

QMC Instruments Ltd

ULN95 Preamplifier



Operating Manual

Serial Number **XXXX**

CONTENTS

Introduction

Packing List

Preamplifier Operation

Preparing the preamplifier

Powering the preamplifier

Power option a) Using an external power supply

Power option b) Using the internal batteries

Recharging the batteries

Altering the detector bias

Troubleshooting

Contract Details and Guarantee

Introduction

The ULN95 (Ultra Low Noise) preamplifier is a voltage mode low noise preamplifier designed for use with cooled detectors. It can be powered either from internal rechargeable batteries or from an external $\pm 15\text{V}$ DC supply. Switchable gain options, a potentiometer bias supply control and full detector status monitoring are provided. Output is 50Ω bnc as standard, and the circuit is housed in an RF shielded enclosure designed to mount directly to the detector cryostat to reduce interference and provide a common ground.

The input impedance is high, so the preamplifier can be used with a range of cooled detectors, including InSb hot electron bolometers (types QFI/X, QFI/XB and QFI/XBI) and composite Silicon and Germanium bolometers (types QSIB/X and QGEB/X).

The technical specification of the ULN95 is given in **Table 1** below.

Output impedance 50Ω bnc	Bias Supply 0-10V multi-turn potentiometer
Input impedance $>10\text{G}\Omega$	Voltage Gain x100, x1000 switchable
Bandwidth 0.5Hz to 1MHz	Output Noise $\approx 1\text{nV Hz}^{-1/2}$ rms $> 1\text{kHz}$ (input shorted) $\approx 3\text{nV Hz}^{-1/2}$ rms at 10Hz

Table 1. ULN95 Technical specification

Packing List

The following items are included in this shipment. Please check the contents against this list and contact QMC Instruments Ltd as soon as possible if you suspect that any items are damaged or missing.

ULN95 Preamplifier

- Preamplifier unit fitted with 220k Ω bias resistor
- 2-off NiCd battery packs, each containing 10 batteries
- 4-off 500mA spare fuses
- 100k Ω , 180k Ω and 1M Ω alternative bias resistors
- ULN95 preamplifier power supply lead
- Operating manual for the preamplifier

Preamplifier Operation

Photographs included in this manual are general photos that may not be specific to your particular preamplifier.

Preparing the preamplifier

The preamplifier batteries have been disconnected for transit. Open the front of the ULN95 by unbolting the four bolts that hold the lid in place. The battery pack should be fixed in position as shown in **Photo 1a**, using the four nylon fixing screws.

The battery connecting lead, **Photo 1b**, which can only be fitted one way, should be connected to the 4-pin connector at the top of the left hand circuit board as viewed with the battery pack uppermost in the box.

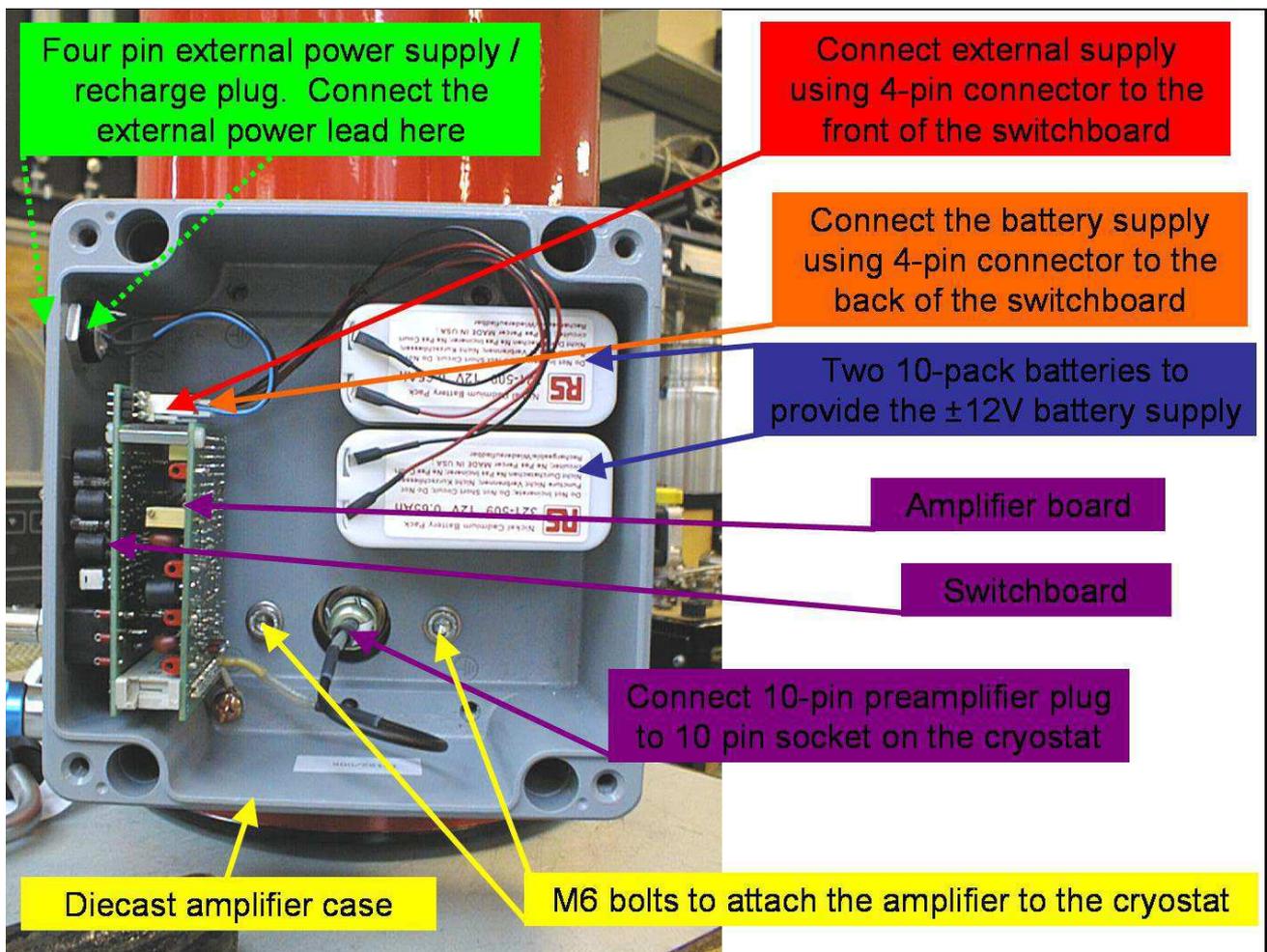


Photo 1a. The preamplifier connections

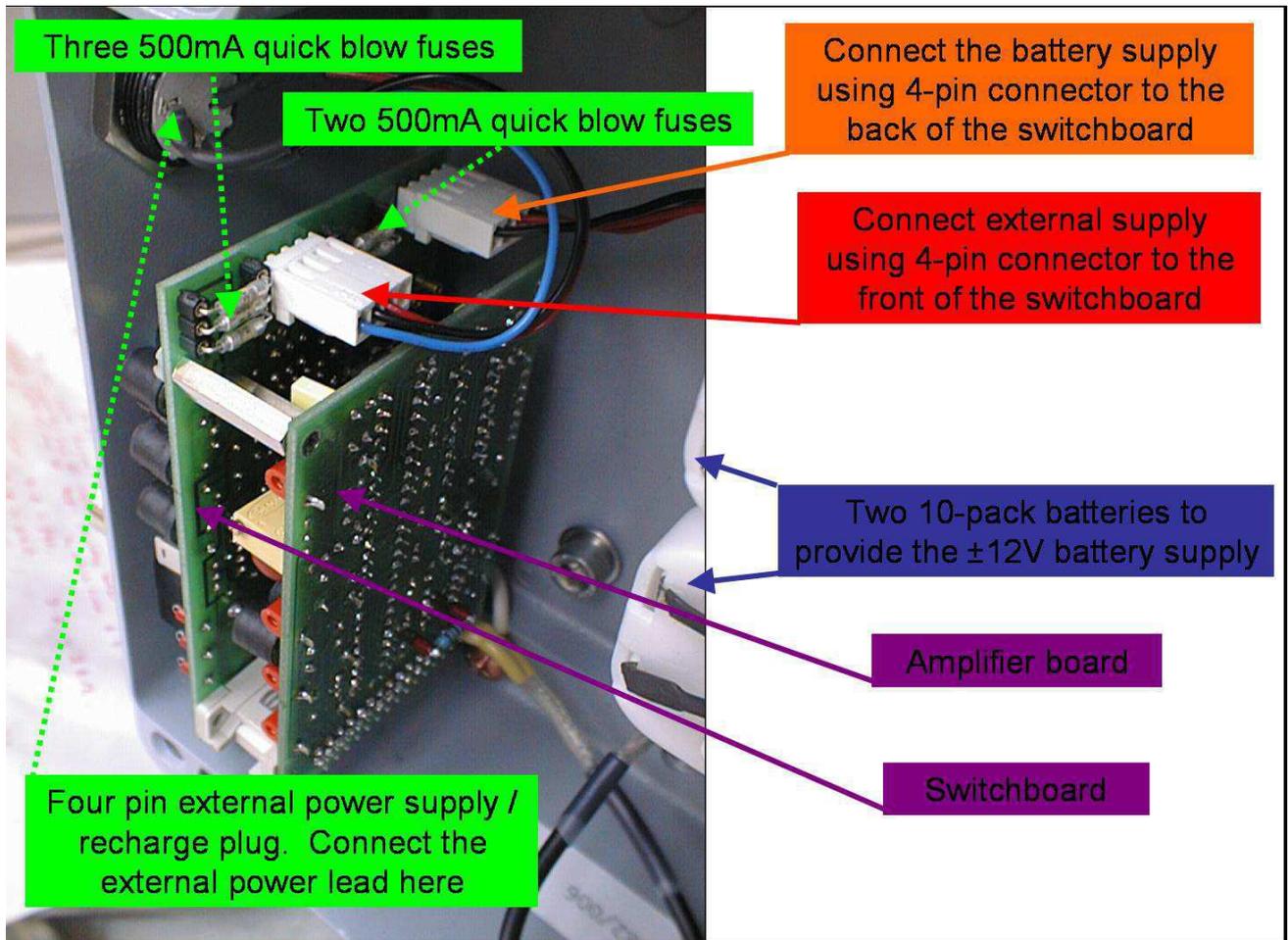


Photo 1b. Connecting the batteries

Powering the preamplifier

The ULN95 can be operated from the internal batteries or from an external power supply. External power is supplied via the 4-pin socket located at the top of the preamplifier control panel. The three isolated pins are used while the earth tag is not used. A twin channel power supply, an example of which is pictured in **Photo 2**, will be needed to run the preamplifier from external power. A power lead is supplied for this purpose. The internal NiCd batteries, which may not necessarily be charged before despatch, are recharged from the external power supply via the same socket. Please note that the NiCd rechargeable batteries will not be able to be recharged and used indefinitely. Through normal and proper use they will need replacing after about 200 charge/discharge cycles.

Power Option a) Using an external PS

Photo 2 shows a typical twin channel laboratory power supply which can supply 30V dc per channel. The photo also shows how the power lead supplied with the detector should be connected to such a supply.

When powering the preamplifier, make sure that the voltage output is at zero before switching on, and then increase the voltage gradually on both power supplies simultaneously to 15V.

If the power supply has a current limiting facility, this should be set to 200mA. The current supplied to the power socket is limited internally but occasionally transients can blow the 500mA protection fuses.

External supply switch-on procedure is as follows from the following initial settings:

RECHARGE = OFF; POWER = EXT; INPUT = SHORTED; BIAS = OFF

1. Ensure that the power supply output voltages are set to 0V
2. Connect the power lead as shown in Photo 2 below. Plug the other end into the **RECHARGE SOCKET**
3. Increase the two output voltages to 15V gradually. The red **PREAMP ON** light should illuminate
4. Set the INPUT switch to the **OPEN** position
5. Set the BIAS switch to the **ON** position
6. Select the desired GAIN

At this stage, you can “Say Hello” to your detector. A hand waved rapidly in front of the detector window should generate a readily visible response on an oscilloscope.

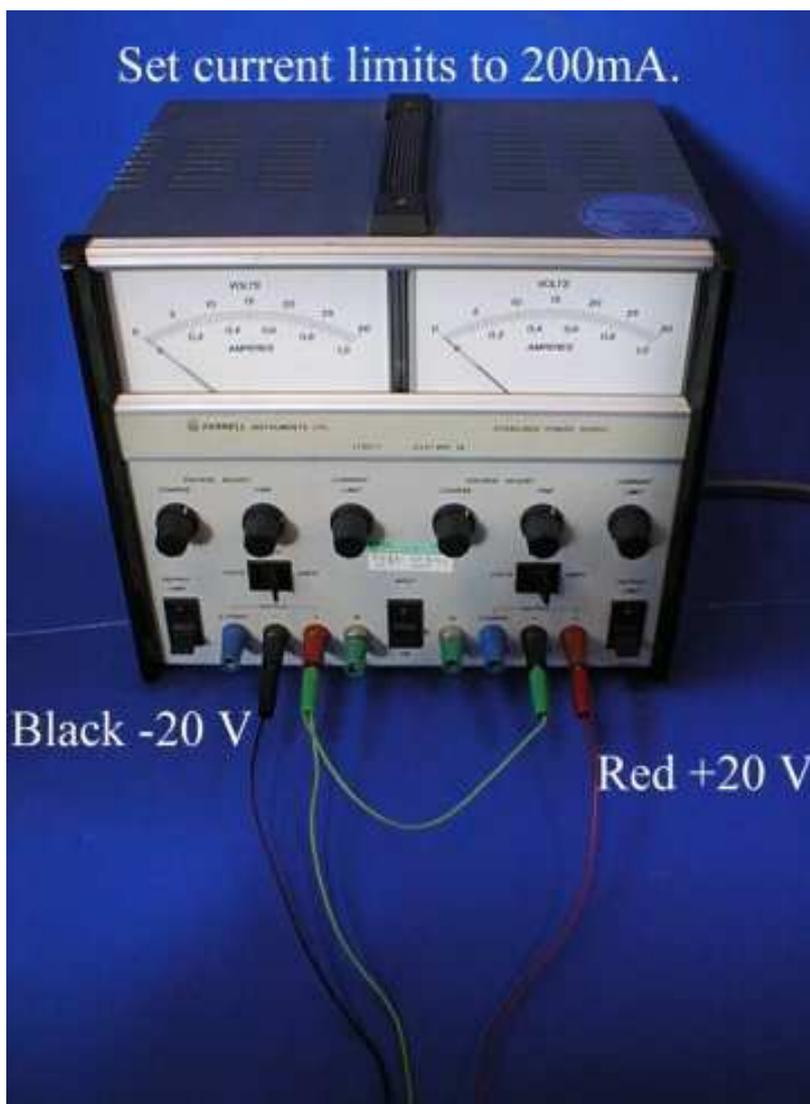


Photo 2. Power supply connections

Power Option b) Using the internal batteries

Battery supply switch-on procedure is as follows from the following initial settings:

RECHARGE = OFF; POWER = EXT; INPUT = SHORTED; BIAS = OFF

1. Set the POWER switch to **BATT**. The **PREAMP ON** light should illuminate
2. Set the INPUT switch to the **OPEN** position

3. Set the BIAS switch to the **ON** position
4. Select the desired GAIN

Fully charged batteries will be able to operate the preamplifier for at least 12 hours. However, this does depend to an extent on the level of output used. The power drain on the batteries is higher if the signal level is large.

Recharging the batteries

Battery recharge procedure is as follows from the following initial settings:

RECHARGE = OFF; POWER = EXT; INPUT = SHORTED; BIAS = OFF

1. Ensure that the power supply output voltages are set to zero
2. Connect the power lead as shown in Photo 2 above. Plug the other end into the **RECHARGE SOCKET**
3. Set the RECHARGE switch to **ON**
4. Increase the voltage to +/-15V as described above. The **PREAMP ON** light should illuminate
5. Increase the voltage gradually to +/-18V. The **RECHARGE ON** light illuminates brightly

Do not exceed a supply voltage of +/-20V. If you proceed according to these instructions it is not possible to overcharge the cells. The batteries will be fully charged when the recharge light goes out, which should take no more than eight hours.

You can operate the amplifier and recharge the batteries simultaneously.

When switching off, remember to switch the power option switch to external supply, otherwise the batteries will drain.

Altering the detector bias

The detector requires a d.c. bias current I_B which is supplied by the preamplifier. When supplied as part of a QMC Instruments Ltd detector system I_B is set to the optimum value during testing; hence it should not normally be necessary to alter the bias conditions of the detector. However, I_B will have to be optimised if the temperature of operation is altered, for example by pumping and cooling the helium bath to 1.5K.

When supplied as a preamplifier for use on other systems, the preamplifier is supplied with a 220k Ω bias resistor and is biased midrange i.e. bias voltage (see below), $V_B=5V$. 100k Ω , 180k Ω and 1M Ω bias resistors are supplied in the event that the 220k Ω resistor is not suitable for your detector. These should be soldered onto the back of the amplifier board in place of the 220k Ω resistor as required.

The bias voltage V_B supplied to the bias load resistor can be measured using the test points within the preamplifier box. On the board closest to the battery pack there are four test points and a variable resistor which are assigned, **photo 3**, as follows:

- TP1 Zero volt test point**
- TP2 V_B test point**
- TP3 I_B test point (1mV/ μ A)**
- TP4 Detector voltage test point, V_{Det}**
- VR1 V_B adjust**

To measure V_B connect a voltmeter across TP1 and TP2. To set V_B adjust the multi-turn potentiometer VR1. V_B will have been set at QMC Instruments Ltd during testing but can be altered using the potentiometer VR1 and measured between TP1 and TP2. To measure I_B connect a

voltmeter across TP1 and TP3 and convert the measured voltage in mV to $I_B/\mu A$ using the conversion factor $1mV/\mu A$. V_{Det} is measured by connecting a voltmeter across TP1 and TP4. The operating resistance of the detector can then be calculated from $R_{Op} = V_{Det}/I_B$. Occasional monitoring of this voltage will confirm that the detector temperature and the bias current are correct and stable.



Photo 3. View of the switchboard and amplifier circuit board identifying the voltage test points and multi turn potentiometer

Troubleshooting

If after recharging the battery packs performance starts to fall it is likely that the NiCd rechargeable battery packs will need replacing. It is normal for NiCd rechargeable batteries to need replacing periodically when they no longer hold charge. Replacement battery packs can be obtained from RS.

If problems are suspected with the ULN95 preamplifier there are some basic checks that can be carried out. Disconnect the ULN95 from the external supply and then open the box it by undoing the four bolts. Check the following:

- Check the five 500mA fuses to make sure that they have not blown, **photo 4**
- The switchboard should be firmly attached to the RF shielded case
- The switchboard and amplifier board should be firmly attached to one another
- Where applicable, the 10-pin or SMA plug should be firmly attached to the cryostat 10-pin or SMA electrical feedthrough
- Confirm that the battery packs are firmly attached in position to the RF shielded casing, and that they are connected to the switchboard
- Confirm that there are no obvious problems with the switchboards and amplifier board. The boards can be detached and removed from the case for inspection. Check for any loose components or blackened areas

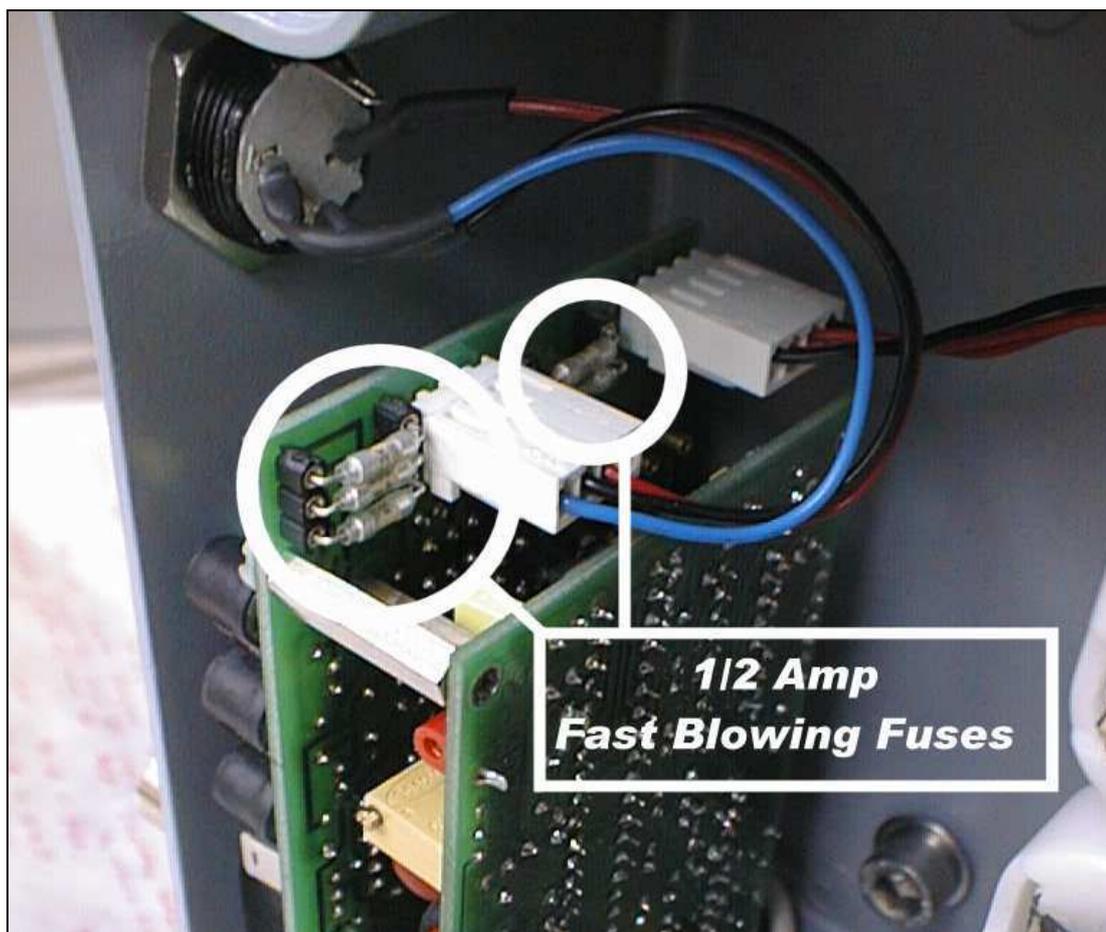


Photo 4. View of the switchboard and amplifier board, showing the location of the 500mA fuses

Figs. 1(a, b) below give typical input shorted noise of the ULN95 amplifier at a gain of x100

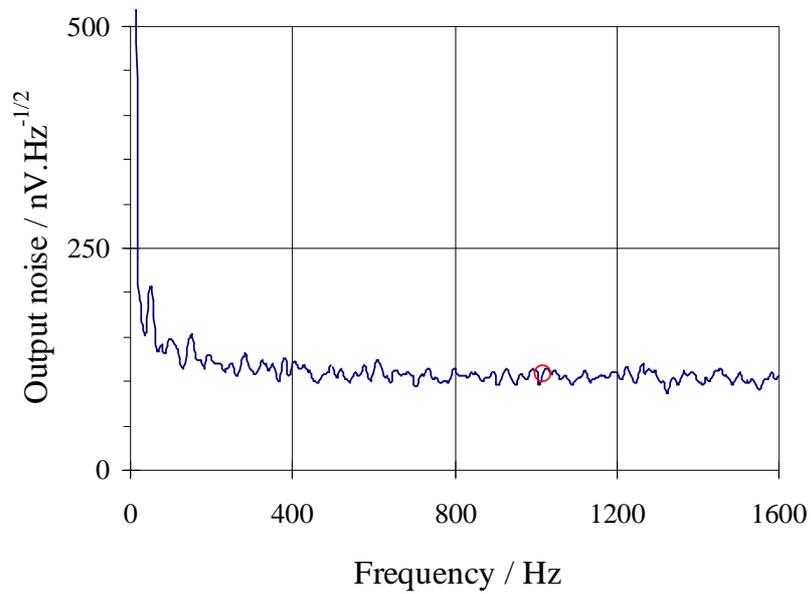


Fig. 5.1a. Typical preamplifier input shorted noise spectra
Amplifier gain = x100. Noise at 1kHz = 1.0nV.Hz^{-1/2}

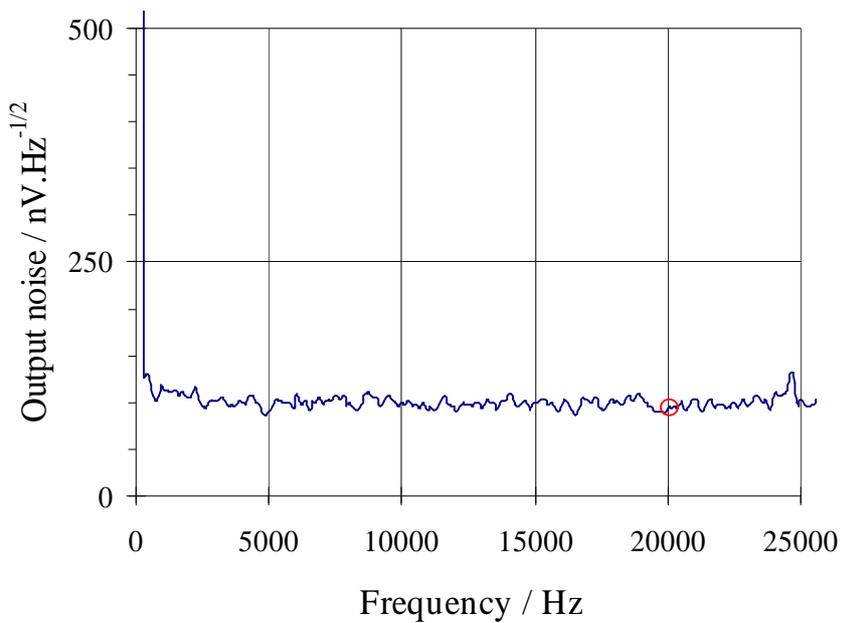


Fig. 5.1b. Typical preamplifier input shorted noise spectra
Amplifier gain = x100. Noise at 20kHz = 1.0nV.Hz^{-1/2}

Contract details and guarantee

This equipment is guaranteed for a period of two years from the date of delivery against failure caused by defective materials or workmanship. Defective parts will be repaired or replaced on return to the final supplier at no cost, provided that failure is not due to misuse or mishandling after delivery. QMC Instruments Limited will assume no liability for loss of life or damage to property arising from the use or misuse of its products.

Purchase Order N^o
Purchase Order Date
QMCIL Reference
Preamplifier Serial Number

On receipt of your shipment

Please check that your equipment has arrived safely. Please advise QMC Instruments if you suspect any damage has been incurred during transport and delivery or if any of the items are missing.

This operating manual contains instructions for operation of the preamplifier, together with QMC Instruments Ltd. test performance data, against which our guarantee is given as stated above. The user is advised to read this document carefully prior to operation of the preamplifier and is reminded that our guarantee will be invalidated if it is damaged through misuse.

Signed.....
Ken Wood - Director, QMC Instruments Ltd.

Date.....

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