Zeroing procedure of 20024 nano-ohmmeter

The purpose of this brief note is to provide a procedure for the best possible zeroing of the causes of offset of the 20024 nano-ohmmeter.

The instrument has the ranges from 320Ω to 32μΩ. The ranges from 320Ω to 3200μΩ have the ability to perform measurements with two different currents: the current "high" provide a resolution of 1μV, while the current "low" provide a resolution of 0,1μV.

The advantage of a high current is to have a resolution in voltage hardly influenced by environmental disturbances and measurement system, such as: the offset of the amplifier, the potential of contact and electromagnetic noise. The disadvantage is a higher dissipation by the Joule effect on what is being measured, in particular on the ranges of 32mΩ and 3200μΩ where there are, respectively, measuring currents of 1A and 10A.

On ranges from 320Ω to 3200μΩ, even with the current "low", the result of the measurement due to the effects or disturbances mentioned above generally does not exceed ± 2÷4 digits, even when you have a slight warming inside the instrument due to the high current supplied.

The range of 320μΩ fall into this category since the measurement current of 10A generates a voltage resolution of 0,1μV.

The range certainly more critical is that of 32μΩ that provide a resolution of only 10nV. With these signal levels is essential to pay attention to any cause of disturbance of the measure in order to minimize the effect. These causes are of two types: internal and external to the instrument and are summarized in the following two tables.

Although always present, these disorders manifest themselves in an absolutely dominant on the lower range. While static noise can be easily eliminated with a zeroing, the presence of noise variables is most annoying and difficult to eliminate.

In chapter **TIPS ON THE MEASUREMENT EXECUTION** of the manual of the instrument are detailed noises, causes and remedies to be taken to eliminate or reduce the negative influences.

Causes internal to the instrument	
Noise	**Possible causes and remedies**
Offset drift of the measuring amplifier *(It appears as an increase or decrease to an asymptotic value for a period of 5 to 10 minutes and amplitude up to 200 ÷ 400nV, corresponding to 20 to 40 digits on the range of 32μΩ)*	The drift of the amplifier is essentially caused by the heating of the components of the same amplifier for temperature variations inside the instrument caused both by internal dissipation (when using a measuring current of 10A) that for changes in ambient temperature of the place where the nano-ohmmeter is located. - It is recommended to start performing measurements on the range of 32μΩ at least 5 to 10 minutes after switching on the instrument. - If the type of measurement permits, is best to wait the adjustment internal temperature due to the 10A measurement current. This will take about 10 minutes.Working with the battery reduces the internal dissipation. - Avoid placing the instrument in the vicinity of air currents of any kind, including fans, air conditioners, windows and doors, movement of people. It is not advisable to place the instrument in a thermostated room because you can have continuous slow temperature oscillations.
Fluctuation due to the connection to the mains voltage *(It appears as an regular fluctuation of the period between a few seconds and the minute with amplitude of a few tens of nanovolt)*	The fluctuation is due to the fact that the measure is not synchronous with the mains frequency. - You can disconnect the instrument from the mains by running it with only the internal battery. To avoid excessive discharge of the battery it is recommended to disconnect the instrument from the mains, for example via a switch or a relay, only when it is necessary to perform the measurement. - Sometimes it might be useful to also disconnect the ground connection (in addition to the power grid), while other times you'll get better results by keeping the ground connection or by using the yellow bushing on the back of the instrument by connecting to a ground point less noisy.

Causes external to the instrument	
Noise	**Possible causes and remedies**
Drift due to temperature variations *(It appears as an increase or decrease to an asymptotic value of duration not defined and of amplitude also of many hundreds of nanovolt, corresponding to several tens of digits on the range of 32µΩ)*	The drift is largely caused by changes in the contact potential along the threads of tension in response to changes in temperature due to: changes in ambient temperature, to having touched bushing, plugs or leads, presence of air currents, variation in insolation along the threads of tension. - It is recommended to place the instrument and the device under test in an isolated area where there are no changes in ambient temperature due to fans , air conditioners, windows and doors, movement of people. - Avoid unnecessarily touching bushes, plugs and voltage probes, waiting for 3 to 5 minutes before taking a measurement after having touched them. In this way one has the thermal settling of potential contact which can have measurable variations with temperature excursions of a few thousandths of a degree Celsius. - Thoroughly clean the area where the voltage probes touch the device to be measured. - Avoid moving the voltage probes after they have been placed because in different places they have different potentials.
Fluctuation due to magnetic fields *(It appears as a random fluctuation of period between the second and few second with an amplitude up to a few hundred nanovolts, corresponding to a few tens of digits on the range of 32µΩ)*	The fluctuation is due to the presence of magnetic fields of variable frequency between about one hertz and the hundred hertz. - It is recommended to keep short the wires of the voltage and current and that are not wobbly or vibrate even in proximity to static magnetic fields. - It is advisable to twist the wires of tension such as for telephone cables in order to reduce the electromagnetic coupling.

In addition to the presence of noise the measurement can be affected by an offset error due to a not adeguate reset procedure. The reason is to be found in the amplifier that is able to only partially compensate the variation of the voltage drop along the wires of the current between the measurements and the Auto-zeroing. Although the measuring amplifier presents an excellent CMMR, must be considered that the resolution in voltage on the range of 32µΩ is 10nV and that the variation of voltage drop on the wires of the current can exceed 500mV each, or 50 million times greater than the resolution of the measurement.

On high-current measures such ratio drops to 500 thousand, and is not a problem . On the low-current measurements, where the resolution in voltage is 0,1µV and the ratio grows to 5 million, offset residue can be ± 1÷5 digits. Shorter and of greater section are the wires of measurement current and the lower the residual offset. Wire of 50-60 cm in length with 6 mm2 of section are a good compromise between ease of use and reduction of offset residue, which in this case hardly exceeds ± 1 digit due to a small change of voltage drop of about 20mV.

On range of 32µΩ may be insufficient. To greatly reduce the residual offset is necessary to reproduce outside the auto-zeroing circuit built into the instrument.

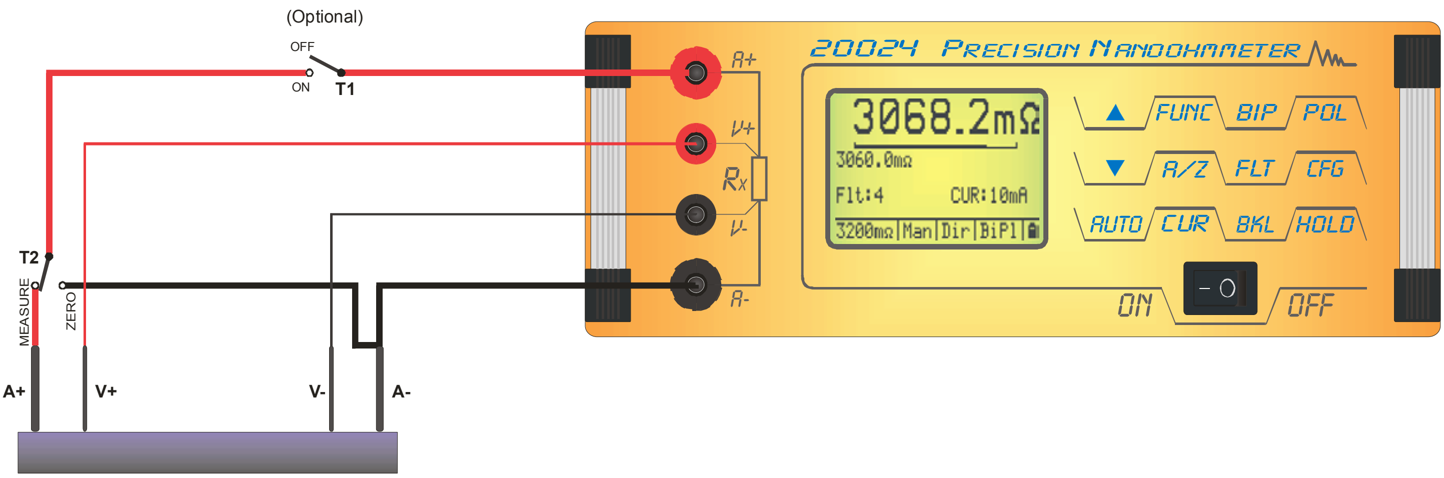
Referring to the next picture you can see that, given the **T1** switch in the *ON* position, the measurement is carried out regularly when the switch **T2** is placed in the *MEASURE* position. Moving the switch in the *ZERO* position the measuring current is diverted from **A+** bushing to **A-** bushing without passing through the device, but going anyway for the electrical wiring. In particular, the voltage drop on the wire negative current remains the same as when the measurement is taken. By carefully analyzing the circuit can in fact verify that the contact resistance of the switch and the resistance of the connection between the switch and the probe **A-** not intervene in the determination of the voltage drop on the wire that connects the bushing **A-** with the probe **A-**.

This external circuit realizes exactly what is proposed in the manual of the instrument in Figure 2 on page 7 to perform the compensation of the voltage drop on the wires of the current, but without having to manually move the wire positive current on the negative probe. A diverter, or better a relay, make automatable this procedure.

The advantage of the addition of the switch **T2** is to substantially reduce to zero the residual offset regardless of the length and the section of the wires of the current. The length is good to be the minimum possible with the section that in any case must not be less than 2,5mm^2. The essential point is that the voltage drop at the terminals of each of the two leads of current remains contained within 500mV.

The function of **T1** is to be able to shut off the current when you do not perform any measurement, reducing the dissipation inside the instrument and increasing the autonomy of battery. A typical case is when you are waiting the adjustment of contact potential after you have moved (heating them for having touched them) the tension probes.

Obviously it is also possible to leave the switch **T1** closed in the *ON* position, waiting at the same time the adjustment of the contact potential that the internal heating of the instrument. Everything depends on the procedure that you want to follow.



One possible procedure is listed in the table below, but there may be variations depending on the specific measurement needs.

Possible reset procedure by offsetting the drop in voltage on leads current	
Action	**Purpose**
Select the filter value by pressing the FLT button	On the two below ranges the minimum filter selectable is 8. The higher the value of the filter, the greater is the stability of the measurement, but is slower the update of the measurement itself.
Close the switch T1 (optional) placing it in the ON position	Allows the supply of the measurement current.
Place the switch T2 in the ZERO position	Allows to perform the compensation of the voltage drop on the wires current.
	Possibility a) a) If you have a need for a fast measurement, albeit with a slightly less accurate zeroing, it is possible to exploit the thermal inertia, so as not to give rise to a sufficient heat propagation. You can then move on to the next step as soon as the measurement is sufficiently stable. Possibility b) a) If you need maximum precision in the zeroing and is required a continuos measurement, is need to wait the final settling of the reading. This wait can take between 5 and 10 minutes.
Press the A/Z button for more than one second, until you hear the second beep *(the first is emitted as soon as the button is pressed)*	Reset the measure saving the detected value in the non-volatile memory of the instrument. This includes resetting of offset of the amplifier and of the contact potential. For more information, see the manual of the instrument under **A /Z - Zeroing procedure** on page 7 and 8 of chapter **DEFINITION BUTTONS AND INPUTS**
Place the switch T2 in the MEASURE position	Allows the normal execution of the measurement.
Open the switch T1 (optional) placing it in the OFF position	Allows the interruption of the measurement current. Alternatively, you can select the range of 3200mΩ or more, which has a small measurement current.