T4200

Precision thermometer for laboratory and quality assurance

- **uncertainty ±0,005°C**
- **resolution: 0,001°C**
- **range: -200°C up to +962°C**
- **excellent long-term stability**
- **2 channels (up to 81 with MUX)**
- **display of both measuring channels**
- **measuring current only about 0.5mA for lowest heating-up of sensor**
- **fast measuring: up to 10/sec**
- **serial interface as standard**
- **4-conductor-technology, Lemo-plugs**
- **highly interference-proof**
- **comfortable input and highest safety of sensor data**
- **controllable from your PC**

The T4200 is designed for precise temperature measurements as demanded in laboratory use and quality assurance (ISO 9000 etc.).

Mode of operation

All temperature measurements by means of resistive sensors (RTD) consist of two steps which is due to its principle. In the first step the resistance value of the temperature sensitive sensor is taken. In the second step the measured temperature value must be calculated from the sensor´s resistance value.

Measuring of resistance

Apart from a sufficient accuracy a temperature measuring device should offer the interchangeability of sensors without calibrating the respective sensor with the measuring instrument. For this purpose it is necessary that the measuring of resistance occurs with a sufficiently small inaccuracy. The inaccuracy in the measuring of resistance is mainly determined by the reproducible resolution as well as by the linearity of the measurement and the accuracy of the reference element.
In the T4200 the high resolution and the excellent linearity are ensured by a analog/digital-converter which was developed especially for this instrument. The measuring of resistance is done with the help of switched direct currents. Thus the effects of thermoelectric voltage on the measured values are avoided without ending up with the problems concerning parasitic capacity and inductances which are typical of many AC-based devices. A hermetically sealed precision resistor integrated into the T4200 is used as a reference element. Doing so it is guaranteed that the measuring of resistance is ensured even without an external resistance-normal with an accuracy of up to ±0,0005 per cent.

Determination of the temperature value

The conversion of the measured resistance into a temperature value makes completely different demands on the measuring instrument than the measuring of resistance. Accuracy is of immediate importance for resistance measurements, whereas determining the appropriate temperature value often requires an input of sensor specific coefficients and thus has to be as user-friendly as possible. Additionally it has to be ensured that those sensor coefficients which have been set by the operator are not inadvertently deleted or changed.
In the T4200 the coefficients of standard sensors according to EN 60751 and ITS 90 are set by the manufacturer. In case other sensor coefficients have to be put in both data security and user-friendliness are most important. The key-controlled input of sensor specific coefficients (up to 12 coefficients for ITS 90-sensors) often proves to be quite laborious. Apart from that – in doing so - only a limited data security can be guaranteed. No matter whether the sensor coefficients or the value couples follow DIN or ITS 90, the resistance value for about 0° C usually must be put in, which is around 100 ohms for Pt-100 sensors. If, for example, it is only possible to put in this value with a resolution of 1.0 mohms, this leads to inaccuracies of up to 10 mK at a measured temperature of about 800° C. On top of that one has to add mistakes in digitization and linearity as well as mistakes of the reference resistor. For these reasons sensor specific coefficients for the T4200 are established with the help of easy-to-use software on the PC. Doing so automatically plausibility checks are carried out to avoid almost any mistakes. Afterwards the sensor data is transmitted from the PC into the T4200. As in any precison multichannel thermometer in the T4200 the sensor coefficients have to be assigned to the appropriate channels. In the T4200 this assignment is conveniently carried out with short user-defined descriptions of the sensors. The T4200 is able to store up to 21 (optionally up to 81) different sets of coeffients, a fact which has two substantial advantages: if multiplexers are used, the appropriate sensor coefficients can be assigned to each measuring channel. And apart from that it is likely that in many cases there are no more than 21 precision sensors, so that coefficients have to be added only when a new RTD is used for the first time. In case the coefficients of a sensor have been stored in the T4200 at an earlier time, they do not have to be put in again, but can be selected

with the help of the user-defined descriptions. Even if more than 21 (optionally 81) sensors are in use, new sensor coefficients don't have to be put in when changing over from one sensor to another which has been used before, they only need to be transmitted again from the PC. Thus special coefficients of new precision sensors only have to be put in once by the user. The user may not have to put in any sensor coefficients at all if he is provided with the appropriate calibration data by the sensors' manufacturer on disk. In this way the T4200 offers a maximum of user-friendliness and data security.

Operation with external multiplexers

For the T4200 multiplexers are available with eight or 16 channels. The multiplexers are controlled by the T4200. Up to five multiplexers can be cascade-connected, so that a maximum of 81 measuring channels can be realized with an T4200. The connection of the temperature sensors is done with the same robust Lemo-plugs as in the T4200.

Fast temperature measurements

In particular when using multiplexers the measuring time should be kept at a minimum. With a lot of self-adjusting measuring bridges this demand can be fulfilled only imperfectly. Operated with full accuracy the T4200 achieves a measuring time of 1 sec. If operated with a reduced accuracy about 10 measurements per second are typical.

Self-heating of the sensor

Especially for the evaluation of precision sensors it has to be ensured that the measuring current doesn't heat up the sensor too much. Here it has to be noted that for example a doubling of the current leads to a fourfold rise in temperature of the sensor. An ignorable self-heating of the sensor is achieved by a measuring current of only 0.5 mA in the T4200.

Ability to re-apply national standards

For any precision thermometer comparisons with national standards are necessary because of the ageing of the reference element. Many measuring bridges use step by step comparative measuring methods. During this procedure every single comparison step should normally be checked. The T4200 uses an integrating conversion method. As monotony is inherent in this procedure, a one-point-calibration is usually sufficient to re-apply national standards. After a few years the linearity can simply be ensured by measuring a second normal.

Less errors with switched current

In any measuring system thermoelectric voltages are to be found due to the Seebeck effect. Here we are talking of direct voltages. In the T4200 switched currents are used, which is why the thermoelectric voltages have no effect on the measured values. Thus no compensation is necessary.

Highly interference proof

A metal cabinet and the high-quality sensor connectors as well as an optimized PCB provide a very good suppression of disturbance. In the T4200 in contrast to many other measuring devices hum voltages are effectively suppressed even if the mains frequency diverges from its nominal value.

Measuring uncertainty and accuracy

According to DIN 1319 the divergence of a measured value from the actual value is determined with the help of the “measuring uncertainty“. The term "accuracy" only describes a qualitative expression. In case that only an accuracy is given for a measuring instrument, other errors as for example that of an external or internal reference resistance can crop up as well. For the T4200 measuring uncertainties are given to form a reliable basis for determining measuring errors.

Technical data

The following specifications are only valid for a nominal operating voltage and an environmental temperature of 23°C.

Measuring range:	-200°C up to 962°C (according to ITS-90) -200°C up to 850°C (according to DIN EN60751)
Resolution:	1 mK
Measuring uncertainty:	10 mK (optionally 5mK in the range of -50°C up to 250°C)
Measuring channels:	2 (optionally up to 81 with external multiplexers)
Sensors:	Pt-100 (optionally Pt-25) in a four-conductor-technology
Connectors:	Lemo 1S, quadripolar, in front panel
Measuring current:	about 0.5 mA switched DC (about 1 mA for Pt-25)
Measuring time:	about 1 sec. per channel, about 0,1 sec. per channel with reduced resolution
Long-term stability:	≤ 5 mK/year
Temperature coeff.:	≤ 1 mK/°C
Display:	LCD, LED backligth, 2 lines à 16 characters, 9mm height
Units:	°C, °F, K, ohm
Interface:	RS-232, isolated
Operation:	menu orientated, alternatively controllable by your PC
Memory:	128 KB (optionally 512 KB)
Supply:	230 V, 50 Hz / 115 V, 60 Hz about 15 VA
Size:	260 x 80 x 240 (width x height x depth in mm)
Weight:	about 2.5 kg

Available accessories

- external multiplexers with 8 or 16 channels (up to 5 switches may be cascade-connected)
- PC software for operation of instrument and measuring data acquisition
- temperature sensors