

Measuring correctly.
Determining air and product
temperatures of food accurately.



Focus on **product quality**.

Food safety and food quality are two of the most important keywords in terms of food processing and distribution. The term food safety mainly refers to the requirements (including those made by legislators) for the protection of consumers against any harm to their health, while the term food quality rather covers the requirements and definition of the customer. Product quality is a perceptible customer benefit, and awakens the desire to purchase the product again. However, it is difficult to make a clear distinction between the concepts, because various points are to be found in both areas. The term food quality will also often be used below as an umbrella term for food quality and safety.

Food producers and the food trade have the task of protecting consumers against harm or damage to their health and of guaranteeing the safety of foods. The sale of foods which are not marketable, qualitatively compromised or unsafe can result in serious damage to the image of the affected companies.

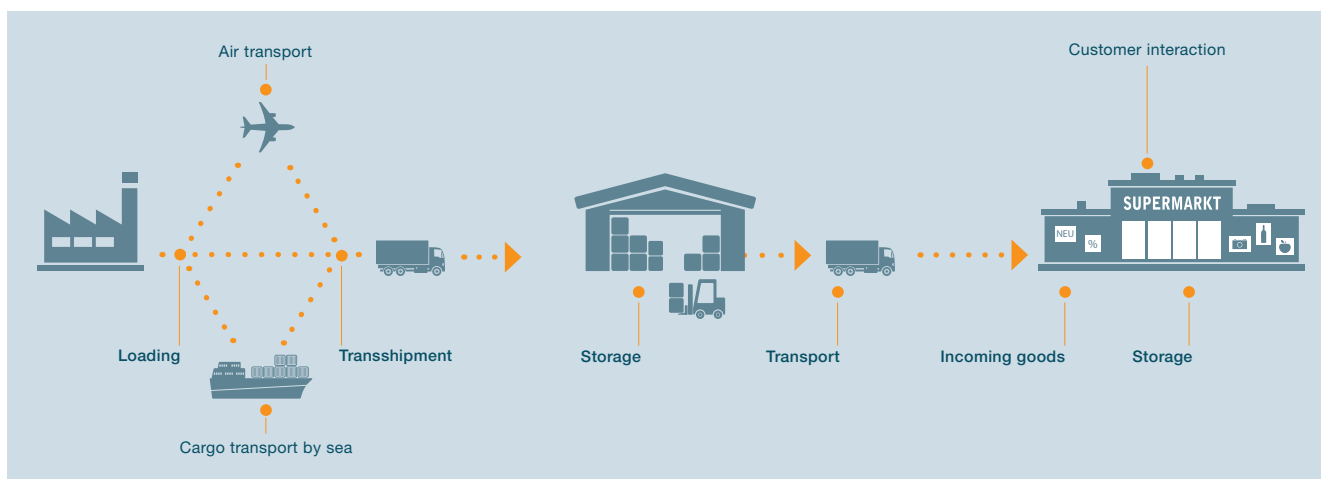
According to the 178/2002 basic regulation, “marketability” means that foods are

- not injurious to health and
- fit for human consumption.

Products which are not deemed to be perfect are for example ones which are not spoiled and are still edible, but do not meet the required standard in terms of their appearance. This may be a lettuce which has become limp and no longer looks appetizing to the purchaser.

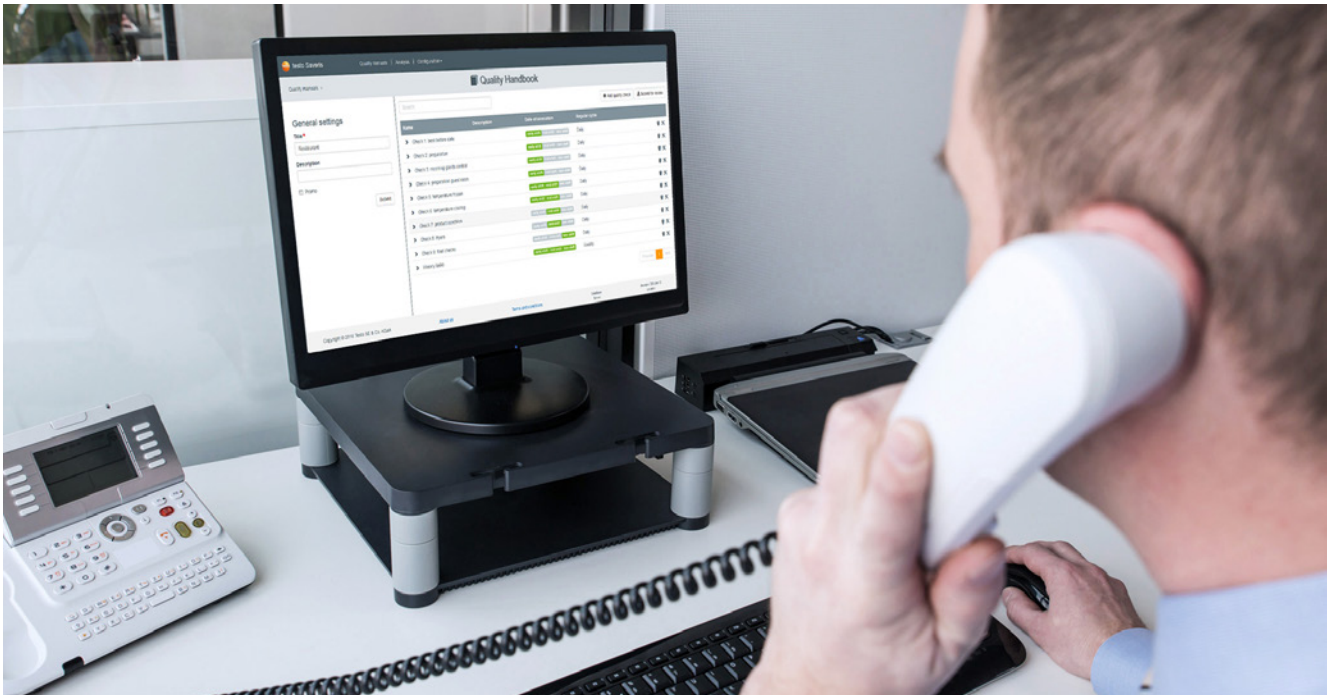
Foods are no longer safe, when they are for instance spoiled. This can lead to nausea, diarrhoea, etc. in the consumer.

Because the quality and safety of foods can be negatively affected by the wrong temperature, monitoring the temperature of products which are subject to the cold chain is a central building block in assuring the required quality and marketability.



From Farm to Fork: the critical points for food quality and safety.

Traceability: crucial in the event of a claim.



Foods run through various processing stages on the way from being raw products to becoming goods that are ready for sale. This creates a chain from producers through to processors and dealers. For example, if spoiled foods get onto supermarket shelves, the question of responsibility arises: **who is liable in the event of a claim?**

According to the principle of due diligence, all food businesses bear the responsibility for meeting the requirements of the food safety laws themselves.

One crucial legal obligation is the assurance of traceability. This must be guaranteed at every stage of the entire food chain (from the producer to the consumer and vice versa). If refrigeration of the product in production, storage, transport and/or sale is crucial to the quality or safety of the food, it must be provable that the right temperature, and thus compulsory refrigeration, has been adhered to here as well.

Temperature measurements for an uninterrupted cold chain.

For companies in the food sector, checking the correct temperature all along the cold chain is one of the basic measures for assuring quality and guaranteeing compliance with legal and internal standards. Because temperature fluctuations are often the cause of spoiling or impaired quality when it comes to food.

In the case of foods which cannot be stored at room temperature without potential problems, the cold chain must not be interrupted. Most products pass through many different hands on their way to the end consumer – in transport, temporary storage facilities and distribution centres. When products are handed over to another logistics service provider or to a distribution centre, the responsibility for food quality and food safety also changes again and again all along the cold chain. Failure to comply with the cold chain can lead to damage to corporate image and thus losses in turnover for the company. Temperature control therefore serves to ensure the safety and marketability of foods which are subject to the cold chain. In addition to the legal requirements and temperature limit values which are binding during the production, transport, storage and sale of foods, various temperature terms are used: **storage temperature, product temperature, air temperature, core temperature and surface temperature.**

What are the differences between these types of temperatures and how significant are they in terms of product quality? Furthermore: what measurement methods are there and which of them are best suited for monitoring food temperature? We would like to examine and clarify these questions in greater detail below.

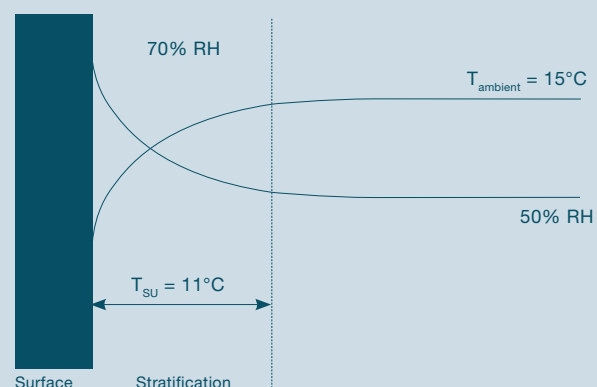
Measuring in rooms: the challenge of stratification

Measurements taken inside a room may be distorted by what is known as stratification around surfaces. The risk of stratification arises if the surface temperature differs a great deal from the air temperature.

To avoid measurement errors of this kind, a minimum distance from surfaces should be adhered to. This minimum distance has been reached when no further changes in the readings occur in spite of the distance being altered. The measuring location for every measurement should therefore be chosen with care and an appropriate measuring distance adhered to.

This also applies to conditioned air inlets from heating or refrigerating equipment. This kind of stratification can also occur in static air between the floor and ceiling, for example in big store rooms. Control measurements should therefore be taken at the points which have been found to be representative from a survey of the indoor climate.

Permanent probes at various locations are usual in refrigerated rooms.



Humidity and temperature behaviour on surfaces.

% RH = relative humidity, T_{ambient} = ambient temperature, T_{SU} = surface temperature

Air and product temperature: what really is the difference?

Foods that have to be refrigerated are cooled in refrigeration facilities, such as freezer rooms, by a flow of cold air.

In terms of temperature control, a distinction needs to be made between the following types of temperature: the **air temperature** indicates how cold the air in the refrigeration facility is. The temperature of the cold air enables us to conclude that the refrigeration facility is achieving the correct cooling capacity. However, the air temperature which is determined cannot be equated with the so-called **product temperature**. The product temperature is predominantly determined by the air temperature.

However, the reaction to fluctuations in the air temperature is dependent on the type of food or packaging or on the condition or degree of processing (pre-cooked, raw, frozen) of the food. The product temperature of a completely frozen chicken is relatively constant, even when there are considerable fluctuations in the air temperature, whereas the temperature of 100 g of fresh minced meat adjusts significantly more quickly to the change in air temperature. This means that the actual product temperature may differ from the air temperature within the refrigeration facility.

Negative influencing factors (e.g. the radiant heat of the refrigeration unit, frequent door opening or loading errors) cause increased **cold air temperatures**, often not noticed by staff. Temperature probes and displays permanently installed by the manufacturer of the refrigeration unit can nevertheless indicate air temperatures within the specified limit values, because the temperature probes are placed in

the air outlet area (that is in the cold areas of the refrigeration facility). This means it is particularly important to take the different **temperature zones** within a refrigeration facility into account when measuring. If this is not done, the air temperature measured and documented by the installed probes is not really correct.

The **product temperature** is the temperature of the product and can be determined either as a surface or core temperature. It is measured on the surface (**surface temperature**) or in the core (**core temperature**) of the food. The product temperature is a crucial factor in terms of compliance with product-specific characteristics through to the expiry of the best before or use by dates.

Two measuring methods: spot check or recording

In terms of temperature control, we differentiate between two types of monitoring:

1. Spot check measurement

Is carried out with portable (mobile) temperature measuring instruments, which are either pure measuring instruments (which merely display the measurement value), or storage thermometers which save the measured data in an internal memory or send them to a data store wirelessly.

2. Continuous data recording

This involves a measuring instrument with a memory remaining with the goods (or in their proximity, e.g. the refrigerated room) and recording and storing values at regular intervals (measuring intervals). Depending on the type of data logger, the data are either stored in an internal memory and read out manually or sent to a data store wirelessly.

Portable measuring instruments: which one meets your needs?

Portable temperature measuring instruments are available in various designs and with different probes.

1 Instruments with a fixed probe



- Particularly suitable for recurring measuring tasks
- Example: core temperature measurement of refrigerated foods, e.g. brined cheese

2 Instruments with a folding mechanism



- Popular design in which the measuring tip is directly attached to the instrument and can be “folded away” to save space
- Example: core temperature measurement of fresh products in refrigerated displays

3 Instruments with exchangeable probes



- Particularly suitable for varied measuring tasks
- Examples: measurement of the air temperature in refrigerated rooms with an air probe, of the core temperature of refrigerated meat or between deep-frozen packages in Incoming Goods

Non-contact measurement: what do I need to keep in mind?

There are instruments which measure the temperature without direct contact with the food: **infrared measuring instruments**. They are suitable for obtaining a rapid overview of the temperature of the products.

This so-called non-destructive measurement enables the temperature to be determined without the instrument coming into contact with the product.

1 The measuring instrument

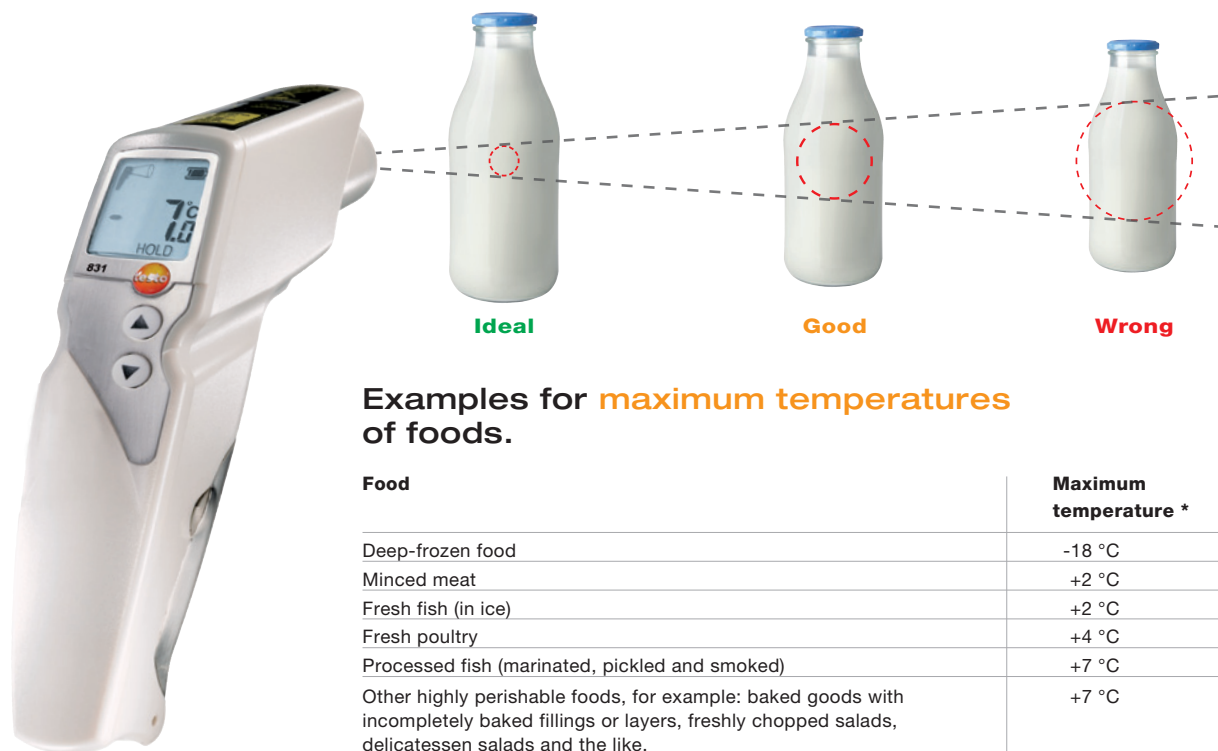
- **Measure with a clean lens.**
Dirty and fogged lenses (e.g. due to water vapour) can falsify the measurement result.
- **Acclimatize the measuring instrument to the ambient temperature.**
Either store the measuring instrument where it is used, or wait until the temperature of the measuring instrument has acclimatized to that of the measurement location. If the instrument temperature does not correspond to the ambient temperature, this can falsify the measurement result.

2 The measurement surface

- **Measure clean surfaces.**
Dirt, dust and frost can falsify the measurement result.
- **Measure packaged foods at points where the product and the packaging are in direct contact.**
Air pockets can falsify the measurement result.

3 The measuring distance

- **The closer the better.**
This ensures that only the measurement object is measured, and not its surroundings too.



Measuring distance for infrared measurement.

Examples for maximum temperatures of foods.

Food	Maximum temperature *
Deep-frozen food	-18 °C
Minced meat	+2 °C
Fresh fish (in ice)	+2 °C
Fresh poultry	+4 °C
Processed fish (marinated, pickled and smoked)	+7 °C
Other highly perishable foods, for example: baked goods with incompletely baked fillings or layers, freshly chopped salads, delicatessen salads and the like.	+7 °C
Pasteurized milk	+8 °C
Butter, cream cheese, soft cheese	+10 °C

* acc. to DIN 10508

Ideal for continuous recording of measuring values: mobile or stationary data loggers.

Data loggers are instruments for continuous data recording which store measured data in an internal memory or send them wirelessly to a storage unit.

1 Mobile data loggers



- Mobile data loggers for accompanying goods: measurement in the products' immediate vicinity
- No direct contact with the goods: placement of the data logger for example in the package or between individual packaging items

Important: data loggers for refrigerated and deep-frozen foods must comply with the EN 12830 standard in the EU.

2 Stationary data loggers



- Stationary data loggers: placement for example in the refrigerated area of a vehicle, in a transport box or in the storage room
- Measurement of the air temperature via the internal probe or with an external probe
- Wide selection of external probes for determining air and product temperature

When using handheld measuring instruments: how do I measure correctly?

The most accurate measurement is always a **core temperature measurement**, i.e. a penetration probe measures the temperature in the interior of the refrigerated goods. However, this means damaging the packaging for many products. In order to avoid this, a **three-stage process** has been established in practice:

1. Firstly, the surface, for instance of yoghurt pots, is scanned using an infrared measuring instrument to get a quick overview of the temperature of the products. If the temperature is clearly within the “green range”, the test is finished. Example: the yoghurt pots have a temperature of +5°C (target: max. +8°C).
2. Is the temperature of some yoghurt pots over +8°C? Then a contact probe is inserted between two yoghurt pots and a measurement taken. This measurement also enables non-destructive temperature checking.
3. Is the temperature still too high? Then a penetration measurement is finally carried out on one or more pots. The probe is inserted through the lid into the foodstuff and thus measures the correct core temperature.

In order to carry out this three-stage process quickly with one temperature measuring instrument, it is best to use a combination instrument that has both an infrared and a penetration probe, e.g. the **testo 104-IR**. You will find more information about this at:

www.testo.com/de-DE/testo-104-ir/p/0560-1040.



Determining the product temperature with handheld measuring instruments.

What else you should keep in mind for measuring instruments

1. Measuring instruments which are used to determine the temperature of foods must be calibrated regularly. A recalibration is recommended when there are larger discrepancies. **Calibration** means comparing the measuring instrument with a reference instrument which is traceable to a national standard. There are special service providers for this, such as Testo Industrial Services GmbH. You can find out more at <http://www.testo-industrial-services.de/services/language=de/408/calibration>
2. In addition to the directives and regulations for food producers, suppliers and retailers, there are also stipulations for **measuring instrument manufacturers** which precisely regulate the technical characteristics or minimum requirements for measuring instruments and data loggers. This is necessary in order to achieve standardized regulations regarding discrepancies in measurements, recording periods, protection against dirt and water, etc. Users should make sure that their instruments comply with the relevant **standards** (e.g. DIN EN 12830, EN ISO 13485, DIN EN 13486) and that what is known as a **type test (approval)** has been carried out by the manufacturer.

When using data loggers: what is it best to measure and where?

1 (Deep) freezers



It is above all the air temperature which is checked in freezers and deep freezers. If these are controlled using spot check measurement, this should be determined using a suitable air probe, preferably in the vicinity of the air recirculation. This is where the air is warmest in the (deep) freezer. If the appropriate temperature is measured here, the freezer can be assumed to be working properly. In order to check whether the cooling capacity is sufficient and to ensure the correct product temperature, a further check of the surface temperature of the refrigerated goods is recommended using an infrared thermometer. The use of data loggers with several input channels is recommended for the long-term temperature monitoring of (deep) freezers: one probe measures the air temperature at ground level, another at the maximum load line and a third at the air recirculation.

2 Refrigerated or deep-freeze rooms



Long-term temperature monitoring is obligatory for all refrigerated and deep-freeze storage areas which are larger than 10 m³. A data logger can be used for this. A suitable measuring interval is 15 minutes (e.g. according to EN 12830). The optimum temperature range for the relevant area can be monitored by means of limit values. Depending on the design of the data logger, the stored temperature data can then be read out either manually or automatically.

WiFi data loggers minimize the manual effort involved in temperature monitoring. These automatically send the measured data to a data store where they can then be easily accessed via PC, tablet and smartphone. Where there are violations of limit values, there is also an alarm notification to enable corrective action to be taken as quickly as possible. Temperature mapping is recommended to ensure optimum placement of the data loggers at the critical points of the refrigerated rooms and store rooms. There are special service providers for this as well.

More information at www.testo.com

If you want to find out more about correct measurement in the food sector, then please contact **A.N. Other**, another@testo.com, +49 123 456789. **We will be happy to help you!**

About us: introducing Testo.

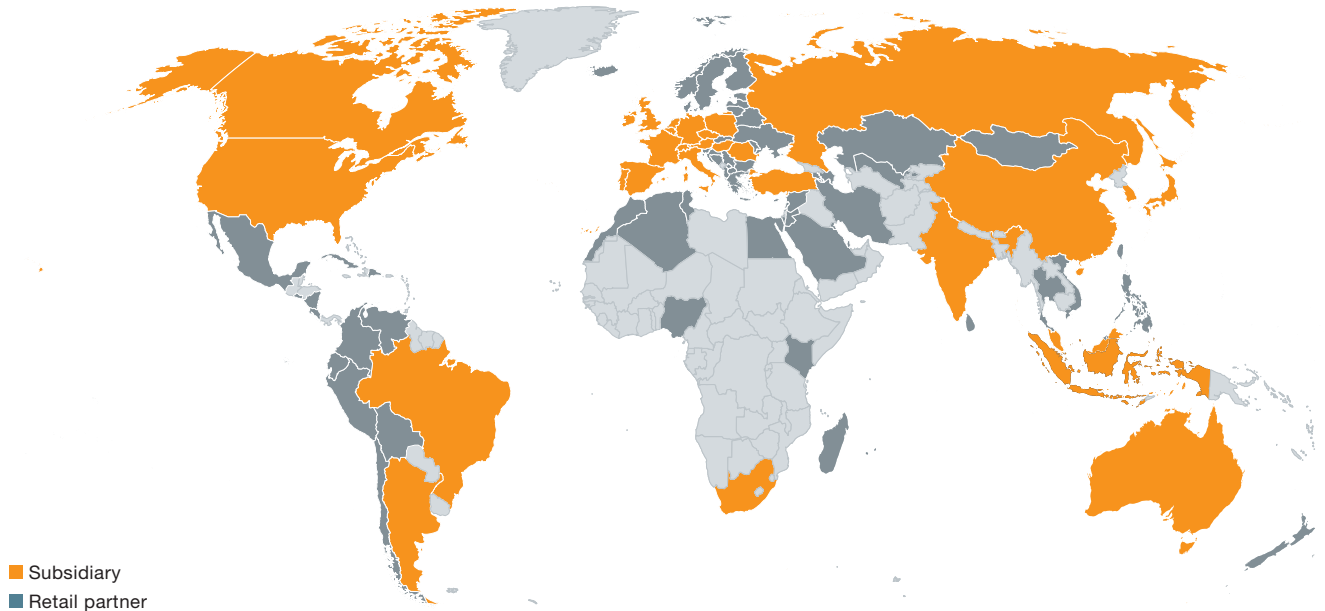


Testo, with its headquarters in Lenzkirch in the Black Forest, is a world market leader in the field of portable and stationary measurement solutions. There are 2,700 employees involved in research, development, production and marketing for the high-tech company in 33 subsidiary companies all around the world. Customers all over the world are impressed by the measuring technology expert's high-precision measuring instruments and innovative solutions for the measurement data management of the future. Testo products help save time and resources, protect the environment and human health and improve the quality of goods and services.

An average annual growth of over 10 percent since the company's foundation in 1957 and a current turnover of more than a quarter of a billion euros clearly demonstrate that the Black Forest and high-tech systems are a perfect match. The above-average investments in the future of the company are also a part of Testo's recipe for success. Testo invests about a tenth of annual global turnover in research and development.

More information at www.testo.com

60 years of success in the field of measuring technology: a global company with roots in the Black Forest.



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Subject to change, including technical modifications.