Product Data

Order Tracking Analyzer — Type 2145

USES:

- ❍ Vehicle pass-by and stationary noise testing
- ❍ Quality control, quality assurance and field performance evaluation
- ❍ Rotating machinery and component noise and vibration “Benchmarking” and “Fingerprinting”

FEATURES:

- ❍ Order analysis (20 orders) simultaneous with $^1/_1$-, $^1/_3$- or $^1/_{12}$-octave analysis, in real time
- ❍ Dual Channel FFT software for troubleshooting and diagnostics
- ❍ Two input channels for microphones, accelerometers (charge) and direct signals
- ❍ Two versatile input channels for tachos (or pulse related transducers)
- ❍ Run-up/run-down measurements controlled by RPM, position, velocity or acceleration (linear or angular)
- ❍ Four DC channels for torque, pressure, temperature etc.
- ❍ Composite spectrum format comprising: two-channel autospectrum and orders; RPM, position velocity and acceleration data (instantaneous and averaged); and DC channels
- ❍ Direct access menu, for user-friendly operation
- ❍ Automated data acquisition using autosequences
- ❍ PC/MS–DOS compatible 3 $^1/_2$″ disk-drive, and non-volatile memory for storage of data and set-ups
- ❍ Portable, battery operation
- ❍ Remote control unit (optional)

The Order Tracking Analyzer Type 2145 is a portable dual-channel frequency analyzer which is tailor-made for analysing rotating equipment of all kinds. The analyzer has two versatile tacho conditioning units which enable it to display in up to 20 orders in real-time, as well as spectra (in $^1/_1$-, $^1/_3$- or $^1/_{12}$-octave bands). Three types of multispectra can be captured and stored, including Normal (for pre- and post-trigger capture), Gated (for examining spectra during any phase of a repetitive cycle) and Interval (for capturing spectra during delimited RPM ranges). A “slice” mode through a multispectrum will display a side view to show how a chosen frequency varies with time, angle or RPM.

The analyzer is operated via user-interactive menus backed up by on-screen help pages to support full operation in the field.

Its internal non-volatile memory and back-up disk storage facilities make the analyzer a powerful data-gathering device with further control and data-processing possibilities via its IEEE–488 and RS–232 interfaces.

Introduction

The Order Tracking Analyzer Type 2145 is tailor-made for any industry which uses and/or produces rotating equipment including compressors, turbines, pumps, or any motor or engine connected to a drive shaft. In fact, the analyzer is equally suited to routine noise and vibration testing of practically any rotating machinery. It is a robust, dual-channel noise and vibration frequency analyzer which is both portable and battery driven, and weighs only 10.4 kg.

When loaded with the standard Software Type 7668, the 2145 will meet the day-to-day requirements of routine machinery and vehicle testing including run-up/run-down tests, as well as provide for more sophisticated data analysis.

Depending on set-up conditions, the 2145 memory can store up to 1660 spectra without memory extension. This memory is non-volatile and is, therefore, protected against power failures. Back-up storage is provided by a built-in PC/MS-DOS compatible $3\,^{1}/_{2}''$ disk-drive. Disks are transferable to a computer for further processing of spectral data. Remote-control commands and measurement data can be sent directly over the IEEE–488 parallel interface or the RS–232 serial interface.

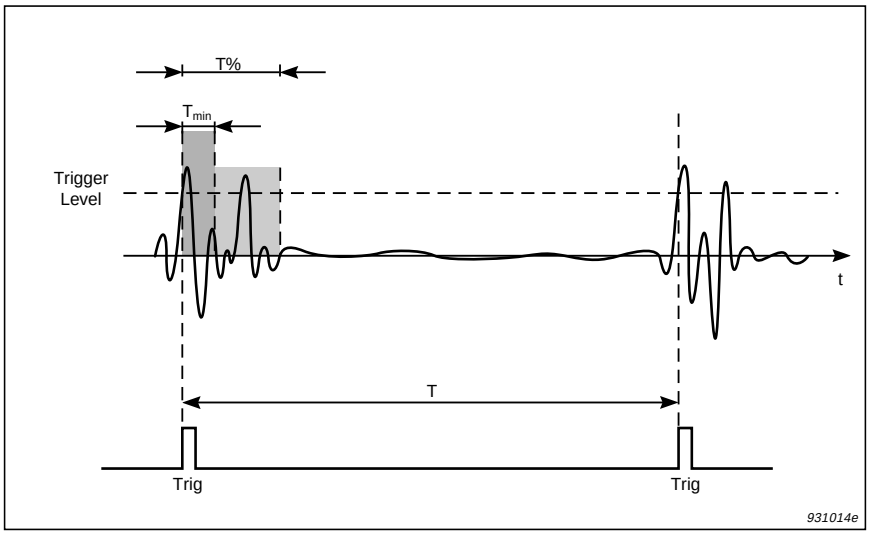

Fig.1 A user-defined hold-off time, T%, tells the tacho unit to ignore the second of a double peaked tachometric signal. Absolute minimum, T_{min}, is 33µs for the Main Tacho Input and 1ms for the Auxiliary Tacho Input

Two Tacho Trigger Inputs

The 2145 has two versatile tacho trigger inputs: Main and Auxiliary.

The Main Tacho Trigger Input will accept tachometric signals for up to 1800000 RPM and the Auxiliary Input up to 60000 RPM.

Both are protected against excessive input voltages and produce clean tacho pulses from ragged input signals; even if they contain spurious or missing information.

Fig.1 shows an example of how a user-defined hold-off time (in terms of a percentage of the tacho interval *T*) is used to ignore the second peak of a double peaked tachometric signal to produce clean tacho pulses. Other selective criteria available for "cleaning up" a tacho signal can be based on level, slope and hysteresis.

Clean tacho pulses are used to derive tacho parameters which gauge position (displacement), velocity and acceleration of moving parts (linear as well as angular), in metric, imperial or user-defined units. These tacho parameters can then be used to control the capture and storage of spectral data whenever pre-specified conditions occur during a test.

The flexibility of the analyzer allows a tacho signal to be taken from any accessible rotating element of a machine. The rotation does not have to be at any particular RPM since the analyzer can account for gearing effects as well as for multiple tacho pulses per revolution.

With two tacho inputs, two quite different measurements can be performed simultaneously. For example, one tacho input can be used for engine RPM before a gear box and the other for drive shaft speed after the transmission, see Fig.2. The two resulting tacho parameters can be used independently to control the analyzer. That is, the pre-transmission engine RPM to control order analysis while post-transmission drive shaft speed controls multispectrum gathering during a run-up. The result will be a multispectrum with order analysis as a function of drive shaft speed without the effects of the gear train.

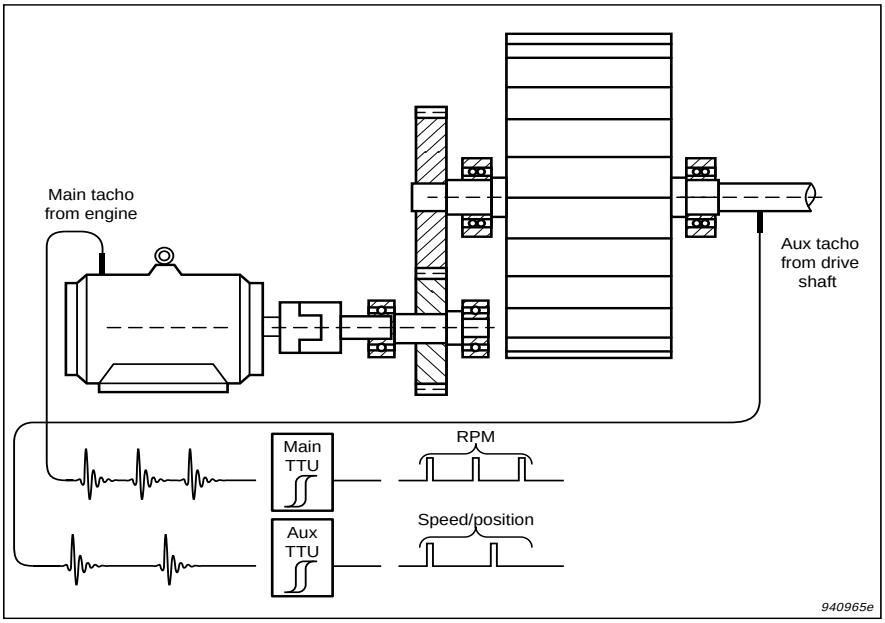

Fig.2 With two tacho inputs, engine RPM controls order analysis before the gear box, while post transmission drive-shaft speed controls multispectrum gathering. The result: multispectrum and order analysis as a function of equipment speed without the effects of gear changes

Data Acquisition

The most immediately noteworthy features of the 2145 as a sound and vibration analyzer are:

- Real-time 20-order analysis* simultaneous with real-time spectral data, i.e. 1/1- 1/3- or 1/12-octave band analysis. A powerful diagnostic tool for analysing harmonics of rotating machinery during speed changes.
- Real-time 1/24-octave band analysis (without orders) for greater selectivity when measuring closely spaced frequency components.
- Any 20 harmonics from 0.01 to 200 orders. This means that two spectra can be examined simultaneously, e.g. 10 order components related to engine RPM and 10 order components related to the transmission shaft from the gear box.
- Composite spectrum format comprising dual-channel autospectra and orders, tacho parameters and DC channels.
- Four DC channels for logging auxiliary data such as load, torque, pressure, temperature, throttle position, etc.
- Interval analyses, i.e. analyses confined within a user-specified interval of tacho parameters, e.g. during RPM changes around an annoying resonance.
- Two channel capability for measuring the pass-by noise of motor vehicles such as required by SAE J986 OCT88 or ISO 362.
- Simple and flexible set-ups for run-up and run-down tests based on RPM, speed, position or acceleration.

Standard spectrum weightings, i.e. A, B, C and D, as well as user-definable weightings can be applied to each line of the measured spectrum, or to the sum of the weighted spectrum.

Max. and min. hold can be applied to total levels, individual frequency bands or single orders.

Multispectra

A multispectrum comprises a number of averaged spectra each separated by an index, e.g. a user-specified change in time, angular displacement or RPM and stored in consecutive order.

* Order analysis using digital resampling, based on tachometric input, followed by DFT analysis.

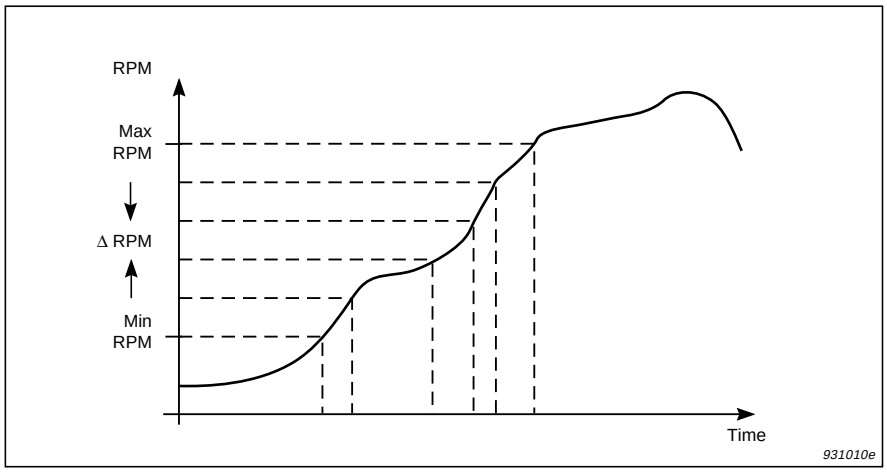

Fig.3 Run-up interval multispectrum between two pre-set RPM values

Trigger Sources

The capture of multispectra can be controlled in several ways, e.g. by triggering on internal parameters such as the level in a particular frequency band, tacho parameter or order, or on the broad band levels in the weighted or linear channels. Other alternatives are a manual decision, an external voltage, free-run or at a pre-set time (with any repetitions at pre-set time intervals).

Three types of averaged multispectra can be captured and stored by the 2145, these are *interval*, *normal* and *gated*.

Interval Multispectra

Tacho parameters are used to confine the capture and averaging of multispectra to a series of fixed intervals within a specified RPM range during say, a run-up or a run-down, around a resonance speed or a pass-by. This kind of analysis lets you explore data at and around certain running conditions. Fig.3 shows a plot of RPM against time. In this example, the analyzer can be set up to capture spectra at a series of fixed RPM intervals "Δ" within a given RPM range during run-up or run-down or a combination of both. In the latter case, the preselected series of RPM intervals and RPM ranges need not be the same for run-up and run-down.

Normal Multispectra

Up to 999 spectra can be captured starting at a specified time after or

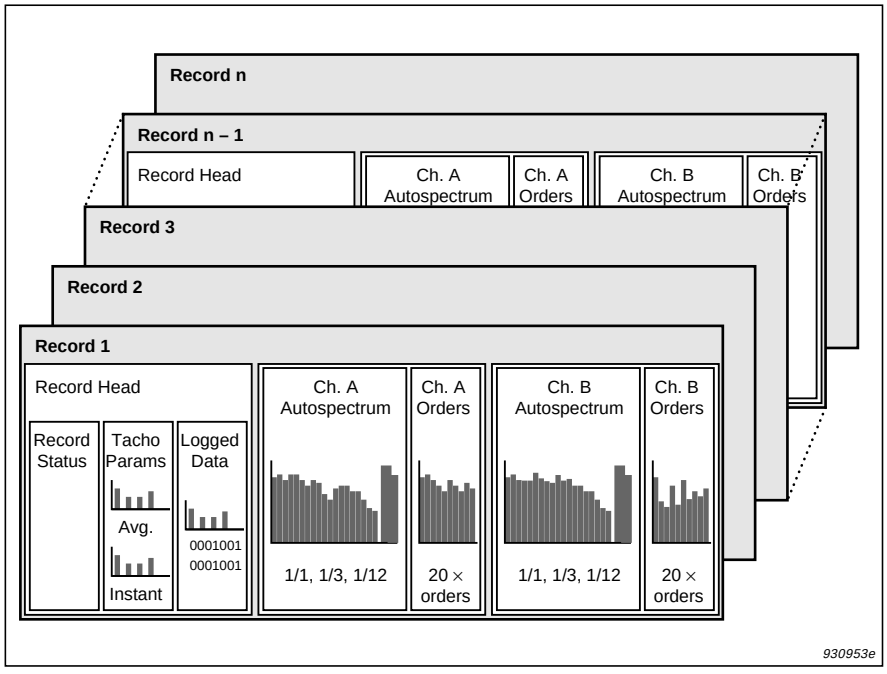

Fig.4 Data content and structure of a multispectrum. Here, each record contains two sets of autospectra with orders as well as full details on all tacho parameters and voltage levels in each DC channel

before triggering. Pre-trigger captures are permitted because real-time spectral data are constantly being calculated by the analyzer and stored in a ring buffer.

Gated Multispectra

Gated averaging builds up a multispectrum based on a series of spectra measured only during pre-defined intervals of a repetitive cycle. For example during a series of 10 degree intervals in a 4-stroke cycle; these intervals would be unaffected by RPM changes. At constant RPM, a series of, say, 10 ms intervals could be investigated. In both cases, a delay after triggering is allowed. Gated multispectra can be likened to observing cyclic machinery using a stroboscope.

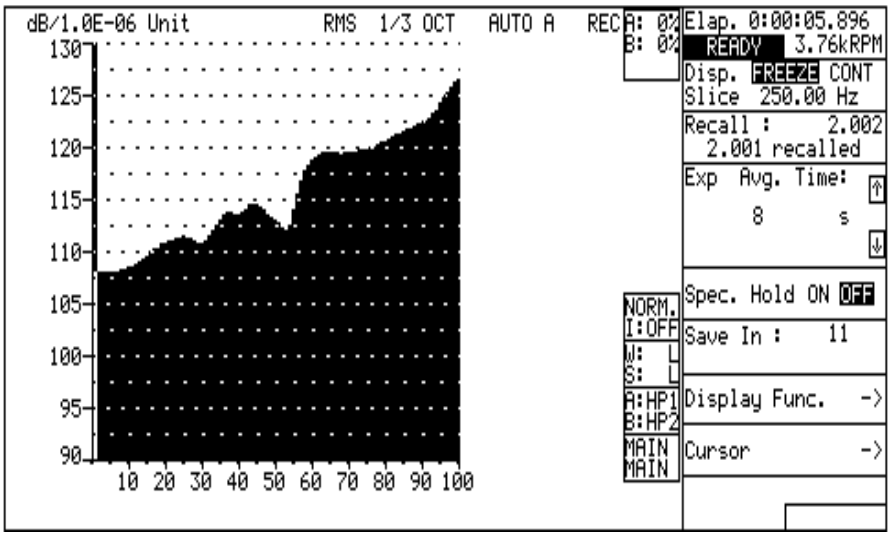

Fig.5 Slice mode display showing how the 250Hz 1/3-octave band varies during a run-up test

Data File Structure

Whenever the 2145 makes a measurement, it measures not only what is currently on display, but also all that can be displayed. So, when a spectrum is stored, it is accompanied by data on orders, tacho parameters and DC voltage levels.

This means that when you recall a stored measurement, you can display everything you need to know about it.

Fig.4 shows the data content and structure of a multispectrum file. Each record, from 1 to *n*, contains two sets of autospectrum with orders. In addition, there are instantaneous and average tacho parameters as well as logged data for all DC channels (representing, say, throttle position, temperature, load, torque, etc.). Any of these can be displayed on the screen and examined in detail, e.g. to see how engine RPM during a run-up influences the noise level in each octave band.

Full set-up and calibration data valid at the time of the measurement are also available for scrutiny.

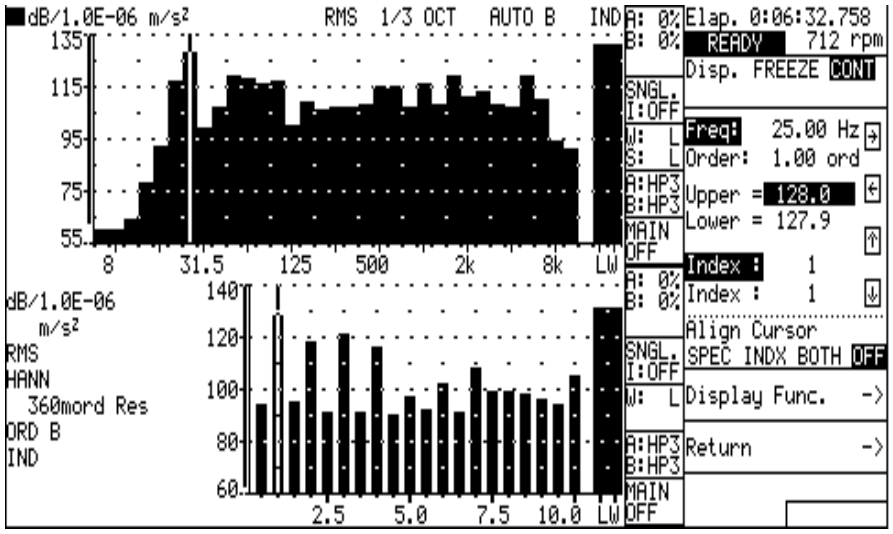

Fig.6 Dual display showing 1/3-octave band autospectrum above and orders below

Slice Mode

Multispectra can be viewed from the "front", i.e. vibration or sound level versus frequency band, and can be flicked through to show how a full spectrum changes with say time, angle or RPM.

The 2145 is capable of "slicing" through a multispectrum at right angles to its frequency axis to give a "side" view. This side view will show

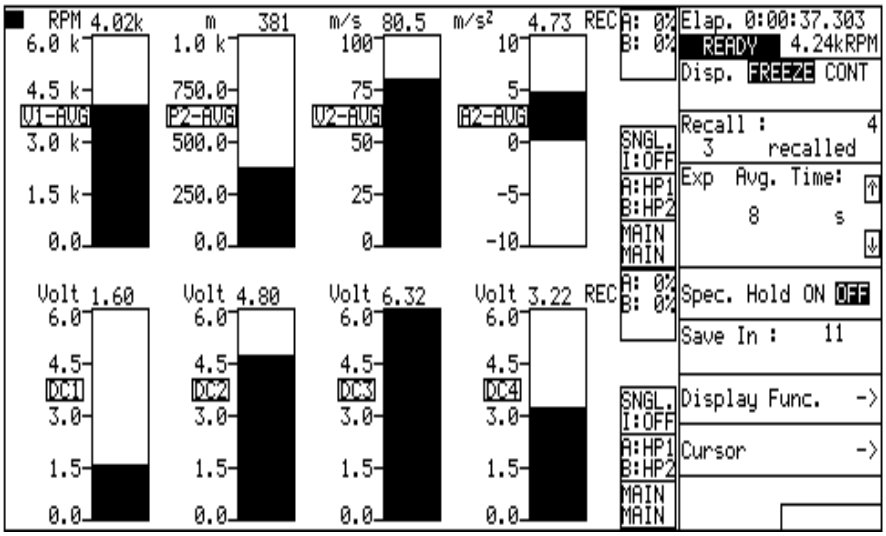

Fig.7 Display of (above) tacho parameters and (below) the voltage levels in the DC channels (which could represent throttle position, temperature, load, torque, etc.)

the variation of the level in a selected frequency band with, accordingly, time, angle or RPM. Slice modes are also possible for orders, tacho parameters, DC channels and overloads.

This will be of interest if you are concerned about particular frequencies exceeding certain critical levels over a working speed range and possibly setting up secondary vibrations.

The slice mode example in Fig. 5 shows how the measured level in the 250 Hz 1/3-octave band varies during a run-up test.

Data-display Facilities

Data-display facilities include:

- Simultaneous displays of an autospectrum and its orders. Fig. 6 shows an example of a 1/3-octave band autospectrum above and its orders below.
- Tacho parameters and DC channels. Fig. 7 shows an example of this.
- Sliced views of all multispectra, orders, tacho parameters and the voltage levels in each DC channel.

Operation

Operation is divided into two modes: Set-up Mode and Measurement Mode. On-screen help is available throughout.

Set-up Mode

The set-up mode is used to configure the analyzer before making any sound and vibration measurements. User-interactive menu pages can be stepped through systematically to set up frequency range, filter bandwidth, orders, tachometric signal conditioning, display axes, averaging mode, trigger and multispectra conditions etc., until the analyzer is fully configured for the required measurements.

Measurement Mode

After you have gone through the set-up mode, the analyzer is ready to go into its measuring mode at the push of a button. Essentially, all measurements yield some kind of averaged spectral data depending on the conditions and selectivities imposed by the set-up of the analyzer. These can be accompanied by additional data such as RPM, torque, pressure etc.

Measurement results can be hard-copied in graphical or tabular format, saved in the 2145's non-volatile memory, or saved on a floppy disk and presented and documented using the optional nVision Data Presentation Software Type 7678 which runs under Microsoft Windows™ 3.1. Or the PC utility disk provided can be used for user text and user page and for converting measurement files into spreadsheet format.

Help Pages

Once a menu page has been called to the screen, you can display its associated help page. The system of help pages, i.e. one for each menu page, provides you with sufficient information for field operation without having to refer to the instruction manual.

Optional Remote Control Unit

To simplify measurement procedures, an optional remote control unit enables you to start and stop measurements while monitoring the main tacho parameter reading. The Remote Control Unit can be used to recall frequently used measurement set-ups and automated test sequences keyed-in using the autosequence facility.

Specifications 2145 with Software Type 7668

Analogue Input Characteristics:

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

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 MΩ || 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: 1µV, 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 MΩ 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 MΩ || 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: 1µV, 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 1pC 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 1pC with 1nF 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

CHANNEL–TO–CHANNEL MATCH:

Max. Gain Difference: 0.1 dB from lower frequency limit to upper frequency limit (in passband)

Max. phase difference for preamplifier and direct input:

50 Hz to 315 Hz: <0.017°
315 Hz to 630 Hz: <0.021°
630 Hz to 1.25 kHz: <0.042°
1.25 kHz to 2.5 kHz: <0.083°
2.5 kHz to 5 kHz: <0.166°
5 kHz to 15 kHz: <0.333°

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 42V 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
MAX. 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 analogue and A/D-converter overloads indicated.
CROSSTALK:
– 60 dB
ATTENUATOR LINEARITY:
± 0.1 dB
ANTIALIASING 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:
1 × 65536 Hz or 2 × 32768 Hz
A/D-CONVERSION:
Resolution: 16 bit
Quantizing Error: Maximum 1/2 LSB

Tachometer and Logging Input Characteristics:

Both tachometer inputs are protected up to 100 V peak. Individual set-ups for each tachometer channel
MAIN AND AUXILIARY TACHO INPUTS:
Input filter: DC coupled, Low pass: –3 dB at 60 kHz
Impedance: 10 kΩ
Input voltage range: 0.5 V to 20 V peak
Hysteresis: 0.2 V, 1.0 V or 2.5 V
Trigger level: –10.0 V to +10 V in 0.1 V steps
Trigger slope: Positive or negative
Trigger hold-off: Set to maximum of relative and absolute hold-off. Relative: 0 to 90% of pulse interval
Absolute (Main): 33 µs to 1.9 s. Precision 12.5%
Absolute (Auxiliary): 1.0 ms to 66 ms. Precision 5%
Trigger time accuracy: 50 mV/slew rate of trigger signal
Tacho divider: 1 to 32767
Tacho frequency range: (Main) 0.06 rpm to 1800000 rpm, (Auxiliary) 0.06 rpm to 60000 rpm
Time base accuracy: 60 ppm
Time resolution: 1 µs
Minimum pulse width: 10 µs
Maximum tacho update rate: (Main) 244 Hz, (Aux) 122 Hz
Tacho frequency accuracy (typical): <0.005%
Transducer power supply: +5V in series with PTC resistor on BNC inner screen. Voltage at 50 mA: 4.3V. Voltage at 100 mA: 3.7 V
Maximum supply current: 110 mA. Recommended 50 mA total for Main tacho, Auxiliary Tacho and trigger In
Tacho input crosstalk: –60 dB (typical)
DC CHANNELS INPUT CHARACTERISTICS:
Input filter: DC coupled, Low pass: –3 dB at 140 Hz
Impedance: 20 kΩ
Input voltage range: 0 V to +6.4 V. Permitted overload range: –5 V to +10 V
Resolution: 0.025 V (8 bits)
Sampling frequency: 10 Hz
DIGITAL INPUT CHARACTERISTICS:
Maximum bit rate: 1 Mbaud
Maximum word size: 16 bits
Signal level: TTL or CMOS
Sampling frequency: 10 Hz

Tacho Parameters:

Two groups of tacho parameters are calculated. Each group is independently derived from either the Main or Auxiliary tacho inputs. Both instantaneous and average parameters are calculated
TACHO PARAMETER V1:
Units: rpm or Hz
Ratio: Entered as two sets of 3-digit nominators and denominators or directly as a factor
TACHO PARAMETERS P2, V2 AND A2:
Position (P2) units: Metres, inches, feet, miles or cycles
Velocity (V2) units: m/s, km/h, mph, fpm, rpm or Hz
Acceleration (A2) units: m/s^2, $feet/s^2$, g or cyc/s^2
Ratio: Entered as two sets of 3-digit nominators and denominators or directly as a factor
ACCURACY:
V1, V2:
Connected to MAIN input, ratio = 1.0
1 mHz – 30 Hz: 0.003%
30 Hz – 488 Hz: V × 1 µs
488 Hz – 30 kHz: 0.05%
Connected to AUX input, ratio = 1.0
1 mHz – 30 Hz: 0.003%
30 Hz – 244 Hz: V × 1 µs
244 Hz – 30 kHz: 0.024%
P2:
Relative: 0.003%
Absolute: 1 revolution (ratio = 1.0)
A2:
Connected to MAIN input, ratio = 1.0
1 mHz – 2 Hz: 15 µHz/s
2 Hz – 488 Hz: $V^3 \times 3$ µs
488 Hz – 30 kHz: V × 0.48 Hz
Connected to AUX input, ratio = 1.0
1 mHz – 2 Hz: 15 µHz/s
2 Hz – 244 Hz: $V^3 \times 3$ µs
244 Hz – 30 kHz: V × 0.12 Hz

Trigger Input:

BNC connector for external trigger to start an average instantaneously or with user-defined delay
Input Filter: DC coupled, low pass: –3 dB at 60 kHz
Impedance: 10 kΩ
Input Voltage Range: 0.5 V to 20 V
Hysteresis: 0.2 V, 1.0 V or 2.5 V
Trigger Level: –5.0 V to +5.0 V in 0.1 V steps
Trigger Slope: Positive or negative
Minimum Pulse Width: 10 µs
Transducer Power Supply: +5 V in series with PTC resistor on BNC inner screen. Voltage at 50 mA: 4.3 V. Voltage at 100 mA: 3.7 V
Maximum Supply Current: 110 mA. Recommended 50 mA total for Main Tacho, Aux Tacho and Trigger Input

Order Analysis:

Order span: 0.01 to 200.0
Number of orders: Any 20 orders within order span
Order resolution (= order span/20): Can be improved by factors of 2, 4, 8 or 16
Record weighting: Rectangular, Hanning or flat top
Maximum ratio between highest and lowest order: 62.8 (rectangular), 80 (Hanning) or 145.9 (flat top)
Analysis range: 0.35 Hz to 11.2 kHz for single channel, 0.35 Hz to 5.6 kHz for dual channel
Real-time performance: Typically (dual channel, order span = 20, resolution improvement =4) orders are calculated without loss of data up to 9200 rpm
Maximum rpm rate: Maximum rpm rate (Δrpm) can be found from the formula (worst case):
$\Delta rpm = 0.0048 \times rpm^2 \times$ (order span)/(resolution improvement) (e.g. Δrpm = 24 krpm/s for rpm = 1000, order span = 20.0 and resolution improvement = 4.0)

Digital Filters:

1/1-OCTAVE FILTERS:
14-pole filters with centre frequencies given by $10^{3n/10}$. Fulfil IEC 225-1966, DIN 45651 and ANSI S1.11-1986, Order 7 Type 1-D, optional range
Single Channel: $-1 \le n \le 14$. 16 filters with centre frequencies from 0.5 Hz to 16 kHz
Dual Channel: $-1 \le n \le 13$. 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: $-4 \le n \le 43$. 48 filters with centre frequencies from 0.4 Hz to 20 kHz
Dual Channel: $-4 \le n \le 40$. 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: $-18 \le n \le 149$. 168 filters with centre frequencies from 0.365 Hz to 5.464 kHz
Dual Channel: $-18 \le n \le 137$. 156 filters with centre frequencies from 0.365 Hz to 2.738 kHz
1/24-OCTAVE FILTERS:
6-pole filters with centre frequencies given by $10^{(n + 0.5)/80}$
Single Channel: $-36 \le n \le 275$. 312 filters with centre frequencies from 0.360 Hz to 2.778 kHz
Dual Channel: $-36 \le n \le 251$. 288 filters with centre frequencies from 0.360 Hz to 1.392 kHz

System Accuracy:

DYNAMIC RANGE:
All distortion (intermodulation and harmonic) and spurious noise at least 80 dB below max. input voltage for 1/3-octave autospectrum
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 µV
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 ±0.005% of maximum input voltage, whichever is greater, measured using a sine wave input at the filter centre frequency. With measurements more than 60 dB below max. input voltage, 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 voltage
FREQUENCY ACCURACY AND STABILITY:
0.01% without warm-up (no adjustment necessary)

Detectors:

Digital true RMS detection of filter bank, two broadband channels, orders and tacho parameters. No crest factor limitation
CONTROL:
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, internal or tacho trigger signal for gating the averaging process
Interval Tacho Control: The averaging process can be automatically stopped and continued by any tacho parameter
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 hr and to 1 s in the range 1 hr to 24 hours
Dual Channel: Averaging times from 2 ms to 24 hours selectable to a resolution of 2 ms in the range 2 ms to 1 hr and to 1 s in the range 1 hr to 24 hours
EXPONENTIAL:
Single Channel: 19 averaging times from 1/512 s to 512 s in a binary sequence
Dual Channel: 18 averaging times from 1/256 s to 512 s in a binary sequence. 1/4 s and 2 s "Fast" and "Slow" sound level meter responses according to IEC 651 type 0

Spectrum Memory:

Non-volatile internal memory for 111 single spectrum or multispectrum files each labelled with up to 80 characters of user-defined text. The text label is stored together with data and is shown in the file list
Control: Manual save, multispectrum or interval multispectrum automatic save
Start conditions: Free Run, Manual, Absolute Time or Internal/External triggering at a specified level with selectable slope
Delay: Pre- and post-trigger delay between start condition and actual multispectrum start, set in seconds
Multispectrum update rate: From 1 ms (2 ms for dual channel) to 24 hours, with 1 ms resolution
Interval Multispectrum update rate: 4 ms when controlled by Main Tacho, 8 ms when controlled by Auxiliary Tacho
Max. no. of spectra: 1660 (for single channel 1/1-octave autospectra)
Max. (or Min.) hold, all bands and orders: Composite spectrum and orders of max. (or min.) RMS level occurring in each channel
Max. (or Min.) hold, specified band or order: Retains the spectrum orders and tacho parameters for which max. (or min.) RMS level has occurred in the specified band

Mass Storage:

Built-in disk-drive for storage of measured data, set-ups, and optional programs
Data media: Removable $3\,^1/_2''$ double sided, high density micro floppy disk
Data format: Compatible with PC/MS-DOS from version 3.2*
Formatted capacity: 1440 kbytes
File list: Contains disk identification, user-definable volume label and file list sorting key. Each file is identified by user-definable file number, data type, size and start time of the measurement

Hard Copy:

Any display on Type 2145/7668, including graphics and all notation, can be printed on graphics printers with IBM, HP or Epson print formats. Measurement results can also be printed in table format

Autosequence:

Allows the user to specify an autosequence of front panel keypushes, the functions of which can be executed on command from a dedicated execution page. Maximum 200 key entries per autosequence. Up to 6 autosequences can be saved in non-volatile memory

* PC-DOS is a trademark of International Business Machines Corporation. MS-DOS is a trademark of Microsoft Corporation

Display:

Liquid Crystal Display (dot matrix, super twisted nematic) with back-light and resolution 480 × 200 points
DISPLAY FORMATS:
Single: A single display showing autospectrum, orders, tacho parameters or DC channels. Digital integration or differentiation of autospectra is possible
Dual: Two displays (input or recalled) shown respectively in the upper and lower parts of the screen
Difference: The upper display is the difference between the upper display function and the lower display
Slice: A slice is taken through at right angles to the frequency axis of a multispectrum (autospectrum, order, tacho parameter, DC channel or overload flag). Slices can be displayed in Single, Dual or Difference mode and "live" while capturing a multispectrum
Menu: The text shown relates to the adjacent soft key control
Y-AXIS:
Annotation: (Autospectrum and orders) Imperial, metric or relative units (dB). Selectable dB reference
Autospectrum type: RMS, power, power spectral density or energy spectral density
Order type: RMS, power or energy
Amplitude scroll: Hard key controls to shift the display up and down
X-AXIS:
Autospectrum display: Logarithmic axis with annotation in Hz at 1/1-octave band centre frequencies conforming with ISO R266. Range from 1 to 16 octaves. 11 octave bands at a time can be displayed
Frequency scroll: Hard key controls to shift the display left and right
Slice display: Linear axis annotated by index numbers from 1 to max. 999 (representing time, position, velocity, angle etc.) or annotated by the unit of the controlling tacho parameter (rpm, metres etc.)
CURSOR:
Reads frequency in Hz on the x-axis (autospectrum display), index or tacho parameter value (slice display) at the same time as reading amplitude level in dB, absolute units, volts or tacho parameter units on the y-axis

Calibration:

Autospectrum and orders: Pressure or acceleration calibration. Direct entry of transducer sensitivity or autocalibration with an appropriate calibrator. Direct entry of decibel (dB) reference
Tacho Parameters: Speed or distance calibration. Direct entry of ratio or autocalibration at a specified speed or distance

Operation:

Menus: User-interactive menus are used to set up the analyzer for measurements. User-defined measurement set-ups can be saved and recalled from non-volatile internal memory or disk
Measurement Mode: For enabling measurements and viewing data and slices called up from the internal memory
Remote Control: An optional Remote Control Unit ZH 0611 gives full control of measurement procedure and displays a selected parameter together with state-of-data-acquisition in an understandable way

IEC/IEEE Interface:

Conforms to IEEE 488.1 and IEC 625-1 standards. Any function shown on display (including measured data, post-processed result, measurement set-up, display set-up or calibration set-up) can be transmitted to and from the analyzer
FUNCTIONS IMPLEMENTED:

Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T5
Listener	L3
Service Request	SR1
Remote/Local	RL1
Parallel Poll	PP1
Device Clear	DC1
Device Trigger	DT1

COMMAND SET:
Simple and easy to remember standard engineering English. Resistant to operator error
CODE:
ASCII (ISO 7-bit) code, or binary
INTERFACE TERMINATOR:
Can be specified on the Interface Menu
DEVICE ADDRESS:
Can be specified on the Interface menu

RS–232–C Interface:

Conforms with the EIA Standard RS–232–C (equivalent to CCITT V24). Allows remote activation of the front panel key functions via a non-intelligent terminal, either directly or via a modem

Power Supply:

Battery: 6 (fully charged and in good condition) rechargeable NiCd cells (QB 0008) operate the system for > 3 hrs continuous use at 25°C. The operating time is reduced if disk-drive or interface bus is used and decreases with decreasing temperature
Power Consumption: 1.2 A during measurements at a typical battery drive-voltage of 7.5 V (back lighting off)
External DC Supply: An external source or filtered DC power in the range of 11–16 V DC will power the analyzer continuously
Mains: The Brüel & Kjær Power Supply ZG 0342 fits into the slot normally occupied by the battery pack and is powered from 100 – 240 V AC mains supply. ZG 0342 complies with IEC 348 Class II

EMC

SUSCEPTIBILITY TO DISTURBANCES SPECIFIED IN EN 50082–2:
Measured with floating input module.
LF Magnetic Field: (30 A/m at 50 Hz)

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

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

Input/Output	Level
Preamp., Probe Direct via Preamp.[1]	< 25 µV
Charge[2]	< 2 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 µV
Charge[2]	< 16 fC

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

Cabinet:

DIMENSIONS:
Height: 175 mm (6.89″)
Width: 356 mm (14.02″)
Depth: 293.5 mm (11.56″)
Weight including batteries: 10.4 kg (23 lb.)

COMPLIANCE WITH STANDARDS:

CE	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive.
Safety	EN 61010–1: 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 (Analyzer): –10 to +55°C (+14 to +131°F) Operating Temperature (Disk drive): –5 to +50°C (+23 to +122°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 43

Ordering Information

Type 2145: Order Tracking Analyzer
includes the following accessories:
AO 0042: Multicable
AO 0399: Cigarette Lighter Cable
2×AO 0479: BNC-to-Lemo Adaptor
AQ 0157: Charging Adaptor
BZ 5086: Type 7668 Program disk VP 7316
Type 7668 PC-utility disk VP 7512
BZ 5075: Type 7651 Program disk VP 7279*
DH 0541: Shoulder Strap
JP 0312: 3-pin DIN Plug
JP 0808: 8-pin DIN Plug
6×QB 0008: 1.25V NiCd Batteries, type R 20 (“D” size)
ZG 0146: Battery Box
ZG 0342: Power Supply

* Dual Channel FFT software – see separate Product Data BP 1285

Optional Accessories:

TRANSDUCERS:
Type 4190: General-purpose 1/2″ Measuring Microphone
Type 2669 L: Microphone Preamplifier
AO 0488: B & K (preamp.) to Lemo Adaptor
Type 4371: General-purpose Accelerometer

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: Calibration Exciter

TACHO PROBES/SENSORS:
MM 0024: Photoelectric Probe
MM 0096: Inductive Probe
MM 0097: Throttle Position Sensor

ENHANCEMENTS:
Type 3558: Pass-by Noise Measurement System
WH 2921: Memory Extension to 1 Mwords
WH 2924: Memory Extension to 512 kwords
ZH 0611: Remote Control Unit

APPLICATION PROGRAMS:
Type 7638: Zwicker Loudness Option
Type 7667: Dual-channel Digital Filter Option

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
UA 0814: IEEE 24-way bus connector kit

MISCELLANEOUS:
QB 0008: 1.25V NiCd Battery, IEC type R 20 (“D” size)
QR 1107: Floppy Disks (High Density)
Type 7678: nVision Data Presentation Software

Brüel & Kjær

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