



Figure 1: Smallest possible noise thanks to selected field effect transistors



Figure 2: Prototype of the amplifier

### Advantages

- ultra-low noise
- can be used in many applications in the fields of cryogenics, and metrology.

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## Ultra-low-noise preamplifier

Measurements with minimum uncertainties? No problem with PTB's ultra-low-noise preamplifier! The resolution for the comparison of impedance standards can be considerably improved. But the most interesting fact is that the requirements can be individually adapted to each measurement process.

### Technical description

Low-noise preamplifiers are necessary in all high-precision AC measuring bridges. In order to reduce this noise influence, an ultra-low-noise preamplifier has been developed. It is characterized by the fact that several selected field effect transistors are connected in parallel at the input which have the lowest possible noise current and noise voltage values.

In addition, at the input level, the circuit is designed in such a way that – besides the generation of a stable standby current by the input transistors – also their drain resistance is dynamically increased. The noise of the pre-stage is thus optimally adapted to the main stage, which guarantees the smallest possible noise data. An optimized feedback network adjusts a stable amplification.

### Application

This novel circuit concept enables the so far unprecedented combination of an input noise voltage of smaller than 0.5 nV and an input noise current of smaller than 5 fA at an input impedance of 1 GΩ parallel to approx. 100 pF (stated for a noise bandwidth of 1 Hz at a measuring frequency of 1 kHz).

### Economic significance

This procedure can be used for the measurement of smallest AC voltages, as is necessary, e.g., when calibrating impedances with quantum Hall resistors. In addition, this method leads to clearly improved results particularly in fields where smallest measurement signals have to be detected in noise. The procedure is therefore of special interest for research & development.

Application possibilities are also found at national metrology institutes which transfer their measurement results and calibration values to industry.

### Development status

First prototypes of the ultra-low-noise preamplifier are being successfully used at PTB and demonstrate the reliability and accuracy of the novel circuit concept.

Licences for the utilization of the new system are available.