ dB, $\sigma < 1$ dB, or $\sigma < 0,5$ dB can be pushbutton selected from the front panel.

The 2131 is provided with an internal amplitude reference for easy calibration. Its level is 100 dB RMS referred to 1 μV. A reference adjustment is also provided enabling the reference level to be adjusted in steps of 10 dB through a range of ± 50 dB.

Digital Filtering

For a complete explanation of digital filtering, reference to one of the standard texts on the subject is recommended, such as "Digital Signal Processing" by A.V. Oppenheimer and R.W. Schafer, published by

Prentice-Hall in 1975 or "Theory and Applications of Digital Signal Processing" by L.R. Rabiner and B. Gold, published by Prentice-Hall in 1975. A generalised block diagram of a two-pole digital filter is shown in Fig.1. This filter is of the type known as recursive, meaning that feedback is used such that the output of the filter is always an explicit function of the previous inputs and outputs. Its properties, i.e., its shape, its relative bandwidth, and whether it is high-pass, low-pass, bandpass or bandstop, are a function of the multiplier coefficients A_0, A_1, A_2, B_1 and B_2. The frequency range in which it operates is a function of the delay z^{-1}. Assuming that the addition and multiplication operations are instantaneous, the delay z^{-1} is equal to one sampling interval. Hence, by altering the sampling interval, it is possible to alter the frequency range in which the filter operates. For instance, doubling the sampling interval, (i.e., halving the sampling frequency), will mean that the filter operates with the same relative bandwidth but in a frequency range one octave lower.

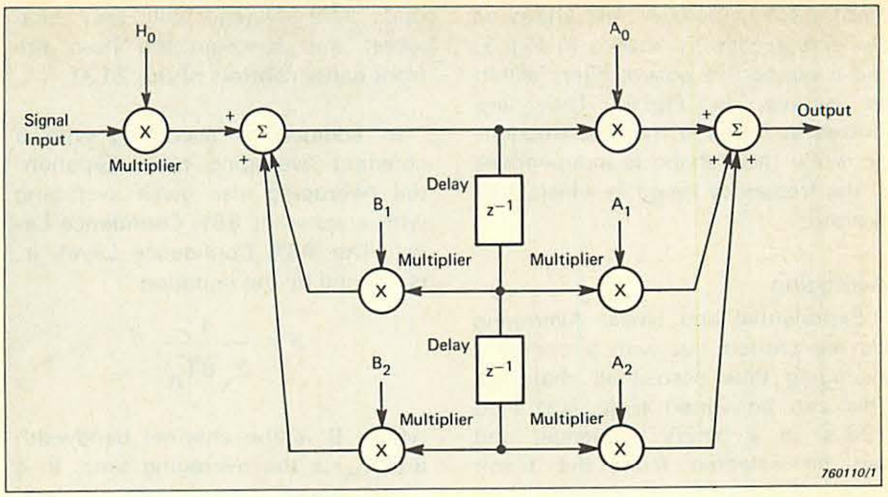


Fig.1. Generalised block diagram of a 2-pole recursive digital filter

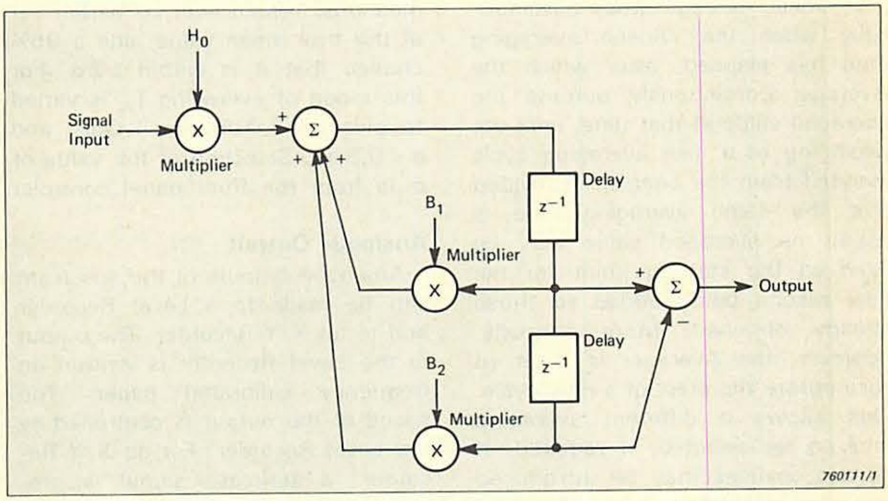


Fig.2. Block diagram of 2-pole digital filter used in the 2131

The properties of a digital filter with respect to response time, phase shift, etc., are virtually the same as for the equivalent analogue filter. The transfer function is written using z-transform notation, and the transfer function of the filter of Fig.1 is:

$$H(z) = H_0 \frac{A_0 + A_1 z^{-1} + A_2 z^{-2}}{1 - B_1 z^{-1} - B_2 z^{-2}}$$

The z-transform is a discrete equivalent of the Laplace transform with the z^{-1} operator taking the place of the Laplace operator s. Conversion between the two can be made using the identity
$z^{-1} = \exp.(-st)$.

In the 2131 filters, a special form of the z-transform is used, known as the matched z-transform, and the filter block diagram is modified to that of Fig.2. The transfer function of this filter is modified with respect to the general case to become:

$$H(z) = H_0 \frac{1 - z^{-1}}{1 - B_1 z^{-1} - B_2 z^{-2}}$$

In a practical digital filter, the multiplication processes take a period of time which is significant when compared to the sampling interval, z^{-1}. The delay is hence modified to make it plus the multiplication time equal to the sampling interval. The input to the filter is a series of digitised samples representing the time function. The filter modifies them to give an output which is a modified series of samples representing the filtered time function.

Filter Characteristics

Octave operation of the Filtering Section is similar to 1/3 octave operation, except that after their first passage through the Bandpass Filter, the samples are re-entered into the Bandpass Filter Multiplexer for a second passage. This double passage through the 6-pole unit gives 12-pole filtering.

The 1/3 octave filters of the 2131 conform to IEC 225 1966, DIN 45 652 and ANSI S1.11, Class III. In octave operation, they conform to IEC 225 1966, DIN 45 652 and

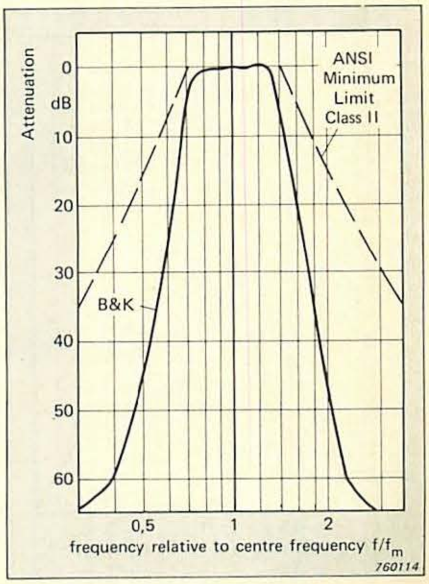


Fig.3. Octave filter characteristic of the 2131 Analyzer

ANSI S1.11, Class II. The shape of the octave filter is shown in Fig. 3, and a typical 1/3 octave filter, within an octave, in Fig. 4. They are plotted in terms of relative frequency, since their shape is independent of the frequency range in which they operate.

Averaging

Exponential and Linear Averaging can be carried out with a constant averaging time across all channels. This can be varied from 1/32 s to 128 s, in a binary sequence, and can be selected from the fromt panel controls.

A Linear Average stops automatically when the chosen averaging time has elapsed, after which the Averager continuously outputs the averaged value at that time, until the beginning of a new averaging cycle initiated from the controls. Provided that the same averaging time is used, the averaged value may be used as the starting point for the new results being added to those already obtained. More normally, however, the Averager is reset to zero before the start of a new cycle. This allows a different averaging time to be selected, if required. If needed, pauses may be introduced into the averaging cycle, allowing, e.g., the change of signal sources.

With Exponential Averaging, the averaging time may be changed at will while the average is in progress. The average will only stop when this is requested from the front panel controls of the 2131.

In addition to averaging with a constant averaging time, Exponential Averaging also gives averaging with a constant 68% Confidence Level. The 68% Confidence Level, σ, is defined by the equation:

$$\sigma = \frac{1}{2\sqrt{BT_A}}$$

where B is the channel bandwidth and T_A is the averaging time. In a measurement on random data, there is then a 68% chance that the measured results will be within $\pm\sigma$ of the true mean value, and a 96% chance that it is within $\pm 2\sigma$. For this mode of averaging T_A is varied to give $\sigma < 2{,}0$ dB, $\sigma < 1{,}0$ dB, and $\sigma < 0{,}5$ dB. Selection of the value of σ is from the front panel controls.

Analogue Output

Analogue outputs of the spectrum can be made to a Level Recorder and to an X/Y Recorder. The output to the Level Recorder is written on frequency calibrated paper. The speed of the output is controlled by the Level Recorder. For an X/Y Recorder, a staircase signal is provided to give the X-deflection. The period of the staircase is 45 s for an output from 25 Hz to 20 kHz and 60 s for an output from 1,6 Hz to 20 kHz. Frequency and amplitude calibration signals are provided. Note that when an output is made with an alternating display, the speed of the output is slowed by a factor of 8, or a factor of 4 if a small internal modification is made. Note also that during all outputs (both analogue and digital), an internal hold function is generated for the period of the output.

Digital Input/Output

Displayed spectra may also be output digitally to a range of digital equipment via the Interface Bus connector. The output is encoded in ISO 7-bit code, (i.e. ASCII, but without the parity bit). On request of a digital output, the internal hold function is immediately activated. However, it is then necessary to wait for up to 22 ms for the beginning of the display update cycle. Once the cycle has begun, it becomes possible to read-out a spectrum at a maximum speed of 60 μs per channel. Where read-out is to slower peripherals, the normal signals are available to control the read-out at a slower rate. Note that it is necessary to wait a minimum of 44 ms between two digital read-outs to ensure that the display screen has been updated.

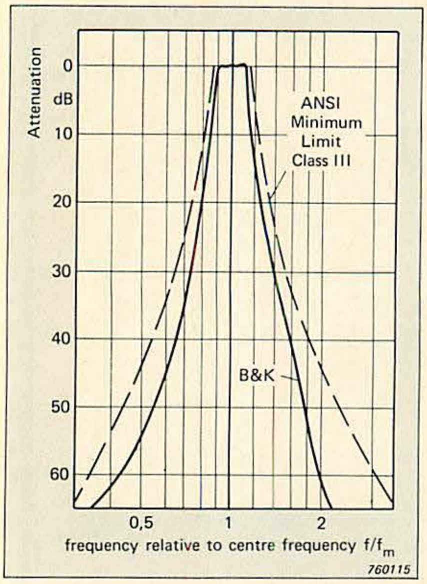
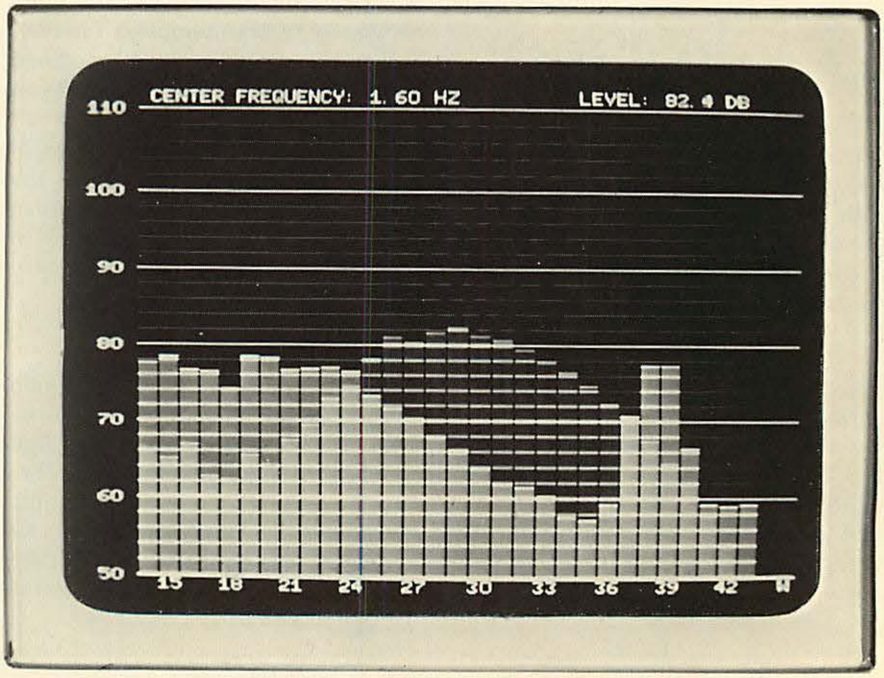


Fig.4. 1/3 octave filter characteristic of the 2131 Analyzer



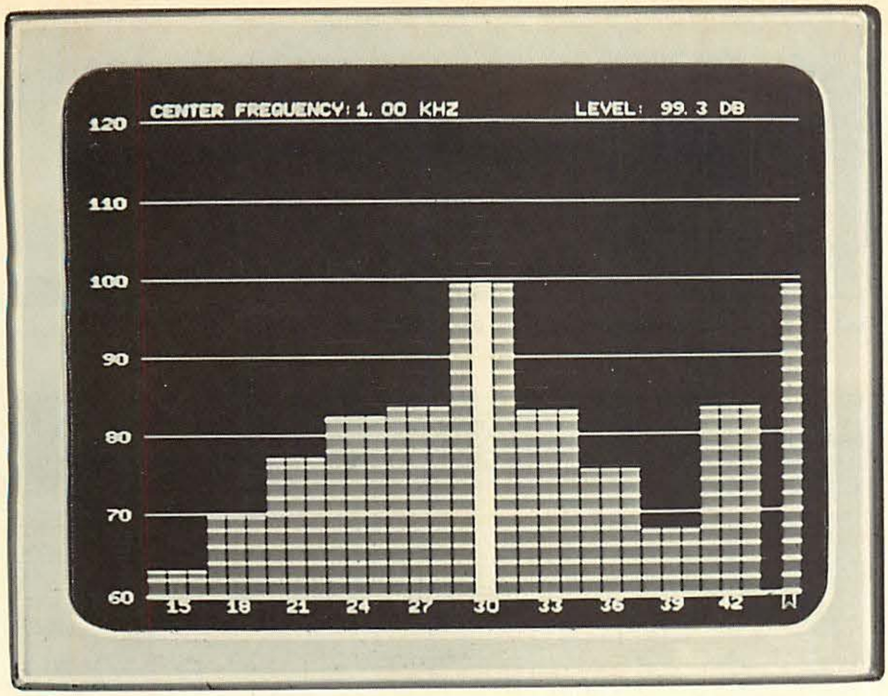


Fig.6. Typical octave spectrum as displayed on the screen of the analyzer

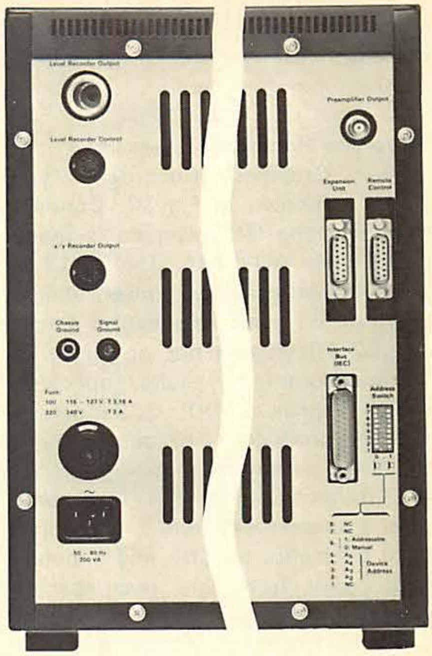


Fig.7. Split view of rear panel showing plugs and sockets

When the 2131 is connected to a computer, a very wide range of remote sense and control functions become available. These are entered via the Interface Bus connector in the form of a code, and are decoded into their actual functions in the remote control and front panel control. Alternatively, after a small internal modification, these signals may be entered via a separate Remote Control socket.

Peripheral Equipment For 2131

Connection of Equipment over IEC Interface

The IEC interface of the 2131 conforms to IEC 625-1 which is compatible with IEEE Standard 488/ANSI MC 1.1. Hence, connection of the 2131 to an IEC or IEEE interface bus system is only a matter of using the appropriate cable.

Of particular interest is the connection of a desk-top calculator to the 2131 over the IEC interface. The calculator can then operate on data supplied by the 2131 in automatic test sequences, the system forming a formidable acoustic measuring package.

Two general purpose programs have been produced by B & K to enable basic acoustical calculations to be made by desk-top calculators on data supplied by the 2131. They are BZ 0011 for the Tek 4051/52, and BZ 0012 for the HP 9825. Further details are available on request.

Alphanumeric Printer Type 2312

The Alphanumeric Printer Type 2312 is shown in Fig. 8. It may be connected to the 2131 over the IEC interface, and used to obtain a hard copy of a spectrum in the form of a print-out giving the level in dB in each channel, such print-outs being initiated over the front-panel controls of the 2131.

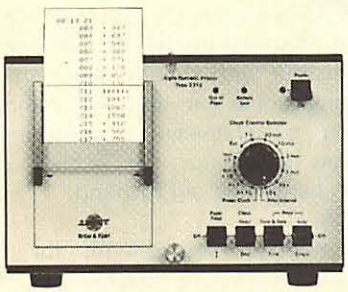


Fig.8. B & K Alphanumeric Printer Type 2312

The 2131 can output data in either of two formats. On delivery, the simpler format is selected, in order to give the faster read-out. In outputs to the 2312, however, it can be an advantage to select the second data format, which will give a more "readable" print-out with no significant increase in the time taken to generate it.

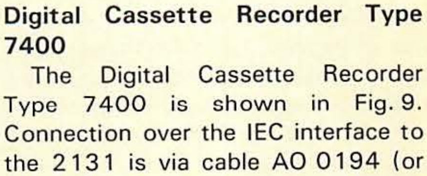


Fig.9. B & K Digital Cassette Recorder Type 7400

Digital Cassette Recorder Type 7400

The Digital Cassette Recorder Type 7400 is shown in Fig. 9. Connection over the IEC interface to the 2131 is via cable AO 0194 (or AO 0184 for earlier Type 7400's fitted with a female, slide-lock interface connector). The 2131 spectrum is stored in a file in the 7400 tape cassette using the 7400 and 2131 front panel controls. To re-access the spectrum it is only necessary to select the spectrum file number on the 7400 and the spectrum can be read back to the 2131 display screen. Up to 500 k bytes of data can be stored on a single cassette enabling approximately 1200 spectra to be stored on the tape.

Graphics Recorder Type 2313

The Graphics Recorder Type 2313 is shown in Fig. 10. Connection over the IEC interface is made using cable AO 0194. The 2313 is a fast digital graphics printer, which, when fitted with Application Package BZ 7001, can not only plot or list measurement results, but also store approx. 300 1/3 octave spectra, produce 1/12 octave spectra, three parameter mapping (amplitude-frequency-time) for reverberation measurement, etc., and produce difference spectra and simultaneous plot from any two spectra stored with Type 2313 or Digital Cassette Recorder 7400. A range of application packages are avaliable for interface with other B & K instruments, see your B & K representative for details.

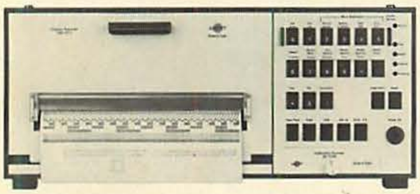


Fig. 10. B & K Graphics Recorder Type 2313

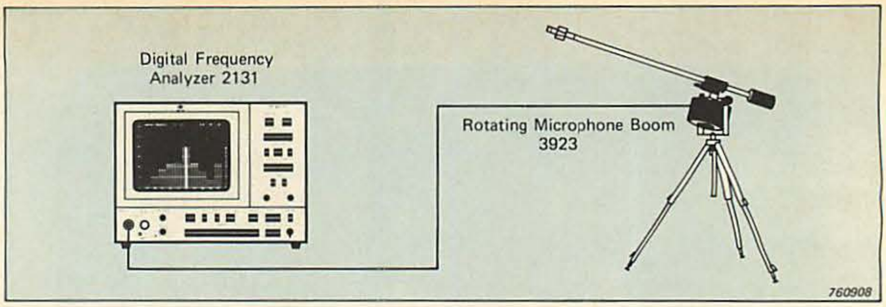


Fig. 11. Use of the Rotating Microphone Boom Type 3923 with the 2131 in Sound Power Measurement

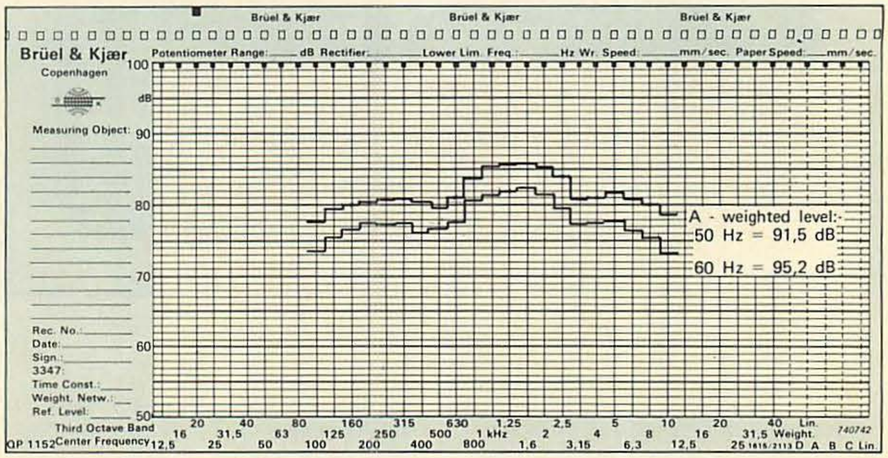


Fig. 12. Typical sound power spectrum of Reference Sound Source Type 4204, used in Sound Power measurements with the 2131 in the comparison method

Examples of Use

Measurement of Sound Power

The measurement of Sound Power is the subject of ISO standards 3740 through to 3746. They specify the measurement of Sound Power under various conditions and to varying degrees of accuracy. Although they do not deprecate the use of exponential or RC type averaging, these documents are unanimous in recommending the use of linear averaging in the measurement of Sound Power.

A 2131 connected to the Rotating Microphone Boom Type 3923 makes an ideal system for measuring Sound Power according to these standards and draft standards. In them, the sound field emitted by the object under investigation can either be measured using an array of microphones set up at predetermined positions around the object, or using a single microphone which is traversed around the object on a fixed path. A system comprising the 3923 and the 2131 uses the latter method. The greatest advantage of this method is that the greater part of the spatial averaging of the sound field is carried out automatically by the linear averaging process of the 2131. At the end of the measurement procedure, the engineer is no longer left with a complex and lengthy calculation process requiring the use of a minicomputer, but with simple data manipulations which can be easily handled using a relatively unsophisticated pocket calculator, or which can even be carried out by hand.

The major requirement for the use of a moving microphone for Sound Power Measurements is that the microphone should make one or more complete traverses around the sound source during one linear averaging period. The path of the traverse, which is usually circular around a sphere or hemisphere having the sound source at its centre, is specified by the relevant document. The 3923 can be used to give circular traverses having varying diameters and periods of 16 s, 32 s, or 64 s. Hence, it is only a matter of selecting the appropriate linear averaging time on the 2131, and synchronizing the start of the 3923 traverse with the start of the averaging period on the 2131 before these requirements are fulfilled. At the end of the averaging period, the 2131 will display a spectrum of the average sound field along the path of the microphone.

At the end of the measurement procedure, a number of spectra will result, each one corresponding to a different traverse path. These spectra may be averaged externally to the 2131, or internally, by adding successive averages and then correcting the spectral levels obtained for the number of spectra added, (note that this process is not recommended for large numbers of spectra, since noise can begin to become significant). The Sound Power of the object under investigation may then be calculated from this resulting spectrum, various corrections being taken into account according to the method in use.

Hence, by using the 2131 with the 3923, the complexities of Sound Power measurement are considerably reduced.

Under reverberant conditions, a further stage of simplification is possible by using the Reference Sound Source Type 4204. This gives a known Sound Power, and allows the comparison method of measurement, specified in ISO 3741, to be used.

Calculator Controlled Operation

The wide range of remote sense and control facilities available on the 2131, and its IEC 625-1 standard interface, make connection of the 2131 to an IEC/IEEE compatible calculator especially interesting. Not only does the digital input and output of data become possible, but almost the complete software control of the 2131.

When it is being controlled over its IEC interface, the 2131 can be contacted over a total of 4 different addresses, two being listen addresses, one for data and one for remote programming information, and the other two being talk addresses, one for data and one for status information. In a typical data transfer, the 2131 will be contacted over its programming listen address, such that its controls can be set for the measurement in progress, and then over its data listen address, for a digital input, or over its data talk address, for a digital output, or over its status talk address, if the status of one of its controls is being interrogated. In this way completely automatic operation can be obtained.

Up to 15 devices can be connected to the IEC interface at any one time. Hence, the 2131 can become a part of a more complex measurement set-up in which all of the instruments are being controlled over their IEC interfaces. This allows the generation of complex test sequences under completely automatic control.

1/12 Octave Analysis

One the properties of a digital filter is that by changing the multiplier coefficients used within the filter, the same hardware can be used to represent a totally different filter shape. In the 2131, the multiplier coefficients are stored in Read Only Memories, (ROMs). In addition to those used in 1/1 octave and 1/3 octave analysis, the ROMs contain an extra set of coefficients which allow 1/12 octave operation. This extra set of coefficients can be accessed over the IEC interface using an interface controller, such as a Graphics Recorder Type 2313 (mentioned earlier), or a desktop calculator.

Note that in the 1/12 octave mode, operation of the 2131 ceases to be in real-time. Instead, a 4-pass analysis is made, the 2131 calculating a new 1/12 octave within each 1/3 octave with each pass, allowing the full 1/12 octave spectrum to be built up. Only one 1/12 octave within each 1/3 octave can be displayed at any one time, and the read-outs are as for 1/3 octave mode.

Extension Units

The range of analysis may also be extended using extension units. A two channel extension unit WH 0490 is available as a plug-in PC card. These two extra channels are displayed in the 1/3 octave mode of analysis. Their characteristics are selectable between A, B, C, D, or Linear Weighting, with Fast, slow, or Impulse response, all switch selectable on the circuit card comprising the extension unit, which is mounted inside the 2131. A WI 1624 Linear Averager modification to the WH 0490 is available to provide true L_{eq} values when the detector response Fast/Slow is selected. A WI 1211/WB 0341 option allows external control of all WH 0490 functions. A seperate WH 0490 System Development data sheet is available for further details.

Another unit, B & K Expansion Unit Type 5765, is available for connection to a 2131 to enable eleven extra channels to be displayed. A control circuit WH 0333 is available for simultaneous control of options WH 0490 and 5765. A seperate 5765 System Development data sheet is available for further details.

Specifications 2131

Preamplifier:

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

Input Impedance:

Direct: 1 MΩ//100 pF

Input Voltage: 1 μV to 100 V plus 6 dB safety factor

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

Overload Indicators: Growth of light intensity in every second line of the display screen when the analogue Input Section of the 2131 is overloaded

Frequency Range: 2 Hz to 100 kHz ± 0,2 dB, 100 to 200 kHz ± 0,5 dB

Output: From "Preamplifier Output" on the rear panel

Filters:

1/3 Octave Filters: 42 Chebyshev filters with centre frequencies from 1,6 Hz to 20 kHz. Fulfil IEC 225-1966, DIN 45 652 and ANSI S1.11-1966 Class III

1/1 Octave Filters: 14 Chebyshev filters with centre frequencies from 2 Hz to 16 kHz. Fulfil IEC 225-1966, DIN 45 652 and ANSI S1.11-1966 Class II

1/12 Octave Filters: 6-pole filters having centre frequencies of, (for the 16 kHz octave), 21,75 kHz, 20,54 kHz, 19,39 kHz, 18,30 kHz, 17,28 KHz, 16,31 KHz, 15,40 kHz, 14,54 kHz, 13,73 kHz, 12,96 KHz, 12,23 kHz and 11,55 kHz. To obtain the centre frequencies in lower octaves, multiply by 2^{-k}, where k is the number of octaves lower

A-filter: Fulfils IEC 651 type I. When "A-weighting" is activated, both the 1/3 and 1/1 octave spectra are A-weighted. The A-weighted level appears in Channel W (1/1 octave only)

Linear filter: Low frequency cut-off at 1 Hz with an 18 dB/octave roll-off. High frequency cut-off 27 kHz with a 72 dB/octave roll-off. The level of the linear filter appears in channel W (1/1 octave only without A-weighting)

ADC: 12-bit two's complement. Quantizing error ± 1/2 LSB. Conversion time 7 μs. Sampling frequency 66,667 kHz

Analogue Antialiasing Filter: 12-pole Butterworth low-pass filter with 27 kHz cut-off frequency and 72 dB/octave roll-off

Detectors:

Digital true RMS detection of the Filter Unit output, using a 13 bit input. 60 dB RMS dynamic range with 9 dB crest factor margin over the top of the dynamic range

Averaging: Both exponential and linear averaging are provided
Averaging Times: Averaging times of from 1/32 s to 128 s in a binary sequence can be selected in both exponential and linear averaging
Confidence Levels: 68% confidence levels of $\sigma < 2{,}0$ dB, $\sigma < 1{,}0$ dB and $\sigma < 0{,}5$ dB can be selected in exponential averaging

System Accuracy:
Accuracy: Accuracy to a sine wave input at the filter centre frequency is as follows, (5 to 40°C)*:
better than ± 0,2 dB 0 to 30 dB below FSD
better than ± 0,4 dB 30 to 40 dB below FSD
better than ± 0,8 dB 40 to 50 dB below FSD
better than ± 1,5 dB 50 to 55 dB below FSD
better than ± 2,0 dB 55 to 60 dB below FSD

With measurements more than 48 dB below full scale, the measuring sine wave should be accompained by another signal outside the measured channel, having an amplitude greater than 40 dB below FSD

Resolution: The spectral level which will be obtained from the alphanumeric displays on the display screen will have the following resolution:
0,1 dB 0 to 50 dB below FSD
0,1 to 0,3 dB 50 to 55 dB below FSD
0,4 to 0,8 dB 55 to 59 dB below FSD
1,0 dB 59 to 60 dB below FSD

Storage Modes:
Input Spectrum Store: "Cont." for continuous update of the Input Spectrum Store with the latest RMS spectrum
"Hold" holds the spectrum contained in the Input Spectrum Store and stops further updating
"Max. Hold" for storing of the maximum RMS signal level in each channel
Memory: "Store" stores the contents of the Input Spectrum Store in the Memory
"Protect" prevents further updating of the Memory

Display Screen:
The display screen shows the contents of whichever store is selected by the Output Spectrum Selector
Size: 11"
Display Area: 15 cm × 21 cm (6 in × 8 1/4 in)
Scale Lines: 31 horizontal lines are electronically generated directly on the screen for parallax-free readings, calibrated in dB. The dB scale changes automatically with Input Attenuator and Reference adjustments
Representation of Channels: In 31 channels, 30 of which represent 1/1 or 1/3 octave information, and one represents the linear channel. Each channel is represented by a column consisting of 10 vertical lines, one of which is darkened to give channel separation. The channels are identified by the channel number, which is, (to the nearest integer) 10 $\log_{10} f_0$, where f_0 is the channel centre frequency. The columns represent whichever frequency range is selected by the Frequency Range selector
Brightness Control: Potentiometer regulation of the scale lines and frequency spectrum. The scale brightness can also be independently varied, allowing fade-out so that only the frequency spectrum is seen
Overload: Input Spectrum Function "Cont.": The spectrum display is intensified when the analogue Input Section of the 2131 is overloaded
Input Spectrum Function "Hold": The spectrum display is kept intensified when the analogue Input Section of the 2131 is overloaded
Input Spectrum Function "Max. Hold": Those channels in which overload occurs are kept intensified
Channel Selector: The selected channel is indicated with an intensified column
Alphanumeric Read-outs: "Center Frequency" gives the selected channel centre frequency in Hz
"Level" gives the selected channel level in dB, maximum reading 216 dB. Dynamic range 66 dB
Line Frequency: 16,67 kHz
Frame Frequency: 45,5 Hz

Analogue Outputs:
Preamplifier Output: Bandwidth, 1 Hz to 200 kHz
Output Impedance, 100 Ω, Maximum Voltage Swing 5 Vp, Minimum Load Impedance, 5 kΩ
Level Recorder Output: Output Impedance 1 kΩ, Maximum Output Voltage + 15 V (nominal 12 V)
Level Recorder Control: Connection to the Level Recorder Control Socket is via Cable AQ 0027 for a 2305 and Cable AQ 0035 for a 2307
X/Y Output: Output Impedance 100 Ω
X-ramp: Staircase voltage going from 0 to 7,27 V in 45 s for a read-out starting at the 25 Hz channel, and from 0 to 10 V in 60 s for a read-out starting at the 1,6 Hz channel. For a read-out with alternating display, these times are increased by a factor of 8 (or 4 after internal modification). Accuracy ± 10 mV
Y-Level: 0 to 6,60 V with a resolution of 0,2 dB and accuracy of ± 10 mV. Pen lift control by contact closure

Digital Input and Output:
Code: ISO 7-bit code (i.e. ASCII but without the parity bit). Range 0 to 216 dB
Logic Levels: TTL Compatible
Dynamic Range: 66 dB
Resolution: 0,1 dB

IEC Interface:
Conforms to IEC 625-1 compatible with IEEE Std. 488. Allows digital input and output and remote programming of the 2131 over the IEC interface bus
Functions Implemented: SH 1, AH 1, T7 T8, L3, L4, DC1

Remote Control
After internal modification, remote programming is also possible via the Remote Control Socket.

Power Supply:
100, 115, 127, 150, 220, 240 V AC ± 10% 50 to 60 Hz, approx. 200 VA
Complies with Safety Class I of IEC 348

Environment:
Temperature Range: (for operation within specifications) + 5°C to + 40°C
Storage Temperature: −25°C to + 70°C
Electromagnetic Compatibility: Complies with American FCC requirements for Class A computing device

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

Dimensions and Weight:
(A-cabinet without feet)
Height: 310,4 mm (12,2 in)
Width: 430 mm (16,9 in)
Depth: 500 mm (19,7 in)
Weight: 29 kg (64 lb)

Accessories Included:

1 Mains cable	AN 0010
1 8-pole DIN plug	JP 0802
2 B & K plugs	JP 0101
1 BNC plug	JP 0035
1 Frequency Scale	SC 0354
1 Roll recording paper	QP 1153
IEC Bus Connector Kit	UA 0793

Accessories Available:

Level Recorder Type 2305 control cable,	AQ 0027
Level Recorder Type 2307 control cable,	AQ 0035
IEC 625-1 interface cable (2 m)	AO 0194
IEC (male, slide-lock) to IEC 625-1 interface cable (2 m)	AO 0184
IEC 625-1 ⟺ IEEE 488 interface cable (2 m)	AO 0265
Adaptor to convert IEEE instrument to IEC 625-1	AO 0195
15-pole plug for extension unit and remote control sockets	JP 1502

(Kit comprising plug JP 1501, cover DH 0207 and sliding lock DH 0292)
WH 0490 2 Channel Extension Unit giving A, B, C, D, or Lin weighting with Fast, Slow or Impulse response in each channel
WI 1624 Linear Averager modification to the WH 0490
WH 1211/WB 0341 for external control of WH 0490
5765 Expansion Unit can add up to 11 further channels to the 2131
WH 0333 for control of both WH 0490 and 5765