1623

Instruction Manual

Tracking Filter Type 1623

A small battery operated tracking filter which can be synchronised with the fundamental frequency or any harmonic between 1/99 and 99/1 of a periodic tuning signal. Combined with a vibration meter, sound level meter, or measuring amplifier, the 1623 allows signal analysis with respect to a variable frequency reference signal, for example vibration level as a function of shaft speed. Frequency range covered is 2 Hz to 20 kHz with filter bandwidths of 6%, 12%, and 23%. Tuned frequency synchronisation signals provided for the Portable Level Recorder Type 2306 and for X-Y recorders. Manual tuning of the filter by means of a front panel tuning knob coupled to a built-in oscillator.

Brüel & Kjær

033-0280

TRACKING FILTER
TYPE 1623

Revision March 1980

CONTENTS

type 1623

Tracking Filter

FEATURES:

- Battery operated
- Frequency range 2 Hz to 20 kHz
- Three selectable filter bandwidths 6%, 12%, 23% (1/3 Octave)
- Tunable from practically any periodic signal
- Manual tuning facility
- Filter frequency/tuning signal frequency ratio adjustable between 99/1 and 1/99
- Synchronization signals for level and X-Y recorders
- Wide dynamic range, >60 dB, with crest factor capability 4
- Large digital display of filter centre frequency
- Low-pass noise filter for tuning signal

USES:

- Synchronous vibration analysis of rotating machinery
- Harmonic analysis of vibration and electroacoustic signals
- Filtering of response signals in vibration testing set-ups
- Harmonic distortion measurements on gramophone pick-ups

Introduction

The fully portable, battery operated, Tracking Filter Type 1623 is a narrow bandwidth filter whose centre frequency automatically locks onto and follows the fundamental frequency, or a harmonic, of a periodic tuning signal originating from, for example, a tachometer or vibration transducer. Its small size and built-in battery power supply make it ideal for field operation with the general purpose Vibration Meter Type 2511.

When combined with a sound level meter, vibration meter, or measuring amplifier, sound, vibration, and other signals which can be converted to electrical waveforms, can be analyzed as a function of a variable frequency reference signal. As a typical example, can be quoted the synchronous vibration analysis of an engine being run up in speed; the vibration level measured can be plotted as a function of engine speed, and the development of resonances excited by the fundamental rotation frequency and its various harmonics can then be studied.

Filters

Both the tuning signal frequency and the filter frequency ranges cover 2 Hz to 20 kHz in one range with automatic tuning. Three constant percentage bandwidth filters are provided with "white noise" bandwidths of 6%, 12% and 23% (1/3 Octave) of the tuned frequency. Constant percentage bandwidth filters give a constant resolution on a logarithmic frequency scale and are therefore able to give a relatively quick analysis over a wide frequency range.

The filter, which has a dynamic range of about 70 dB, consists of a digitally tuned pair of two-pole Butterworth filters that give good selectivity with an attenuation of 12 dB/octave. Characteristic curves for the filters are shown in Fig. 1.

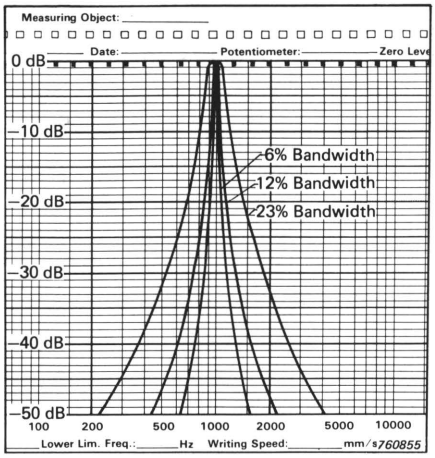


Fig.1. Typical filter characteristics of Tracking Filter Type 1623

The large digital display on the front panel, showing the frequency to which the filter is tuned, is easily readable in daylight conditions.

Filter Tuning

Practically any well defined periodic signal with a level between 20 mV (noise free) and 120 V peak-to-peak and a noise level less than 20 mV peak-to-peak, is suitable for tuning the filter. The signal can, for example, be obtained from a tachometer, photo-electric transducer, eddy current probe, accelerometer, microphone, force transducer, magnetic transducer, capacitive transducer etc. (with suitable preamplifier where necessary) which will give a signal in synchronization with some periodic motion of the measuring object.

A manually set trigger level enables the periodicity of the tuning signal to be detected in the most suitable portion of the waveform; this adjustment together with the hysteresis effect exhibited by the trigger, makes it possible for a reliable control pulse to be obtained from almost any periodic waveform.

In addition to the "tachometer" input, two other possibilities exist for automatically tuning the filter: (1) Where the signal to be filtered has a well defined periodic content itself, this can also provide the tuning signal. (2) In cases where a periodic component of the signal to be filtered is not clearly defined, the filter can be tuned through any single decade using the filter's own output as a tuning source. In this case, the tracking frequency multiplier facility, of course, cannot be used. One would normally expect this closed loop control system to be unstable, but with the unique digitally tuned filter used in the 1623, this is not the case.

Note that for ordinary frequency analysis work the 1623 can be automatically tuned by the Sweep Unit Type 5555.

Photo-Electric Transducers for "Tachometer Tracking"

For analyses on rotating machinery, a reliable method of tuning the filter is by means of a photoelectric transducer which gives a well defined pulse each time a photo-diode or transistor is triggered by an interrupted light source.

The B & K Photoelectric Tachometer Probe MM 0012 is a combined infra-red light source and pickup device built into a common housing, which is ideal for triggering the 1623. It is positioned up to 15 mm from a convenient rotating machine part so that the light beam is reflected back from a contrasting band attached to the part. A white paper, or aluminium foil strip glued onto a black background is ideal. The device is fitted with a red filter to reduce interference from mains-operated lights. Power for the MM 0012 is derived directly from an extra shield in the tachometer input socket (BNC) of the 1623.

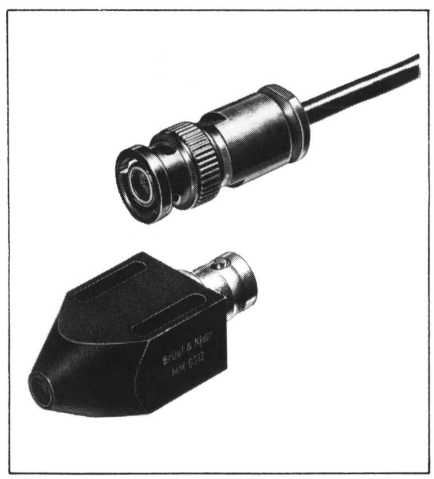


Fig.2. Photoelectric Tachometer Probe MM 0012, available as an accessory for the Tracking Filter Type 1623

Manual Tuning

By means of a tuning knob on the front panel, the 1623 can be manually tuned and used as an ordinary tunable bandpass filter for frequency analysis work in the field. The tunable range from 2 Hz to 20 kHz is covered in this mode in two ranges (2 Hz to 200 Hz and 200 Hz to 20 kHz). The frequency tuning knob is also used to preset the filter centre frequency to the approximate starting frequency of the tuning signal. This significantly reduces the time taken for the filter to automatically lock onto the tuning signal, especially at lower frequencies.

Auxiliary Sweep Unit An alternative to manual tuning of the 1623 for ordinary frequency analysis work is the Frequency Sweep Unit Type 5555 available on special order from the B & K Systems Engineering Group. The 5555 connects to the tachometer input of the 1623 and facilitates automatic frequency sweep between two preset frequencies selected on the front panel of the 5555. Start frequencies of 2, 20, 200, and 2000 Hz may be chosen while the upper frequency may be set to 20, 200, 2 K, and 10 kHz. Coverage up to 20 kHz is possible by using the frequency multiplier facility in the 1623.

It may be seen from Fig.5 that for a given filtered signal accuracy the sweep speed is limited at high frequencies by the writing speed of the recorders, Types 2306 and 2309. At low frequencies the limiting factor is the 1623 filter settling time which in turn depends on the filter bandwidth chosen. These values are set on the front panel of the 5555 so that changeover from one limiting parameter to the other is automatic during sweep thus ensuring the shortest possible analysis time.

The 5555 is equipped with a built-in NiCd battery which may be recharged in-situ by battery charger ZG 0113 which is supplied as an accessory to the 1623. Battery condition is indicated on a meter.

Tracking Frequency Multiplier

This facility enables the filter to be tuned to any ratio combination between 1/99 and 99/1 times the tuning signal frequency, thus allowing any harmonic or sub-harmonic (between these limits and within the frequency limits of the instrument) of the fundamental of the measured signal to be examined. This feature makes the vibration an-

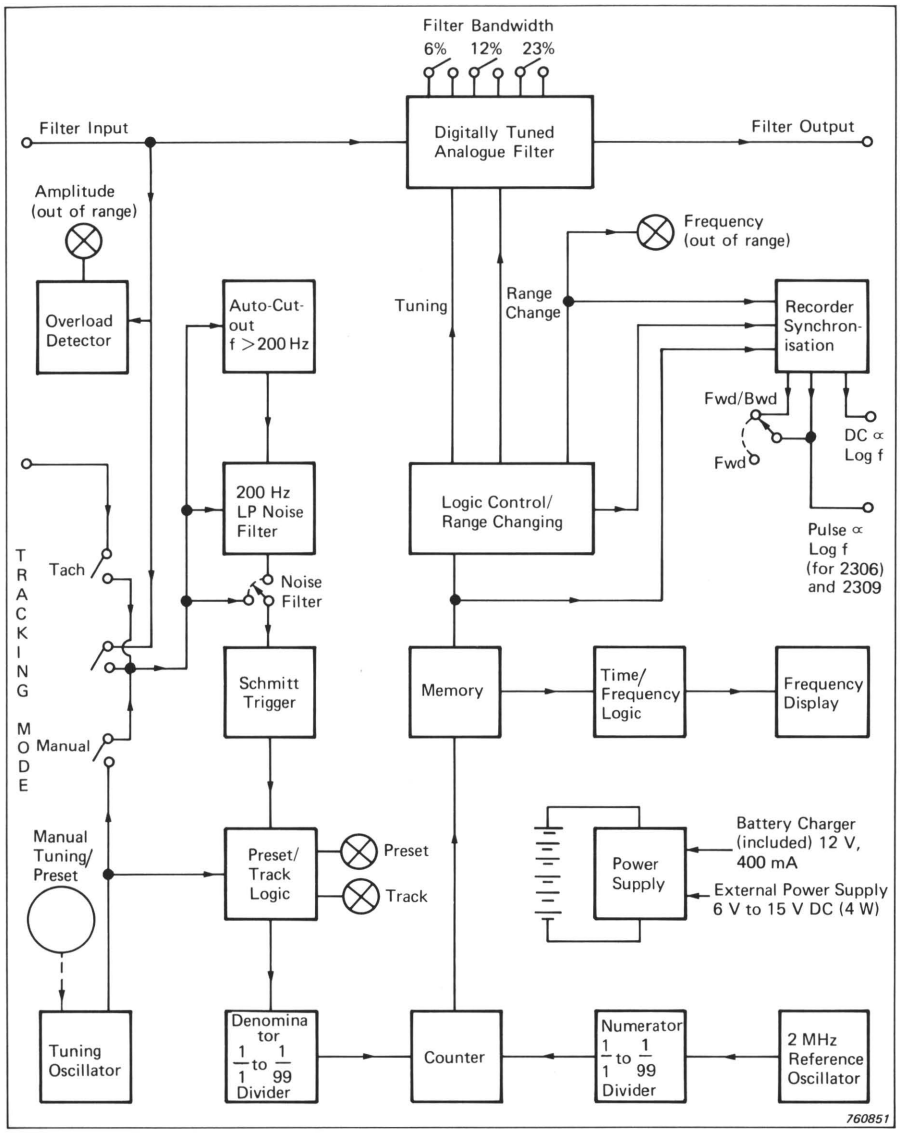


Fig.3. Simplified block diagram of Tracking Filter Type 1623

alysis of machinery containing gear wheels and shafts rotating at different speeds a relatively simple matter. The multiplication ratio is selected and clearly indicated by two pairs of tens and units knobs on the front panel.

Noise Filter

A special low-pass filter is built into the tracking input circuitry in order to attenuate high frequency ripple which could cause false triggering at low frequencies. If the noise filter is switched in, it automatically becomes inoperative for tuning signal frequencies above 200 Hz. This filter is particularly applicable for filtering out the 1 kHz synchronization signal when the 1623 is used in conjunction with the Frequency Response Test Unit Type 4416 and the Test Records QR 2009 and QR 2010.

Principle of Operation

Reference is made to the simplified block diagram shown in Fig.3. The tuning signal is converted by the Schmitt trigger into a uniform pulse form with a period time equal to the period of the original input waveform. This period time is measured by counting the number of periods of oscillation of a 2 MHz oscillator between each trigger pulse, and this number is then shifted into the memory. The tracking frequency multiplier function is achieved by dividing the pulse rate and/or by dividing the oscillator rate (in effect multiplying the pulse rate) by the figure selected on the denominator and numerator knobs, respectively.

From the memory, logic circuits digitally control the tuning of the main filter according to the calculated period time. The filter range is one decade of frequency, but range changing is automatic until the frequency limits are reached, after which the out-of-range "frequency" lamp lights. The filter is tuned over each decade with a hyperbolic sweep consisting of 175 discrete steps. The step width varies between 0,8% and 2% of the tuned frequency as shown in Fig.4. Due to the stepwise method of tuning the filter, the 1623 is not suitable for use where phase accurate signals are required.

The memory also controls the frequency display logic where the calculated period time is converted to frequency for the digital display. So that the specified filter gain accuracy is not significantly altered, it is recommended that the frequency tuning is not swept faster than indicated in Fig.5. This chart is based on the filter settling time. The example shows a sweep from 10 Hz to 50 Hz with the 12% bandwidth filter which requires a minimum sweep time of 5 s — 1 s = 4 s. With a logarithmic sweep, the sweep rate (determined by the lowest frequency, 10 Hz) will be 5 decades per minute. The sweep rate could be progressively increased with increasing frequency to 25 decades/min at 50 Hz.

Recorder Synchronization

Synchronization signals are provided for controlling one of the axes of a recorder in accordance with the tuned frequency, so that vibration level versus frequency or r.p.m. plots can be made. Two forms of synchronization signal are provided: A pulse

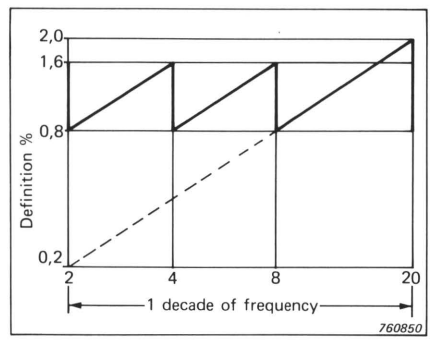


Fig.4. The filter is tuned through each decade of frequency in steps. The step width and therefore the filter definition varies between 0,8% and 2% of the tuned frequency as shown. The definition of the frequency display varies between 0,2% and 2%, as traced by the broken line

output representing the tuned frequency, on a logarithmic scale. This is intended for controlling the position of the recording paper on the portable Level Recorder Types 2306 and 2309. A switch on the rear panel of the 1623 selects either forwards and backwards paper movement or forwards (increasing frequency) paper movement only. Unless the Level Recorder Type 2306 is modified the recording paper can only be fed in the forward direction. Where the tuned frequency falls, for example due to a reduction of machine r.p.m., the paper feed will stop. The paper feed will commence only if that frequency (or r.p.m.) is reached and exceeded again.

Modification Kits for the Level Recorder Type 2306 to enable it to run both backwards and forwards are: Kit No. WB 0250 for 2306's with serial No. lower than 718 058. Kit No. WB 0329 for 2306's with serial No. 718 058 and higher.

Two-Channel Level Recorder Type 2309 may be run in both forward and backward directions under control from the 1623.

The second form of synchronization signal provided is a DC ramp voltage which is logarithmically proportional to the filter tuned frequency. This operates in both directions and is intended for controlling one of the axes of the X-Y Recorder Type 2308.

Power Supply

The internal power supply consists of six, 4 Ampere-hour capacity Nickel Cadmium rechargeable cells. Their capacity is sufficient to cover a continuous operating time of 8 hours. The separate battery charger, Type ZG 0113, supplied can recharge the cells from a completely discharged condition in about 14 hours.

Alternatively, an external DC power supply of + 6 V to + 15 V can be used to power the instrument. The external power supply and battery charger are connected through a socket on the rear panel of the 1623.

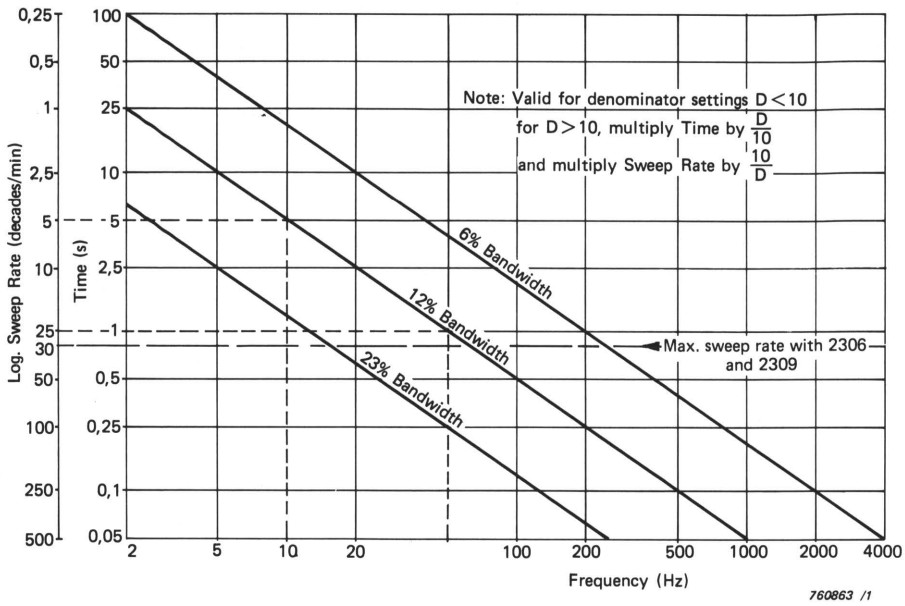


Fig.5. Chart for determining the recommended maximum logarithmic frequency sweep rate and the recommended minimum frequency sweep time for filtered signal inaccuracy <—1 dB (additional to specified filter gain accuracy)

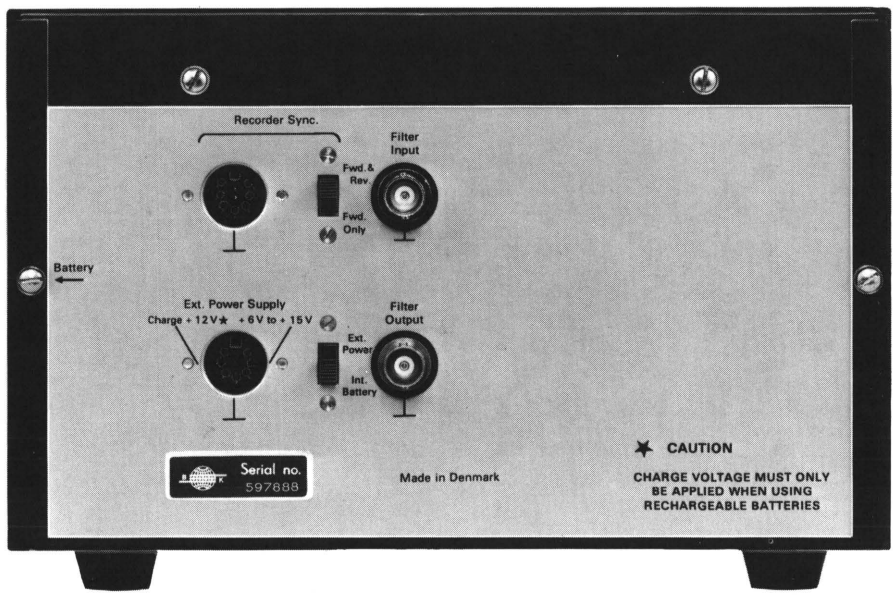


Fig.6. Rear panel view of Tracking Filter Type 1623

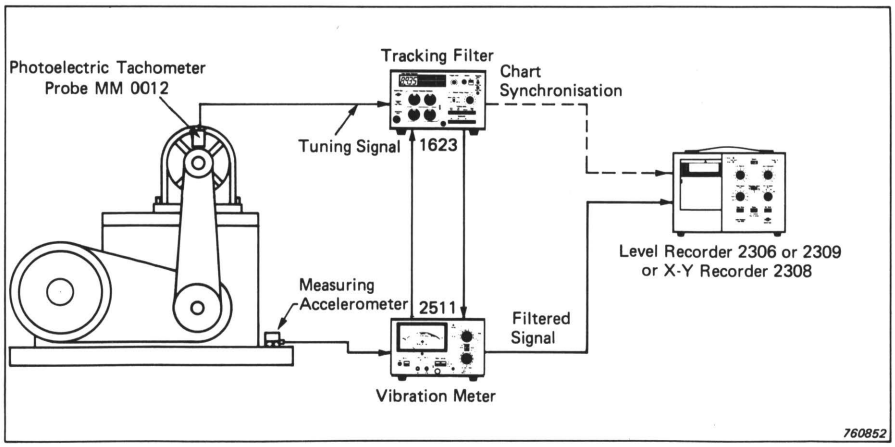


Fig.7. Typical instrument set-up for synchronous vibration analysis

Examples of Use

Vibration Analysis

The 1623 is a valuable accessory to the portable Vibration Meter Type 2511. Fig.8 shows the two instruments mounted in a sturdy carrying case to make up a versatile vibration analysis system. With the two instruments alone, manually-swept frequency analyses can be performed; the addition of a battery operated, portable Level Recorder Type 2306 or 2309 will permit frequency analyses to be recorded on amplitude and frequency calibrated paper. The addition of a tracking pick-up will allow the vibration analysis of fundamental and harmonic components, as a function of a machine's running speed, to be performed and recorded. These instruments combinations are shown in Fig.7.

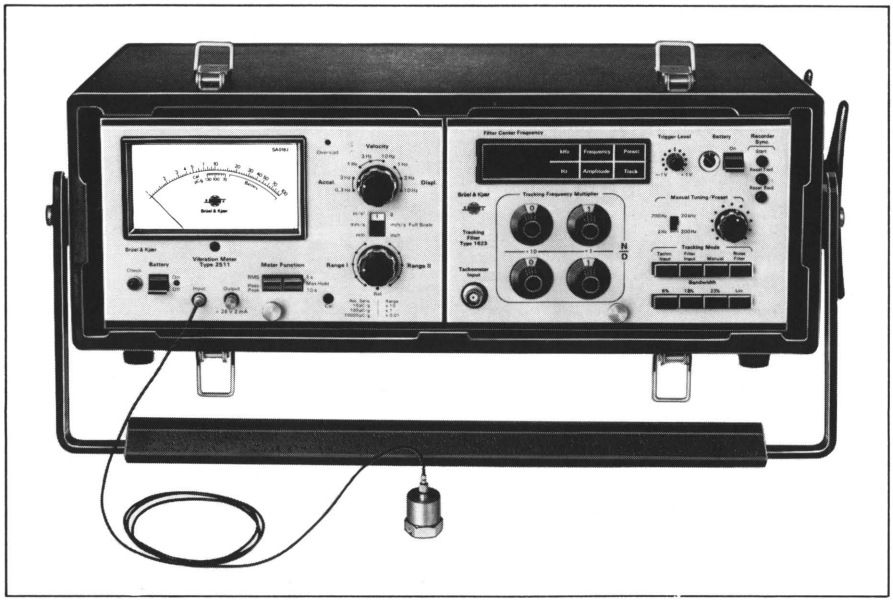


Fig.8. The Portable Vibration Meter Type 2511 combined with the Tracking Tunable Filter Type 1623 mounted in a sturdy, hard-foam carrying case KA 2000

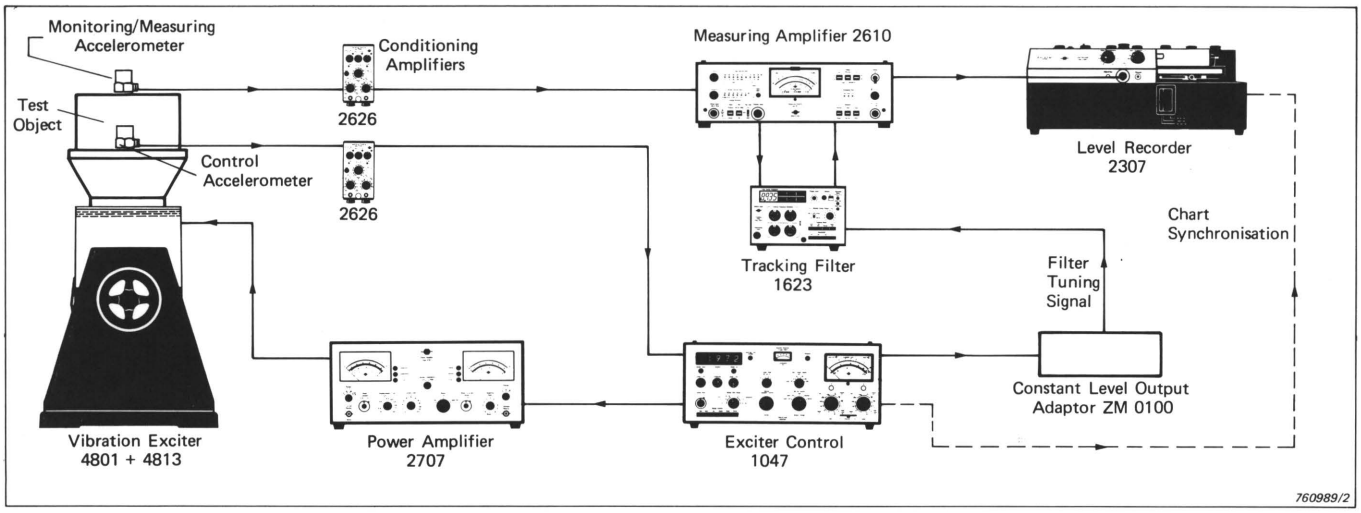


Fig.9. Typical instrument set-up for vibration testing where a Tracking Filter Type 1623 is used for filtering the test object response signal

Vibration Testing

In swept frequency vibration testing, a tracking filter is often used to filter the test object response signal. A typical instrumentation set-up showing this application is shown in Fig.9.

Used in the monitoring of vibration tests, the 1623 will allow the recording of both the fundamental and the harmonic responses of test objects.

Harmonic Distortion Measurements on Audio Systems

Recording the various harmonic components produced by audio reproduction systems is straight-forward when using the Tracking Filter Type 1623. The sweeping frequency test signal from a sine generator or test recording is also used to tune the tracking filter, and the required harmonic is selected on the 1623 multiplier-divider facility.

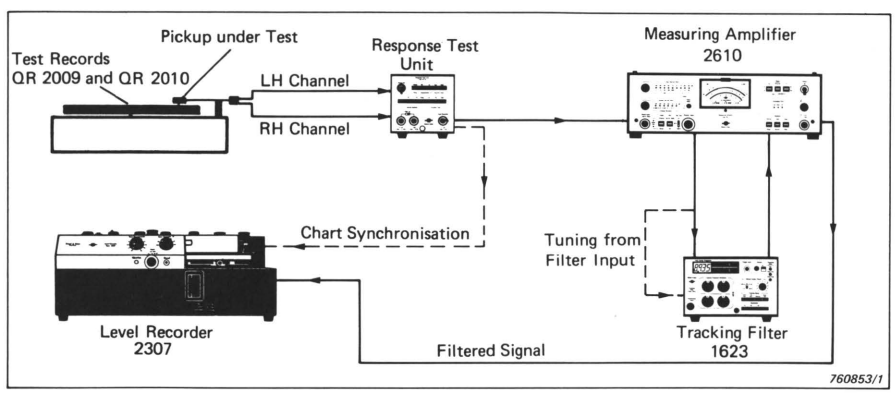


Fig.10. Instrument set-up for plotting harmonic distortion curves for gramophone pick-ups

A special filter is included in the 1623 to attenuate the 1 kHz synchronization signal which precedes each test band on the B & K Stereo Test Records QR 2009 and QR 2010. An instrumentation set-up for performing harmonic distortion measurements on gramophone pick-ups is shown in Fig.10.

Specifications 1623

Filter Frequency Range:
2 Hz to 20 kHz continuously tunable from tachometer input

Manual Tuning:
2 Hz to 200 Hz
200 Hz to 20 kHz

Filter Bandwidth:
Switchable effective noise bandwidths of 6%, 12%, and 23% (~ 1/3 octave) constant percentage bandwidth plus linear position
(3 dB bandwidths of 5,4%, 10,8% and 21,7%)

Filter Type:
Two-pole Butterworth band-pass filter
Filter flank Slope: 12 dB/octave. (See Fig.1.)
Octave selectivity (±1 dB):
6% B/W 57,5 dB
12% B/W 45,5 dB
23% B/W 34,1 dB

Dynamic Range:
> 60 dB under 1 V RMS plus crest factor 4

Digital Display:
Gas display shows filter centre frequency
Overall accuracy: ± 1,5%

Filter Input:
BNC socket
Max. level: 4 V peak
Input impedance: 1 MΩ
Max. DC offset: 42 V DC

Filter Output:
BNC socket
Output impedance: < 1 Ω
Load impedance: ⩾ 500 Ω
DC offset at output: < 2 mV

Filter Gain:
0 dB with following accuracy

Bandwidth	2 Hz to 2 kHz	2 kHz to 20 kHz
6%	± 1 dB	± 2 dB
12%	± 0,5 dB	± 1 dB
23%	± 0,25 dB	± 0,5 dB

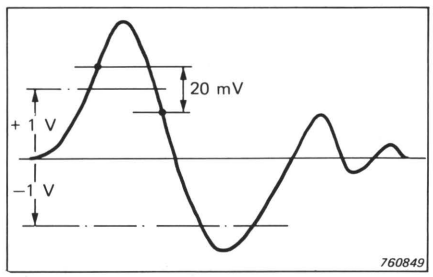
additionally + 0 dB —1 dB accuracy for filter sweep in accordance with Fig.5

Noise:
< 1 mV RMS

Distortion:
< 0,1%

Tuning Signal ("Tachometer") Input:
BNC socket (with double shield)
20 mV to 120 V peak-to-peak
Max. Signal: including DC offset 42 V RMS
Maximum noise: 20 mV peak-to-peak
Input impedance: 10 MΩ
Frequency range: 2 Hz to 20 kHz
Power supply for pickup on inner shield of socket + 7,5 V (direct internal connection to battery)

Trigger Level:
Adjustable + 1 V to —1 V
Hysteresis: 20 mV



Sweep Rate:
See Fig.5

Frequency Multiplier:
1/99 to 99/1 of tuning signal frequency

Output of Tuned Frequency for Recorder Synchronisation:
Rear panel connection through 8-pin DIN socket
1. Log f → pulse for B & K Level Recorder Types 2306 and 2309
   Max. sweep rate: 2 s/decade
   Frequency accuracy of pulse output: ± 2%

2. Log f→DC for X-Y recorder e.g. Type 2308
   Range 2 Hz to 20 kHz covers 0 to 7 V
   Output impedance: 2,2 kΩ
   Max. sweep rate: 2 s/decade
   Frequency accuracy of DC output: ± 2%

Environmental Conditions:
The instrument performs within specifications under the following conditions:
Temperature: —10°C to + 50°C
Humidity: 0 to 95% relative humidity, non condensing
Electromagnetic: Field strengths up to 100 A/m

Internal Power Supply:
6 × NiCd rechargeable cells
Operating capacity: 8 hours continuous

External Power Supply:
Rear panel connection through 7-pin DIN socket
Requires + 6 V to + 15 V, 3,5 W

Battery Charger:
B & K Type ZG 0113
Input: 100 to 130 V AC or 200 to 240 V AC
Output: 12 V 400 mA. Short circuit protected
Time for complete recharge: approx. 14 hours

Dimensions: (excl. feed knobs etc.)
Height: 133 mm (5,2 in)
Width: 210 mm (8,3 in)
Depth: 200 mm (7,9 in)
(B & K module cabinet KK 0025, 6/12 of 19" rack module)

Weight:
Including batteries, 3,2 kg (7 lb)

Accessories Included:
3 BNC plugs JP 0035
1 7-pin DIN plug JP 0703
1 8-pin DIN plug JP 0802
6 NiCd cells QB 0008
Battery charger ZG 0113
Spare fuses VF 0032

Accessories Available:
Photoelectric Tachometer Probe MM 0012
Sweep Unit Type 5555

2. CONTROLS

2.1. FRONT PANEL

Fig.2.1. Front panel of the Tracking Filter Type 1623

FILTER CENTER FREQUENCY: A digital display of the centre frequency to which the filter is tuned; with either Hz or kHz illuminated.

Frequency: When illuminated indicates that the signal from the tuning source selected (possibly modified by the setting of the TRACKING FREQUENCY MULTIPLIER knobs) is outside the frequency range 2 Hz to 20 kHz. Synchronisation signals to recorders are blocked when the **Frequency** lamp lights but synchronisation is not lost.

Amplitude: When illuminated indicates that the filter input signal level exceeds 4 V peak.

Preset: When illuminated indicates that the filter is not being tuned by a **Tachometer Input** signal or **Filter Input** signal and is therefore automatically tuned to the frequency determined by the setting of the MANUAL TUNING/PRESET knob multiplied by the N/D ratio set on the TRACKING FREQUENCY MULTIPLIER.

Track: When illuminated indicates that the filter is being tuned by the tuning signal selected by depressing either the **Tachometer Input** or **Filter Input** or **Manual** pushbuttons.

TACHOMETER INPUT:

A BNC socket accepting either single or double shielded BNC plugs for a tuning signal input. The inner shield is connected through the **On/Off** switch to the built-in battery supply (+ 7,5 V) and is intended for powering a photoelectric pickup (e.g. B & K Type MM 0012). Signal level 20 mV (noise free) to 120 V peak-to-peak. Maximum signal level including DC offset 42 V RMS. Noise level less than 20 mV peak-to-peak. Input impedance 10 MΩ.

TRIGGER LEVEL:

For positioning a 20 mV wide amplitude window, through which the tuning signal is viewed, within the range ± 1 V. Enables the periodicity of the tuning signal to be detected in the most suitable portion of the waveform.

BATTERY:

Toggle switch which applies power to the instrument. The adjacent meter indicates if the instrument is powered (by the internal or an external supply) and if the supply voltage is sufficiently high (blue/green area) or whether the supply voltage is too low or the battery should be charged (red area < 6 V).

TRACKING MODE:

Three pushbuttons which select the source of tuning signal for the filter.

Tachm. Input: Selects a signal applied to the TACHOMETER INPUT Socket.

Filter Input: Selects the signal applied to the FILTER INPUT socket (rear panel).

Manual: Allows filter tuning by means of the MANUAL TUNING knob.

Noise Filter: Connects a special low-pass noise filter into the tuning circuit to attenuate high frequency noise in the tuning signal. It becomes automatically inoperative for tuning signals above 200 Hz. See section 4.7.

BANDWIDTH:

Four pushbuttons to select effective filter bandwidths of **6%, 12%, 23%** (~ 1/3 Octave), or **Linear.**

In the linear position the filter input is connected directly to the output socket.

MANUAL TUNING/PRESET:

With the TRACKING MODE — **Manual** pushbutton depressed the tuning knob can manually tune the filter over the frequency range 2 Hz to 20 kHz in two ranges, 2 Hz to 200 Hz and 200 Hz to 20 kHz as selected on the adjacent slide switch. Whenever the **Preset** window in the display is illuminated the filter is tuned to the frequency determined by the position of the MANUAL TUNING/PRESET knob multiplied by the N/D ratio set on the TRACKING FREQUENCY MULTIPLIER.

TRACKING FREQUENCY MULTIPLIER:

Four ten-position switches which multiply the tuning signal frequency by the ratio indicated by the upper (**N**umerator) knobs and lower (**D**enominator) knobs. The centre frequency of the filter is therefore tuned to the tuning signal frequency × N/D. All ratios between 1/99 and 99/1 are selectable.

RECORDER SYNCHRONISATION:

Three pushbuttons which direct the filter-to-recorder synchronisation circuitry. These comments apply to operation with the Portable Level

Recorders Types 2306 and 2309. (Comments in parentheses apply to operation with an X-Y recorder, eg. Type 2308).

Reset Forward: When pressed, resets the pulse counter in the synchronisation system to 0 position. Can take up to 10 s to achieve this condition. With an already synchronised level (X-Y) recorder, pressing the **Reset Forward** button will move the paper (pen) forward to a "reset" position on the next (same) chart about 4 mm before the 2 Hz line when paper QP 0120, QP 0143 or QP 0124 is fitted to the level recorder.

Reset Reverse: When pressed, resets the pulse counter in the synchronisation system in the reverse direction to 0 position. With an already synchronised level (X-Y) recorder, pressing the **Reset Reverse** button will move the paper (pen) backwards to a position on the chart about 4 mm before the 2 Hz line when paper QP 0120, QP 0143 or QP 0124 is fitted to the level recorder. Applies only for Level Recorder Type 2309 and when the Level Recorder Type 2306 is modified for backwards movement and when the RECORDER SYNC. slide switch is in the **Fwd. & Rev.** position.

Start: When pressed, indexes the pulse counter in the synchronisation system forward to a condition in agreement with the frequency indicated by the frequency display. With an already synchronised level (X-Y) recorder, pressing the "Start" button will move the paper (pen) forward to this frequency.

Holding the **Start** pushbutton in the depressed position locks all outputs from the RECORDER SYNC. socket. This prevents the recorder paper (pen) moving backwards and forwards while, for example, adjustment are being made to the tuning of the filter. Synchronisation with recorders is NOT lost, on release of the **Start** button the recorder paper (pen) will move directly to the tuned centre frequency.

2.2. REAR PANEL

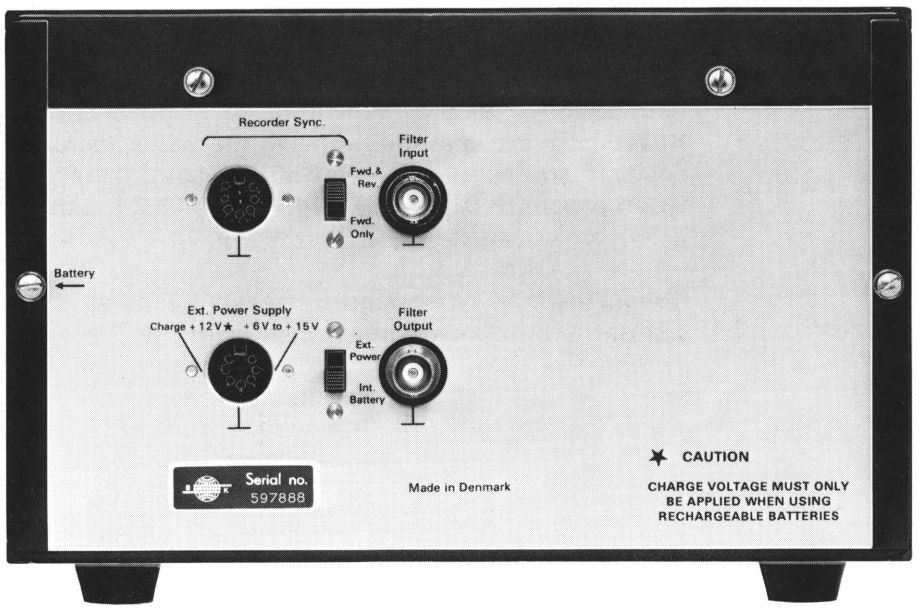


Fig.2.2. Rear panel of the Tracking Filter Type 1623

RECORDER SYNC.: An 8 pin DIN socket giving access to the various synchronisation signals for X-Y and level recorders.

Pin 1 carries forward-reverse instruction for Level Recorder Type 2306 and 2309.

Pin 2 signal ground.

Pin 4 carries pen down instruction for Level Recorder Type 2309 and for an X-Y recorder. When RECORDER SYNC. **Reset Fwd.** or **Reset Rev.** are depressed pin 4, which is normally grounded, is opened to lift the pen until the reset condition is achieved.

Pin 7 carries a pulse output for automatic synchronisation of the recording paper on the Portable Level Recorders Type 2306 and 2309.

Pin 8 carries a DC ramp voltage which is logarithmically proportional to the filter tuned frequency (2 Hz to 20 kHz covers approx. 0 to 7 V). Intended for controlling one of the axes of an X-Y recorder.

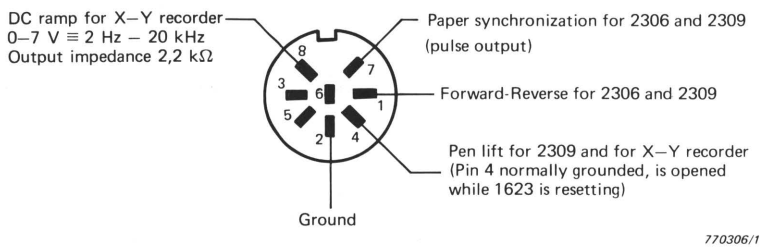


Fig.2.3. Pin designations for RECORDER SYNC. socket viewed from outside

The adjacent slide switch is set to **Fwd. & Rev.** (forward & reverse) when the 1623 is used with an X-Y recorder, a Level Recorder Type 2309 or a Level Recorder Type 2306 which has been modified (see p.4 for Kit No.'s) to run in both directions. The **Fwd. Only** position is selected when working with unmodified Type 2306 Level Recorders.

EXTERNAL POWER SUPPLY:

A 7 pin DIN socket for connection of an external supply for powering the instrument (+ 6 V to + 15 V DC) and a + 12 V charging voltage for recharging the internal batteries. See section 3.2. Pin designations are as shown in Fig.2.4. Power consumption is approx. 3,5 W.

The adjacent slide switch selects either **External Power** supply or **Internal Battery** for powering the instrument.

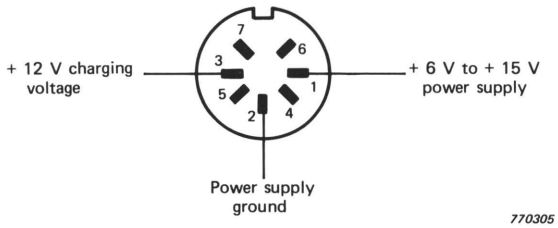


Fig.2.4. Pin designations for EXT. POWER SUPPLY socket viewed from outside

FILTER INPUT:

A BNC socket for applying the signal to be filtered. Nominal input level 1 V RMS. Crest factor capability 4. Input impedance 1 MΩ. Maximum allowable DC offset 42 V DC.

FILTER OUTPUT:

A BNC socket for feeding the filtered signal out of the instrument. Output impedance $< 1\,\Omega$. Required load impedance $\geqslant 500\,\Omega$. DC offset at output < 2 mV.

BATTERY COVER RELEASE SCREW:

Enables the side plate to be removed for access to the internal rechargeable cells.

3. PRELIMINARY

3.1. MOUNTING

The 1623 cabinet is designed to fit the B & K modular cassette system. Its width is 6/12 of the width of the combining frame KK 0014 and the carrying case KA 2000 so that it can be, for example, combined with the General Purpose Vibration Meter Type 2511 (also 6/12 wide) to fill either of these.

To mount the 1623 into the combining frame or the carrying case, first remove the base panel of the 1623 by loosening the base securing screw on the front panel, remove the rubber feet and inclining leg, then remount the base panel into the base of the combining frame or carrying case. The 1623 can then be slid into position and fastened with the securing screw on the front panel.

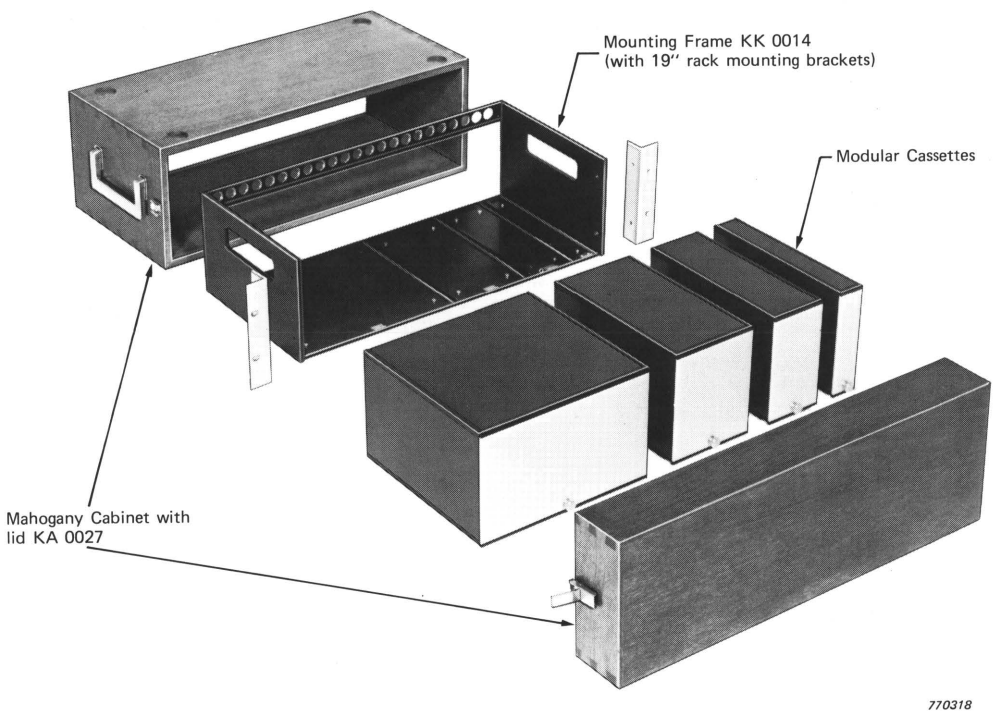


Fig.3.1. The cassette combining system

Fig.3.2. The Portable Vibration Meter Type 2511 combined with the Tracking Filter Type 1623 mounted in a sturdy, hard-foam carrying case KA 2000

3.2. POWER SUPPLY

There are several methods of supplying power to the 1623, they are described in the following subsections. Whichever supply method is used, check that the battery condition indicating meter deflects to the blue/green area, thus indicating sufficient supply voltage.

3.2.1. Rechargeable Cells (B & K no. QB 0008)

Six rechargeable nickel-cadmium cells are supplied with the 1623. They are each rated at 1,2 V with a capacity of 4 Ah and are specified to give at least 500 charge cycles before replacement is necessary. The need for replacement is indicated by the cells failing to reach a fully charged condition after being left on charge for 14 hours or more (with battery charger ZG 0113 supplied). A fully charged battery can be expected to give a continuous operating capacity of 8 hours. The cells are mounted in the 1623 as follows:

1. Lay the instrument on its left side panel (viewed from the front) and remove the screw marked **Battery** on the rear panel. The side panel can now be slid out of the instrument body.

2. Place the cells in the compartment with their polarities as indicated. (See Fig.3.3.)
   WARNING: There is a possibility of explosion if recharging is attempted on cells that have been fitted with their poles reversed.

3. Replace the side panel and stand the instrument on its feet, or use the stand to raise the front panel as desired.

4. Slide the power supply switch on the rear panel to **Internal Battery.**

5. Set the BATTERY switch to **On**, and check that the battery condition indicating meter registers in the blue/green area, indicating that the battery is in usable condition.

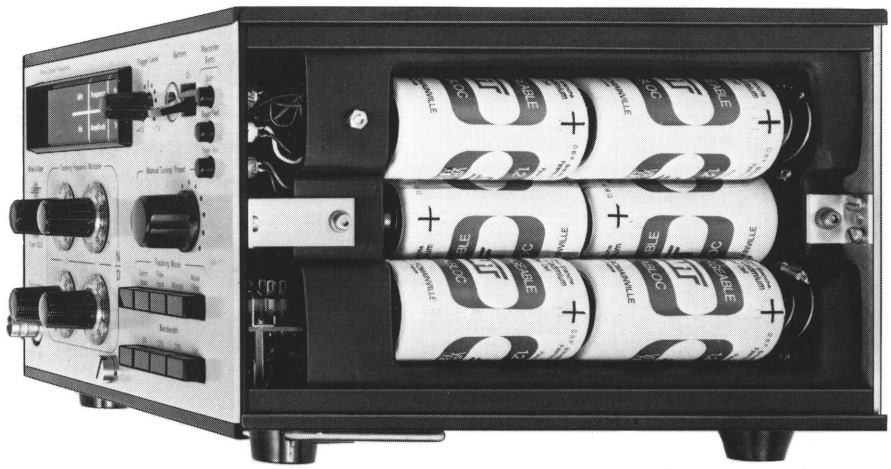


Fig.3.3. Location of the six cells in the battery compartment of the Type 1623

6. Switch the instrument **Off** to conserve battery power if it is not to be used immediately.

Note that the Battery Charger Unit ZG 0113 has a current capability which is about equal to the current consumption of the 1623 when operating, so that with well-charged cells, the ZG 0113 will act as an AC Mains power adaptor. (The power supply slide switch on the rear panel is set to **Int. Battery**.)

3.2.2. Dry Cells 1,5 V

Ordinary 1,5 V dry cells to IEC R 20 (33 mm × 60 mm high) can also be used. "Long Life" alkaline cells will give an operating capacity of about 12 hours continuous operation while ordinary cells will give 0,5 to 2 hours.

Never attempt to recharge ordinary or alkaline cells — there is a danger of explosion.

3.2.3. External DC Supply 6 to 15 V

A car battery or other DC source of between 6 V and 15 V with a power capability of at least 3,5 W can be used to power the 1623. The source is connected to the 1623 via the rear panel socket marked EXT. POWER SUPPLY with the connections shown in Fig.3.4.

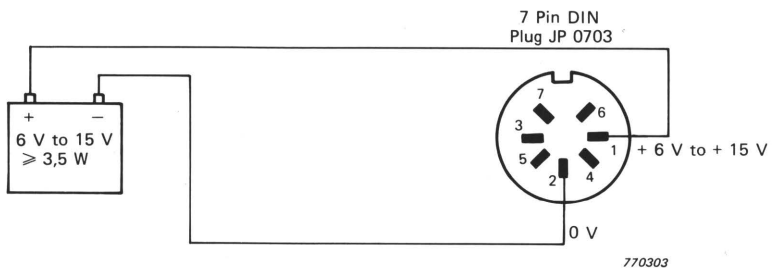


Fig.3.4. Connections for external power supply. Soldering side of plug shown

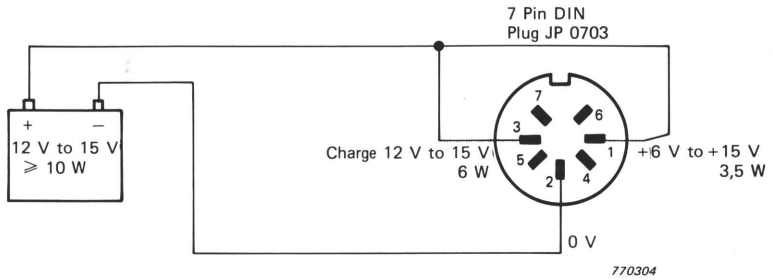


Fig.3.5. Connections for simultaneous operation and recharge. Soldering side of plug shown

For simultaneous operation and recharge of the internal cells, a 12 V to 15 V DC source can be connected to the 1623 as shown in Fig.3.5.

When powering the 1623 from an external power supply (and when simultaneously charging the battery) the slide switch on the rear panel which selects the power source is switched to **Ext. Power**.

3.2.4. Power Supply Type 2808

The B & K Power Supply Type 2808 is an AC mains operated, plug-in power supply and battery charger for certain B & K portable instruments (see Fig.3.6). It can be used with the 1623 to simultaneously power the instrument and charge the batteries. It is connected to the EXT. POWER SUPPLY socket of the 1623 by the cable AQ 0035 (which simply connects two 7-pin DIN plugs (JP 0703) with pin 1 to pin 1, pin 2 to pin 2 etc.) and the slide switch is moved to **Ext. Power**. The 2808 supplies an operational output of 7,5 V DC, at up to 1,25 A, on pin 1 and a charging output of 12 V DC at up to 400 mA, on pin 3.

Fig.3.6. Power Supply Type 2808

3.3. CHARGING THE INTERNAL BATTERY FROM THE AC MAINS

A battery charger ZG 0113 (Fig.3.7) is supplied with the 1623 for recharging the six nickel-cadmium cells QB 0008. The battery charger is encapsulated for life and double

insulated, it supplies 12 V DC at up to 400 mA. Colour coding for the mains power cable is as follows:

Blue — Neutral
Black — 100 to 130 V AC
Brown — 200 to 240 V AC

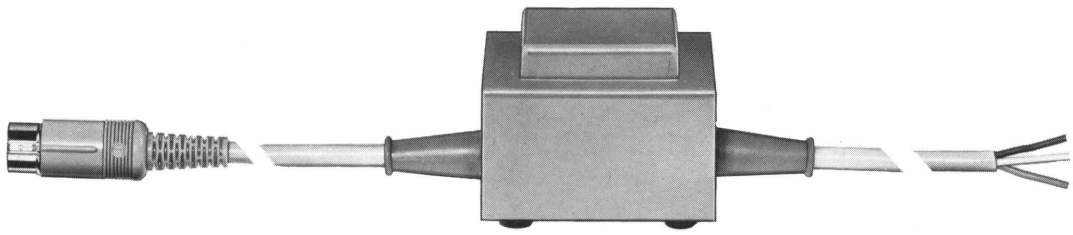


Fig.3.7. Battery Charger ZG 0113

The ZG 0113 is terminated with a 7-pin DIN plug which plugs into the EXT. POWER SUPPLY socket of the 1623. Expected life for the fully charged Nickel-Cadmium battery is about 8 hours. Alternative methods for charging the battery are mentioned under sections 3.2.3 and 3.2.4.
WARNING: There is a danger of explosion if recharging is attempted on cells that have been fitted with their polarities reversed.

Time taken for a full recharge of the Ni-Cd cells is about 14 hours. If the cells are not fully charged after this period, replacement is indicated. A minimum of 500 recharge cycles is specified for these cells but their lifetime can be extended if they are not allowed to become fully discharged too often.

Never attempt to recharge any type of non-rechargeable cells — there is a danger of explosion.

Whenever a charging voltage is applied to the EXT. POWER SUPPLY socket (Pin 3), charging power is being applied to the cells in the 1623. The position of the slide switch marked **Ext. Power — Int. Battery** on the rear panel, is irrelevant.

Note that the Battery Charger Unit ZG 0113 has a current capability which is approximately equal to the current consumption of the 1623 when operating, so that with well-charged cells, the ZG 0113 will act as an AC Mains power adaptor. With this method of powering/charging the 1623 the rear panel power supply slide switch should be switched to **Int. Battery**.

The output of the ZG 0113 is short circuit protected by a thermal overload cut-out which breaks the mains power supply when the primary windings reach a temperature of approx. 80°C. Power is reconnected again automatically after a period of 10 to 30 mins. depending on the ambient temperature.

3.4. FUSE REPLACEMENT

The instrument is protected by a 0,63 A slow-blow fuse B & K Type VF 0032. Access to the fuse is gained by removing the two screws securing the top panel and sliding the panel backwards. The fuse holder is positioned in the upper right-hand corner (viewed from the front) of the cabinet.

4. OPERATION

4.1. USING THE 1623 FILTER

The 1623 will be used as an external frequency selective synchrónous filter in connection with ordinary sound and vibration measuring instruments such as sound level meters (e.g. Types 2203, 2209, 2210, 2218), vibration meters (e.g. Types 2510 and 2511), and measuring amplifiers.

The above mentioned instruments all have sockets for the connection of an external filter which are self explanatory. Before using the filter with other instruments the input signal level and input/output impedances should be checked; see under FILTER INPUT and FILTER OUTPUT in section 2.2.

The selectivity of the 1623's constant percentage bandwidth filter is selected by depressing one of the BANDWIDTH pushbuttons (6%, 12% or 23%) as required.

4.2. SUITABLE TUNING SIGNALS

The tuning signal should have a level of between 20 mV and 120 V peak-to-peak, have a well defined periodic content and have a noise level of less than 20 mV peak-to-peak. If the filter input signal is of this nature, it can also be used for tuning the filter simply by depressing the TRACKING MODE **Filter Input** pushbutton. For measurements on rotating machinery a non-contacting tachometer probe will be a convenient means of tuning the 1623. The Brüel & Kjær Photoelectric Tachometer Probe MM 0012 and Magnetic Transducer MM 0002 can be used for this purpose.

Fig.4.1. Photoelectric Tachometer Probe MM 0012

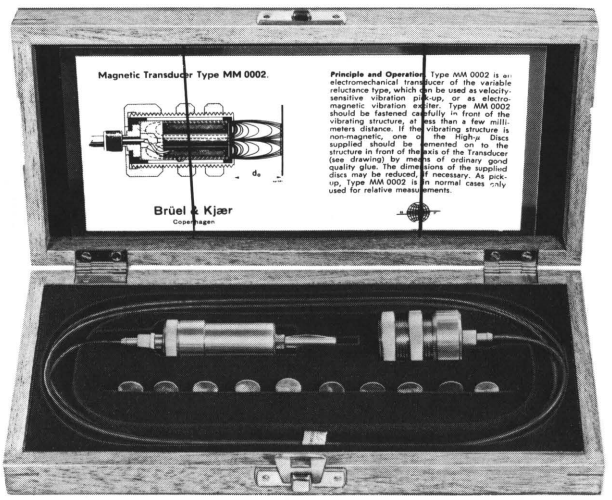


Fig.4.2. Magnetic Pickup MM 0002

4.2.1. Photoelectric Tachometer Probe MM 0012

The probe can be directly connected to the TACHOMETER INPUT socket via the 3 m long cable AO 0158 supplied with the probe. The outer shield of the cable and the centre conductor carry the signal and the inner shield carries the power supply to the probe (+ 7,5 V DC). The probe consists of a combined infra-red light source and photo-sensor fitted with a red filter to reduce its sensitivity to artificial light. When projected onto a matt black surface the output is almost 0 V, and onto a highly reflective white surface close to the probe tip the output will rise to a positive level depending on the proximity and reflectivity of the surface. In practical applications a signal suitable for tuning the 1623 can be obtained with a distance up to 15 mm from a rotating object with a piece of black adhesive tape fixed so that it passes the projection path of the MM 0012. If the background is a dark colour a piece of white tape will give a stronger signal. With a white stripe on a black background a positive going pulse is obtained, see Fig.4.3. The TRIGGER LEVEL knob should be set on the + side of the zero point (marked by a vertical line). For a black stripe on a white background the opposite applies. The MM 0012 will often give a satisfactory signal merely by projecting it onto gear teeth, fan blades etc. A black felt-tip pen (spirit based) is very useful for marking (wider than 5 mm) stripes on rotating parts instead of using tape. Note that some metallic surfaces, for example anodized aluminium, even though black in colour are very reflective.

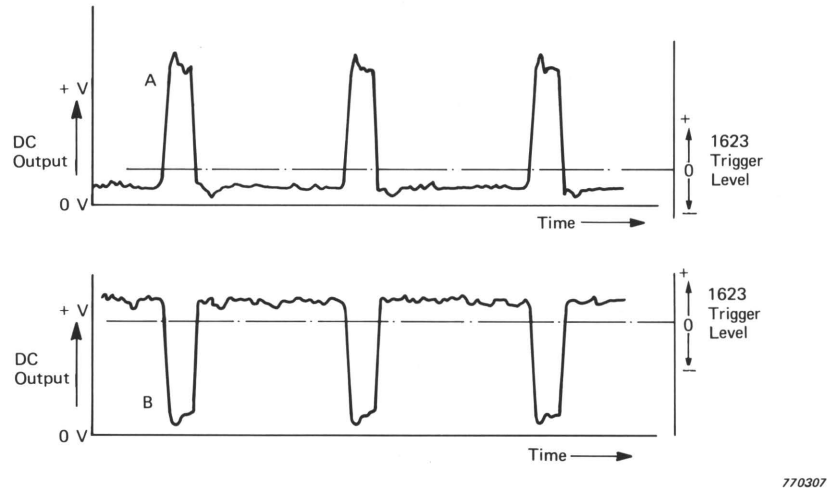


Fig.4.3. Typical output signal from Photoelectric Tachometer Probe MM 0012. (A) from a white stripe on a black background and (B) from a black stripe on a white background

4.2.2. Magnetic Pickup MM 0002

Magnetic Pickup MM 0002 produces an output signal which reflects disturbances in the magnetic field surrounding it. It can be connected directly to the TACHOMETER INPUT socket of the 1623 via a microplug to BNC adaptor (JP 0145). It will generate a suitable signal for tuning the 1623 when placed close (less than 1,5 mm) to rotating fan or turbine blades and gear teeth for example. The rotating parts must be of a "magnetic" material, if this is not the case or where the part is regular, a flywheel for example, one of the high permeability discs supplied with the transducer can be glued onto the rotating part. (Check that the 1,7 gr mass will not upset the balance of the member.) With the MM 0002 mounted at a distance of 1,5 mm from a 60 mm dia. brass rotating part, and with a high permeability disc glued on the end of the part (e.g. edgewise oriented) a satisfactory tuning signal could be obtained at rotation speeds above about 500 rpm (~ 8,5 Hz). Stronger signals could be obtained by reducing the distance between the rotating part and the MM 0002 and by affixing the high μ disc on the circumference of the part.

4.3. SETTING THE TRIGGER LEVEL

After connecting the desired tuning signal with the TRACKING MODE pushbuttons (**Tachometer Input** or **Filter Input**) the TRIGGER LEVEL knob is rotated either in the + or — direction until the adjacent **Preset** window light is extinguished and the **Track** window lights up and the frequency display becomes stable. The knob position is noted and is then turned further in the same direction until the display again becomes instable or reverts to **Preset**. The knob is then turned approximately halfway back towards the previously noted position. The filter is now tuned to the frequency indicated in the display. The nature and polarity of the tuning signal will determine whether the TRIGGER LEVEL knob should be tuned in the + or — directions. If the peak-to-peak level of the tuning signal is high (120 V max.) and the noise level also high, it may be necessary to attenuate the signal with a voltage divider (see Fig.4.4) in order to reduce the signal and noise levels.

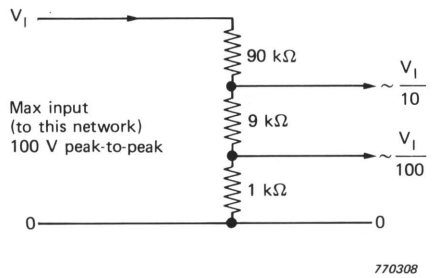


Fig.4.4. Voltage divider network for attenuating tuning signals in order to reduce the signal and noise levels. Use resistors or a variable resistance rated at 1/8 W or greater. Connection cables should be as short as possible

4.4. MANUALLY TUNING THE FILTER

Whenever the "Preset" window in the display is illuminated the filter centre frequency is determined by the setting of the MANUAL TUNING/PRESET switch and knob (× N/D). With the TRACKING MODE **Manual** pushbutton depressed the setting of the MANUAL TUNING/PRESET switch and knob overrides all other tuning signals. This manual tuning facility can be used in two ways:

1. Presetting the filter to, for example, the fundamental rotation frequency of a machine, before locking onto it with a tuning device. This reduces the filter settling time as compared with allowing the filter to automatically align itself with the trigger frequency provided by the tuning signal.

2. Frequency analysis by manually tuning the filter slowly through the frequency range of interest and noting the signal level on the measuring instrument as a function of frequency. An initial sweep with the 23% filter will localise the frequencies of particular interest, these can then be examined more closely using either the 12% or 6% bandwidth filter.

With manual tuning, the frequency range 2 Hz to 20 kHz is covered in two ranges 2 Hz to 200 Hz and 200 Hz to 20 kHz, which are selected by a range changing switch adjacent to the MANUAL TUNING knob. These two ranges overlap somewhat (the low freq. range covers up to ~ 300 Hz while the high range starts at ~ 200 Hz) which may be inconvenient when recording a level frequency plot. This problem is overcome very simply by performing a frequency sweep as follows:

1. Synchronise the recorder as described in section 4.5.

2. With the TRACKING MODE **Manual** pushbutton depressed tune the filter by setting the MANUAL TUNING/PRESET switch to 2 Hz to 200 Hz and selecting the required starting frequency by a means of the MANUAL TUNING knob.

3. Slowly sweep upwards in frequency to the limit of the knob (~ 300 Hz) and note the actual frequency at this limit.

4. Press in the RECORDER SYNC. **Start** pushbutton which locks the synchronisation signal to the recorder. (Valid for 1623 serial numbers higher than 597890.)

5. While holding this pushbutton depressed move the MANUAL TUNING/PRESET slide switch up to the 200 Hz to 20 kHz position and with the MANUAL TUNING knob select the limit frequency (or a lower frequency) which was noted in step 3.

6. Release the RECORDER SYNC. pushbutton and continue the frequency sweep upwards as desired.

Note that when 20 kHz has been exceeded, the FREQUENCY (out of range) lamp will light which automatically blocks further synchronisation signals to the recorder, i.e. it stops the paper (pen) drive at 20 kHz. Turning the MANUAL TUNING/PRESET knob back to 20 kHz will allow the RECORDER SYNC. pushbuttons to reset the 1623 and the recording paper (pen).

An alternative method of avoiding problems with the two manually tuned frequency ranges overlapping is to perform the manually tuned frequency analysis with the RECORDER SYNC. slide switch in the **Forward Only** position. When the end of the 2 Hz to 200 Hz range is reached (~ 300 Hz) the MANUAL TUNING/PRESET knob is turned back to ~ 2 Hz, the adjacent slide switch is moved to 200 Hz to 20 kHz and the manual sweep is then continued. The paper (pen) synchronisation will automatically be engaged when the low range finishing frequency is reached (~ 300 Hz).

4.5. SYNCHRONISATION WITH RECORDERS

It will normally be desired to plot out a signal level as a function of the filter's tuned frequency. The 1623 is provided with both a pulse output for use with the battery operated Level Recorders Types 2306 and 2309 and also a DC ramp voltage for controlling one of the axes of an X-Y recorder. Both outputs are proportional to the log. of the tuned frequency.

4.5.1. Synchronisation with the Portable Level Recorders Types 2306 and 2309

For 2306s NOT modified to run in both the backward and forward directions

1. Connect the 1623 and the 2306 into the instrumentation chain as required. Frequency calibrated paper QP 0124, QP 0143 or QP 0120 for the 2306 will be convenient for most applications.

2. Connect the RECORDER SYNC. socket on the rear panel of the 1623 to the REMOTE CONTROL socket on the Level Recorder Type 2306. For 2306s with serial nos. lower than 718058 the REMOTE CONTROL socket is 7 pin and cable AQ 0182 should be used. For instruments with higher serial nos. the REMOTE CONTROL socket is 8 pin and cable AQ 0034 should be used. Alternatively cables can be made according to Fig.4.5.

3. Set the rear panel RECORDER SYNC. slide switch to the **Fwd. Only** position.

4. Set the PAPER SPEED knob on the 2306 to EXT.

5. Press the TRACKING MODE **Manual** pushbutton and manually tune the filter to convenient starting frequency, i.e. 2 Hz, 10 Hz etc. using the MANUAL TUNING/PRESET knob and the frequency display.

6. Press the **Reset Forward** pushbutton on the 1623 and wait up to 10 s for the digital counter in the 1623 to achieve the reset condition. The chart paper on the 2306 will move forward to an arbitrary position.

7. Press the **Start** pushbutton on the 1623 which indexes the counter in the 1623 forward to a condition in agreement with the frequency selected by the MANUAL TUNING/PRESET knob. The position of the recording chart on the 2306 can now be adjusted with the paper drive thumbwheel (PAPER DRIVE pushbutton "Off") so that the pen lies over the frequency indicated on the 1623 digital display.

8. With the PAPER DRIVE pushbutton on the 2306 "On" the MANUAL TUNING/PRESET knob on the 1623 can be turned in the clockwise direction to check that the chart movement is synchronised. If the tuned frequency is reduced the paper feed will stop and will recommence when the previously reached frequency is exceeded. Chart synchronisation is not lost.

9. Press the **Reset Forward** pushbutton to move the chart paper forward to about 4 mm before the 2 Hz line on the next chart. Press the **Start** pushbutton to move the chart paper forward to the frequency indicated on the frequency display.

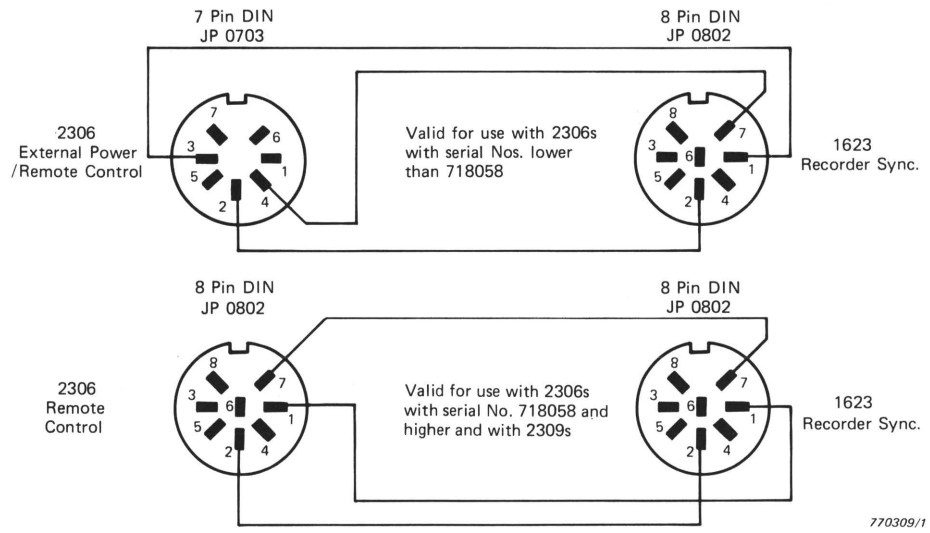


Fig.4.5. Connections for synchronisation cable between 1623 and the Portable Level Recorders Types 2306 and 2309. Applicable for both forward and backward and forward-only paper movement. Soldering side of plugs shown

For 2306s modified to run in both the backward and forward directions and for 2309s

The synchronisation procedure is the same as for unmodified 2306's except that the rear panel RECORDER SYNC. slide switch can be set to **Fwd. & Rev.** so that the chart paper also moves backwards when turning the MANUAL TUNING/PRESET knob backwards.

Pressing the **Reset Rev.** pushbutton moves the paper chart backwards to the reset position (about 4 mm before the 2 Hz line) on the same chart. Pressing the Reset Fwd. pushbutton moves the paper chart forwards to the reset position (about 4 mm before the 2 Hz line) on the next chart.

4.5.2. Synchronisation with an X-Y Recorder

1. Connect the 1623 and the X-Y recorder into the instrumentation chain as required.

2. Connect the RECORDER SYNC. socket on the rear panel of the 1623 to the X or Y input of the X-Y recorder as required. A cable can be made up according to Fig.4.6.

3. Set the rear panel RECORDER SYNC. slide switch to **Fwd. & Rev.**

4. Set the sensitivity of the X-Y recorder as required remembering that the 1623's DC proportional to log f output gives + 1,75 V per decade of frequency increase.

5. Press the TRACKING MODE **Manual** pushbutton and manually tune the filter to a convenient starting frequency, i.e. 2 Hz, 10 Hz etc. using the MANUAL TUNING-/PRESET knob and the frequency display.

6. Press the **Reset Rev.** pushbutton on the 1623 and wait for the recorder pen to stop moving.

7. Press the **Start** pushbutton on the 1623 which indexes the counter forward to a condition in agreement with the frequency selected by the MANUAL TUNING-/PRESET knob. The position of the pen on the X-Y recorder can now be adjusted to a suitable starting position which represents the frequency indicated on the 1623 digital display.

8. The MANUAL TUNING/PRESET knob on the 1623 can be turned to various frequencies to establish the calibration of the paper chart on the X-Y recorder.

9. Pressing the **Reset Rev.** pushbutton will move the pen back to a position just behind the position equivalent to 2 Hz. Pressing the **Start** pushbutton will move the pen forward to the position determined by the MANUAL TUNING/PRESET knob (as displayed in the frequency display).

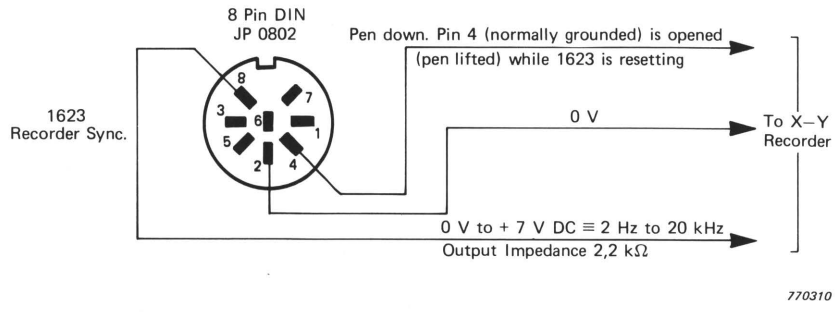


Fig.4.6. Connections for synchronisation cable between 1623 and an X-Y recorder. Soldering side of plug shown

4.6. USING THE TRACKING FREQUENCY MULTIPLIER

Once the 1623 has accepted a tuning signal (indicated by an illuminated **Track** window and a stable frequency display) the filter can be tuned to any harmonic or subharmonic of this frequency within the range 99/1 to 1/99 and within the frequency range 2 Hz to 20 kHz. The desired ratio is set on the TRACKING FREQUENCY MULTIPLIER **N**umerator and **D**enominator knobs.

For example, if a photoelectric or magnetic pickup is used to provide a tuning signal from the blades of a five-bladed fan, the filter is tuned to the fundamental rotation frequency by setting the TRACKING FREQUENCY MULTIPLIER to 1/5. If it is further required to examine the 5th harmonic of the fundamental rotation frequency one should set the tracking frequency ratio to 5/5 rather than 1/1 because any slight unevenness in the angular spacing of the blades will be averaged out. This is due to the tuning circuitry in the 1623 only seeing one of the five pulses from the pickup per revolution.

It should be noted that the frequency range 2 Hz to 20 kHz applies to the filter tuned frequency. It is, to a certain extent, possible to tune the filter from signals which have frequencies outside these limits if the tracking frequency multiplier is used to bring the tuned frequency inside the limits and assuming a well defined waveform of high level.

4.7. USING THE SPECIAL NOISE FILTER

The right hand pushbutton of the TRACKING MODE pushbuttons marked **Noise Filter** couples a low pass filter into the tuning signal input which can be used where it is suspected that high frequency ripple may be disturbing a low frequency tuning signal. The rejection characteristic of the noise filter is shown in Fig.4.7.

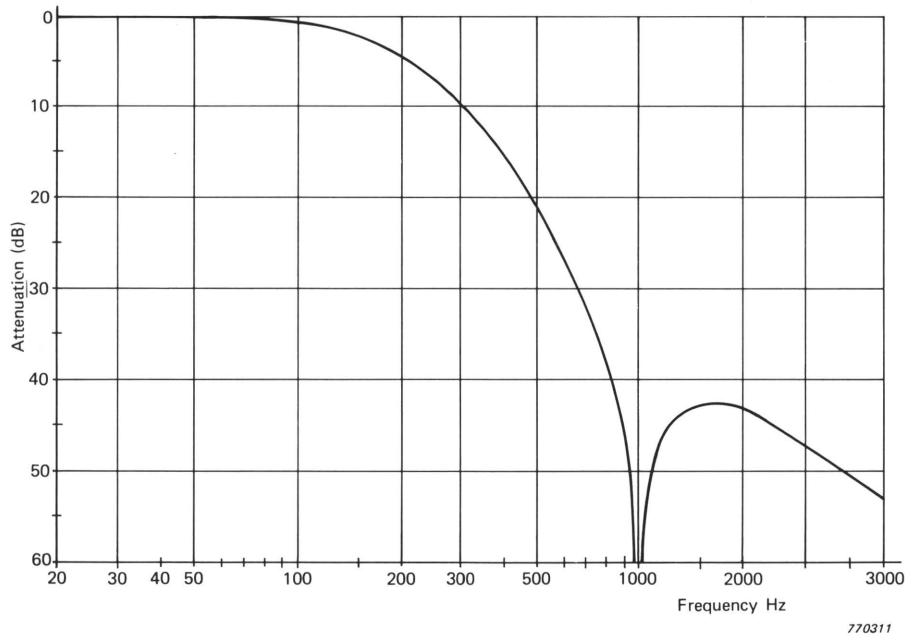


Fig.4.7. Frequency response of the special low-pass noise filter in 1623

In normal circumstances with the **Noise Filter** pushbutton in, the noise filter automatically becomes inoperative when the tuning signal frequency exceeds approx. 200 Hz and couples in again when the tuning signal frequency falls below approx. 200 Hz.

An exception to this rule occurs with the filter resting in **Preset** at a frequency between 2 Hz and 200 Hz and with the noise filter switched in, if a tuning signal of above 200 Hz is applied the filter will only track onto it if the tuning signal level is high enough to compensate for the attenuation of the filter at the tuning frequency. This need not be a problem because the **Preset** frequency needs only to be set above 200 Hz, for example, by setting the MANUAL TUNING/PRESET slide switch to the **200 Hz to 20 kHz** position. As a general rule one should always try to pre-tune the 1623 with the MANUAL TUNING/PRESET knob, to the frequency one expects the tuning (tracking) signal to start at.

When using the noise filter in conjunction with the Photoelectric Tachometer Probe MM 0012, best triggering is obtained when the generated waveform is approximately symmetrical. This is achieved by making the reflective and non-reflective portions of the rotating part approximately equal in width.

The noise filter is of special value when performing harmonic analysis on audio equipment using the Frequency Response Test Unit Type 4416 and the Test Records QR 2009 and QR 2010. In this application, high frequency record noise and the 1 kHz synchronisation tone on the records are automatically filtered out by the noise filter at low tuning frequencies. A suitable setting of the TRIGGER LEVEL knob for this application is approx. + 0,4 V or —0,4 V.

4.8. FILTER SWEEP RATE LIMITATIONS

As is the case with all electronic filters, a certain time is required for the filter to settle at the tuned frequency. In practice this means that if the 1623 is swept across a frequency range too rapidly, with either the external tuning signal or the manual tuning control, the filter will not be given enough time to up-date (settle). This can result in significant errors in the filtered signal level.

With reference to the chart shown in Fig.4.8 it can be seen that the settling time of the filter is a function of frequency, with the longest time needed for the lowest frequency. The fastest possible sweep while maintaining specified filter accuracy (with < -1 dB additional error) is attained with a hyperbolic sweep in accordance with Fig.4.8. The minimum time required for performing such a sweep between two frequencies can be found from this chart. With a linear or logarithmic sweep the filter sweep rate is determined by the lowest tuned frequency, but as the sweep progresses up in frequency the sweep rate could be progressively increased.

With a logarithmic sweep, the initial sweep rate in decades/minute, again determined by the lowest tuned frequency can also be found directly from Fig.4.8.

A further factor which limits the frequency sweep rate is the maximum sweep rate of the Level Recorder Type 2306 which, in combination with the 1623 is 30 decades/minute.

When tuning the filter from a tachometer signal from a rotating machine it will be difficult to accurately assess the rate at which the machine speed is changing. It should be borne in mind that higher frequencies and wider bandwidths make the situation less critical.

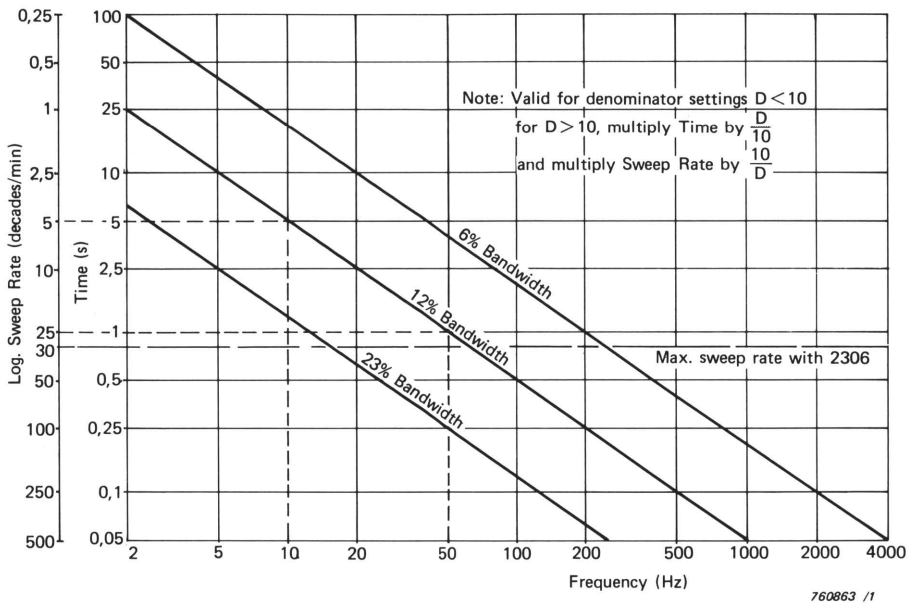


Fig.4.8. Chart for determining the recommended maximum frequency sweep rate and the recommended minimum frequency sweep time for a filtered signal amplitude inaccuracy <—1 dB (additional to specified filter gain accuracy). The example shows a 10 Hz to 50 Hz sweep with the 12% bandwidth filter requiring a sweep time of 5 s — 1 s = 4 s. With a logarithmic sweep the sweep rate (determined by the lowest frequency, 10 Hz) will be 5 decades/min. The sweep rate could be progressively increased with increasing frequency to 25 decades/min. at 50 Hz

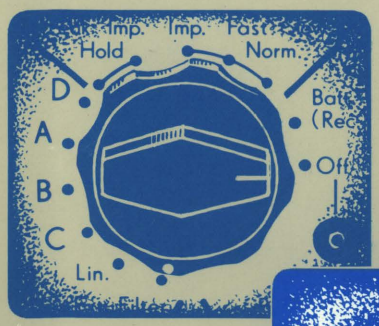
4.9. TUNING THE 1623 FROM THE FILTERED OUTPUT SIGNAL

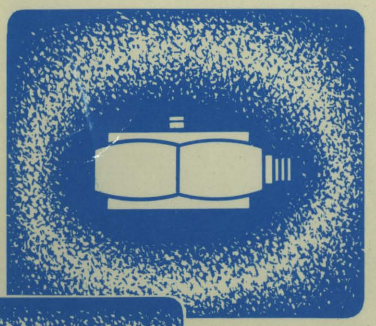
In certain circumstances, for example where an external tuning signal is not available and where the filter input signal is unsuitable, the filter can be tuned from the filtered output signal. This only applies to tuning within one of the decades 2 Hz to 20 Hz, 20 Hz to 200 Hz, 200 Hz to 2 kHz, and 2 kHz to 20 kHz, and assumes that a well defined frequency component can be located.

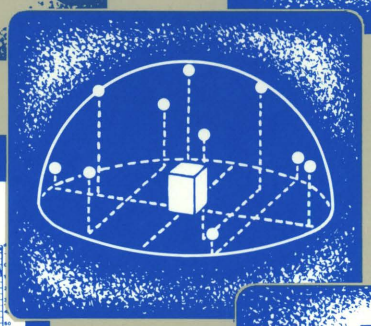
A BNC T connector is used at the FILTER OUTPUT socket with one leg feeding the measuring instrument used and the other leg connected via a BNC-BNC cable to the TACHOMETER INPUT socket.

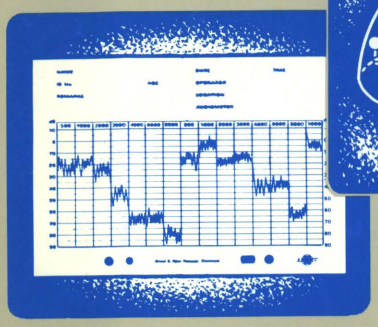
To obtain a stable tuning frequency it will often be necessary to average over several periods of the tuning signal. This is achieved by setting the TRACKING FREQUENCY MULTIPLIER knobs to, for example, 04/04.

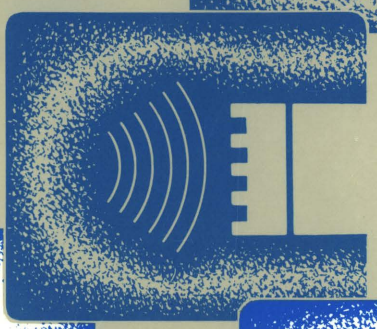
A suitable tuning signal must be located in the filter output signal by searching with the MANUAL TUNING/PRESET knob and the trigger level must be adjusted to a suitable level. Setting up the filter in this way will often take some time and patience but the task can be simplified by monitoring the tuning signal with an oscilloscope (via a BNC 'T' connector at the **Tachometer Input**). The miniature battery operated Oscilloscope Type 4714 is convenient for this purpose. Setting-up is more critical with narrow bandwidths, therefore select the 23% bandwidth filter when possible.

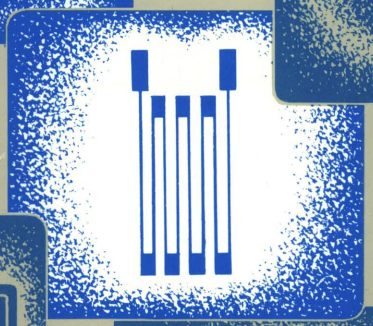


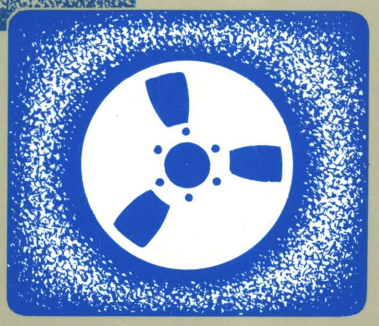


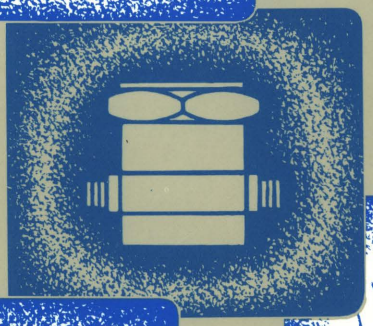


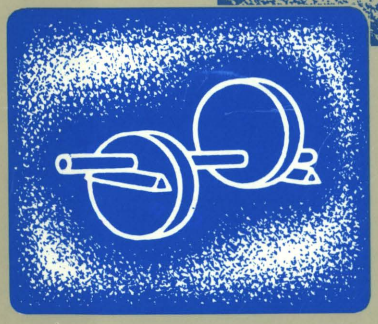


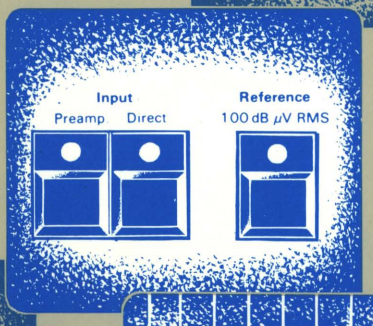


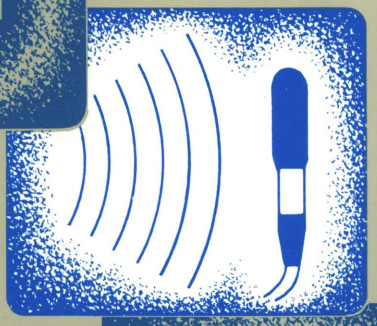


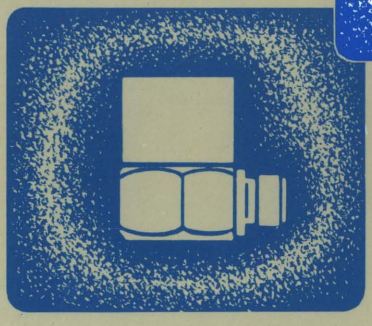


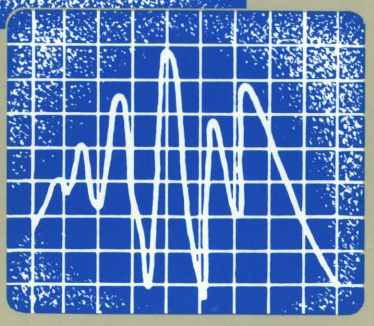


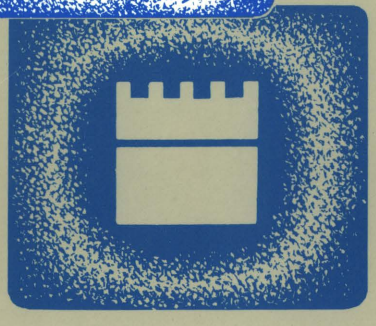












Brüel & Kjær DK-2850 NÆRUM, DENMARK · Telephone: + 452800500 · Telex: 37316 bruka dk

Printed in Denmark by Nærum Offset