



## Portable Vibration Meter

type 2511

### FEATURES:

- Self contained rechargeable battery supply
- Measures acceleration, velocity, and displacement parameters over a very wide range
- Frequency range 0,3 Hz to 15 kHz
- General purpose accelerometer included
- Calibrated in both British and Metric units
- RMS and true peak-to-peak detector with hold facility
- Selectable low-pass and high-pass filters
- External filter available
- AC; DC Lin; and DC Log recorder outputs
- Built-in calibrator
- Battery charger supplied as standard

### USES:

- Measurement and monitoring of vibration levels on machinery
- Production quality control
- Vibration measurements on land, air, and sea vehicles
- Frequency analysis in conjunction with an external filter
- Failure forecasting and trouble shooting in industrial plant
- Measurements on vibration test set-ups

Vibration Meter Type 2511 is an exceptionally wide range instrument which is used in conjunction with a piezoelectric accelerometer to measure mechanical vibration and shock in terms of acceleration, velocity, and displacement. It is completely portable and is built to a high standard of accuracy and stability making it suitable for both laboratory and field conditions. The instrument is fully calibrated in both Metric and British units and has a charge amplifier input which allows the use of long cables between the accelerometer and the meter without any reduction in sensitivity.

The Type 2511 is a valuable tool in the investigation of the dynamic behaviour of mechanical structures. It can be used to monitor vibration levels in production machines on a periodic basis so that any increase can be noted and corrective action taken before a complete machine failure. It may be used in production quality control to ensure that manufactured goods are within specification before dispatch. It can be used in tracking down the source of vibrations which produce noise so that damping can be applied. In design and development, it can be





used in assessing the vibration "quality" of a prototype. In civil engineering it can be used in the investigation of vibration on roads, bridges, dams, buildings etc. Its operation is simple and quite suitable for use by non-scientific personnel not conversant with electronic instrumentation.

### Accelerometer

Supplied as standard equipment with the Type 2511 is a Brüel & Kjær accelerometer Type 4370. This is a high quality piezoelectric device which produces an electrical signal proportional to the acceleration to which it is subjected and has an output of 10 pC/ms<sup>-2</sup> (100 pC/g). This accelerometer will cover the majority of ordinary measuring needs but by using Accelerometers types 4371/4384 or Type 4378 which have sensitivities of 0,1 × and 3,16 × relative to the Type 4370 the working range of the instrument is considerably increased. Table 1 shows the measuring ranges of the Type 2511 with the three different accelerometers.

### Dynamic Range

The measuring ranges shown in the table are for wide band measurements without any external filter. The lowest measurable levels are dependent on the internal noise level of the instrument, which is reduced as the measuring bandwidth is reduced. With the use of third octave or narrower bandwidth external filters, measurements can be made at significantly lower levels. The lower limits shown in Table 1 are 6 dB above the wide-band RMS noise floor.

### Integrators

In order to measure velocity or displacement parameters, the acceleration signal from the transducer is integrated or double integrated respectively.

### Frequency Range and Filters

The instrument has a frequency range from 0,3 Hz to 15 kHz in the acceleration mode, in the velocity and displacement modes the frequency range will be determined by the integrator filters. The frequency characteristics in the three modes is shown in Fig. 1.

A two position switch on the rear panel enables either a 1 kHz or 15 kHz low pass filter to be selected, which heavily attenuate the possible affect of high frequency vibration components on the accelerometer mounted reso-

Accelerometer	Mode LLF for min. level	Wide Band Measuring Range		
		Min. (RMS)	Max.	
4378 (31,6 pC/ms <sup>-2</sup> )	Acc'n 0,3Hz	m/s <sup>2</sup>	0,0006	31,6
		g	0,00006	3,16
	Vel. 3 Hz <sup>+</sup>	mm/s	0,006	316
		in/s	0,0003	31,6
Disp. 10 Hz <sup>+</sup>	mm	0,0001	3,16	
	inch	0,00001	0,316	
4370 (10 pC/ms <sup>-2</sup> Supplied as Std.)	Acc'n 0,3Hz	m/s <sup>2</sup>	0,002	100
		g	0,0002	10
	Vel. 3 Hz	mm/s	0,02	1000
		in/s	0,001	100
Disp. 10 Hz <sup>+</sup>	mm	0,0003	10	
	inch	0,00002	1	
4371 (1 pC/ms <sup>-2</sup> )	Acc'n 0,3Hz	m/s <sup>2</sup>	0,02	1000
		g	0,002	100
	Vel. 3 Hz <sup>+</sup>	mm/s	0,2	10000
		in/s	0,01	1000
Disp. 10 Hz <sup>+</sup>	mm	0,003	100	
	inch	0,0002	10	

+ By switching to the next lower LLF than stated in Vel. and Disp., the internal noise level (and therefore the lowest measurable level) will increase by a factor of < 5 in Vel. and increase by a factor of 10 in Disp.

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Table 1. Measuring ranges of the Type 2511 in conjunction with three B & K accelerometers. The figures quoted are for wide band measurements. The minimum RMS levels quoted lie 6 dB (2×) above the wide band RMS noise level

nance frequency. For measurements at frequencies above 1 kHz with Accelerometer Type 4370 which has a useful operating frequency range extending up to 6 kHz, extra attenuation of high frequency vibration components is needed. This can be achieved by mounting the Accelerometer on a Mechanical Filter UA 0559 before attaching it to the measurement point. Five UA 0559's are supplied in the Mechanical Filter Set UA 0553 which is available as an extra. With Accelerometers Type 4378 and 4371/4384 which have a useful operating frequency range extending up to 4 kHz and 12 kHz respectively, the use of a mechanical filter is not necessary.

High pass filters are incorporated to limit the low frequency response of the instrument to 1 Hz, 3 Hz or 10 Hz as desired. This facility will reject the influence of low frequency noise and will be found particularly useful when measuring low level signals in the velocity and displacement modes.

With the instrument switched to measure RMS velocity, with a lower limiting frequency of 10 Hz, and the 1 kHz Low Pass filter switched in, the pass band of the Type 2511 closely approximates the requirements of the VDI, ISO, BS and DIN standards for vibration severity measurements.

### External Filter

Input and output sockets of the BNC type are provided on the rear panel for direct connection of an external filter. The use of an external filter will increase the versatility of the instrument in that it can be made sequentially sensitive to a series of narrow frequency bands. This is necessary where it is required to perform a frequency analysis of a signal or locate the frequency at which a mechanical resonance peak occurs, for example. The portable, battery operated, Tunable Band Pass Filter Type 1621 is ideal for use with the Type 2511. Either 23% (approx. 1/3 Octave) or 3% bandwidths are switch selectable and manually tunable over the frequency range 0,2 Hz to 20 kHz. Tracking Filter Type 1623 (see Fig.7) gives a choice of three bandwidths, 6%, 12% and 23%, and can also be manually tuned. The 1623 can, additionally, be tuned from an external signal, for example from a photoelectric transducer, so that vibration level can be plotted as a function of a machine's varying rotation speed and its harmonics.

### Meter, Detector and Hold Facility

The indicating meter has a 40 dB measuring range (2 decades), and is logarithmically graduated from 1 to 100 giving the same reading accuracy throughout the range. A spare scale is supplied which is graduated directly in dB.

Both true peak-to-peak and RMS detectors are included in the Type 2511, these will be used according to the type of signal, and by requirements set by particular standards. Generally, the RMS detector is used where the energy content of a signal is important as, for example, set by the vibration severity standards previously mentioned. The peak-to-peak detector is useful for measuring shocks, and vibration in the displacement mode.

A very useful feature is the "hold" facility which operates in both the RMS and peak-to-peak modes. This enables the meter to retain the maxi-

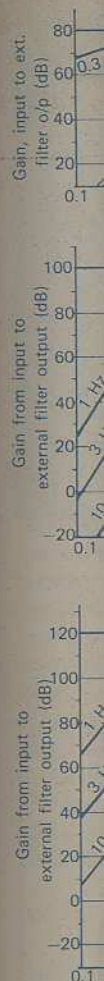


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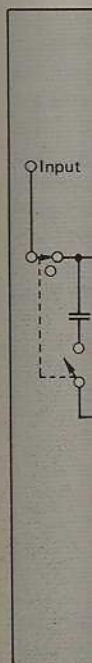


Fig. 2. I



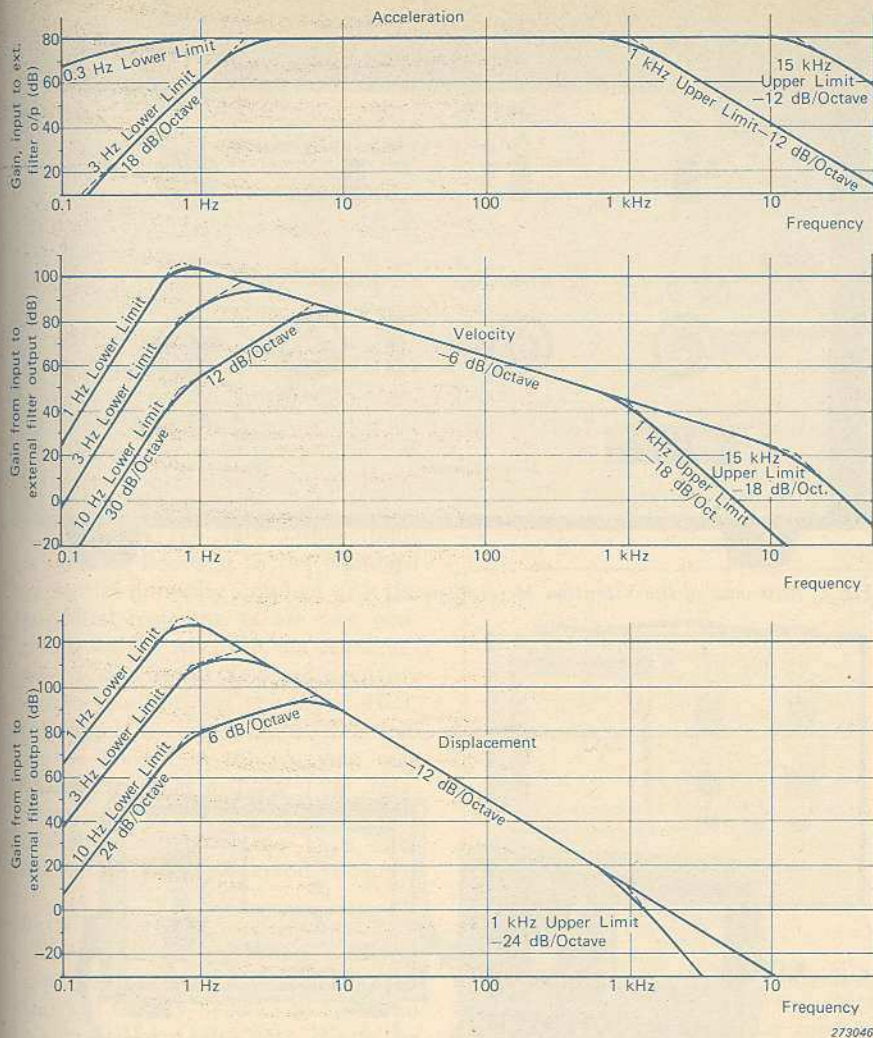


Fig. 1. Transfer characteristic curves of the Type 2511 when switched to Acceleration, Velocity, and Displacement; the instrument is switched to maximum sensitivity. The dotted line shows the idealised filter shape

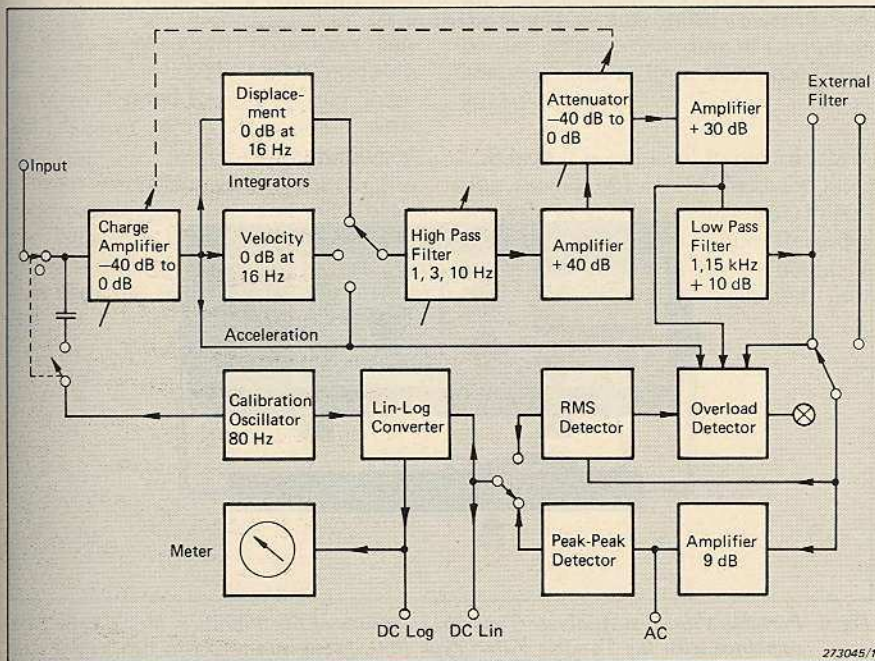


Fig. 2. Block diagram of Vibration Meter Type 2511

imum vibration level of a particular transient, for example an engine passing through a resonance. The maximum level is held on the meter after the transient has occurred.

### Overload Indicator

To warn the user of an overload condition a warning light on the front panel is activated by a level detector. This detector senses overload at four different points in the circuit thus ensuring that all possible overload eventualities are covered.

### Calibrator

The calibrator consists of an 80 Hz oscillator which applies a reference charge signal to the input of the instrument. This enables the meter to be set to a reference point by means of the adjuster on the front panel. Calibration checks can be made on all three parameters, Acceleration, Velocity and Displacement.

The meter calibration of the Type 2511 can be adjusted to suit accelerometer sensitivities between 0.7 and 1.3 times, or decade multiples of, the 4370's sensitivity by means of the calibrator adjuster. The meter pointer is moved from the 10 position on the secondary meter scale to read the actual charge sensitivity of the accelerometer used.

### Input and Output

A standard miniature socket is provided on the front panel for direct input of the reinforced accelerometer cable. A parallel input socket on the rear panel accepts a BNC type plug.

The acceleration, velocity or displacement signal as registered on the meter is also available from a BNC output socket on the rear panel of the instrument. The signal can thus be examined on an oscilloscope or a permanent record can be made by connecting a tape recorder or a chart recorder.

The signal is available as an unrectified AC output for oscilloscopes and many chart recorders. Some recorders require a DC signal, both linear and logarithmic proportional outputs are available for this case.

### Power Supply

Supplied as standard with the Type 2511 are four rechargeable cells, QB 0008, and a battery charger unit, ZG 0113 shown in Fig. 3. For use in the field, the rechargeable batteries will give about 10 hours continuous



operation. Where recharging from an AC mains supply is not possible the Type 2511 can be run from ordinary IEC Type 20 cells. Good quality alkaline cells can give about 15 hours continuous operation, and ordinary "long life" cells give up to 4 hours continuous operation.

In the laboratory and for more permanent applications the charger unit permanently coupled to the fully charged cells will be the most convenient form of power supply.

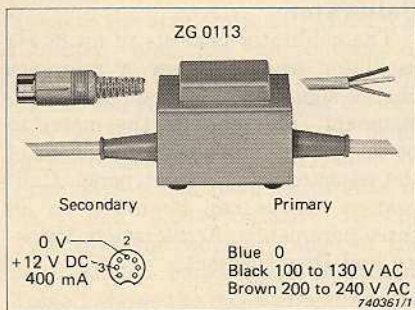


Fig. 3. The battery charger ZG 0113 supplied as standard

Where it is required to operate the instrument and recharge the batteries at the same time, the B & K Power Supply ZG 0199 should be used. A 12 V car battery can also be used to simultaneously charge the NiCd cells and power the Type 2511. For monitoring applications where a number of vibration meters may be installed together, it will be convenient to use a common power supply. The B & K Power Supply Type 2805 can power up to 8 2511's simultaneously with a  $\pm 14$  V supply.

The meter scale is marked to indicate battery condition; when a push button on the front panel is depressed the meter indicates battery recharging or renewal.

A miniature connector on the front panel supplies a + 28 V power supply for use with Accelerometers with built-in preamplifiers.

#### Physical Description

The Type 2511 is a light-weight easily operated instrument with a large 110 mm  $\times$  63 mm meter. A carrying handle is built into the top of the cabinet and the underside is fitted with a hinged support leg for inclining the instrument for bench use. With the "B" version of the Type 2511 a mahog-

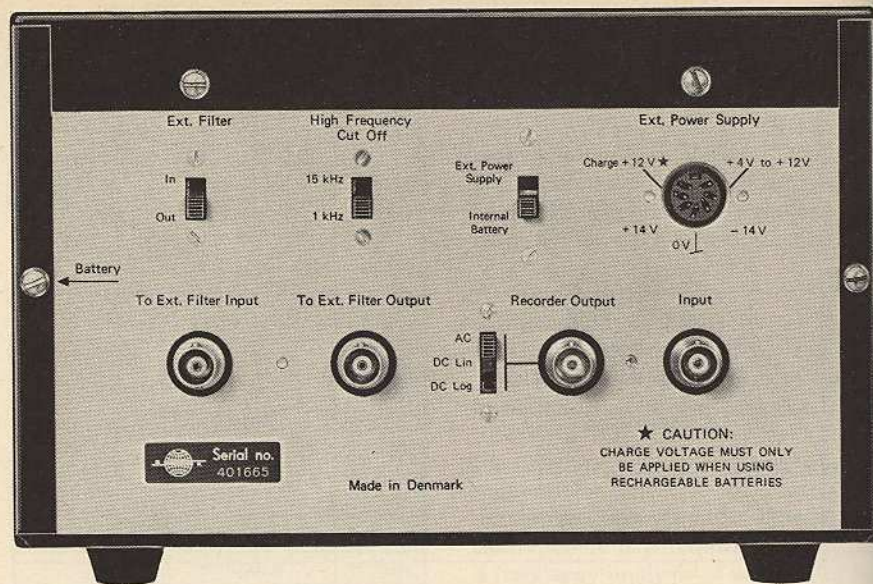


Fig. 4. Rear view of the Vibration Meter Type 2511

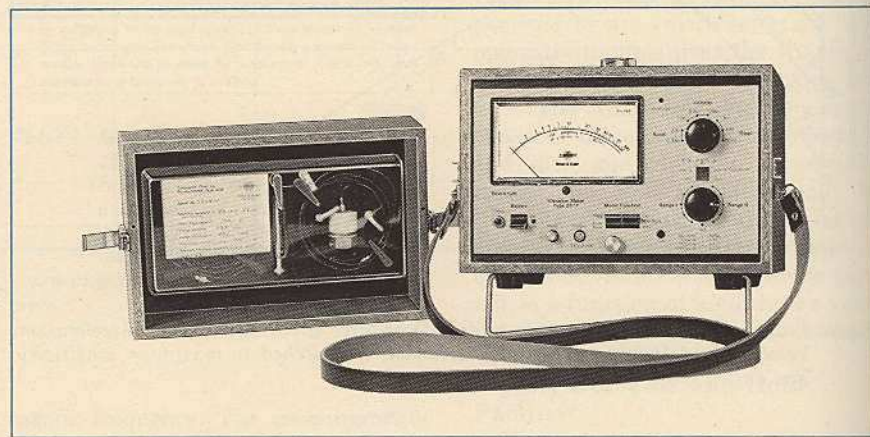


Fig. 5. Type 2511 B consists of the Type 2511 A fitted into a mahogany cabinet with shoulder strap, and accessories stored in the lid

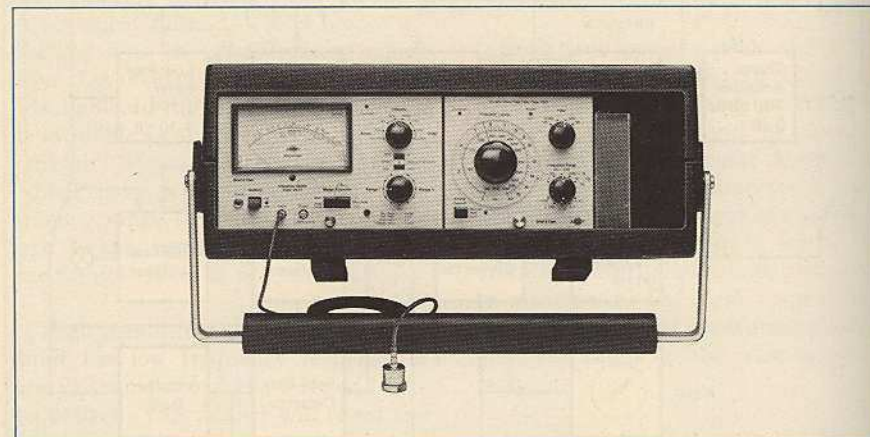


Fig. 6. Portable Vibration Analyzer Type 3513 consists of the Vibration Meter Type 2511 combined with the Tunable Filter Type 1621, fitted into a robust, lightweight case KA 2004

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any cabinet is supplied. The removable lid contains the accelerometer and accessories conveniently stored for on-site measurements.

### The Type 2511 as a Vibration Analyzer

As described under "External Filter", the Type 2511's versatility can be considerably increased by adding a portable, battery operated, band pass filter.

The Type 2511 and the filter Type 1621 are supplied together as a completely portable vibration analyzer set Type 3513, shown in Fig.6. The two instruments are fitted into a light-weight but robust hard-foam plastic carrying case KA 2004. Other items included in addition to the standard accessories normally supplied with the individual instruments are two connection cables AO 0133, six rechargeable NiCd-cells QB 0008 and a battery charger ZG 0113 for the Type 1621. The Tracking Filter Type 1623 can also be housed in the carrying case KA 2004 together with the Type 2511. Please ask for the separate product data sheets covering the Type 3513 and Filters Types 1621 and 1623.

### Data Recording

The results of vibration measurements and analyses made out in the field will usually need to be reviewed or analyzed at a later date. While the results can be noted by hand from the meter of the Type 2511, some form of permanent record made directly on-the-spot, will often be desirable for speed and convenience.

Direct paper-chart recordings can be made by using the small, portable battery operated Level Recorder Type 2317, shown in Fig. 8, together with the vibration meter. For frequency analysis work; (for example using the filter sets Types 1621 and 1623 with the Type 2511) the paper movement of the level recorder can be synchronised with the frequency sweep of the

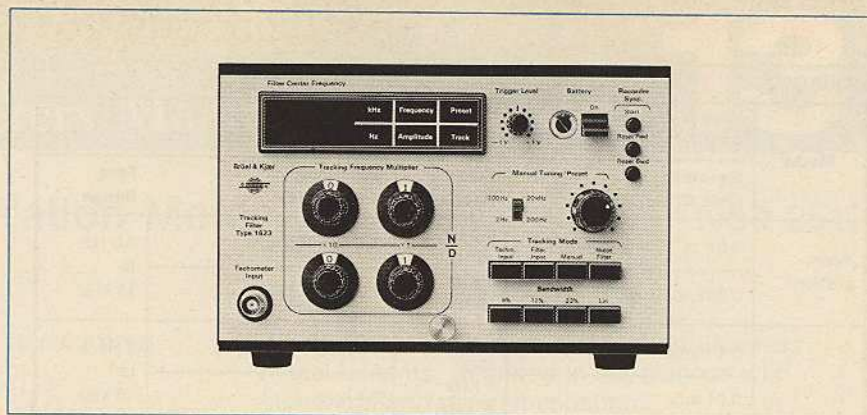


Fig. 7. The Tracking Filter Type 1623

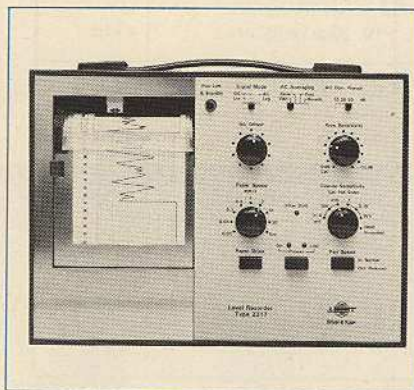


Fig. 8. The portable, battery operated, Graphic Level Recorder Type 2317 (also available in leather carrying case, Model F)

filter so that frequency and amplitude calibrated spectrograms can be produced directly. Suitable recording paper for graphic recording of frequency analyses with a Type 2317 and Type 2511 is QP 0120.

Where it is required to record vibration signals out in the field for later analysis in the laboratory, the Portable Instrumentation Tape Recorder Type 7005 shown in Fig. 9 should be used. This is battery operated, four

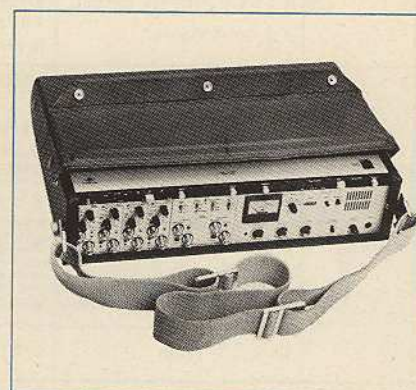


Fig.9. The portable, battery operated Tape Recorder Type 7005 (Model F in leather carrying case shown)

channel recorder with specifications fully up to laboratory requirements. Sequential frequency analysis of transient and non-repetitive signals, such as mechanical shocks, is conveniently performed using the tape loop cassette supplied as standard.

Please ask for separate product data sheets covering the Portable Level Recorder Type 2317 and the Portable Tape Recorder Type 7005.



# Specifications 2511

## SENSITIVITY:

Mode	With Accelerometer 4370, 10 pc/ms <sup>-2</sup>		With Accelerometer 4371 or 4384, 1 pc/ms <sup>-2</sup>	
	Sensitivity (Full Scale)	Freq. Range	Sensitivity (Full Scale)	Freq. Range
Acceleration	0,01 to 100 m/s <sup>2</sup>	0,3 Hz to 1 kHz (6 kHz)*	0,1 to 1000 m/s <sup>2</sup>	0,3 Hz to 15 kHz
	0,001 to 10 g		0,01 to 100 g	
Velocity	0,1 mm/s	3 Hz + to 1 kHz (6 kHz)*	1 mm/s	3 Hz + to 15 kHz
	0,01 in/s		0,1 in/s	
	1 mm/s	1 Hz to 1 kHz (6 kHz)*	10 mm/s	1 Hz to 15 kHz
	0,1 in/s		1 in/s	
	10; 100; 1000 mm/s	1 Hz to 1 kHz (6 kHz)*	100; 1000; 10000 mm/s	1 Hz to 4 kHz
	1,0; 10; 100 in/s		10; 100; 1000/in/s	
Displacement	0,001 mm	10 Hz + to 1 kHz (2,5 kHz)*	0,01 mm	10 Hz + to 2,5 kHz
	0,0001 in		0,001 in	
	0,01 mm	3,16 Hz + to 850 Hz	0,1 mm	3,16 Hz + to 850 Hz
	0,001 in		0,01 in	
	0,1; 1,0; 10 mm	1 Hz to 275 Hz	1; 10; 100 mm	1 Hz to 275 Hz
	0,01; 0,1; 1,0 in		0,1; 1,0; 10 in	

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## METER CALIBRATION:

Adjustable to suit accelerometer sensitivity  
Range: ± 3 dB

## EXTERNAL POWER SUPPLY:

+ 4 V to + 15 V, 1,7 W (2 W in Ref.) or ± 14 V, 45 mA

## INTERNAL POWER SUPPLY:

4 × 1,5 V cells (IEC Type R 20)

## BATTERY LIFE:

9 to 10 hours continuous operation with NiCd cells. 15 hours with Alkaline and 3 to 4 hours with standard batteries  
Charging time for fully discharged batteries: approx. 14 hours. Charging current: approx. 400 mA

## ENVIRONMENTAL CONDITIONS:

Operating temperature: -10°C to +50°C  
Humidity range: 0 to 90% RH non condensing at 30°C or 0 to 85% RH at 50°C. Electro-magnetic fields up to 100 amp/m increase noise floor < 14 dB

## CABINET:

A model, B & K module cabinet KK 0025, 6/12 of 19" rack module  
B model, as A model but with mahogany cabinet and shoulder strap

## DIMENSIONS: (excl. feet, knobs, etc.)

Height: 133 mm (5,2 in)

Width: 210 mm (8,3 in)

Depth: 200 mm (7,9 in)

## WEIGHT:

2,4 kg (5,3 lb)

## ACCESSORIES INCLUDED:

Accelerometer..... Type 4370  
Reinforced low noise, Teflon PFA cable, 3 m (10 ft) long..... AO 0122  
Low noise, Teflon, cable 1,2 m (4 ft) long..... AO 0038  
Magnet..... UA 0642  
Probe with sharp tip..... YP 0080  
Round tip..... DB 0544  
4 Rechargeable batteries..... QB 0008  
Battery charger..... ZG 0113  
dB scale..... SA 0208  
7 pin DIN plug..... JP 0703  
3 BNC plugs..... JP 0035  
0,63 A fuses..... VF 0032

## ACCESSORIES AVAILABLE:

Wide range of accelerometers and filter  
Mechanical filter set..... UA 0553  
Mahogany Cabinet..... KA 0055  
Power Supply..... ZG 0199

\*Low frequency limits determined by noise, lower frequencies possible with external filter

With 1 kHz low-pass filter switched out and external filter used, (6 kHz is accelerometer + 10% limit)

## VIBRATION PICK-UP:

B & K Piezoelectric Accelerometer Type 4370  
Sensitivity: 10 pC/ms<sup>-2</sup> (~ 100 pC/g)

## MAX. EQUIVALENT NOISE LEVEL:

With a 10 pC/ms<sup>-2</sup> accelerometer and switched to RMS detector

Acc.: 0,001 m/s<sup>2</sup> (~ 0,0001 g) 0,3 Hz to 15 kHz

Vel.: 0,01 mm/s (~ 0,0004 in/s) 10 Hz to 15 kHz

Disp.: 0,00015 mm (0,000006 in) 10 Hz to 1 kHz

## ACCURACY (INCL. ACCELEROMETER):

± 5% absolute overall for 2511 + accelerometer within linear ranges. At both ends of a selected frequency range the accuracy is ± 5% from the appropriate filter characteristic (see also Fig. 1)

## HIGH-PASS FILTER:

3 Pole Butterworth, fall off 18 dB/octave

## LOW-PASS FILTER:

2 Pole Butterworth, fall off 12 dB/octave

## FILTER ATTENUATION:

Mode	0,3 Hz HP	1 Hz HP	3 Hz HP	10 Hz HP	1 kHz LP	15 kHz LP
Acceleration	< 30% at 0,3 Hz < 5% at 0,7 Hz	—	—	—	—	—
Velocity	—	< 10% at 1 Hz < 5% at 1,2 Hz	< 3% at 3 Hz < 5% at 2,9 Hz	< 3% at 10 Hz < 5% at 9,2 Hz	< 30% at 1 kHz < 5% at 600 Hz	< 30% at 15 kHz < 5% at 9 Hz
Displacement	—	< 20% at 1 Hz < 5% at 1,3 Hz	—	—	—	—

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## DETECTORS:

Quasi RMS: True reading indicated for sinusoidal signals and noise with crest factor < 3  
Time constants 1 s and 10 s switchable  
Time constant in "Max. Hold": 1 s  
Max. hold drift: < 10% per 5 min. with f.s.d. and < 40°C < 80% RH

## True peak-to-peak:

Time Constants 1 s and 10 s  
Max. hold drift: < 10% per 30 min. with f.s.d. and < 40°C < 80% RH  
Rise time: > 25 μs (15 kHz LP filter)  
Dynamic range for both detectors: 40 dB

## EXTERNAL FILTER SOCKETS:

2 × BNC  
Signal level 1 V peak or RMS  
Input socket impedance: 16 kΩ

## RECORDER OUTPUTS:

Output impedance: 1 kΩ  
Approx. levels for f.s.d.  
AC: 2,7 V RMS. Overload 6,8 V peak  
DC log: 2,0 V; 0,05 V/dB. Overload 2,25 V  
DC Lin: 3,0 V. Overload 4,5 V



Human

## USES:

- Measurement human
- Monitor
- Measurement inspect power
- Frequency

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