

Product Data

Bus-controlled Frequency Analyzers — Types 2140, 2141

USES:

- Dual-channel constant-percentage frequency analysis of sound and vibration signals in real-time use
- Vehicle and aircraft testing
- QC testing (on-line production control)
- Environmental noise/vibration measurement
- Real-time frequency analysis up to 22.4 kHz (single channel), 11.2 kHz (dual channel)
- 80 dB dynamic range, auto-calibration
- 1/1-, 1/3-, 1/12-, 1/24- octave filters
- Large internal non-volatile memory
- Spectra annotated in decibels or in absolute units
- May be configured with another input module and program to meet special demands
- Bootload facility for loading alternative programs
- Computer controlled multichannel analysis
- Up to 14 analyzer units plus a standard IEEE controller can be configured as a multichannel analysis system

FEATURES:

- Inputs: preamplifier (for microphone), charge (for accelerometer) and direct (via adaptor)

Dual Channel Bus-controlled Frequency Analyzers Types 2140 and 2141 are remote controlled analyzers for acoustics and vibration measurements in production and laboratory environments. Type 2141 offers cross-spectra, complex sound intensity, coherence and frequency response functions.

The analyzers feature real-time digital filtering over a wide frequency range. Real-time operation is important for the analysis of non-stationary signals such as decays and impulsive events. The analyzers are operated remotely from a controller, using either the IEEE-488 or RS-232 interface.

The large internal non-volatile memory and data transfer capabilities make the analyzers useful data gathering devices.

As they have no display or external push-button controls, these analyzers can be enclosed in very compact modular housings (H: 177, W: 142.5, D: 320 mm). Three of these units can be mounted side-by-side in a standard 19" rack. The analyzers are fitted with dual-channel input modules so it is possible to construct compact multichannel analysis systems.

Each analyzer is powered by an external DC source, e.g. a general purpose laboratory power supply or a car battery. For powering several units, WB 1250 is capable of supplying up to 15 analyzer units, i.e. 30 input channels.

With the exception of the analog input modules (input amplifiers, attenuators and filters), the analyzers are digital instruments. This means that calibration is extremely stable, exhibiting virtually no drift effects.

The internal memory holds several hundreds of spectra. This memory is non-volatile, which means that stored data is protected against power failures. Data files can also be transferred to an external computer for storage on disk.

Types 2140 and 2141 operate in real-time when analysing in 1/1- or 1/3-octaves. There is a choice of real-

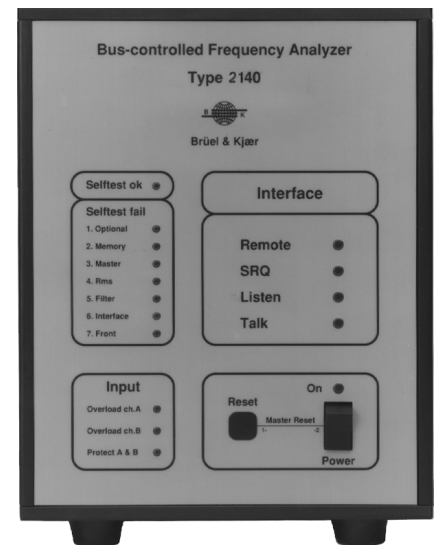


Fig.1 Type 2140 front panel

time or multi-pass analysis for 1/12- and 1/24-octave bandwidths. Multi-pass analysis involves the analyzers processing signals from batches of filters in sequence, rather than from all filters simultaneously, which increases the available frequency range. This method works for stationary or repeatable signals.

Introduction

Bus-controlled Frequency Analyzers Types 2140 and 2141 are designed for use in fixed measurement set-ups, in laboratory or production environments. They are remotely operated from a controller, using either the IEEE-488 or RS-232 interface.

Input/Output

The analyzers have inputs on the back panel for connecting accelerometers, microphone preamplifiers or direct electrical signals, and standard RS-232 and IEEE-488 digital interface connector sockets. Each of the signal inputs has a dynamic range of more than 80 dB. Instantaneous overloads are indicated by LEDs on the front panel (see Fig. 1) and can also be read out over the interface. As an extra option, WH2702, the conditioned input signals present in front of the anti-aliasing filters can be output via the two BNC connectors on the back panel, labelled "Analog Outputs Ch.A & Ch.B". The signals can then be viewed on an oscilloscope, monitored using headphones, or fed to another instrument for further analysis.

High-pass filters with 0.1 dB cut-off frequencies of 0.7 Hz (0.35 Hz for charge input), 20 Hz or 100 Hz can be selected for all inputs. In addition, an analogue A-weighting filter can be selected for the microphone preamplifier input and the direct input. Pre-A-weighting allows SLM type measurements to be made, fulfilling IEC 651 Type 0.

Microphone Preamplifier Inputs

The 7-pin preamplifier input sockets supply power for microphone preamplifiers, and a selectable microphone polarization voltage of 0V, 28 V or 200 V (separate selection for each channel), allows connection of most types of Brüel & Kjær Measurement Microphone.

Accelerometer Inputs

The analyzers have built-in charge sensitive preamplifiers. Input is via 10-32 UNF micro-connectors and the input signal measuring range is adapted to the wide range of Brüel & Kjær Accelerometers.

Direct Inputs

Voltage signals are connected to the preamplifier inputs via LEMO-to-BNC socket adaptors (included as accessories). Input coupling is AC.

Interface

All measurements and data transfer operations are carried out by remote control over the interface bus. The IEEE-488 parallel interface and the RS-232 serial interface provide con-



Fig.2 Using the 2140/WH2857 with the QCMASK program to measure the mechanical power of a small motor

venient access to all analyzer functions and to measured data.

Operation

Programmable Operation

The analyzers are controlled by programming over the interface. The command set is extensive, being made up from standard engineering English which is simple and easy to remember.

This user-friendly command set makes it easy to program the analyzers with a wide range of different measurement set-up parameters, including: single- or dual-channel operation, calibration parameters, filter bandwidth, averaging mode, etc. The current set-up is automatically saved in non-volatile memory, so that the next time an analyzer is switched on, the settings remain unchanged.

Applications Programs

3 applications programs, WT9338, WT9390 and WT9550, for use on an IBM-compatible PC (with GPIB interface from National Instruments), are available from Brüel & Kjær for controlling the analyzers.

WT9338 QCMASK and WT9550 QCBRAIN: are used with the analyzers for quality control applications. These programs operate with both IEEE and RS-232 interfaces. They are designed for use in on-line pro-

duction testing. Faults in the product are detected by comparing the noise or vibration spectrum of the test object with that from a reliable unit. The programs are particularly suitable for manufacturers of rotating equipment, e.g. pumps, compressors, motors, fans.

QCMASK is based on purely statistical such as gaussian classifiers, statistical marks, etc. QCBRAIN is based on a neural network classifier allowing, for example, arbitrary non-linear classifications.

WT9390 Set-up Program: for control of basic set-up and measurement functions in an interactive mode using the IEEE interface.

The program can be used to transfer measured raw spectra to a PC, and to display the data in various ways on the computer monitor. The program can also make hard copies of the data on a printer connected to the PC's printer port.

User Programs

Alternatively, users can write their own dedicated control programs to process and display the measured spectra. Set-up Program WT9390, or part of it, can be used by a programmer to create a customised solution.

Pre-configured Set-ups

Factory-programmed default settings for acoustics and vibration measurements are permanently available so that the analyzers can be quickly set-

up for measurement. Up to four complete user-defined set-ups can be stored in the non-volatile memory to enable rapid re-configuration of an analyzer. Set-ups can also be transferred to the controller and stored on disk for use on another occasion.

Bootload

The bootload feature allows you to load alternative programs into an analyzer by transferring them from your controller over the IEEE interface (see Analyzer Variants).

Calibration

When a system consisting of an analyzer and transducers is to be calibrated, a reference source is used to apply a known calibration level to the transducers. From WT9390, a complete calibration set-up including calibration level and frequency data can be sent to the analyzer over the interface, where the autocalibration feature can be used. This automatically adjusts the sensitivity of the input channels, so that the measured results correspond to the calibration level of the reference source.

If no reference source is available and the sensitivities of the transducers are known from their calibration chart, an approximate calibration can be done by transferring figures for transducer sensitivities to the calibration set-up of the analyzer.

dB reference levels and units can also be changed from default values in the calibration set-up for easy calibration of, for example, hydrophones.

Measurement Types

In their basic form, both analyzers offer 1 Ch. and 2 Ch. autospectrum analysis. Types 2141 also has additional measurement types for sound intensity, cross-spectrum and pressure-residual intensity index:

1 Ch. Autospectrum Analysis: A- or B-Channel Autospectrum is measured. In this case the upper frequency limits are doubled (see Table 1).

2 Ch. Autospectrum Analysis: A- and B-channel autospectra are measured simultaneously. Table 1 shows the frequency ranges for real-time and multi-pass analysis.

Sound Intensity Analysis (2141):

Active and reactive intensity, mean pressure, and particle velocity are measured simultaneously. This means that all information about the

Upper Frequency		Bandwidth (Octaves)			
Single-channel	Dual-channel	$1/1$	$1/3$	$1/12$	$1/24$
22.4 kHz	11.2 kHz	Real Time	Real Time	4 Pass	8 Pass
11.2 kHz	5.6 kHz	–	–	2 Pass	4 Pass
5.6 kHz	2.8 kHz	–	–	Real Time	2 Pass
2.8 kHz	1.4 kHz	–	–	–	Real Time

Table 1 Upper frequencies and bandwidths for single- and dual-channel analysis, 2140 and 2141

sound field in one particular direction is captured in a single measurement. Furthermore, it allows calculation of A- and B-channel autospectra, phase spectra, and coherence spectra.

Cross-spectrum Analysis (2141):

A- and B-channel autospectra together with real and imaginary parts of the cross-spectrum are measured simultaneously. This makes it possible to calculate phase and coherence spectra as well as three frequency response functions (H1, H2, and H3) in real-time.

Pressure-Residual Intensity Index (2141):

Using Sound Intensity Calibrator Type 3541 allows the pressure-residual intensity index of the measurement system (microphones, preamplifiers and analyzer inputs) to be measured.

Some of these features are available in the variants of Type 2140, see page 5 and Table 3.

Averaging

There is a choice of exponential or linear averaging, with selectable averaging times. Averaging operations are controlled by sending the probe commands to the analyzer. Selectable averaging times depend on the selected bandwidth and whether the analyzer is in single- or dual-channel mode. For single-channel $1/3$ -oct. analysis, the range is 1ms to 24 hrs for linear averaging, and $1/512$ s to 512s in a binary sequence for exponential averaging. For dual-channel analysis, the minimum averaging times are doubled.

Operation

A/L- and W-Channels

Two broadband channels, “A/L” and “W”, are associated with each measured spectrum and available for read-out together with the spectral data. The A/L-channel shows the overall level of the input signal measured with a broadband linear (“L”) or A-weighting (“A”) filter. The broadband level of a weighted spectrum is shown in the W-channels. The level is calculated on the basis of the band-pass filter outputs. A weighting function (which may be linear) can be applied independently to the whole spectrum, the W-channel, or both.

Maximum and Minimum Hold

The maximum or minimum levels that occur during real-time measurements can be held and saved as the measurement result.

The Maximum or Minimum Hold condition can be applied to one or all frequency bands, or to any one of the A/L-or W-channels.

In dual-channel mode on the 2140, or in any of the measurement modes on the 2141, two different hold functions can be specified and used at the same time.

Multispectrum and Slice

A multispectrum is a number of spectra stored in succession in the same file. This file can be viewed from two angles, either from the “front” where the spectra can be flicked through one after another, or from the “side” where each frequency band is viewed individually as a function of spectrum number; this is called a “slice”. **Normal Multispectrum:** Spectra can be recorded as a function of time, for example for measurements of impulse noise, or they can represent ge-

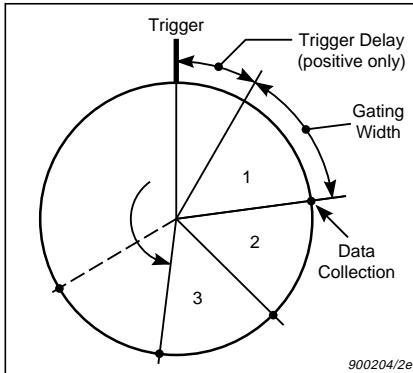


Fig. 3 Gated measurement cycle

ometrical points when measuring sound power. The recording rate is up to 1000 spectra/second (single-channel operation).

Gated Multispectrum: Allows multispectra from successive trigger cycles to be averaged into a single multispectrum. The number of averaged multispectra equals the number of triggers.

Gated measurements are normally used for measuring noise from rotating machines or other repetitive noise.

Fig. 3 shows the gating principle in one trigger cycle. The “gate” opens after a user-specified trigger delay (positive only) has elapsed. One spectrum is measured while the gate is open. As the gate closes, the spectrum is saved in an accumulator. The open-close-save sequence is then repeated for all spectra in the trigger cycle forming one multispectrum.

Matrix Multispectrum: Matrix Multispectrum allows the spectra in a multispectrum to be arranged in a row-column-direction system. This serves two purposes: one is to ease the overview of measurements, the other is to make sound intensity data compatible with computer programs and Brüel & Kjær laboratory analyzers (for example Type 2133) so that sound power determination and other data processing can be made.

Multispectrum Trigger

The following trigger conditions can be applied to the start of averaging when collecting a multispectrum:

Free Run: The measurement defined by the current set-up is continually repeated after Averaging (Start) is sent.

Manual: This triggers a measurement as defined by the current set-up. This is often used for sound intensity measurements with Matrix Multispectrum.

Time: Measurement begins at a time specified by the user. A fixed repetition interval can be set where required.

Internal: Measurement begins when a specified trigger level is exceeded (positive-slope trigger) or fallen below (negative-slope trigger) in either a specified frequency band or in one of the channels displaying the broadband weighted or non-weighted spectrum level. Internal triggering is allowed on several spectrum types, for example intensity spectra or cross-spectra. Internal triggering is used, for example, for pistol-shot reverberation measurements.

External: Measurement begins on the arrival of an external trigger signal at the Trigger Input socket on the back panel of the analyzer. This is often used for tachometer input with Gated Multispectrum, or for run-up/coast-down measurements with Normal Multispectrum.

Pre- and Post-trigger Delay

The user-defined post-trigger delay (0 to 5000 s depending on set-up) can be used to delay the start of averaging for a fixed period after the trigger conditions have been met. Alternatively, entering negative values for the post-trigger delay results in a pre-trigger delay. Pre-trigger delay enables spectra monitored prior to the trigger conditions being met to be included as part of the measurement result. The maximum pre-trigger delay is 34 spectra for 1/3-octave measurements.

Data Storage

Spectrum Memory

The spectrum memory is part of the memory allocated for storage of measured data. The number of spectra that the spectrum memory can hold depends on the selected filter bandwidth, frequency range and the measurement type, single channel, dual channel or sound intensity (sound intensity for Type 2141 only).

Table 2 shows the number of spectra that the memory can hold, measured with the maximum real-time frequency range (upper freq. limit 22.4 kHz in single-channel mode and 11.2 kHz in dual-channel mode for 1/1-octave and 1/3-octave spectra).

Spectra are saved individually or as multispectra in up to 111 files. Note, however, that for multispectra

the maximum number of spectra which can be saved in one file is 999.

Disk Storage

If more data storage capacity is needed, files stored in spectrum memory can be transferred over the interface to the controller, in binary or ASCII format, and stored on disk.

Spectrum Recording Rate

The analyzers can record spectra at intervals down to 1 ms with no loss of data (no “gaps” between measurements). This maximum rate is obtained with single-channel, real-time operation. In general, the recording rate depends on the chosen measurement type (single/dual-channel analysis), filter bandwidth, frequency range and, if linear averaging has been selected, the linear averaging time.

Measurement Text

Each file can be labelled with up to 40 characters of text. Files can be sorted in the file list, by name (number), time, length, or type. “Type” classifies the spectra/time records into groups according to: number of lines, measurement type, whether they were measured or calculated, and whether they are single spectra or multispectra.

Multichannel Analysis System

In the example illustrated in Fig. 4, eight Type 2140 units and a common power supply, WB 1250, make up a system for measurement of spectra in 16 input channels simultaneously.

The system shown takes up an installation height of 177.8 mm per row, or in total 533.4 mm. The WB 1250 power supply is capable of supplying up to 15 analyzers (30 input channels). Several analyzers, of the same or different types, can be configured as a multichannel system for analysis of signals from multiple transducers (e.g. accelerometers and/or microphones) at various measuring points around (on) the test object. In this way very descriptive measurement results can be obtained over time (e.g. a monitoring system) or for several different test objects (e.g. test-cell measurements). For the analysis of transient events, each analyzer may

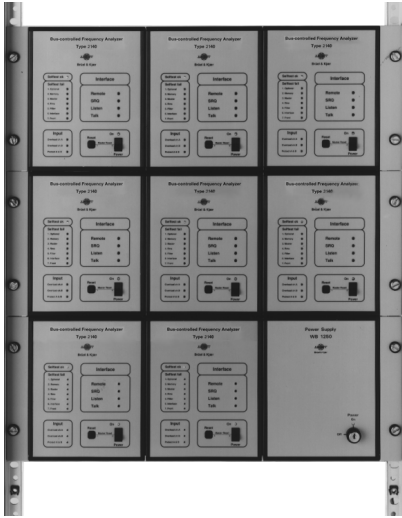


Fig. 4 Rack-installed 2140 Analyzer System powered by WB 1250

be set up to measure a triggered multispectrum, in which case all subspectra of the individual multispectra will be time coincident.

Post-Processing

The analyzers are mainly intended as data *gathering* devices. However, they also have some data *processing* facilities. Some of these facilities function in real-time and some can be applied to recalled spectra.

Spectrum Unit

The spectrum unit is PWR (power) or RMS (root mean square), depending on the type of measurement.

Sound Power Calculation

Sound power can be calculated on the basis of SPL or intensity measurements. Data must be arranged in a multispectrum. The calculation is made by entering the physical size of the enclosing area.

Spectrum Arithmetic

The Spectrum Calculator is used for arithmetic operations on spectra recalled from memory.

The arithmetic basis for spectrum additions and subtractions can be selected as either “dB” (for which 50 dB

Bandwidth	Type 2140		Type 2141		
	Single channel	Dual Channel	Single channel	Dual Channel	Sound Intensity
1/1-octave	2457	1843	2457	1843	1203
1/3-octave	1474	951	1474	951	541
1/12-octave	589	340	589	340	178
1/24-octave	342	193	342	193	99

Table 2 Storage capacity for real-time spectra

Modification No.	Analyzer Features	Mode	Comments
WH 2855	Dual-channel autospectrum (to 20 kHz)	DF	Standard 2140 with dual-channel analysis extended to 20 kHz
WH 2857	Full dual channel with cross functions (not intensity)	DF	Standard 2140 with mechanical power measurement option
WH 2859	Dual-channel FFT with cross functions	FFT	FFT analysis instead of digital filtering
WH 2960	Single-channel autospectrum (to 20 kHz)	DF	Standard 2140 for single-channel measurements
WH 2990	Single-channel autospectrum	FFT	FFT equivalent of WH 2960

^① Digital filtering

Table 3 Analyzer variants

plus 50 dB equals 100 dB) or as “absolute power”, for which dB units are first converted to absolute power units for the arithmetic operation and then converted back to dB for the final answer (50 dB plus 50 dB equals 53 dB).

“dB” arithmetic is used for adding/subtracting single number constants or weighting corrections to/from spectra. “Absolute power” arithmetic is for adding and subtracting spectra or background noise spectra.

Digital Spectrum Weighting

Spectrum Weighting is used to add user-defined weightings or standard A-, B-, C-, and D-weightings to input spectra (real-time) or to spectra recalled from the memory. Spacer (S) and Spacer + A (SA) weightings are also available for intensity spectra. The shape of these weightings is de-

pendent on the nominal microphone spacing of the sound intensity probe. User-defined weightings are entered as a series of points, with the analyzer interpolating between the points to produce the complete weighting function, or they can be based on measured data. A total of four user-defined weightings can be saved in the non-volatile internal memory. User-defined weightings can be used, for example, to mask unwanted frequency components.

Analyzer Variants

A number of variants of the standard 2140 Analyzer are available. These are described briefly in Table 3. Please contact Brüel & Kjær if you would like more information.

Specifications 2140, 2141

Input Characteristics

All inputs pseudo difference. Choice of analog ground floating or connected to chassis. Individual set-up for each channel

DUAL-CHANNEL INPUT MODULE:

Two identical input channels (Ch.A & Ch.B) with both preamplifier and accelerometer inputs. All inputs are pseudo difference. Choice of analog ground floating or connected to chassis. Attenuators and Filters for the two channels may be set-up individually over the interface bus

PREAMPLIFIER INPUT:

Pseudo Difference Input: Two 7-pin preamplifier sockets or one 18-pin socket (for sound intensity probes)

Input impedance (signal to signal ground): 1 M Ω || 100 pF

Signal ground to analogue ground impedance: 50 Ω || 10 nF

Input ranges: Twelve 80 dB ranges with a FSD from 10 mV to 3.16 V (rms sine) selectable in steps of 5 dB

Frequency Range: 0.7 Hz to 22.4 kHz, ± 0.1 dB

Noise: 1 μ V, measured in 1/3-octave bands in input range 10 mV with input short-circuited

Microphone polarization: 0 V, 28 V, 200 V from 10 M Ω source

Power supply: 28 V

Heater Voltage: None

High-pass filter cut-offs:

-0.1 dB at 0.7 Hz (-3 dB at 59 mHz).

Slope 6 dB/octave

-0.1 dB at 20 Hz (-3 dB at 6.6 Hz).

Slope 12 dB/octave

-0.1 dB at 100 Hz (-3 dB at 33 Hz).

Slope 12 dB/octave

A-filter: According to IEC publication 651 type 0

DIRECT INPUT:

Pseudo Difference Input: Two BNC sockets (via preamplifier-to-BNC adaptors)

Input impedance (signal to signal ground): 1 M Ω || 100 pF

Signal ground to analogue ground impedance: 50 Ω || 10 nF

Input ranges: Twelve 80 dB ranges with a FSD from 10 mV to 3.16 V (rms sine) selectable in steps of 5 dB

Frequency Range: 0.7 Hz to 22.4 kHz, ± 0.1 dB

Noise: 1 μ V, measured in 1/3-octave bands in input range 10 mV with input short-circuited

High-pass filter cut-offs:

-0.1 dB at 0.7 Hz (-3 dB at 59 mHz).

Slope 6 dB/octave

-0.1 dB at 20 Hz (-3 dB at 6.6 Hz).

Slope 12 dB/octave

-0.1 dB at 100 Hz (-3 dB at 33 Hz).

Slope 12 dB/octave

A-filter: According to IEC publication 651 type 0

ACCELEROMETER INPUT:

Pseudo Difference Input: Two micro connectors, 10-32 UNF

Input impedance (signal to signal ground): 39 Ω || 220 pF

Signal ground to analogue ground impedance: 50 Ω || 10 nF

Input ranges: Eighteen 80 dB ranges with a FSD from 1 pC to 17.8 nC (rms sine) selectable in steps of 5 dB

Frequency Range: 0.35 Hz to 22.4 kHz, ± 0.1 dB

Noise: Measured in 1/3-octave bands in input range 1 pC with 1 nF transducer capacitance:

0.35 Hz to 35 Hz: < 3 fC

35 Hz to 2.8 kHz: < 0.5 fC

2.8 kHz to 8.9 kHz: < 1 fC

8.9 kHz to 22.4 kHz: < 1.5 fC

High-pass filters cut-off:

-0.1 dB at 0.35 Hz (-3 dB at 50 mHz).

Slope 6 dB/octave

-0.1 dB at 20 Hz (-3 dB at 6.6 Hz).

Slope 12 dB/octave

-0.1 dB at 100 Hz (-3 dB at 33 Hz).

Slope 12 dB/octave

MAXIMUM RATINGS:

Input:

Preamplifier & Direct: 7.5 V peak, 50 V DC.

Accelerometer: 33 nC peak

Signal Ground/Chassis Ground: For safe operation in accordance with IEC 1010, the voltage between signal ground and chassis ground (in "floating" mode) must not exceed 42 V RMS. To ensure safe operation in accordance with IEC 1010 at higher voltages, the user must limit all input currents to 0.7 mA peak

Signal Ground/Analogue Ground: 5 V peak. If this limit is exceeded, the user must limit the ground current to 50 mA. If the voltage exceeds 1 V peak, the dynamic range is decreased

MAXIMUM INDUCED COMMON

MODE VOLTAGE:

42 V RMS, 100 V peak

COMMON MODE REJECTION:

Floating input, 50 Ω source impedance:

0.35 Hz to 1 kHz: > 75 dB

1 kHz to 22.4 kHz: > 50 dB

DIFFERENTIAL COMMON MODE

REJECTION:

50 Ω source impedance: DC to 250 Hz > 35 dB

OVERLOAD DETECTION:

Both analog (including excessive common mode level) and A/D-converter overloads are detected

CROSSTALK:

-60 dB

ATTENUATOR LINEARITY:

± 0.1 dB

ANTI_ALIASING FILTER:

Cut-off frequency: 30 kHz (single channel), 15 kHz (dual channel). Provides at least 80 dB attenuation of those input frequencies which can cause aliasing in the pass-band

SAMPLING RATE:

65.536 kHz (single channel)

32.768 kHz (dual channel)

A/D-CONVERSION:

Resolution: 16bit

Quantizing Error: 1/2 LSB

Digital Filters

1/1-OCTAVE FILTERS:

14-pole filters with centre frequencies given by $10^{3 \times n/10}$. Fulfil IEC 225-1966, DIN 45651 and ANSI S1.11-1986, Order 7 Type 1-D, 2141 optional range

Single Channel: $-1 \leq n \leq 14$. 16 filters with centre frequencies from 0.5 Hz to 16 kHz

Dual Channel: $-1 \leq n \leq 13$. 15 filters with centre frequencies from 0.5 Hz to 8 kHz

1/3-OCTAVE FILTERS:

6-pole filters with centre frequencies given by $10^{n/10}$. Fulfil IEC 225-1966, DIN 45651 and ANSI S1.11-1986, Order 3 Type 1-D

Single Channel: $-4 \leq n \leq 43$. 48 filters with centre frequencies from 0.4 Hz to 20 kHz

Dual Channel: $-4 \leq n \leq 40$. 45 filters with centre frequencies from 0.4 Hz to 10 kHz

1/12-OCTAVE FILTERS:

6-pole filters with centre frequencies given by $10^{(n+0.5)/40}$

Single Channel: $-18 \leq n \leq 173$. All 192 filters with centre frequencies from 0.365 Hz to 21.752 kHz can be measured in a four-pass mode, or 168 filters from 0.365 Hz to 5.464 kHz can be shown in real-time

Dual Channel: $-18 \leq n \leq 161$. All 180 filters with centre frequencies from 0.365 Hz to 10.902 kHz can be measured in a four-pass mode, or 156 filters from 0.365 Hz to 2.738 kHz can be shown in real-time

1/24-OCTAVE FILTERS:

6-pole filters with centre frequencies given by $10^{(n+0.5)/80}$

Single Channel: $-36 \leq n \leq 347$. All 384 filters with centre frequencies from 0.360 Hz to 22.067 kHz can be measured in an eight-pass mode, or 312 filters from 0.360 Hz to 2.778 kHz can be shown in real-time

Dual Channel: $-36 \leq n \leq 323$. All 342 filters with centre frequencies from 0.360 Hz to 11.060 kHz can be measured in an eight-pass mode, or 288 filters from 0.360 Hz to 1.392 kHz can be shown in real-time

BROADBAND FILTERS:

Two broadband channels, labelled "L" and "W", are associated each input channel ("A" or "B").

L-Channel: Represents broadband level of the input signal (A-weighted or unweighted)

W-Channel: Represents broadband level of the measured spectrum, possibly post-weighted with A,B,C or D standard curves or user-defined

System Accuracy

DYNAMIC RANGE:

All distortion (intermodulation and harmonic) and spurious noise at least 80 dB below max. input for 1/3-octave spectrum

OVERALL FREQUENCY RESPONSE:

± 0.1 dB at filter centres from lower frequency limit to upper frequency limit

(See Input Characteristics for frequency limits)

NOISE:

Voltage input: Measured in 1/3-octave bands in input range 10 mV with input short-circuited: 0.7 Hz to 22.4 kHz < 1 μ V

Charge input: Measured in 1/3-octave bands in input range 1 pC with 1 nF transducer capacitance:

0.35 Hz to 35 Hz: < 3 fC

35 Hz to 2.8 kHz: < 0.5 fC

2.8 kHz to 8.9 kHz: < 1 fC

8.9 kHz to 22.4 kHz: < 1.5 fC

AMPLITUDE MEASUREMENT STABILITY:

± 0.1 dB

AMPLITUDE LINEARITY:

± 0.05 dB or $\pm 0.005\%$ of max. input, whichever is greater, measured using a sine wave input at the filter centre frequency. With measurements more than 40 dB below max. input, the measuring sine wave is accompanied by another sine wave (of a lower frequency) outside the measured band, having an amplitude greater than 20 dB below max. input

FREQUENCY ACCURACY AND STABILITY:

0.01% without warm-up (no adjustment necessary)

Detectors

Digital true RMS detection of filter bank and two broadband channels. No crest factor limitation

UPPER FREQUENCY LIMIT FOR ANALYSIS:
11.2 kHz for dual-channel autospectra. (Ch.A + Ch.B)
22.4 kHz for single-channel autospectrum. (Ch.A or Ch. B)

CONTROL:

Note: All control must be exercised over the interface bus

Start: Clears the average accumulator and starts an average

Stop: Stops the averaging process

Proceed: Continues an average without clearing the average accumulator

Averaging gate: External or internal trigger signal for gating the averaging process

Averaging

LINEAR:

Averaging without truncation

Single Channel: Averaging times from 1 ms to 24 hours selectable to a resolution of 1 ms in the range 1 ms to 1 hour and to 1 s in the range 1 hour to 24 hours

Dual Channel: Averaging times from 2 ms to 24 hours selectable to a resolution of 1 ms in the range 2 ms to 1 hour and to 1 s in the range 1 hour to 24 hours

EXPONENTIAL:

Single Channel: 19 averaging times from 1/512s to 512s in a binary sequence

Dual Channel: 18 averaging times from 1/256s to 512s in a binary sequence

Averaging times of 1/4s and 2s correspond to "Fast" and "Slow" sound level meter responses, respectively

Spectrum Memory

Non-volatile internal memory in which a maximum of 111 files, each containing a single spectrum or a multispectrum, can be stored.

Control: Manual save (controlled from computer) or multispectrum automatic save

Max. no. of spectra: 1843 for a dual-channel 1/1 oct. measurement

Max. (or Min.) hold, all bands: Composite spectrum of max. (or min.) RMS level occurring in each channel

Max. (or Min.) hold, specified band: Retains the spectrum for which max. (or min.) RMS level has occurred in the specified band

Interfaces

NB! All control, set-up and data transfer must take place over the Interface Bus

IEC/IEEE INTERFACE:

Conforms to IEEE 488.1 and IEC 625-1 standards.

Functions Implemented:

Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T5
Listener	L3
Service Request	SR1
Parallel Poll	PP1
Device Clear	DC1
Device Trigger	DT1
Remote/Local	RL0

Command Set: Simple and easy to remember standard engineering English. Resistant to operator error

Code: ASCII (ISO 7-bit) code, or binary

Interface Terminator: Default is ASCII <LF>, (decimal 10)

Device Address: Specified via back panel Address Switch

RS-232 INTERFACE:

Conforms to the EIA Standard RS-232-C (equivalent to CCITT V24)

Allows remote activation of the analyzer functions via a non-intelligent terminal

Controls/Indicators

FRONT PANEL:

LED Indicators: Show if the analyzer is switched on, Self-test, Interface and Overload status, and whether Ch.A and Ch.B are protected. (Protect relays break the signal path, if the Analog Input Module is exposed to excessive signal levels).

Reset: Used to reset the analyzer manually

Power Switch: Switches the analyzer On and Off.

Master Reset: Returns the analyzer to factory default settings

BACK PANEL:

Polarization Voltage A&B: Selects a microphone polarization voltage of 0, 28, or 200V for each input, as specified on the microphone calibration chart

Auxiliary Connector: Reserved for future use
Interface IEEE-488: 24-pole male socket for remote control of the analyzer and for digital output of measurement results via the IEEE-488 parallel interface

Interface RS-232: 24-pole male socket for remote control of the analyzer and for digital output of measurement results via the RS-232 serial interface

Address Switches: 8 external and 4 internal DIP switches, the settings of which determine the active interface, the Device Address (IEEE-488), and some RS-232 parameters. The remaining RS-232 parameters are selectable using the internal switches

Applications: 7-pin LEMO socket, reserved for future use

Analog Output Ch.A, Ch.B: Used only if enhancement WH2702 has been fitted. BNC connectors for Ch.A and Ch.B, outputting the conditioned signals present in front of the anti-aliasing filters for the two channels.

Ext. Power: 7-pin DIN socket for connection of an external power supply

Fuse 5A: Fuse holder containing a T5A fuse

Ext. Trigger: Triaxial BNT connector for input of an external trigger signal to start an average. 5V available from the connectors inner screen for powering of an external trigger source. (e.g. a photoelectric tachometer probe)

Preamplifier A&B: Two 7-pin connectors for connecting microphone to the internal preamplifiers

Charge A&B: Two TNC connectors for connecting accelerometers to the built-in, charge-sensitive amplifiers

Chassis/Floating: Connects/disconnects analog ground to/from the analyzer chassis

Sound Intensity/Remote Control: 18 pin Lemo for use with Sound Intensity Probe Type 3548

Power Supply

The 2140 Analyzer must be powered from an external source via the "Ext. Power" socket (7-pin DIN socket). The source must be capable of delivering a filtered DC Voltage in the range 11V to 16V

Power consumption: Approx. 8.5W

EMC

SUSCEPTIBILITY TO DISTURBANCES SPECIFIED IN EN 50082-2:

LF Magnetic Field: (30 A/m at 50 Hz)

Input/Output	Level
Preamp., Probe Direct via Preamp. ¹	< 10 μV
Charge ²	< 1 fC

¹ Input section with max. gain and input short-circuited

² Input section with max. gain and 1 nF termination

COMPLIANCE WITH STANDARDS:

CE	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive.
Safety	EN 61010-1 and IEC 1010-1: Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN 50081-1: Generic emission standard. Residential, commercial and light industry. EN 50081-2: Generic emission standard. Industrial environment. CISPR 22: Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device.
EMC Immunity	EN 50082-1: Generic immunity standard. Residential, commercial and light industry. EN 50082-2: Generic immunity standard. Industrial environment. Note: See "EMC".
Temperature	IEC 68-2-1 & IEC 68-2-2: Environmental Testing. Cold and Dry Heat. Operating Temperature: -10 to +55°C (+14 to +131°F) Storage Temperature: -25 to +70°C (-13 to +158°F)
Humidity	IEC 68-2-3: Damp Heat: 90% RH (non-condensing at 40°C (104°F))
Mechanical	Non-operating: IEC 68-2-6: Vibration: 0.3 mm, 20 m/s ² , 10-500 Hz IEC 68-2-27: Shock: 1000 m/s ² IEC 68-2-29: Bump: 1000 bumps at 250 m/s ²
Enclosure	IEC 529: Protection provided by enclosures: IP 20

Radiated RF: (3 to 10 V/m, 80% AM, 1 kHz)

Input/Output	Level
Preamp., Probe Direct via Preamp. ¹	< 30 μ V
Charge ²	< 32 fC

¹ Input section with max. gain and input short-circuited
² Input section with max. gain and 1 nF termination

Conducted RF: (3 to 10 V, 80% AM, 1 kHz)

Input/Output	Level
Preamp., Probe Direct via Preamp. ¹	< 1 μ V
Charge ²	< 5 fC

Cabinet

The 2140 Analyzer is supplied in a lightweight metal cabinet. 3 x 2140 units can be installed side-by-side in a standard 19" rack, thus allowing for the build-up of very compact multi-channel analyzer systems. The 3 analyzers take up an installation height of 4 standard rack-mounting height units ≥ 177.8 mm

DIMENSIONS: (without feet)**Height:** 177 mm (7.0")**Width:** 142.5 mm (5.6")**Depth:** 320 mm (12.6")**Weight:** 5.5 kg (12lb. 3oz.)

Ordering Information

Accessories Included

Types 2140 and 2141 Bus-Controlled Frequency Analyzers

Include the following accessories:

JP 0710: 7-pin DIN plug (for Ext. Power socket)
 2 x AO 0479: Falcon (LEMO)-to-BNC Adaptor
 5 x VF 0015: 5 A fuses
 WL 0845: Short Interface Cable (0.4 m), IEEE-488 (multichannel systems only)
 Type 7667: 3 1/2" disk containing the analyzer program

Optional Accessories**POWER SUPPLY**

WB 1250: 12 V power supply for multiple 2140 & 2141 units

TRANSDUCERS

Type 4190: General-purpose 1/2" Measuring Microphone
Type 2669: Microphone Preamplifier
Type 4371: General-purpose Accelerometer
JP 0162: Adaptor for Type 4371
AO 0488: 7-pin B&K (preamp.) to LEMO Adaptor

Brüel & Kjær supplies a wide range of microphones and accelerometers. Please ask for

more information regarding the different types and their uses

CALIBRATION

Type 4226: Multifunction Acoustic Calibrator
Type 4228: Pistonphone
Type 4231: Sound Level Calibrator
Type 4294: Calibrator Exciter
Type 3541: Sound Intensity Calibrator

INTERFACE

AO 0195: Adaptor to convert IEEE-488 connector to IEC 625-1 (25-way)
AO 0264: Interface Cable (2m), IEC 625-1 (25-way) to IEEE-488
AO 0265: Interface Cable (2m), IEEE-488 to IEEE-488
UA 0814: IEEE-488 24-way bus connector kit
WB 1264: Production Controller Interface
WL 0945: Null-modem Cable for RS-232 (1.5m, 25-pin female to 9-pin male)
WL 0946: Null-modem Cable for RS-232 (1.5m, 25-pin female to 25-pin female)
WL 0947: Null-modem Cable for RS-232 (1.5m, 25-pin female to 25-pin male)
 PLC controller

HARDWARE ENHANCEMENT

WH 2702: Analog Output Modification

ANALYZER VARIANTS

Brüel & Kjær supplies a number of variants of the basic Type 2140 Analyzer. Please ask for more information regarding the different types and their uses.

WH 2855: Dual-channel digital filtering (DF), two autospectra up to 20kHz
WH 2857: Dual-channel DF, autospectra, cross-spectra (plus mechanical power measurements)
WH 2859: Dual-channel FFT with cross functions
WH 3129: Single-channel CPB
WH 3130: Single-channel FFT

ANALYZER UPGRADE

WH 2858: Upgrade from Type 2140 to Type 2141

COMPUTER SOFTWARE

For use with an IBM-compatible PC

WT 9338: QCMAK
WT 9390: Set-up Program
WT 9550: QCBRAIN
Type 7680: Sound Power program, pressure based
Type 7681: Noise Source Location program

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

Brüel & Kjær

WORLD HEADQUARTERS: DK-2850 Nærum • Denmark • Telephone: +4542800500 • Telex: 37316 bruka dk • Fax: +4542801405 • e-mail: info@bk.dk