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# product data

## types 2616, 2623, 2624, 2625 and 2626

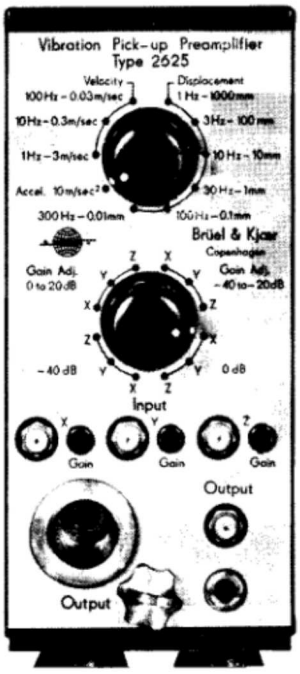
# accelerometer preamplifiers

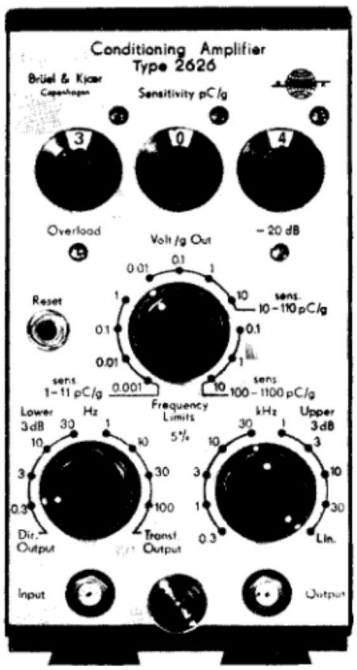









Common Features:

- Wide frequency range
- Wide dynamic range
- High input impedance
- Wide application range
- Small size

Common Uses:

- Vibration measurements with accelerometers
- Vibration monitoring
- General purpose impedance conversion

## Preamplifiers Types 2616, 2623, 2624, 2625 and 2626

When measuring vibration by means of an accelerometer it is necessary to incorporate a preamplifier between this and the measuring amplifier. The preamplifier is introduced in the measuring circuit for two reasons:

1) to amplify the relatively weak output signal from the accelerometer and 2) to transform the high output impedance of the accelerometer into a lower value. The signal from the piezoelectric accelerometer appears as a voltage across a capacitive impedance. This charge is proportional to the acceleration to which the accelerometer is exposed.

As the capacitive output impedance of the accelerometer is very high the associated amplifier must be of a special design having a high input impedance. This is necessary in order to avoid loading of the accelerometer and thereby obtaining decreased sensitivity and limitation at the low end of the frequency range.

The B & K preamplifiers are designed according to two different amplifier principles 1) the voltage preamplifier and 2) the charge amplifier. The output signal of the voltage preamplifier is directly proportional to the input voltage whereas the output signal of the charge amplifier is proportional to the input charge.

**Voltage Preamplifiers**

The voltage preamplifier is based on the use of the accelerometer as a voltage source. This

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requires the input impedance to be high and non-capacitive. Hereby the unavoidable reduction of the accelerometers sensitivity is kept as small as possible and independent of frequency in almost the entire measuring range. The capacitance of the connecting cable between the accelerometer and the preamplifier will load the accelerometer. Thus the sensitivity of the system will also depend on the cable used.

**Charge Amplifiers**
The charge amplifier is based on the use of the accelerometer as a charge source. It works on the change of charge appearing at the input when the accelerometer is vibrated. This charge is transformed in the amplifier (which is a high gain operational amplifier with capacitive feedback) into a voltage signal at the output. As the amplifier is only sensitive to changes in input charge the capacitance of the cable between the accelerometer and the amplifier is of little importance when the cable has a fixed capacitance. Of the five amplifiers described here the Types 2616, 2623 and 2625 are voltage amplifiers and the Types 2624 and 2626 are charge amplifiers.

# Preamplifier Type 2616



Specific Features:
- Overload indicator
- Adjustable gain
- Operates on 6 to 35 V DC

Specific Uses:
- Vibration preamplifier in battery operated set-ups
- Shock measurements

The Preamplifier Type 2616 is designed for mounting near to the accelerometer thus enabling short cables to be used to the transducer and long cables to the indicating instrument. This ensures that noise and loss in the cable do not interfere with the measurements when the measuring instrument is a long distance from the accelerometer.
A field-effect transistor (F E T) in the input stage assures a high input impedance of 1200 MΩ, wide frequency range, and low noise. The input is decoupled by a 2000 pF capacitator and the input stage is DC coupled to the second feedback amplifier stage.
The equivalent circuit of the preamplifier is shown in Fig. 1.
The maximum output current where clipping occurs is 1 mA, which gives the high frequency limits shown in Fig. 2.
The maximum input voltage is 1 V RMS (pos. 0 dB) and 100 V RMS (pos. – 40 dB).
The gain of the amplifier can be switched from 0 dB to – 40 dB and a potentiometer attenuates the signal over a range of about 20 dB.
A peak-indicating overload indicator shows the peak value of the input signal for crest factors up to 10 and for frequencies higher than 20 Hz and indicates when the amplifier is clipping.
The output impedance is less than 100 Ω.
The 2616 is powered by 6 Mallory cells (1.35 V each) which are contained in a battery compartment attached to the preamplifier (Fig. 4).

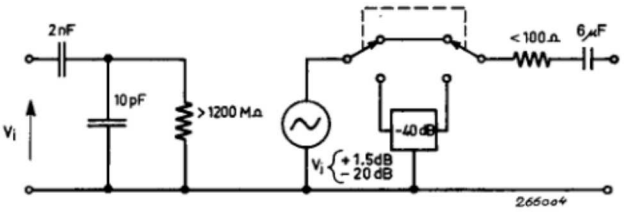



**Fig. 1. Equivalent diagram of Type 2616.**

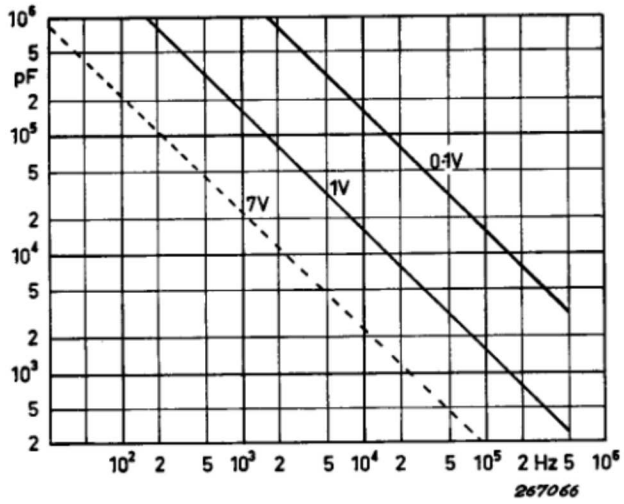



**Fig. 2. High frequency limits of Type 2616 for different loads and output voltages.**

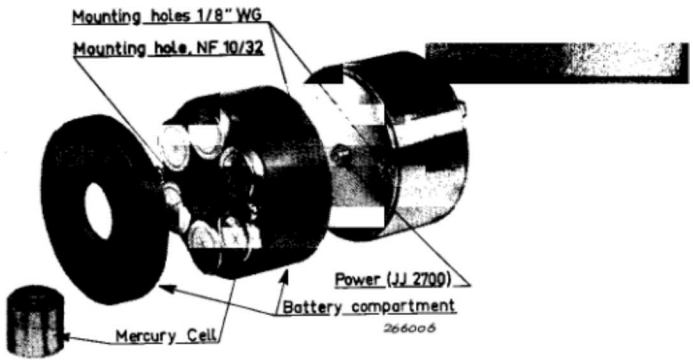
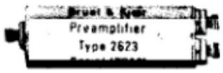



**Fig. 3. Exploded view of the battery compartment in Type 2616.**



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# Preamplifier Type 2623




Specific Features:

- Operates in extreme dynamic environments
- Small size

The Preamplifier Type 2623 is designed as an impedance transformer having a very high input impedance and a low output impedance. This compact, rugged unit operates in extreme dynamic environments and mounts on or near the transducer, eliminating the effects of noise and losses in connecting cables and permitting the use of readout instrumentation at a considerable distance from the measuring point.

The Preamplifier is ideal for low level, low frequency measurements, yet its dynamic range of 110 dB from 0.1 Hz to 500 kHz also permits measurements at high signal levels.

Noise due to direct vibration of the unit is not measurable in the presence of the vibration noise of the connecting cables, so that the amplifier can be mounted directly onto an accelerometer, or very close to it. The unit's inherent low noise also makes it suitable for impedance conversion of other piezoelectric devices, such as microphones, hydrophones, pressure transducers, etc.

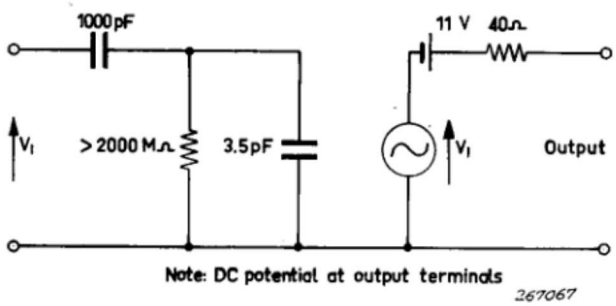



**Fig. 4. Equivalent diagram of Type 2623.**

The 2623 contains a two stage preamplifier, having a gain of unity (0 dB). From Fig. 4, which shows the equivalent circuit of the unit, it can be seen that the input is led via a 1000 pF capacitor to a very high input impedance of more than 2 GΩ ($2 \times 10^9$ Ω) at room temperature obtained by using a field-effect transistor.

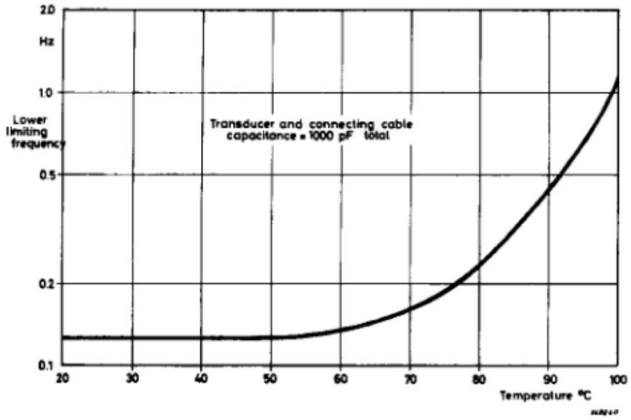



**Fig. 5. Variation of low frequency cut-off with temperature.**

Specific Uses:

- Vibration measurements in extreme environments
- Vibration measurements where preamplifier should be very near transducer
- Shock measurements

The input impedance reduces with temperature, but is still greater than 200 MΩ at 100°C. Temperature does not affect the gain of the amplifier.

The input coupling capacitor and the input impedance determine the low frequency cut-off and this varies with temperature as shown in Fig. 5.

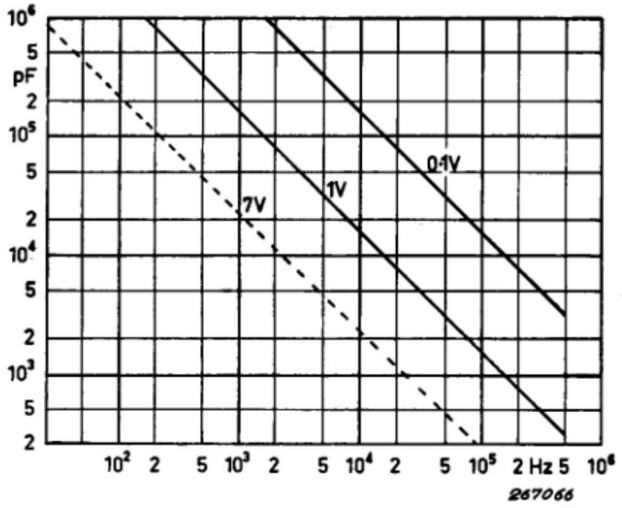



**Fig. 6. High frequency limits of Type 2623 for different loads and output voltages.**

The capacitive load will affect the upper cut-off frequencies, where clipping occurs, as shown in Fig. 6. A load of 10 nF (about 100 m of cable) at 1 V RMS output will give an upper limiting frequency of 15 kHz.

The 2623 requires an external power supply of 28 V DC. Current consumption is 2 mA. When used in conjunction with one of the B & K

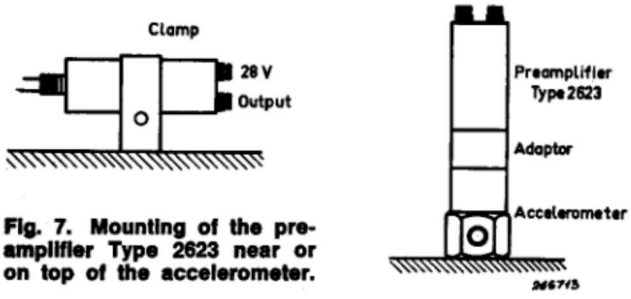



**Fig. 7. Mounting of the preamplifier Type 2623 near or on top of the accelerometer.**



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measuring units, Adaptor ZR 0024 can be used to supply the necessary voltage and provide microcircuit connections. The modular power supply, Type 2805, can also be used and can supply up to ten units at a time.

# Charge Amplifier Type 2624

Specific Features:

- Frequency range down to 0.003 Hz
- Permissible capacitive load at input max. 1 μF
- Short rise time
- Modular construction for B & K system

The Charge Amplifier Type 2624 is independent of type and length of cable to the accelerometer within wide limits making it especially attractive in vibration measurements where cables of different type and length are used to the accelerometer. The amplifier also gives the possibility of measurements at very low frequencies such as measurement of shocks.

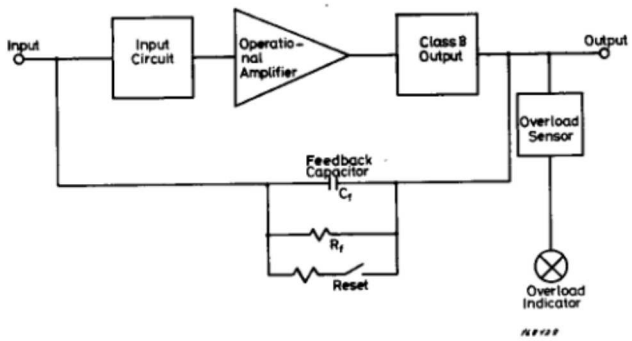



**Fig. 8. Block diagram of Type 2624.**

The amplifier contains an input circuit with a field effect transistor which gives a high input impedance of more than 10 GΩ. See block diagram Fig. 8.
The input circuit is followed by a high gain operational amplifier and a class B output stage which delivers the relatively high capacitive current required by the feedback capacitor $C_f$ at high frequencies. The feedback resistor $R_f$ stabilizes the DC level of the amplifier. The output voltage is proportional to the charge appearing across the accelerometer.
The preamplifier is provided with an overload indicator which lights up when the dynamic range is exceeded and when the amplifier is blocked due to saturation. A reset button is used for recovery of normal working conditions after overload. The output may be scaled to 0.1, 1 or 10 mV/pC giving different low frequency limits. See table Fig. 10.

The unit can be mounted directly onto an accelerometer by means of an adaptor supplied, or it can be mounted nearby with the clamp supplied (see Fig. 7), using screws or a magnet.



Specific Uses:

- Vibration measurements with long or different cables to accelerometer
- Low frequency measurements
- Shock measurements

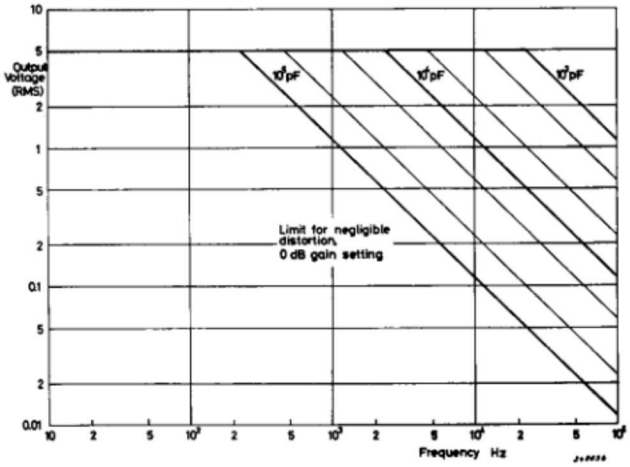



**Fig. 9. Distortion limits for Type 2624 for different loads and output voltages.**

The table gives the frequency response of the 2624 in the different sensitivity ranges. The values are valid when the capacitive load at the input is negligible.

| Sensitivity mV/pC | −3 dB point, Hz | Frequency Range Hz |
|---|---|---|
| 0.1 | 0.003 | 0.03–30,000 ± 1 % |
| 1 | 0.03 | 0.3–30,000 ± 1 % |
| 10 | 0.3 | 5–10,000 ± 5 % |
| 0.1 | 0.3 | 3–30,000 ± 1 % |
| 1 | 3 | 30–30,000 ± 1 % |
| 10 | 30 | 150–10,000 ± 5 % |

**Fig. 10. Frequency response for different sensitivity settings.**

Input and output sockets are microsockets 10–32 NF and the preamplifier is completely protected against overload and short circuits.



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# Vibration Pick-up Preamplifier Type 2625



Specific Features:

- Acceleration, Velocity and Displacement networks
- Three selectable inputs
- Adjustable gain
- Modular construction for B & K system

Specific Uses:

- Measurement of acceleration, velocity and displacement with an accelerometer
- Comparison measurements
- Triaxial measurements

The Vibration Pick-up Preamplifier Type 2625 is especially designed for the measurement of velocity and displacement in addition to acceleration as it is provided with integration networks.

It is provided with three inputs (micro socket type 10–32 NF) with individual sensitivity adjustment (see Fig. 11). The three input sockets are connected to the Selector Switch which selects one of the three inputs and short circuits the other two. It will accommodate three accelerometers at once, making comparative measurements very easy. This also makes the preamplifier ideally suited for triaxial measurements.

The Selector Switch also controls four different gain ranges for the three inputs: 1) variable from −40 dB to −20 dB, 2) variable from 0 dB to 20 dB, 3) fixed at −40 dB, 4) fixed at 0 dB. The signal is fed to the differential amplifier and output stage (which have feedback adjustment) via the field effect transistor input stage (input impedance variable between 450 MΩ and 3 GΩ depending on gain setting) and further into the integration networks. These networks provide for the velocity and displacement function.

The integration networks are passive RC networks with the frequency ranges as stipulated in the table Fig. 12. The networks are used in order to obtain the best possible signal to noise

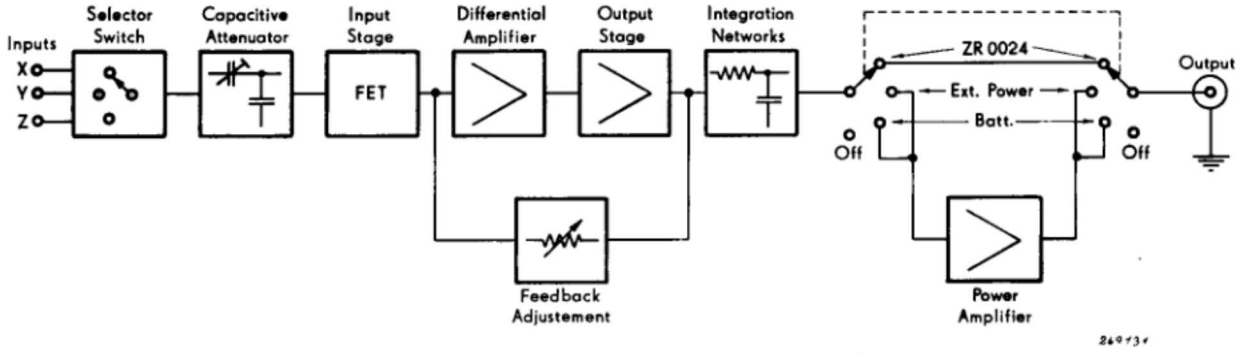



**Fig. 11. Block diagram of Type 2625.**

| Mode | Range | Frequency Range Hz |
|---|---|---|
| Vel. | 3.16 m/sec | 1–4000 |
| Vel. | 0.316 - | 10–10,000 |
| Vel. | 0.0316 - | 100–30,000 |
| Displ. | 1000 mm | 1–30 |
| Displ. | 100 - | 3–100 |
| Displ. | 10 - | 10–300 |
| Displ. | 1 - | 30–1000 |
| Displ. | 0.1 - | 100–3000 |
| Displ. | 0.01 - | 300–10,000 |

**Fig. 12. Frequency ranges of the integration networks.**

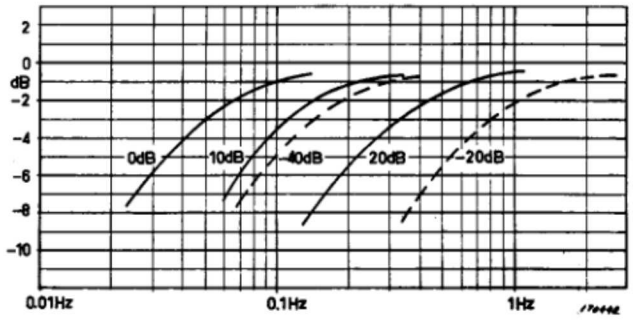



**Fig. 13. Lower frequency response curves of Type 2625 for different gain settings.**



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ratio by setting the low frequency limit as high as possible.
In the acceleration mode the integration networks are not incorporated. The Preamplifier has a power supply selector for choice of three sources of supply: 1) Power Supply ZR 0024, 2) other external power supply, 3) built-in batteries. In the two latter positions the output is taken from the built-in power amplifier. In these positions the maximum output current (± 2.3 mA) is available.
The lower frequency response for different gain setting is shown in Fig. 13.

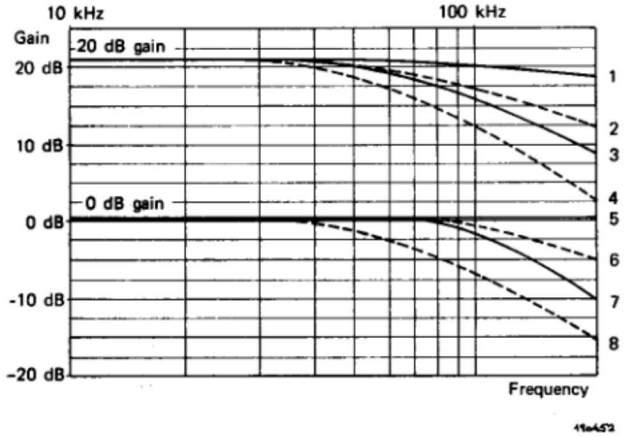



**Fig. 14. Upper frequency response curves of Type 2625. Curve identification: Full line curves: response with output amplifier. Dashed curves: without output amplifier. Input signal levels: 1 and 2: 0.1 V RMS. 3 and 4: 0.5 V RMS. 5 and 6: 1 V RMS. 7 and 8: 5 V RMS.**

Fig. 14 shows the upper frequency response for two different gain settings and four different signal levels. The curves give the response with the power amplifier and without.
When the preamplifier is operated from the ZR 0024 Power Supply the maximum output voltage and current available in position Accel. is ± 7 V and ± 1 mA. Fig. 15 shows the limitation of high frequency performance when working with capacitive loads.

# Conditioning Amplifier Type 2626

Specific Features:

- 3 digit transducer conditioning pC/g
- Direct read-out of amplifier sensitivity volt/g
- High gain, 60 dB
- Step wise adjustable HP and LP filters
- Overload and underload indicators
- Output direct coupled with negligible DC of-set or transformer coupled floating
- Fast recovery
- Low noise

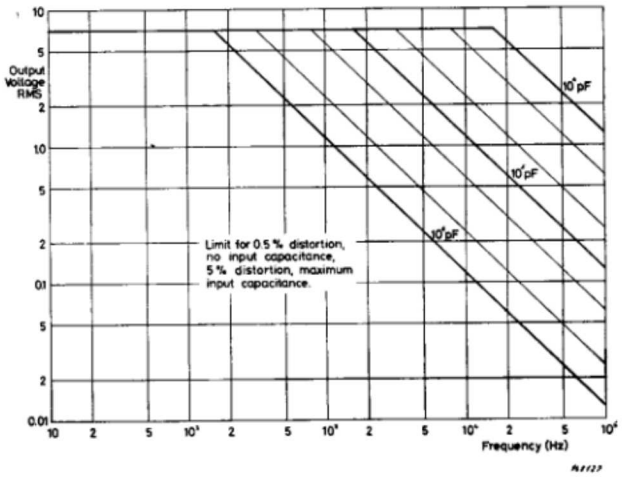



**Fig. 15. High frequency limits of Type 2625 without output amplifier for different loads and output voltages.**

When operated from Ext. Power or Batt. the power amplifier is incorporated. This gives a maximum output voltage and current of ± 7 V and ± 2.3 mA, thus reducing the loading restriction considerably as shown in Fig. 16.

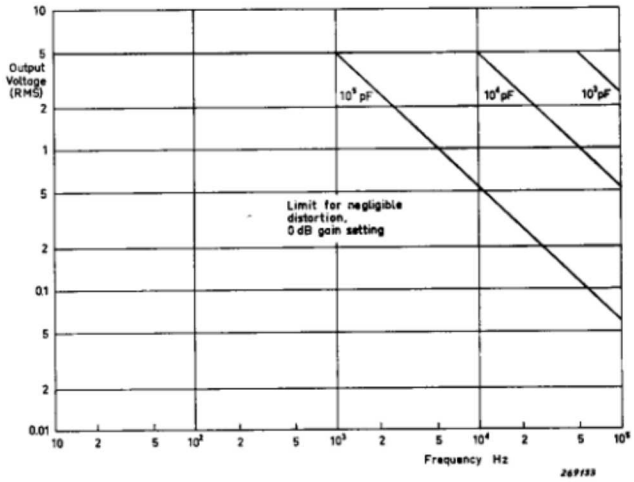
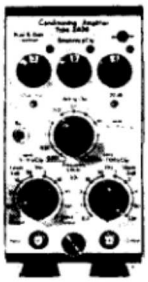



**Fig. 16. High frequency limits of Type 2625 with output amplifier for different loads and output voltages.**



Specific Uses:

- Vibration measurements with long cables between transducer and amplifier
- General purpose vibration measurements including servo loops



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The Conditioning Amplifier Type 2626 is designed as a charge amplifier. It offers wide conditioning possibilities to different transducers and measuring requirements. The amplifier features a 3 digit sensitivity adjustment network which enables the amplifier sensitivity to be adjusted to the particular transducer used. The network is calibrated in pC/g.

The amplifier has a rated output stepwise adjustable between 1 mV/g and 10 V/g depending on the sensitivity of the transducer. The maximum gain is 60 dB.
Adjustable HP and LP filters are available. The filter scales give the 5 % as well as the 3 dB frequency limits.

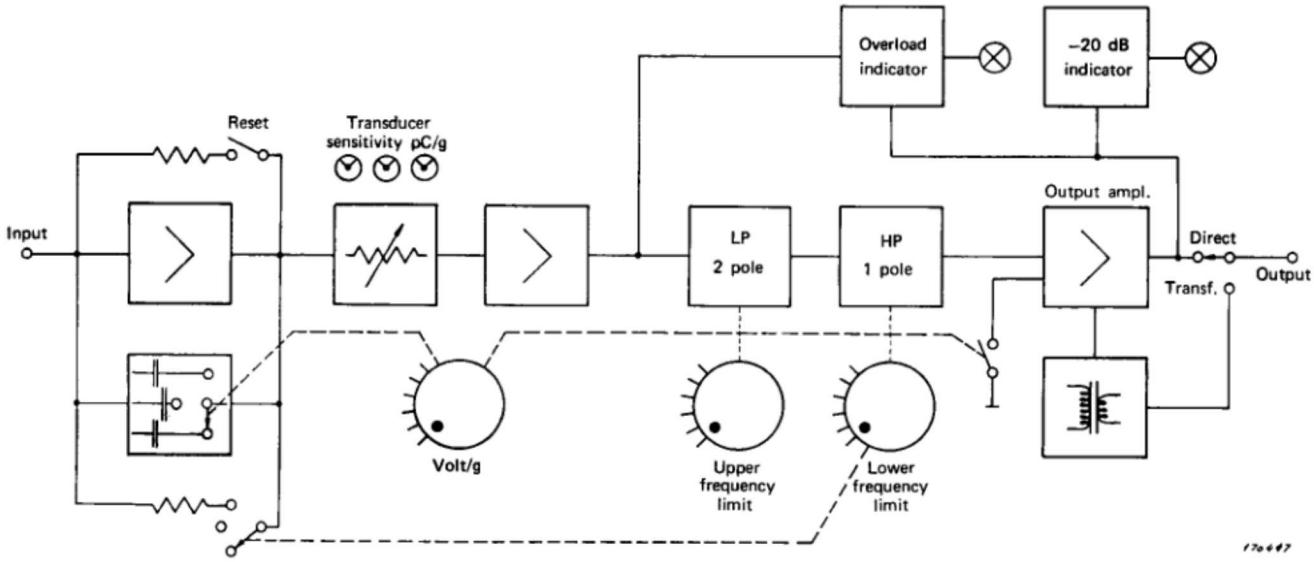



**Fig. 17. Block diagram of Type 2626.**

Fig. 17 shows the block diagram of the amplifier. The signal from the transducer is fed to the input section of the 2626 which contains an amplifier stage with capacitive feedback forming a charge amplifier. The signal goes on to the conditioning section where the sensitivity is adjusted to match the transducer and further to a Low Pass filter (2 pole Butterworth) and a High Pass filter (single pole) where the upper and lower frequency limits of the amplifier are determined. From the filters the signal is fed to an output amplifier and further to the output. The signal is available either directly coupled or through a transformer (switchable) for floating output. Two neon indicators are connected to the output, one acts as an overload indicator, the other indicates when the signal level is more than 20 dB below full output.
The frequency response of the amplifier will be influenced by loading of the input and the output. Fig. 18 shows the upper frequency limits for different output loads and output voltages. The curves show the response for a large signal (20 Vpp) and a small signal (2 Vpp). Fig. 19 shows the upper frequency limits for different input loads and sensitivity settings.

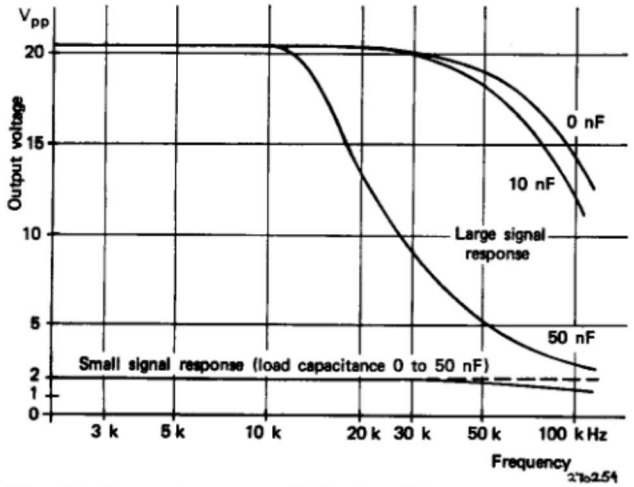



**Fig. 18. Upper frequency limits for different output loads. (Distortion approx. 1 %).**

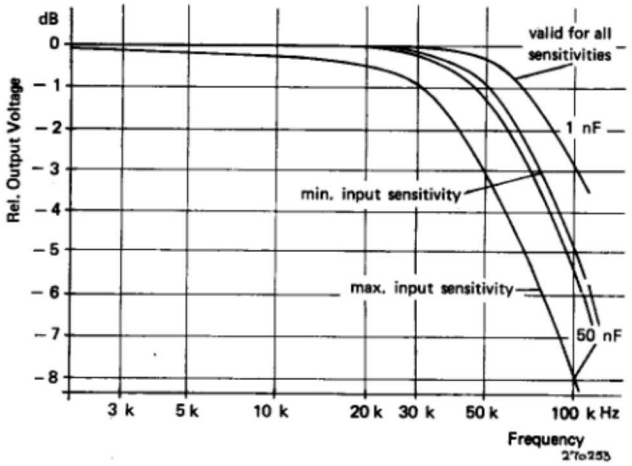



**Fig. 19. Upper frequency limits for different source capacitances and input sensitivities.**



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# Specifications

| B & K Type no. | 2616 | 2323 | 2624 | 2625 | 2626 |
|---|---|---|---|---|---|
| Input Impedance | > 1.2 GΩ | > 2 GΩ | > 10 GΩ (Input DC shunt resistance) | 450 MΩ to 3 GΩ | > 10 GΩ (Input DC shunt resistance) |
| Input Capacitance | 10 pF | 3.5 pF | Charge input | 14 pF | Charge input |
| Max. Input Signal | 100 V RMS (in pos. – 40 dB) | 7 V RMS | $10^5$ pC | ± 700 V (in pos – 40 dB) | $10^5$ pC |
| Max. Input Load | – | – | 1 μF for 1 % error (in pos. 0.1 mV/pC) | – | – |
| Output Impedance | < 100 Ω | < 40 Ω | 1 Ω (¼ loaded)* 3 to 5 Ω (full load) | < 30 Ω (Power amplifier) | < 10 Ω (Direct) |
| Max. Output Voltage/ Current | 1 mA | 1 mA | ± 10 V – ± 10 mA | ± 7 V – ± 2.3 mA (Power amplifier) | ± 10 V – ± 10 mA |
| Output Load Impedance | > 10 kΩ | > 50 kΩ | > 1 kΩ | ≥ 1 MΩ (Integration networks) ≥ 3.5 kΩ (Power amplifier) | Direct: > 1 kΩ Transf.: > 10 kΩ |
| Frequency Range | 0.13 Hz to 500 kHz (1 nF at input) | 0.16 Hz to 500 kHz (1 nF at input) | 0.003 Hz to 100 kHz (see curves and table inside) | 1 Hz to 35 kHz (see curves and table inside) | 0.3 Hz to 100 kHz (3 dB) 1 Hz to 30 kHz (5 %) |
| Noise | ≤ 25 μV (2 Hz to 40 kHz) 1 nF at input) | ≤ 15 μV (2 Hz to 40 kHz) (1 nF at input) | max. 20 μV + max. 10 μV/100 pF△ | < 20 μV (2 Hz to 40 kHz) (1 nF at input) | < 10 μV RMS RTI |
| Harmonic Distortion | < 1 % | < 1 % | < 0.5 % (no cap. load) < 5 % (full cap. load) | < 1 % (5 V RMS input, acc. mode) | < 1 % |
| Gain | + 1.5 dB to – 20 dB (attenuator on 0 dB) | 0 dB ± 0.05 dB | 0.1 – 1 – 10 (– 20, 0, + 20 dB) | Fixed 0 dB and – 40 dB Variable 0 to 20 dB and – 40 dB to – 20 dB | 60 dB |
| Rise Time | 1 μsec | 3 μsec | Prop. to pulse height Typically 1.8 V/μsec | – | Prop. to pulse height Typically 5 V/μsec |
| Overload Recovery Time | – | – | ≥ 5 msec | – | 10 μsec |
| Power Supply | 6 to 35 V DC 3 to 10 mA or internal battery B & K no: QB 0007 | 28 V DC 2 mA | 28 V DC 17 to 40 mA | 28 V DC 2 or 7 mA or internal battery B & K no: QB 0010 | 100 to 240 V AC < 70 mA |
| Internal Battery Supply | Six mercury cells 1.35 V Mallory: RM1R IEC Type MR7 | None | None | Three 9 V batteries IEC Type 6F22 | None |
| Dimensions: Height Width Depth | 66 mm (2.6 in) 52 mm (2 in) (diam.) | 45 mm (1.77 in) (length) 14 mm (0.55 in) (diam.) | 132.6 mm (5.22 in) 30.3 mm (1.19 in) 200 mm (7.87 in) | 132.6 mm (5.22 in) 61 mm (2.40 in) 200 mm (7.87 in) | 132.6 mm (5.22 in) 69.5 mm (2.74 in) 200 mm (7.87 in) |
| Weight | 290 g (10.3 oz) | 20.6 g (0.73 oz) | 585 g (1.29 lb) | 820 g (1.8 lb) | 1.75 kg (3.89 lb) |
| Acessories Included | 1 Cable AO 0037 1 Allen Key QA 0013 6 Batteries QB 0007 | 1 Adaptor UA 0144 1 Clamp DH 0120 2 Cables AO 0037 1 Allen Key QA 0013 | 2 Cables AO 0037 | 2 Cables AO 0037 1 Coaxial Plug JP 0101 | – |

* Charge Input
△ Source Capacitance

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