Laboratory technical sales manual

LIEBHERR

LKPv and LGPv laboratory appliances with Profi-Controller

Alarm, memory and safety functions
Temperature, door-open and power failure alarms
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Description of the NF X 15-140 test procedure
Results according to NF X 15-140

LK(U)v, LCv, LK(U)exv, LG(U)ex and LGT laboratory appliances with Comfort-Controller

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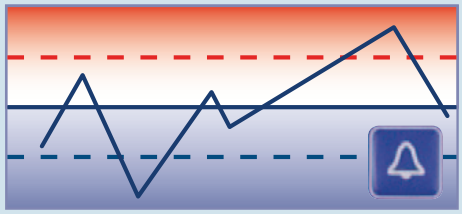
Alarm, memory and safety functions

Liebherr Mediline refrigerators and freezers with Profi-Controller help to protect your inventory. These cabinets offer a variety of alarm, memory and safety features designed to greatly reduce the risk of loss of contents.

Temperature, door-open and power failure alarms

High and low temperature alarms

All LKPv and LGPv modells have integrated high and low internal air temperature alarms with both audio and visual signals. The factory settings for the alarm limits are + 3 /– 2 K in relation to the set temperature. If the set temperature is altered to meet a specific storage temperature requirement then the alarm settings move in parallel and do not need to be adjusted separately. There is a 30 minute delay to avoid unwanted alarms due to e.g. door opening.



Door-open alarm

All LKPv and LGPv modells register when doors are left open or ajar and have an integrated audio and visual door-open alarm. This alarm has a 1 minute delay which can be adjusted.

Power failure alarm

All LKPv and LGPv modells have a battery back-up which operates an audio and visual alarm immediately upon power failure. Both the integrated temperature data logger and the optional external temperature monitoring via the RS 485 interface continue to function during power failure for up to 72 hrs.

Internal system alarms

The following alarms are related to internal self-checks of the refrigeration system and the electronic controller probes. While these might not be immediately relevant to the everyday operation of the cabinets they do provide added security by warning probably before the air temperature probe registers an alarm condition. They also provide a service engineer with valuable information thus allowing quicker intervention.

High condenser temperature alarm

This integrated audio and visual alarm warns of excessive condenser temperatures possibly caused by e.g. high ambient temperatures or blocked air-flow to or from the refrigeration system.

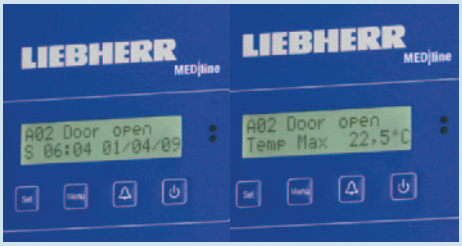
Low evaporator temperature alarm

This integrated audio and visual alarm warns of low evaporator temperatures possibly caused by e.g. defective air-circulation fan or blocked internal air-flow. This alarm will possibly warn much sooner than the high or low temperature alarm.

Probe failure alarm

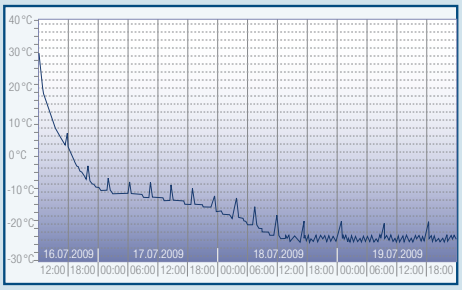
As a self-control system, defective probes are registered and the controller cause an audio and visual alarm signal. In case of an air-probe error the controller has pre-defined operating modes to maintain the internal temperature at + 5 °C.

Internal memory functions



Internal alarm memory

This function stores to memory details of the last 30 alarms: time and date of the start and the end of the alarm condition, the type of the alarm condition and the maximum and minimum internal air temperatures measured during this alarm condition period are registered.



Internal temperature memory

This function stores to the memory the internal temperature profile at 4-minute intervals. 2800 temperature logs are stored to memory, which corresponds to approximately a 7-day logging period.

Special safety functions

Solid-state relay for maximum reliability

The LKPv and LGPv models all have a solid-state relay guaranteed to > 1 billion compressor start cycles. As well as allowing very accurate temperature control this feature practically excludes the possibility of burnt relay contacts as a cause for extreme internal temperatures.

Double fan cooling

All LKPv and LGPv modells have a double internal fan arrangement so that in case of one defective fan the cooling system continues to function at reduced capacity. The highly reliable fans Liebherr uses are guaranteed to 80 000 hrs operating time.

Temperature and alarm documentation

Liebherr Mediline refrigerators and freezers with Profi-Controller help to protect your inventory. These cabinets offer a variety of features and options designed both for external monitoring of the internal temperatures, the product temperatures and alarm conditions to greatly reduce the risk of loss of contents.

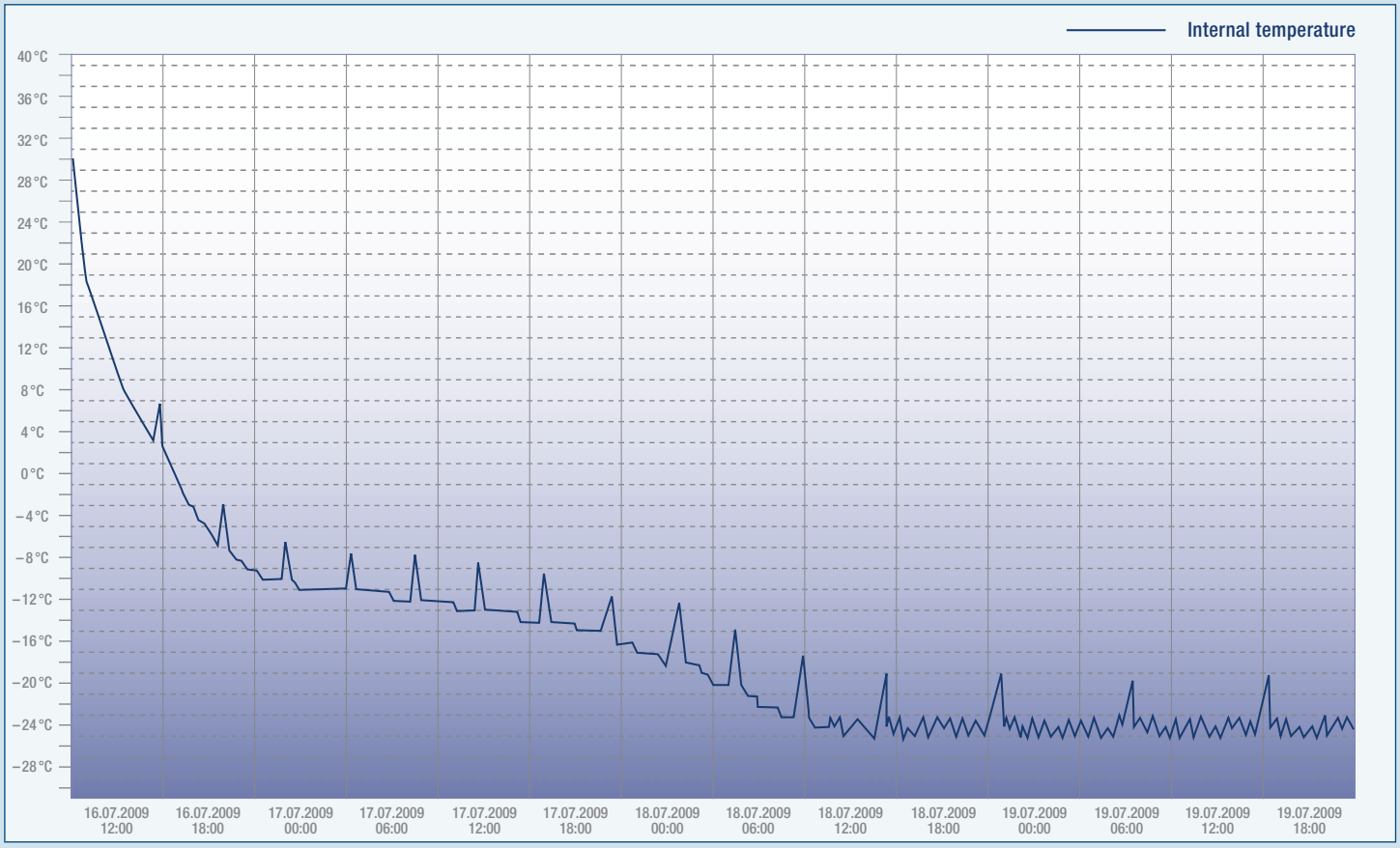
External temperature and alarm monitoring connections

Infrared interface and optional infrared key

All LKPv and LGPv models have an integrated temperature data logger which stores up to 2800 air-probe temperature values recorded at 4 minute intervals, which equals approximately 7.7 days. In order to use this data an infrared device (“key”) is available as an optional extra. The data is transferred from the infrared interface on the cabinet to the “infrared key”. This “key” is then connected by cable to a PC or laptop and the data is transferred onto the dedicated software on the PC. Only one set of data i.e. from one cabinet, can be transferred at one time.

The optional kit includes all the necessary components: key, cable and software including manual. The software allows visualisation and analysis of the temperature data in various formats including a graph. The data can also be exported to Excel, Word and other standard formats for storage or further analysis.

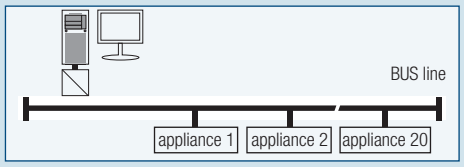
Example: visualisation of temperature data



RS 485 interface and optional signal converter

All LKPv and LGPv models have an RS 485 interface. If an RS 485 monitoring system is not already in place, a converter kit is available as an optional extra to convert the RS 485 signal to an RS 232 signal and allow connection to a PC or laptop.

The RS 485 bus connection is made using standard shielded data cables, e.g. type LiYCY 2 x 0,14 mm². The maximum possible length of the data lines depends on the quality of the components used. The maximum range is 500 m. A maximum of 20 appliances can be wired in series.

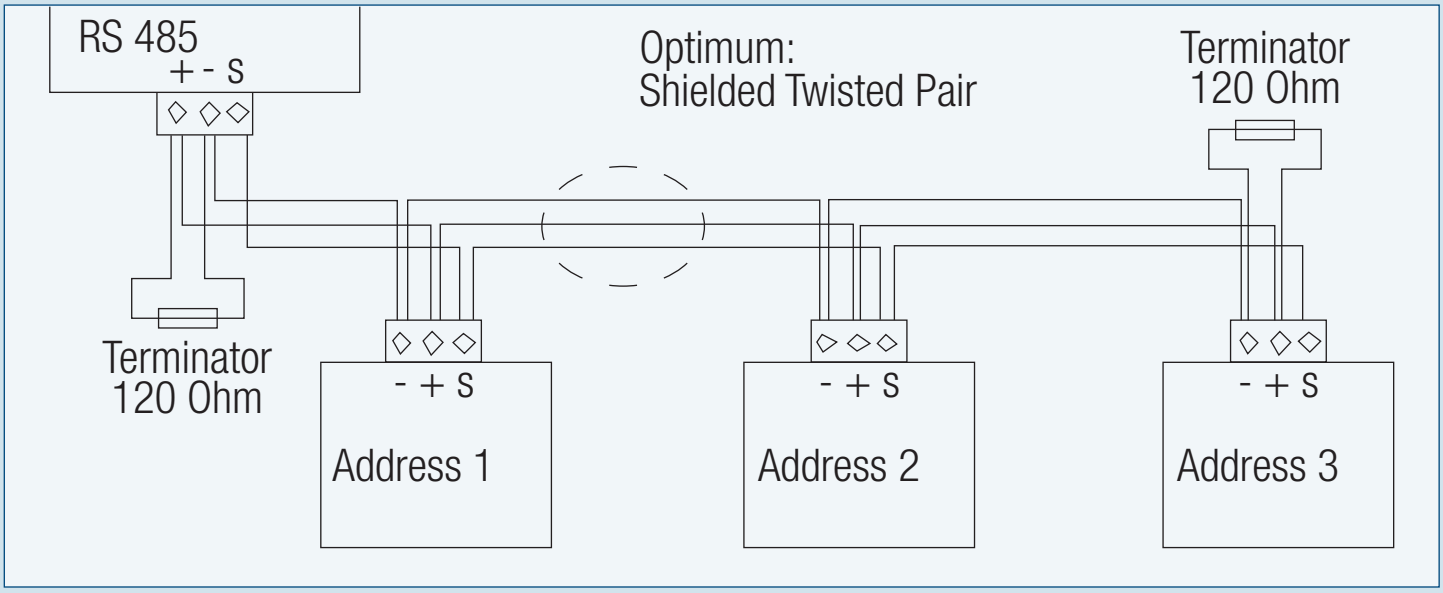


Dedicated software is provided in the accessory package allowing visualisation, analysis and export to other formats for storage. The software reads the air-probe temperature at 2 minute intervals and records alarm conditions. When an alarm condition is registered the software will warn on the PC on which the software is running. If this PC is not supervised (e.g. at night or over weekends) then the alarm signal might not be recognised. In order to avoid unrecognised alarms the software includes an email function, which sends an email in case of an alarm condition to predefined email addresses. These emails can be easiliy checked with a smartphone. Therefore the user will be warned without having direct access to a computer.

Networking

Both laboratory appliances with Profi-Controller as well as laboratory appliances with Comfort-Controller can be networked using the same Liebherr accessory package “RS 485 interface converter including temperature monitoring software”.

Example: RS 485 network



External alarm contact connection

Volt-free contact

All LKPv and LGPv models have an integrated volt-free contact. The relay contact can be wired into a warning system in the building which would advise e.g. security personnel or a janitor outside of working hours. Warning systems with audio or visual alarms are possible.

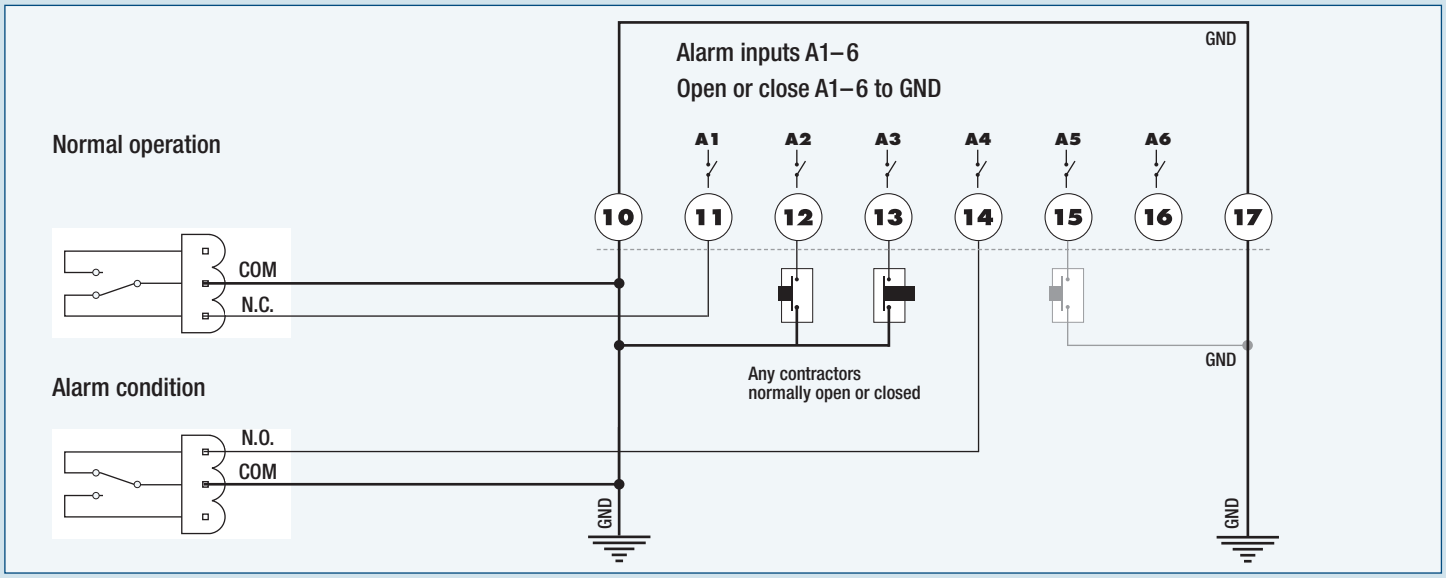
The following example shows a circuit with a visual alarm. Either normal operation or alarm condition or both can be indicated. Either AC or DC circuits are possible, max AC 230 V / 5 Amp.

Example: visual alarm system using volt free alarm contact

Alternatively, if no internal warning system is in place and additional wiring inside the building is problematical, the volt-free contact can be used in conjunction with e.g. a GSM alarm dialler. There are many different versions of GSM alarm dialers available on the market which either call a telephone number and/or send a text message in case of an alarm. Depending on the specification of the alarm dialler, potentially many appliances can be connected to one dialler. Being GSM appliances, only a SIM card and a power supply are required.

The following example shows a circuit with a GSM dialler: A change in relay setting activates the alarm function of the dialler and thus initiates either a telephone call or an SMS to pre-defined numbers with a pre-recorded message. The dialler in the example has 6 addressed alarm inputs. This could be 6 individual appliances or 6 rooms, each with several appliances wired in series.

Example: GSM dialler alarm system using volt free alarm contact



In spite of all efforts to produce appliances of unequalled reliability, Liebherr strongly recommends that the volt-free contact is wired into some kind of independent and external warning system. Please take a few moments to consider the value of the contents of the refrigerators and freezers under your supervision. The cost of such a warning system is often negligible in comparison to the value of the contents.

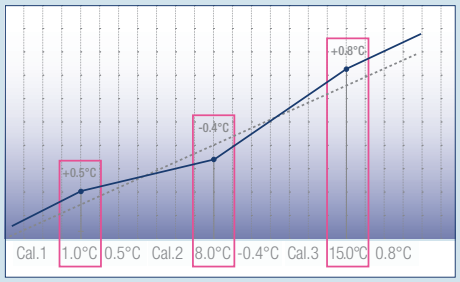
Product temperature monitoring connection

Interface for optional NTC product temperature probe

All LKPv and LGPv models have an integrated interface for connecting an optional available NTC product temperature probe to the Profi-controller. The controller can be set to display either the internal air temperature, as registered by the air probe or the temperature registered by the product probe or both. Also the temperature alarm limits as well as the temperature alarm delay for the product temperature probe can be adjusted by the user to suit individual requirements. In addition the product temperature can be monitored on an external documentation system via the RS 485 interface.

Whereas the air probe is in a fixed position, the product probe will be located by the user, e.g. in a phial or in a measurement package in order to simulate a product temperature.
The product temperature probe is water resistant and resistant to corrosion (IP 68 and AISI 316). It complies with all relevant NSF standards.

Due to possible tolerances of the product temperature probe the temperature displayed can differ from the product probe temperature. Using the calibration function, the temperature displayed can be aligned with the product probe temperature at as many as three temperature points. The correction value for the compensation of the differences can be adjusted in 0,1 °C steps.



Safety feature table

Laboratory appliances with Profi-Controller	LKPv 6520	LKPv 6522	LKPv 8420	LKPv 1420	LKPv 1422	LGPv 6520	LGPv 8420	LGPv 1420
Spark-free interior	No	No	No	No	No	No	No	No
High / Low temperature alarm, audio and visual	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Door-open alarm, audio and visual	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Power failure alarm through battery backup for 72h, audio and visual	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Volt-free contact for external alarm signal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS 485 data transfer interface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Infrared data transfer interface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Infrared data transfer key with data monitoring software	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory
RS 485 / RS 232 converter with data monitoring software	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory
NTC product temperature probe	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory
Internal alarm memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min. / Max. temperature memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Access port for e.g. PT 100 probe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Probe failure alarm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Condenser and evaporator temperature alarms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Temperature consistency and distribution according to NF X 15-140

The Liebherr laboratory cabinets are all tested in-house to the NF X 15-140 test procedure. Liebherr's modern R&D facility has climate controlled test rooms which conform to EN 23953.

Description of the NF X 15-140 test procedure

The general test conditions are as follows:

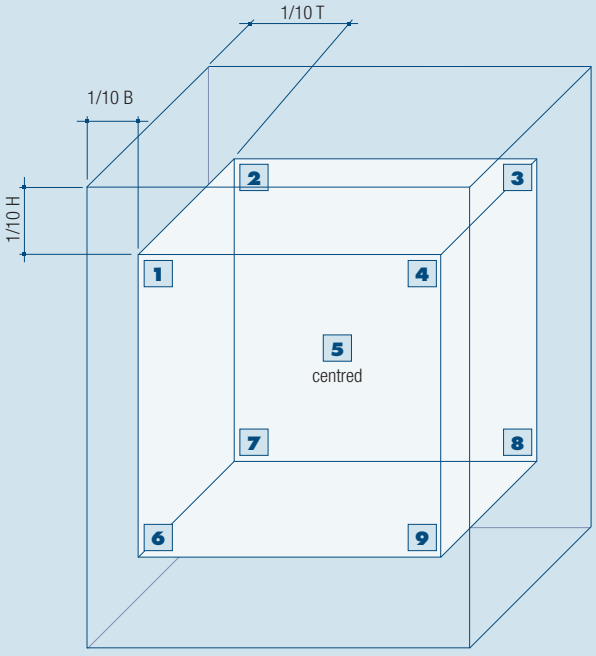
- Ambient temperature + 25 °C
- 60 % relative humidity
- Refrigerator set temperature + 5 °C
- Freezer set temperature – 20 °C

Measurements are made using 9 x PT 100 air temperature probes positioned in accordance with NF X 15-140.

"Unless specifically stipulated, the temperature probes are located at equal distances from the walls of 1/10 of each of the dimensions of the internal volume (w/h/d). The location of the probes used for characterization forms a supposedly representative sample of the working space."

The characterization is performed using nine probes; one located at each corner, one in the centre of the working space.

Location of the probes used for characterization



Cabinets are tested empty over a period of 24 hrs including defrost cycles.

Test criteria for characterising the temperature consistency and distribution

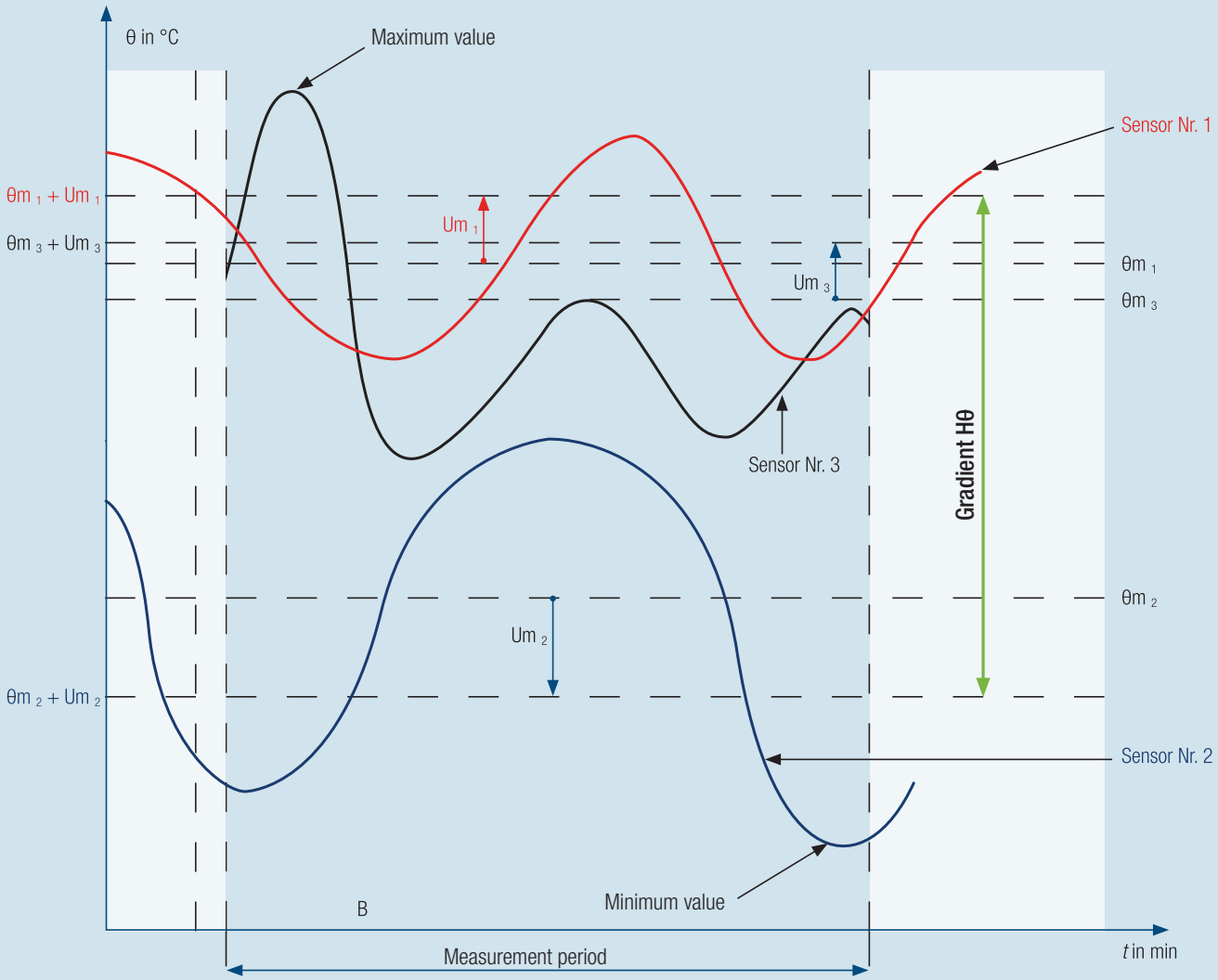
1) **Gradient** or **homogeneity:** "The gradient HΘ is the maximum difference, obtained in an achieved environment, between the mean values of measurements θ_{mj} increased by their expanded uncertainty U_{mj}, within the working space during the measurement time."

Gradient: "Distribution of temperatures within the chamber"

$$H\Theta = \max(\theta_{mj}+U_{mj}) - \min(\theta_{mj}-U_{mj})$$

max = (mean value warmest probe + expanded measurement uncertainty)
min = (mean value coldest probe – expanded measurement uncertainty)

Example: Gradient (Homogeneity)



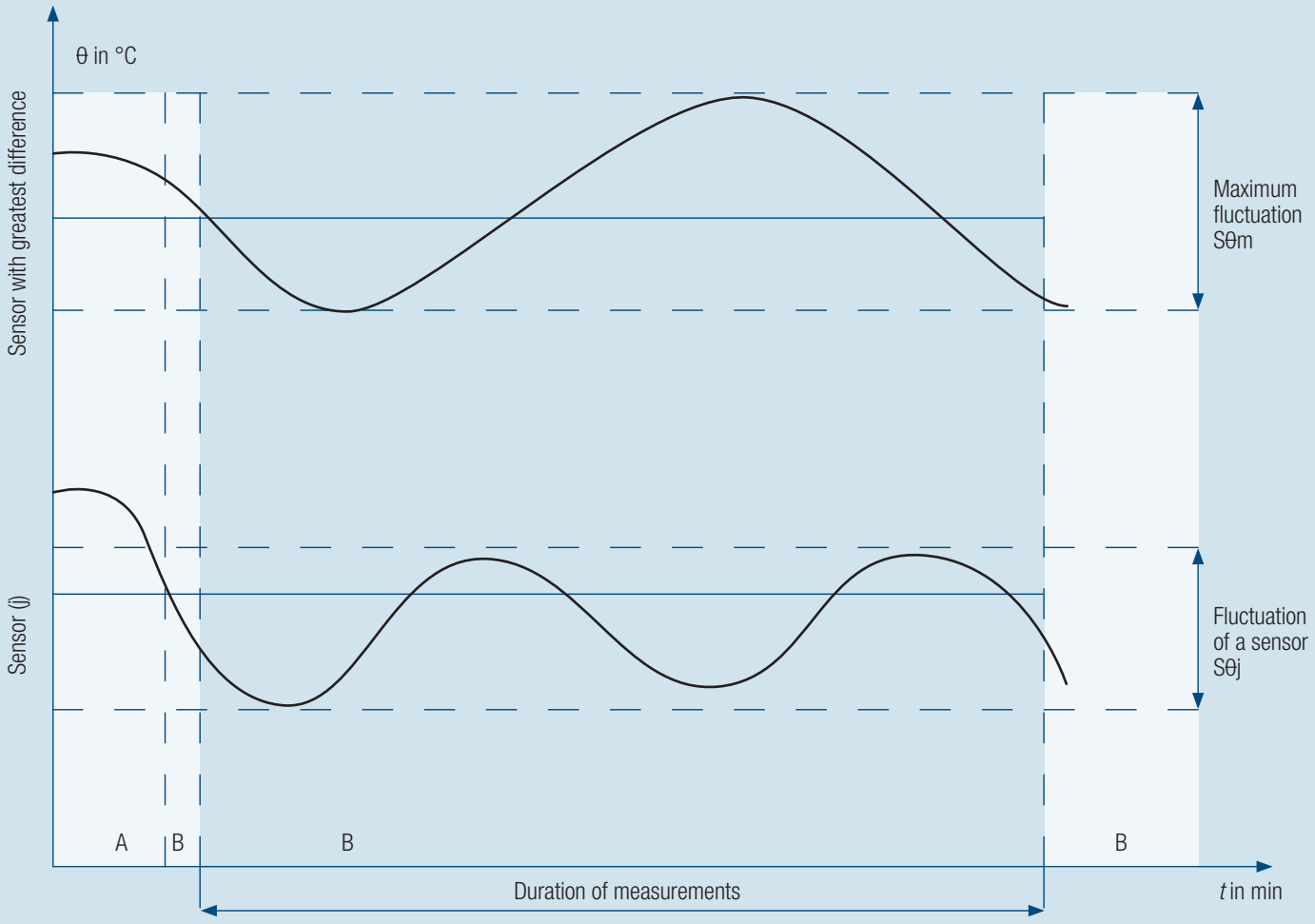
The gradient indicates the temperature distribution within the cabinets. Especially in the laboratory sector optimum temperature distribution is crucial to guarantee the safe storage of samples or other products at any place within the unit. The lower the gradient the better is the temperature distribution within the unit.

2) **Fluctuation:** "The characterisation of the temperature fluctuation within the working space enables to determine the variation in maximum temperature at a measurement point of the working space during the measurement time."

"Maximum fluctuation: Value of the probe with the greatest difference between highest and lowest measured temperature"

The lower the maximum fluctuation the better is the temperature consistency within the units.

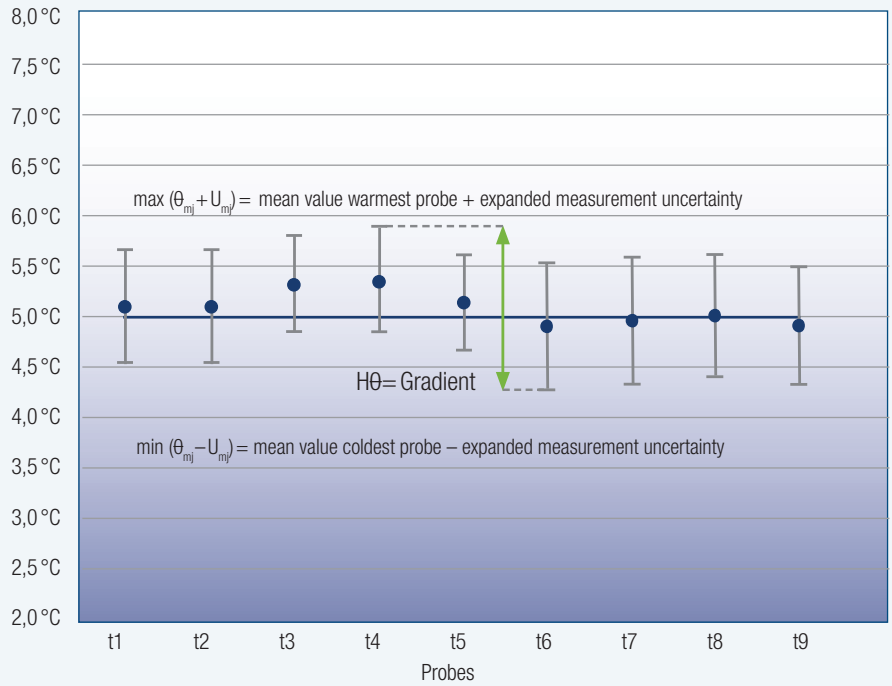
Example: Fluctuation



Results according to NF X 15-140

The evaluation of air temperatures of the LKPv and LGPv models according to NF X 15-140 using a PT 100 temperature probe with 25 g copper leads to the following results:

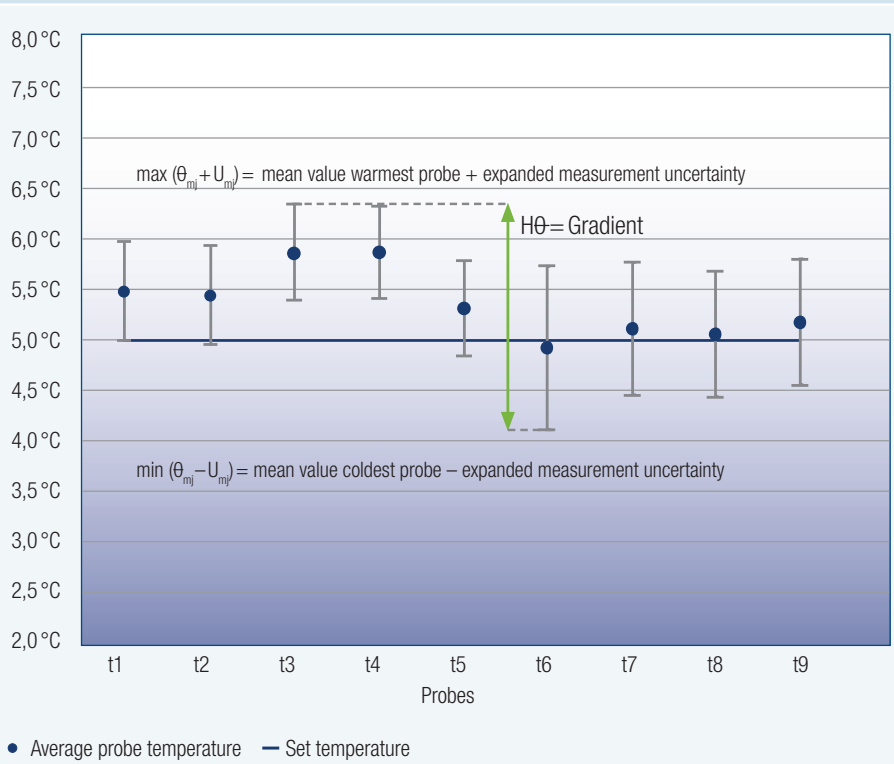
LKPv 6520



Gradient HΘ: **1.8 K** (+0.9 K / –0.9 K from set temperature)

Max. Fluktuation: **1.0 K**

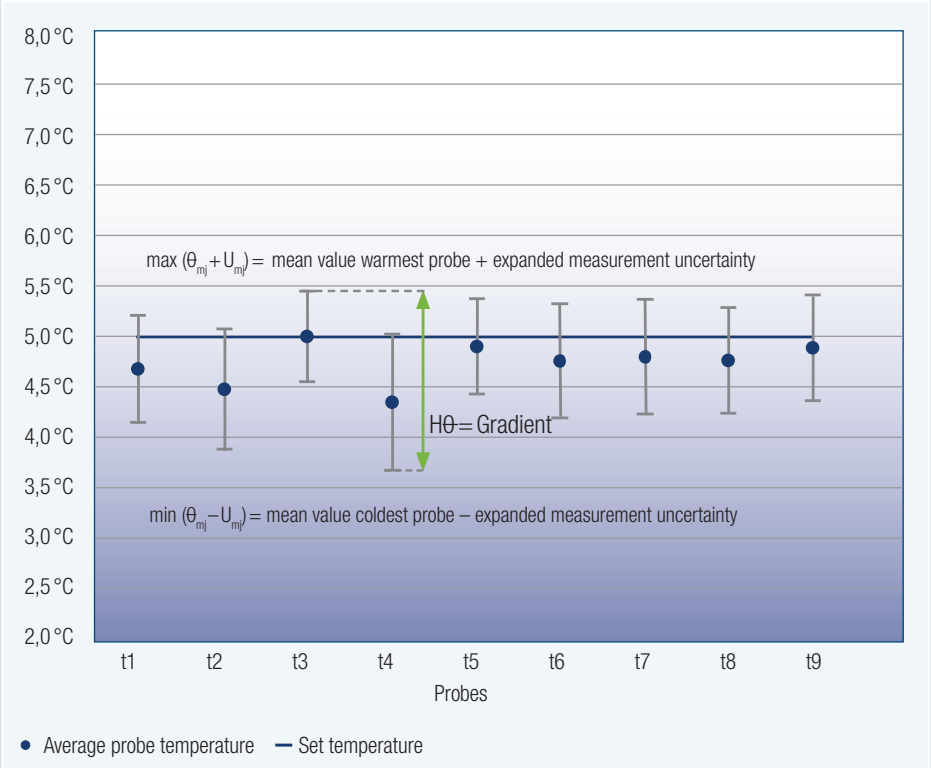
LKPv 6522



Gradient HΘ: **2.3 K** (+1.4 K / –0.9 K from set temperature)

Max. Fluktuation: **1.6 K**

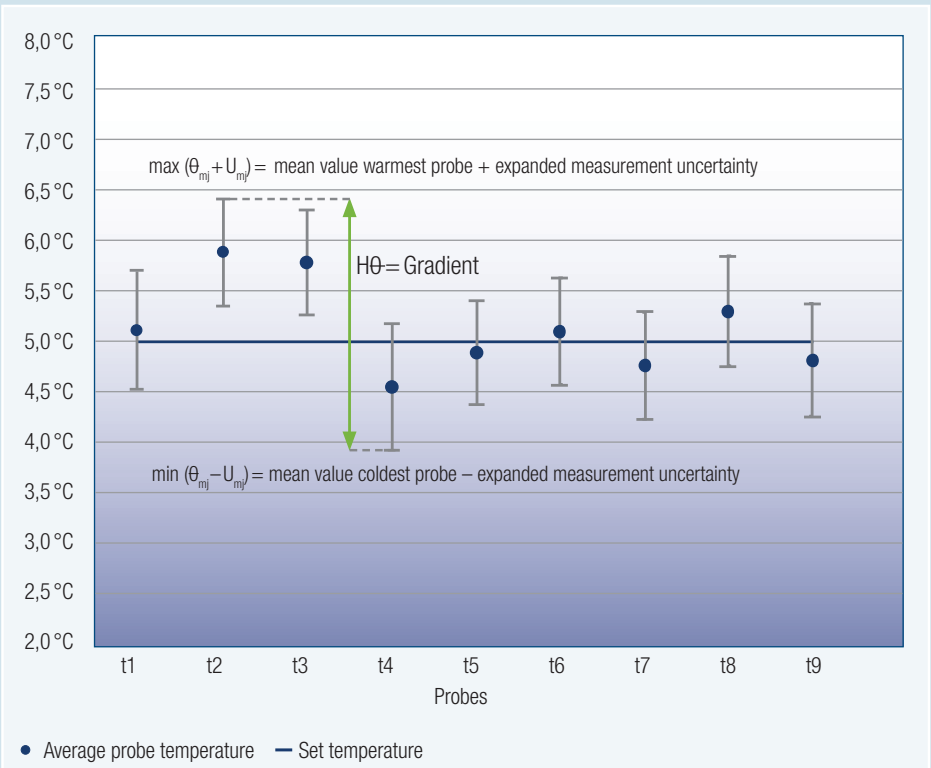
LKPv 1420



Gradient HΘ: **2.0 K** (+0.5 K / – 1.5 K from set temperature)

Max. fluctuation: **1.2 K**

LKPv 1422

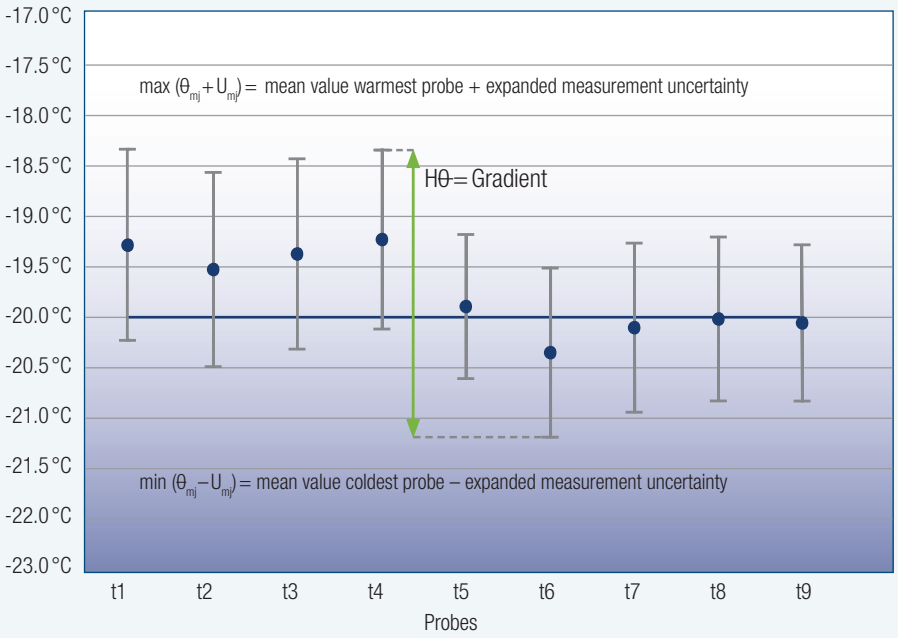


Gradient HΘ: **2.6 K** (+1.5 K / – 1.1 K from set temperature)

Max. fluctuation: **1.6 K**

LKPv and LGPv laboratory appliances with Profi-Controller

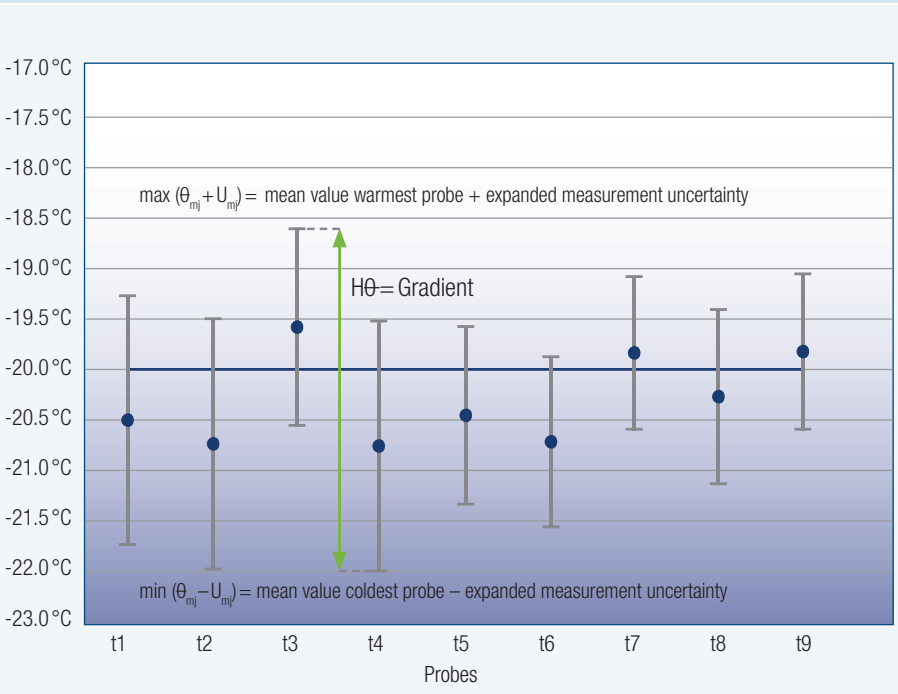
LGPv 6520



Gradient Hθ: **3.0 K** (+1.75 K / –1.25 K from set temperature)

Max. fluctuation: **3.6 K**

LGPv 1420



Gradient Hθ: **3.5 K** (+1.5 K / – 2.0 K from set temperature)

Max. fluctuation: **3.9 K**

The evaluation of the LKPv 8420 and LGPv 8420 models will be available in December 2011.

Alarm, memory and safety functions

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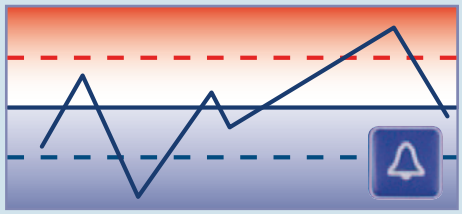
Temperature, door-open and power failure alarms

High and low temperature alarms

All LK(U)v, LCv, LK(U)exv, LG(U)ex and LGT models have integrated high and low internal air temperature alarms with both audio and visual signals. The factory settings for the alarm limits are +1/–1K in relation to the set temperature: If the set temperature is altered to meet a specific storage temperature requirement then the alarm settings move in parallel and do not need to be adjusted separately. There is a 60 minute delay to avoid unwanted alarms due to e.g. door opening. The alarm parameters can however be adjusted by the user to suit individual requirements.



Door-open alarm

All LK(U)v, LCv, LK(U)exv, LG(U)ex and LGT models register when doors are left open or ajar and have an integrated audio and visual door-open alarm. This alarm has a 1 minute delay.

Power failure alarm

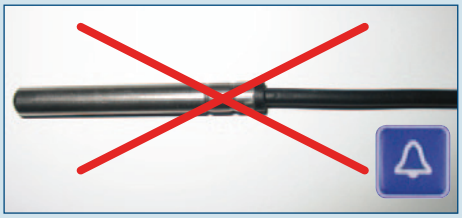
All LK(U)v, LCv, LK(U)exv, LG(U)ex and LGT models indicates a visual power failure alarm after the return of the power supply. The power failure alarm remains until it is manually reset.

Internal system alarm

The following alarm is related to internal self-checks of the electronic controller probes. While this might not be immediately relevant to the every-day operation of the cabinets it does provide added security by warning probably before the air temperature probe registers an alarm condition.

Probe failure alarm

As a self-control system, defective probes are registered and the controller cause an audio and visual alarm signal. In case of an air-probe error the controller has pre-defined operating modes to maintain the internal temperature at + 5 °C.



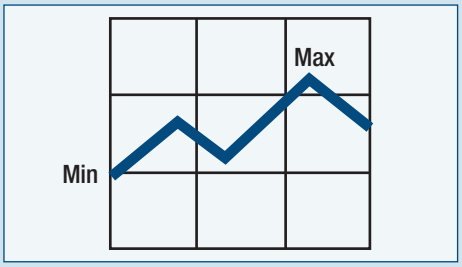
Internal memory functions

Internal alarm memory

This function stores to memory details of the last three temperature and power failure alarms. Time and date of the start and the duration of the alarm conditions are registered.

Min./max. temperature memory

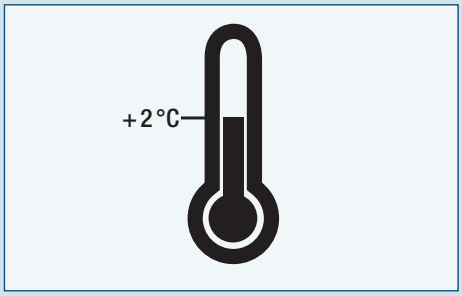
After reaching the set temperature for the first time, the Comfort controller begins continuously to store to memory the highest and lowest internal temperatures registered. These minimum and maximum temperatures can be read out from the memory. After reading the min/max memory, the values can either be reset or left in the memory. Normally the values would be noted by the user and the memory reset in order to define the next period to be registered. The controller also registers the time elapsed since the last reset up to a period of ~ 40 days.



Special safety function

Electro-mechanical +2 °C safety thermostat for laboratory refrigerators with Comfort-Controller

In order to ensure maximum reliability, the Comfort-Controller has a heavy-duty compressor relay thus reducing the possibility of burned relay contacts. Should however a defect occur, an additional safety thermostat backs up the controller to prevent the product temperature from dropping below +2 °C.



Temperature and alarm documentation

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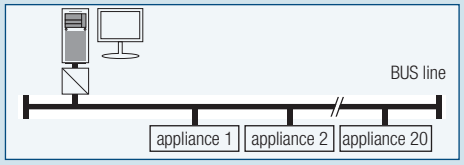
External temperature and alarm monitoring connection

RS 485 interface and optional signal converter

All LK(U)v, LCv, LK(U)exv and LG(U)ex models have an integrated RS 485 interface. If an RS 485 monitoring system is not already in place, a converter kit is available as an optional extra to convert the RS 485 signal to an RS 232 signal and allow connection to a PC or laptop.



The RS 485 bus connection is made using standard shielded data cables, e.g. type LiYCY 2 x 0,14 mm². The maximum possible length of the data lines depends on the quality of the components used. The maximum range is 500m. A maximum of 20 appliances can be wired in series.

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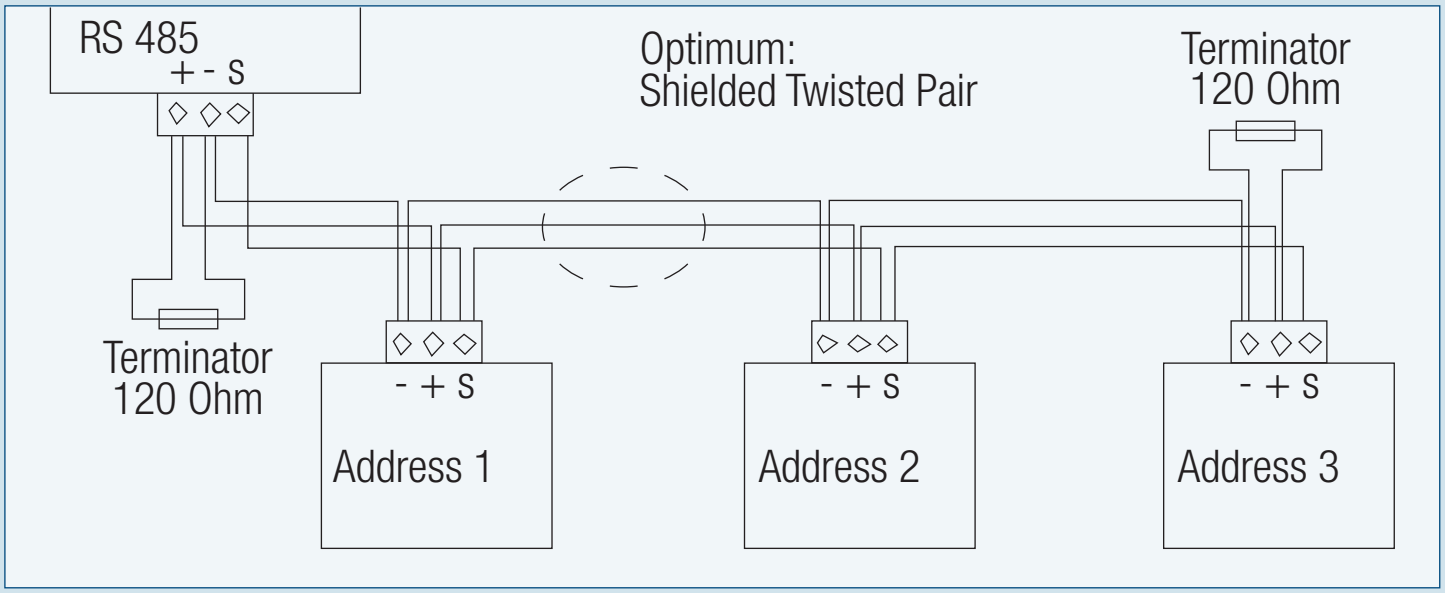
Example: RS 485 network



External alarm contact connection

Volt-free contact

All LK(U)v, LCv, LK(U)exv, LG(U)ex and LGT models have an integrated volt-free contact. The relay contact can be wired into a warning system in the building which would advise e.g. security personnel or a janitor outside of working hours. Warning systems with audio or visual alarms are possible.

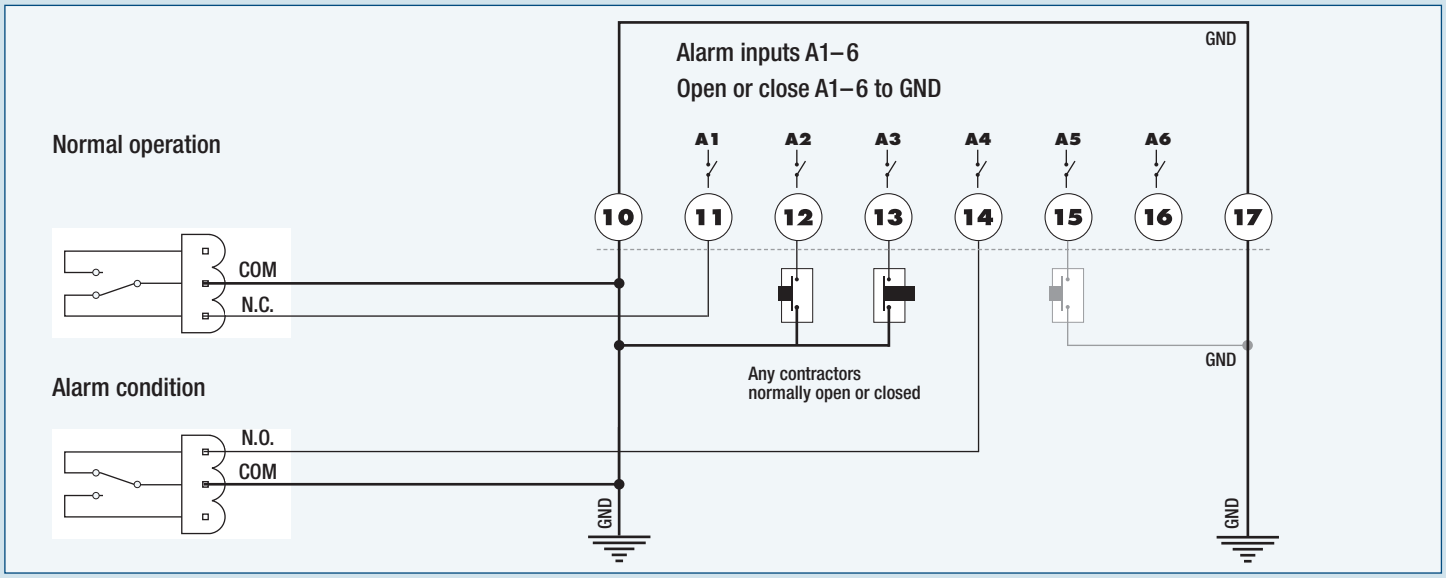
The following example shows a circuit with a visual alarm. Either normal operation or alarm condition or both can be indicated. Either AC or DC circuits are possible, max AC 230 V / 5 Amp.

Example: visual alarm system using volt free alarm contact

Alternatively, if no internal warning system is in place and additional wiring inside the building is problematical, the volt-free contact can be used in conjunction with e.g. a GSM alarm dialler. There are many different versions of GSM alarm dialers available on the market which either call a telephone number and/or send a text message in case of an alarm. Depending on the specification of GSM alarm dialers, potentially many appliances can be connected to one dialler. Being GSM appliances, only a SIM card and a power supply are required.

The following example shows a circuit with a GSM dialler: A change in relay setting activates the alarm function of the dialler and thus initiates either a telephone call or an SMS to pre-defined numbers with a pre-recorded message. The dialler in the example has 6 addressed alarm inputs. This could be 6 individual appliances or 6 rooms, each with several appliances wired in series.

Example: GSM dialer alarm system using volt free alarm contact

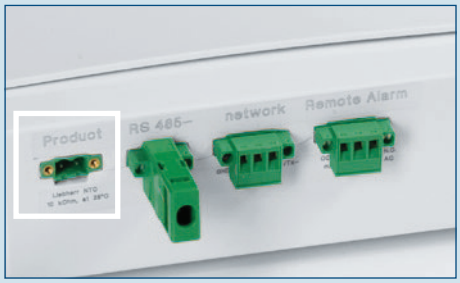


In spite of all efforts to produce appliances of unequalled reliability, Liebherr strongly recommends that the volt-free contact is wired into some kind of independent and external warning system. Please take a few moments to consider the value of the contents of the refrigerators and freezers under your supervision. The cost of such a warning system is often negligible in comparison to the value of the contents.

Product temperature monitoring connection

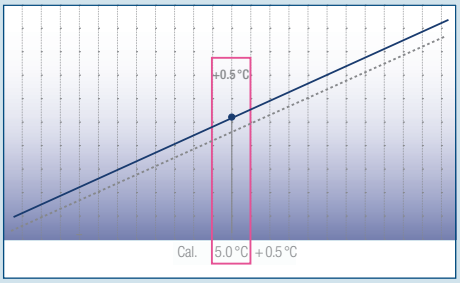
Interface for optional NTC product temperature probe

All LK(U)v, LCv, LK(U)exv, LG(U)ex and LGT models have an integrated interface for connecting an optional available NTC product temperature probe to the comfort controller. The controller can be set to display either the internal air temperature, as registered by the air probe, or the temperature registered by the product probe. Depending on this selection the temperature alarm limits are related either to the air probe or to the product probe. In addition the product temperature can be monitored on an externaldocumentation system via the RS 485 interface.



Whereas the air probe is in a fixed position, the product probe will be located by the user, e.g. in a phial or in a measurement package in order to simulate a product temperature.
The product temperature probe is water resistant and resistant to corrosion (IP 68 and AISI 316). It complies with NSF standards.

Due to possible tolerances of the product temperature probe the temperature displayed can differ from the product probe temperature. Using the calibration function, the temperature displayed can be aligned with the product probe temperature. The correction value for the compensation of the differences can be adjusted in 0,1 °C steps.



Safety feature table

Laboratory appliances with Comfort-Controller	LKUv 1610	LKUv 1612	LKUexv1610	LGUex 1500	LKv 3910	LKv 3912	LKexv 3910	LGex 3410	LCv 4010
Spark-free interior	No	No	Yes	Yes	No	No	Yes	Yes	No
High / Low temperature alarm, audio and visual	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Door-open alarm, audio and visual	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Power failure warning after power supply is returned, visual	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Volt-free contact for external alarm signal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS 485 data transfer interface	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
RS 485 / RS 232 converter with data monitoring software	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory
NTC product temperature probe	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory	Accessory
Internal alarm memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Min. / Max. temperature memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
+2°C safety thermostat	Yes	Yes	Yes	No	Yes	Yes	Yes	No	For refrigerator compartement
Access port for e.g. PT 100 probe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Probe failure alarm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Low temperature freezers to -45°C	LGT 2325	LGT 3725	LGT 4725
Spark-free interior	No	No	No
High / Low temperature alarm audio and visual	Yes	Yes	Yes
Lid-open alarm, audio and visual	Yes	Yes	Yes
Power failure warning after power supply is returned, visual	Yes	Yes	Yes
Volt-free contact for external alarm signal	Yes	Yes	Yes
RS 485 data transfer für Datentransfer	Yes	Yes	Yes
RS 485 / RS 232 converter with data monitoring software	Accessory	Accessory	Accessory
NTC product temperature probe	Accessory	Accessory	Accessory
Internal alarm memory	Yes	Yes	Yes
Min. / Max. temperature memory	Yes	Yes	Yes
Access port for e.g. PT 100 probe	Yes	Yes	Yes
Probe failure alarm	Yes	Yes	Yes

Temperature consistency and distribution according to NF X 15-140

The Liebherr laboratory cabinets are all tested in-house to the NF X 15-140 test procedure. Liebherr's modern R&D facility has climate controlled test rooms which conform to EN 23953.

Description of the NF X 15-140 test procedure

The general test conditions are as follows:

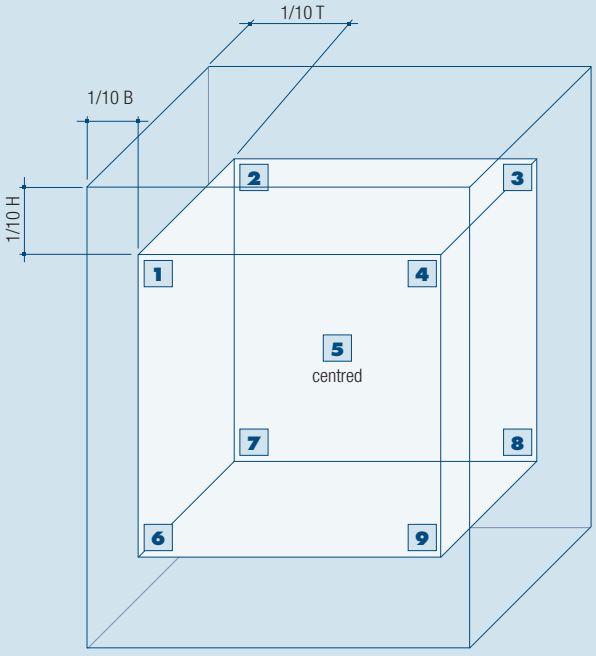
- Ambient temperature + 25 °C
- 60 % relative humidity
- Refrigerator set temperature + 5 °C
- Freezer set temperature – 20 °C
- Low temperature freezer set temperature – 45 °C

Measurements are made using 9 x PT 100 air temperature probes positioned in accordance with NF X 15-140.

"Unless specifically stipulated, the temperature probes are located at equal distances from the walls of 1/10 of each of the dimensions of the internal volume (w/h/d). The location of the probes used for characterization forms a supposedly representative sample of the working space."

The characterization is performed using nine probes; one located at each corner, one in the centre of the working space.

Location of the probes used for characterization



Cabinets are tested empty over a period of 24 hrs including defrost cycles.

Test criteria for characterising the temperature consistency and distribution

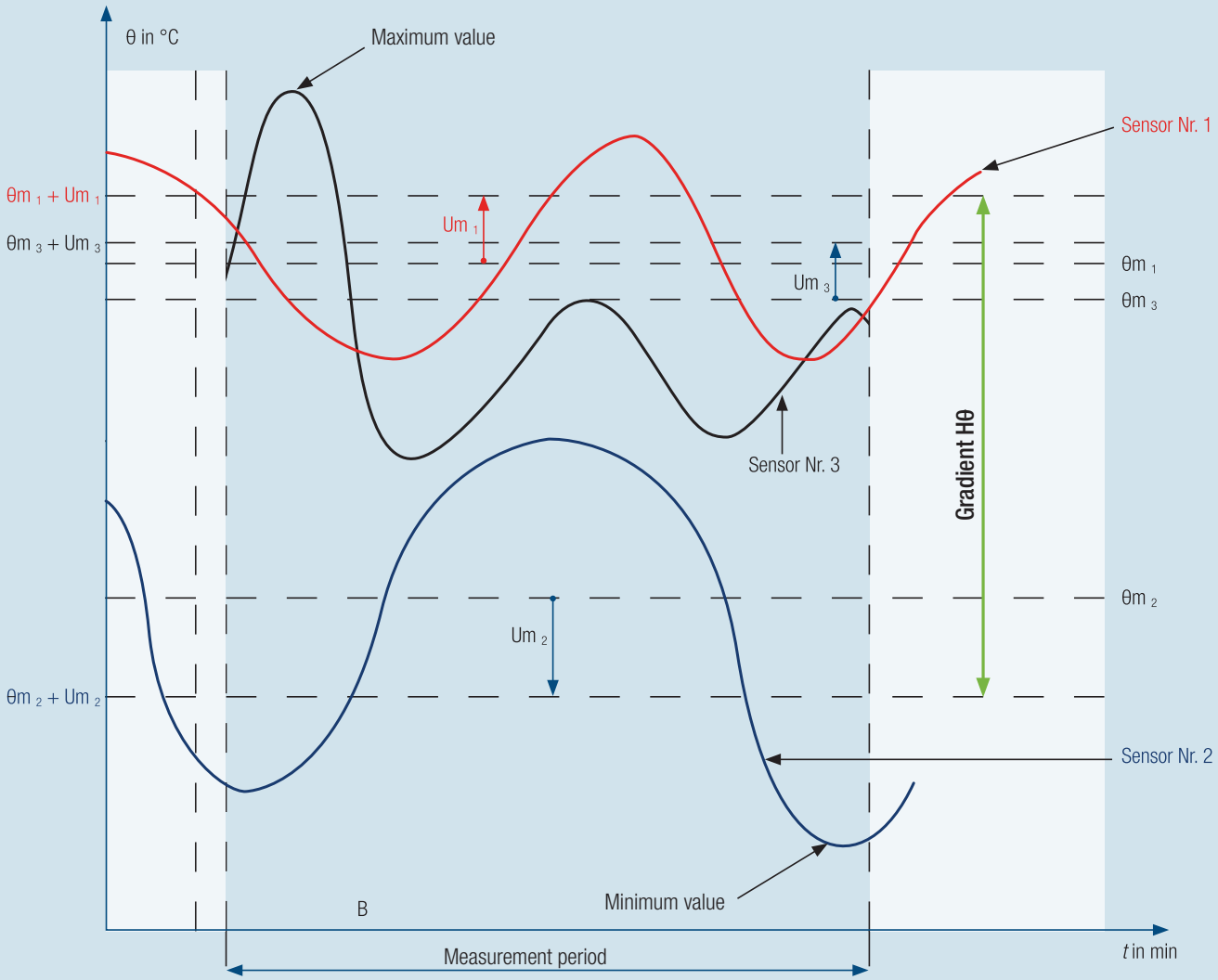
1) **Gradient** or **homogeneity:** "The gradient HΘ is the maximum difference, obtained in an achieved environment, between the mean values of measurements θ_{mj} increased by their expanded uncertainty U_{mj}, within the working space during the measurement time."

Gradient: "Distribution of temperatures within the chamber"

$$H\Theta = \max (\theta_{mj}+U_{mj}) - \min (\theta_{mj}-U_{mj})$$

max = (mean value warmest probe + expanded measurement uncertainty)
min = (mean value coldest probe – expanded measurement uncertainty)

Example: Gradient (Homogeneity)



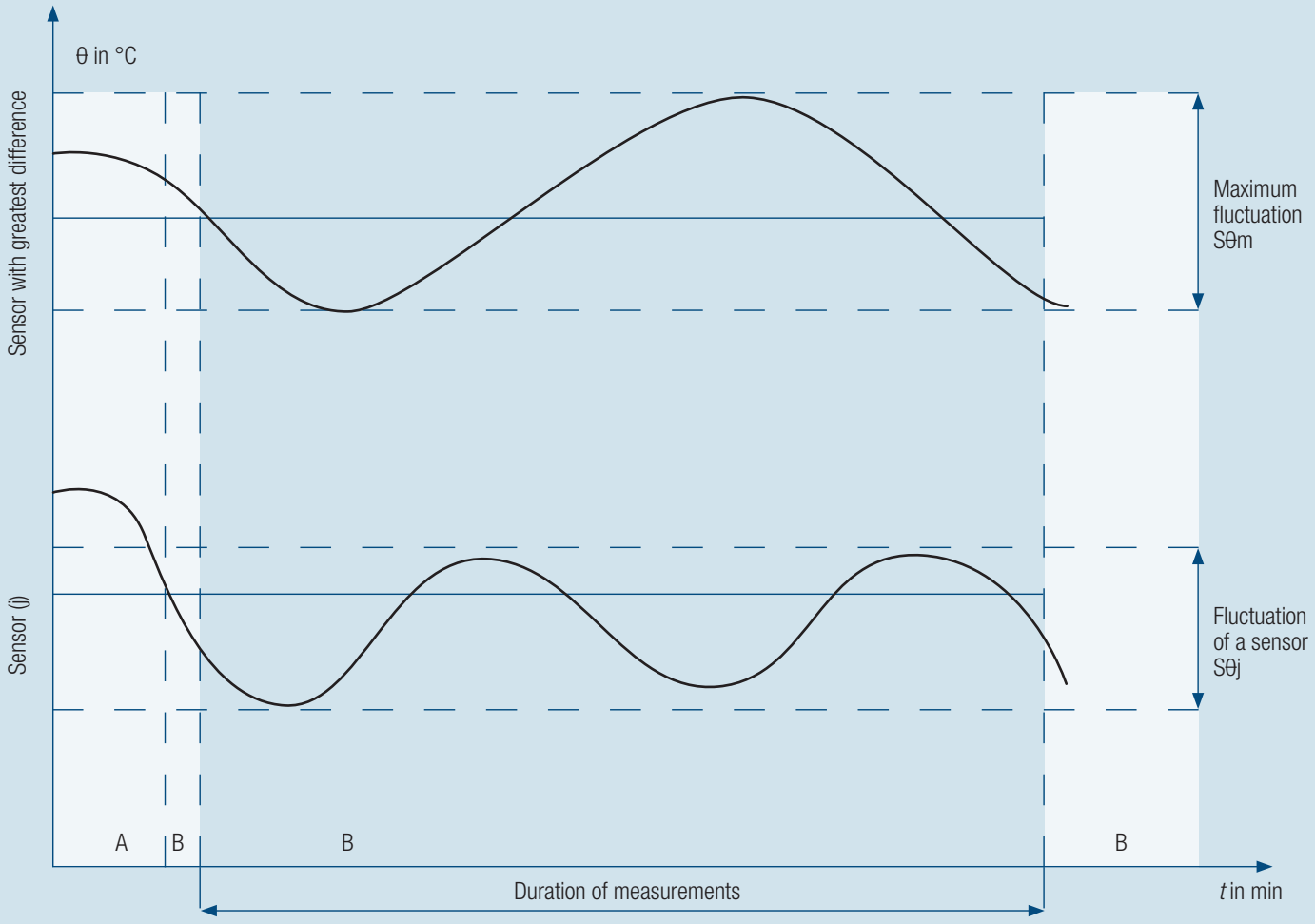
The gradient indicates the temperature distribution within the cabinets. Especially in the laboratory sector optimum temperature distribution is crucial to guarantee the safe storage of samples or other products at any place within the unit. The lower the gradient the better is the temperature distribution within the unit.

2) **Fluctuation:** "The characterisation of the temperature fluctuation within the working space enables to determine the variation in maximum temperature at a measurement point of the working space during the measurement time."

"Maximum fluctuation: Value of the probe with the greatest difference between highest and lowest measured temperature"

The lower the maximum fluctuation the better is the temperature consistency within the units.

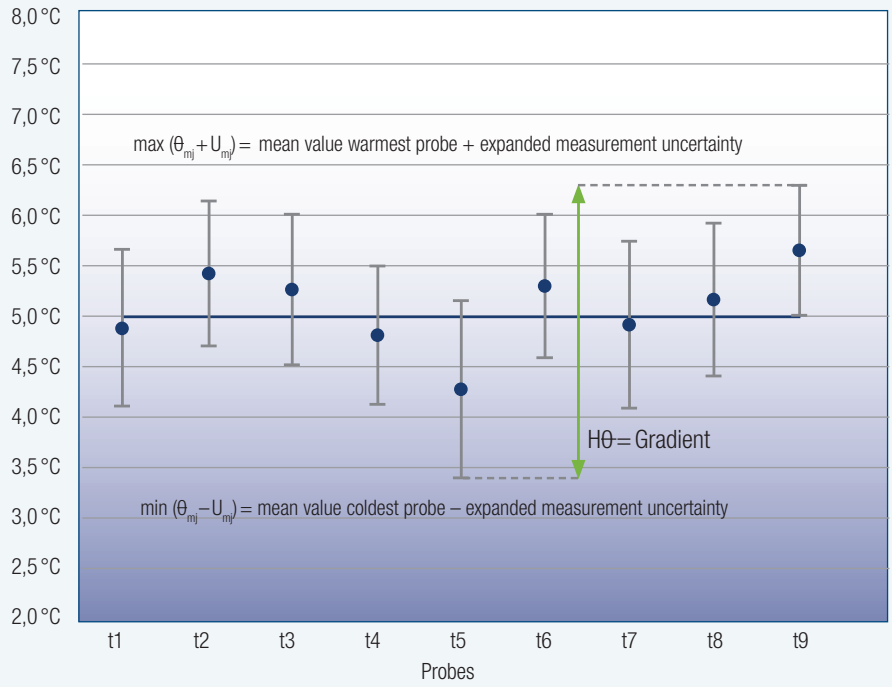
Example: Fluctuation



Results according to NF X 15-140

The evaluation of air temperatures of the LK(U)v, LCv, LK(U)exv, LG(U)ex and LGPv models according to NF X 15-140 using a PT 100 temperature probe with 25 g copper leads to the following results:

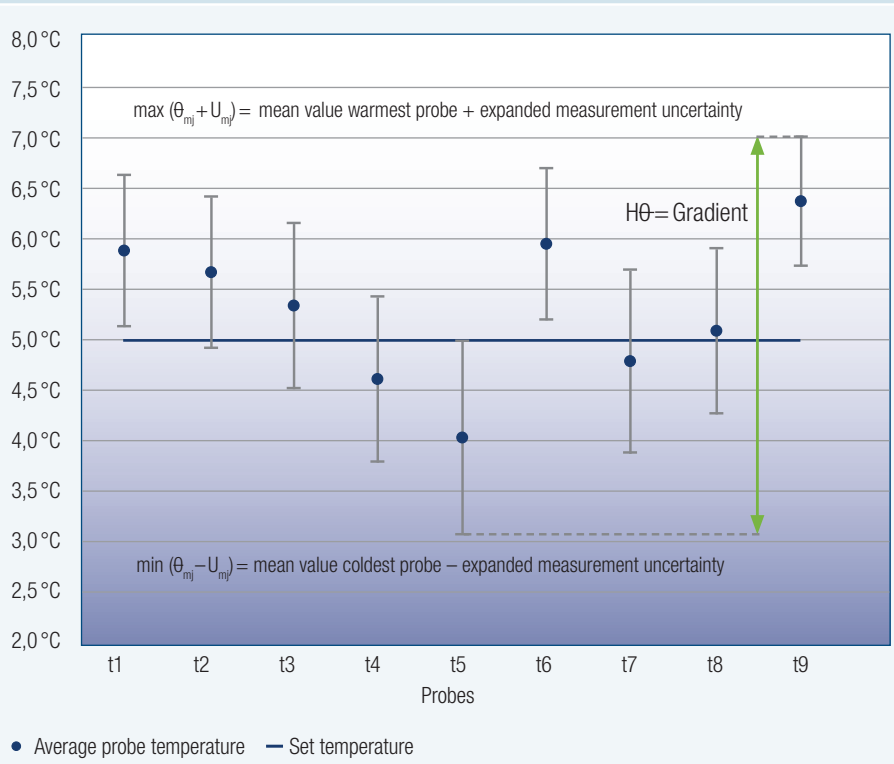
LKUv 1610



Gradient HΘ: **2.9 K** (+1.3 K / –1.6 K from set temperature)

Max. fluctuation: **2.5 K**

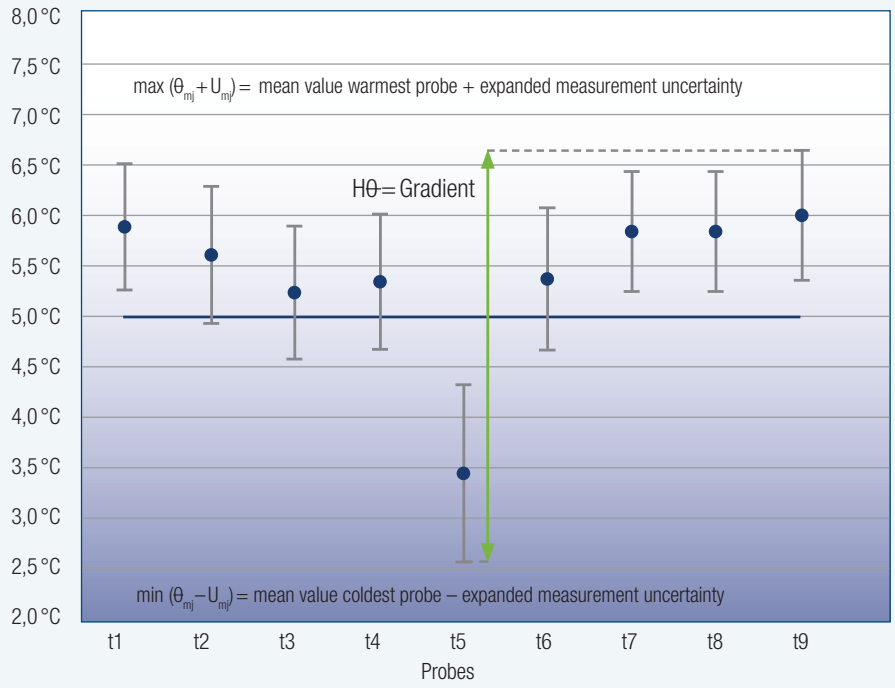
LKUv 1612



Gradient HΘ: **4.0 K** (+2.0 K / –2.0 K from set temperature)

Max. fluctuation: **3.3 K**

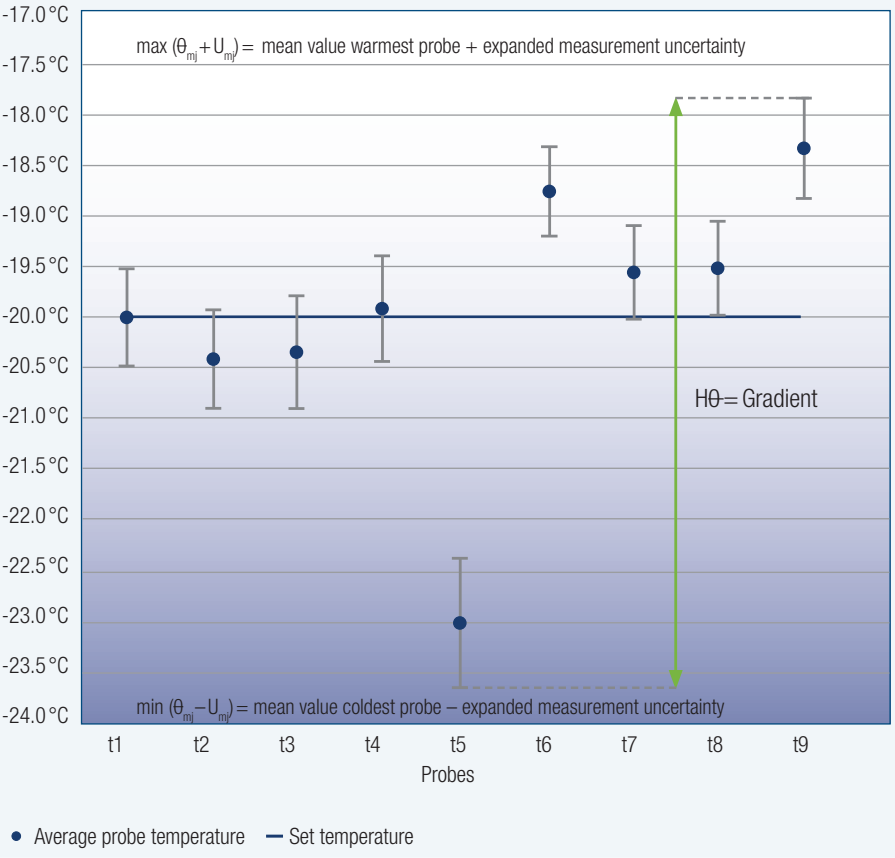
LKUexv 1610



Gradient HΘ: **4.1 K** (+1.6 K / –2.5 K from set temperature)

Max. fluctuation: **3.0 K**

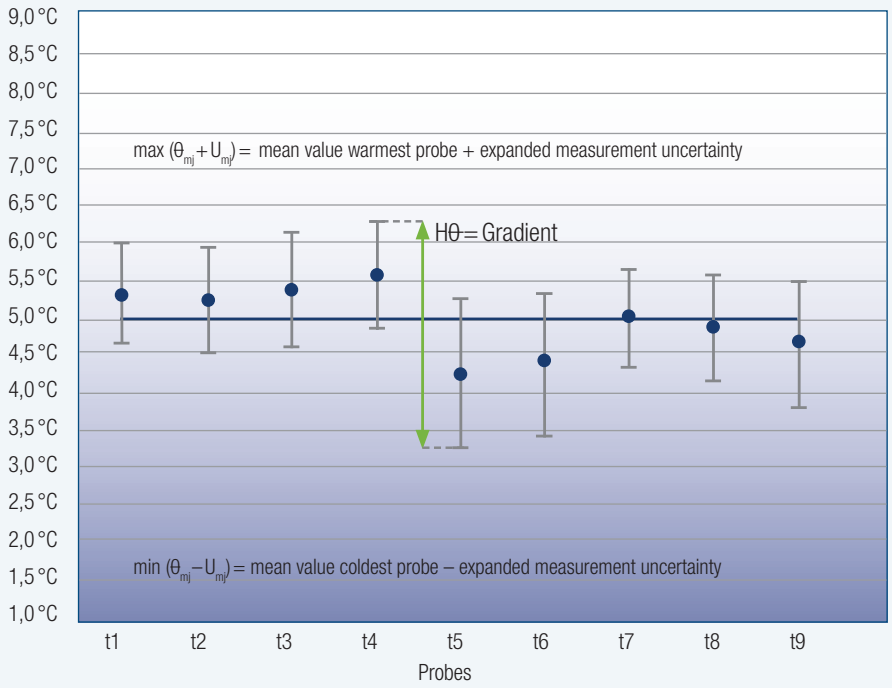
LGUex 1500



Gradient HΘ: **5.7 K** (+2.1 K / –3.6 K from set temperature)

Max. fluctuation: **0.80 K**

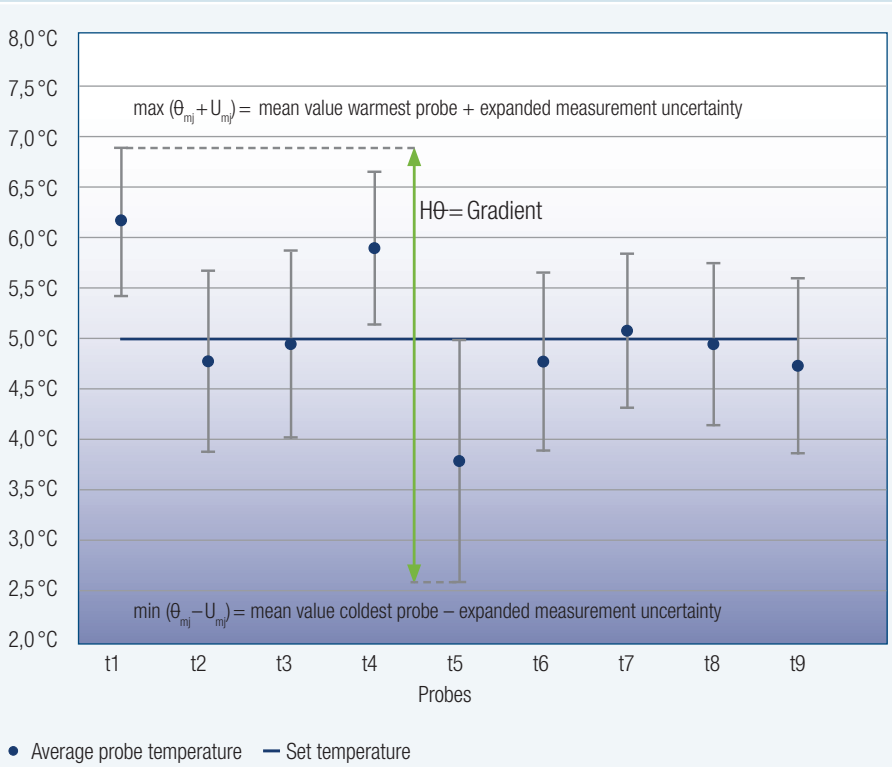
LKv 3910



Gradient HΘ: **3.0 K** (+1.25 K / –1.75 K from set temperature)

Max. fluctuation: **2.5 K**

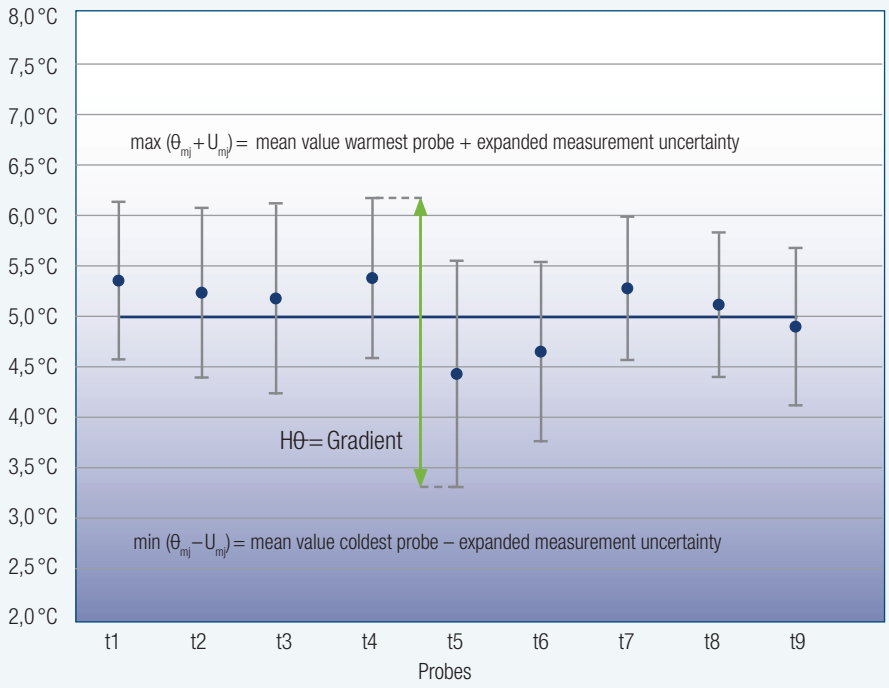
LKv 3912



Gradient HΘ: **4.2 K** (+1.8 K / –2.4 K from set temperature)

Max. fluctuation: **3.7 K**

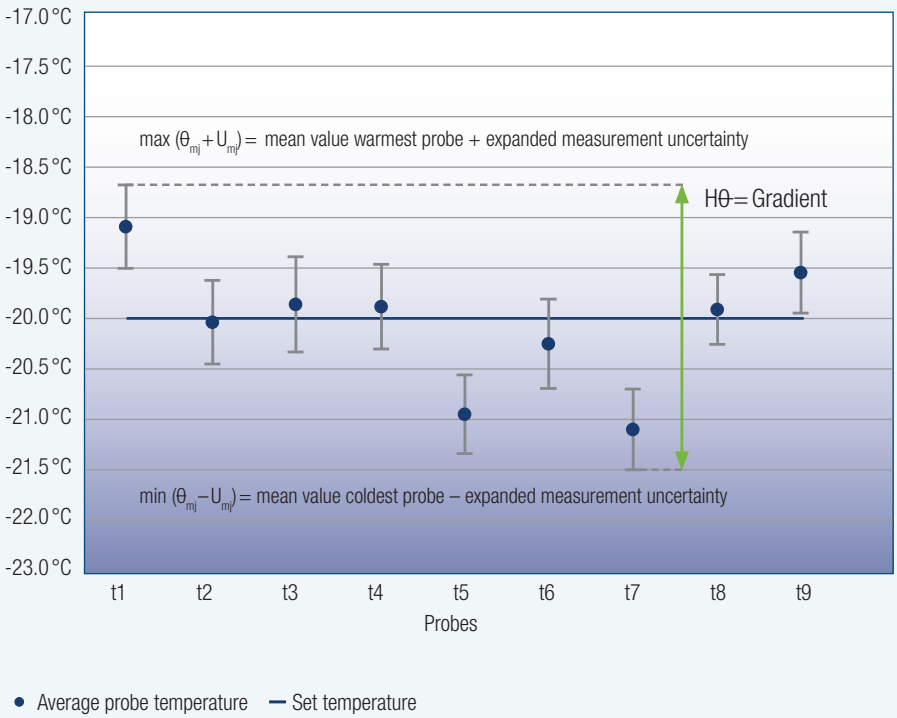
LKexv 3910



Gradient HΘ: **2.8 K** (+1.2 K / –1.6 K from set temperature)

Max. fluctuation: **3.4 K**

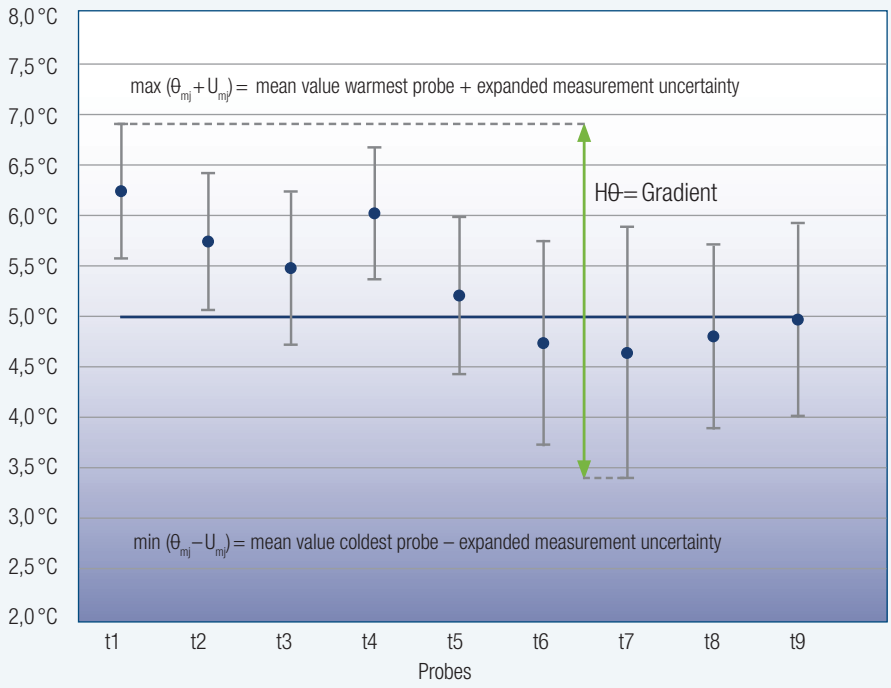
LGex 3410



Gradient HΘ: **2.9 K** (+1.4 K / –1.5 K from set temperature)

Max. fluctuation: **0.40 K**

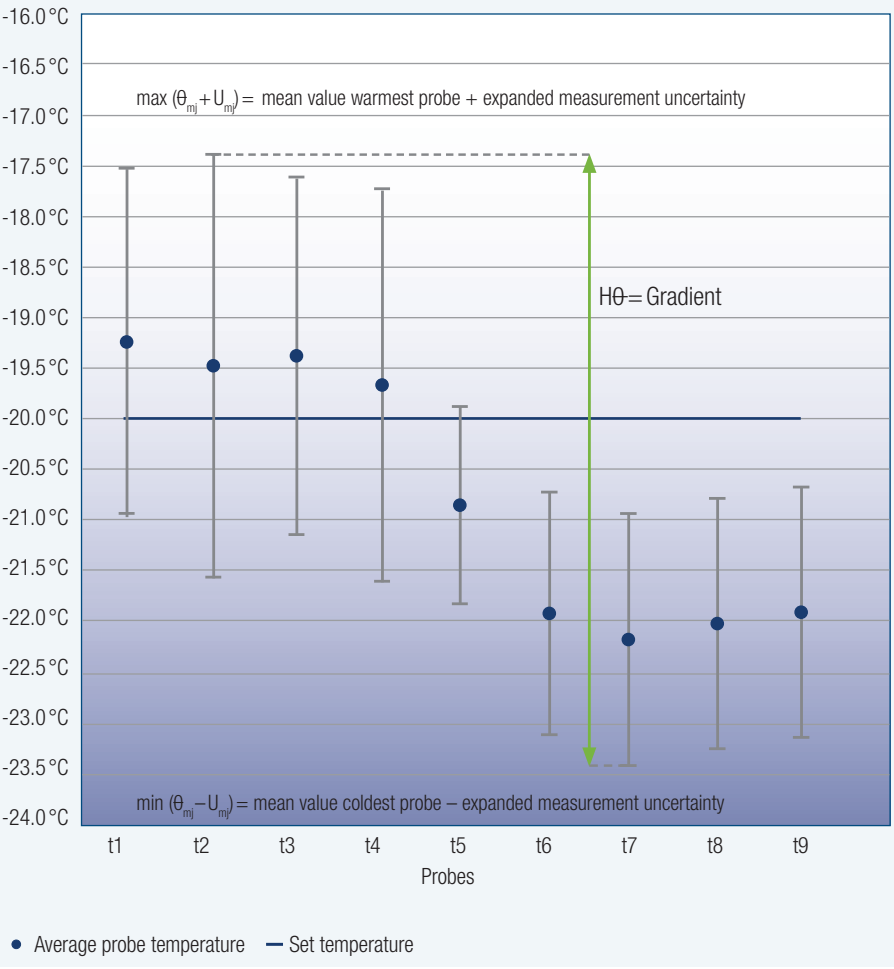
LCv 4010 – Evaluation of refrigerator compartment



Gradient HΘ: **3.4 K** (+1.8 K / –1.6 K from set temperature)

Max. fluctuation: **4.0 K**

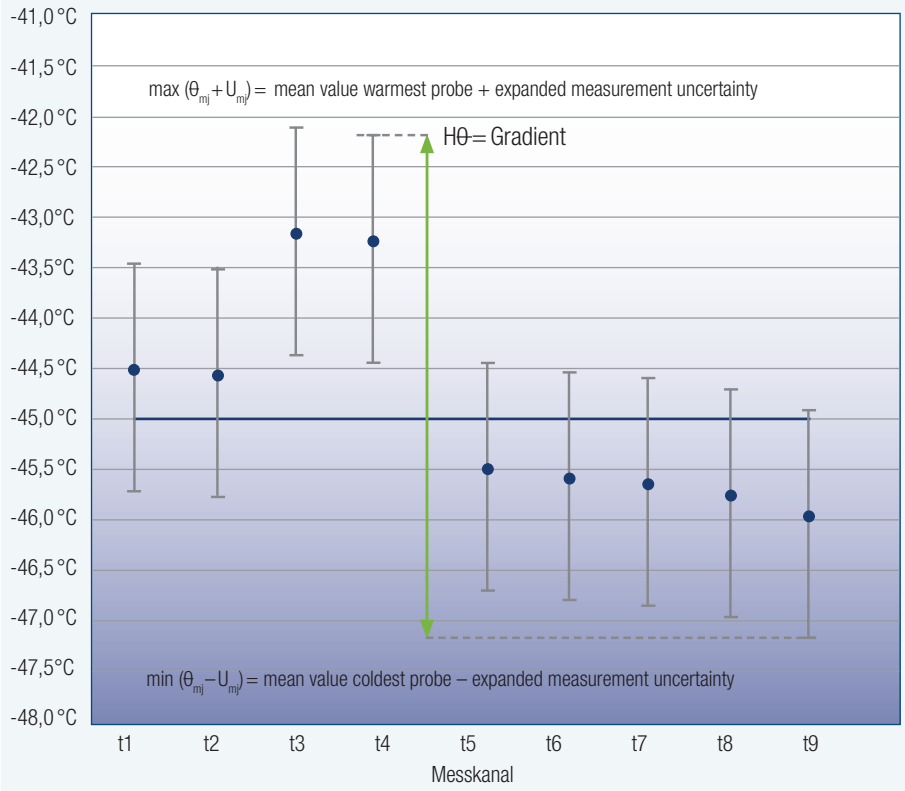
LCv 4010 – Evaluation of freezer compartment



Gradient HΘ: **6.0 K** (+2.6 K / –3.4 K from set temperature)

Max. fluctuation: **3.4 K**

LGT 2325 *

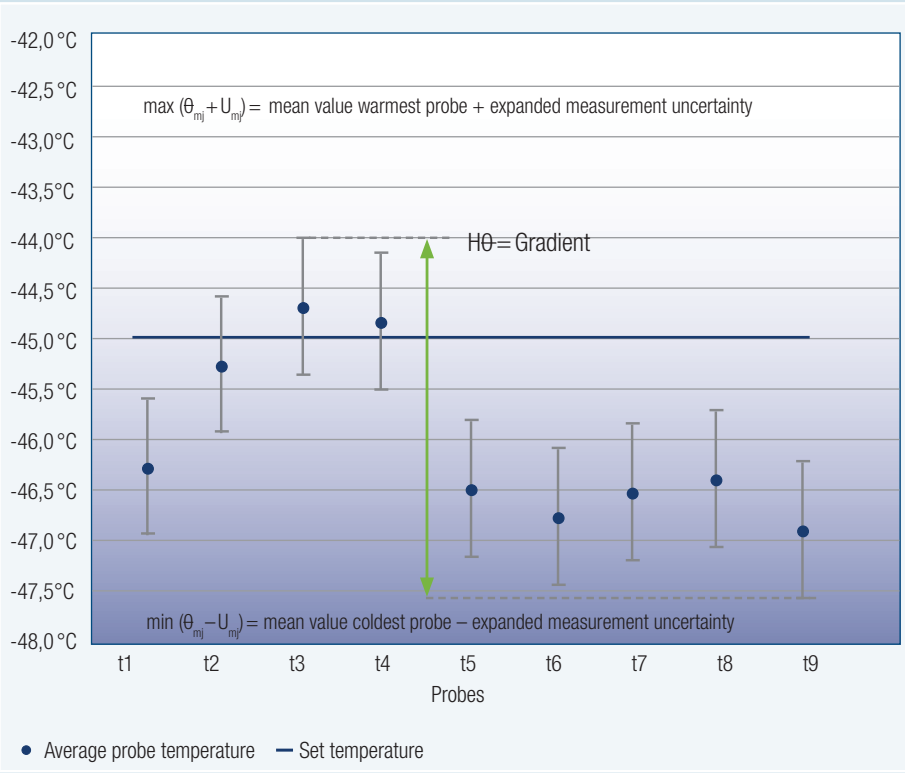


Gradient HΘ: **4,58 K** (+ 2,45 K/-2,13 K from set temperature)

Max. fluctuation: **1,8 K**

*If the cabinet is operated at -20 °C it is recommended to reduce the predefined offset of 2,7 K to 1,0 K (see user manual).

LGT 3725 *

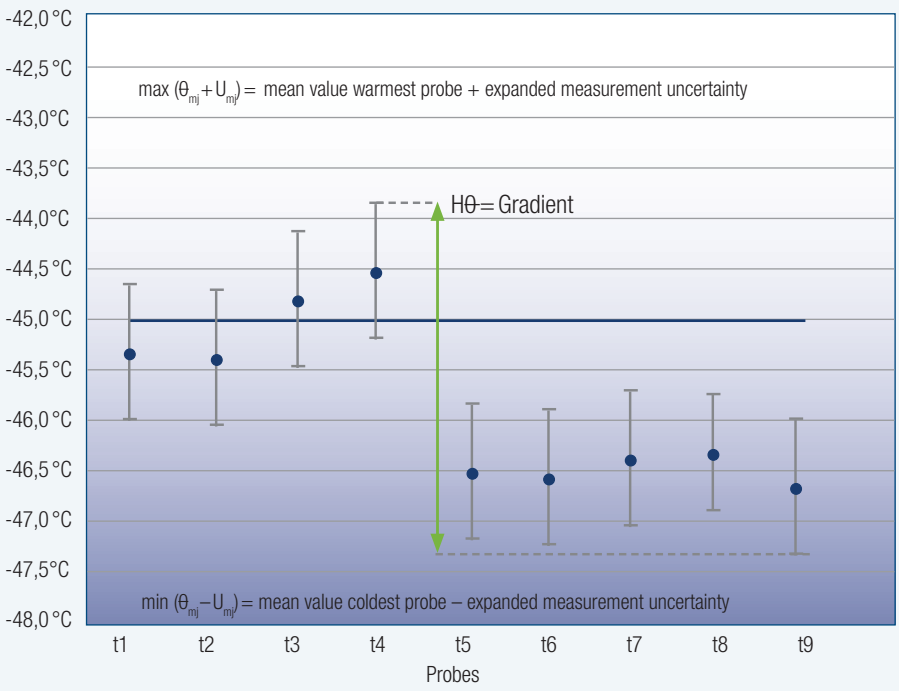


Gradient HΘ: **3,23 K** (+ 0,82 K/-2,41 K from set temperature)

Max. fluctuation: **0,5 K**

*If the cabinet is operated at -20 °C it is recommended to reduce the predefined offset of 2,7 K to 1,0 K (see user manual).

LGT 4725 *



Gradient Hθ: **3,27 K** (+ 0,8 K/-2,47 K from set temperature)

Max. fluctuation: **1,1 K**

*If the cabinet is operated at -20 °C it is recommended to reduce the predefined offset of 2,7 K to 1,0 K (see user manual).