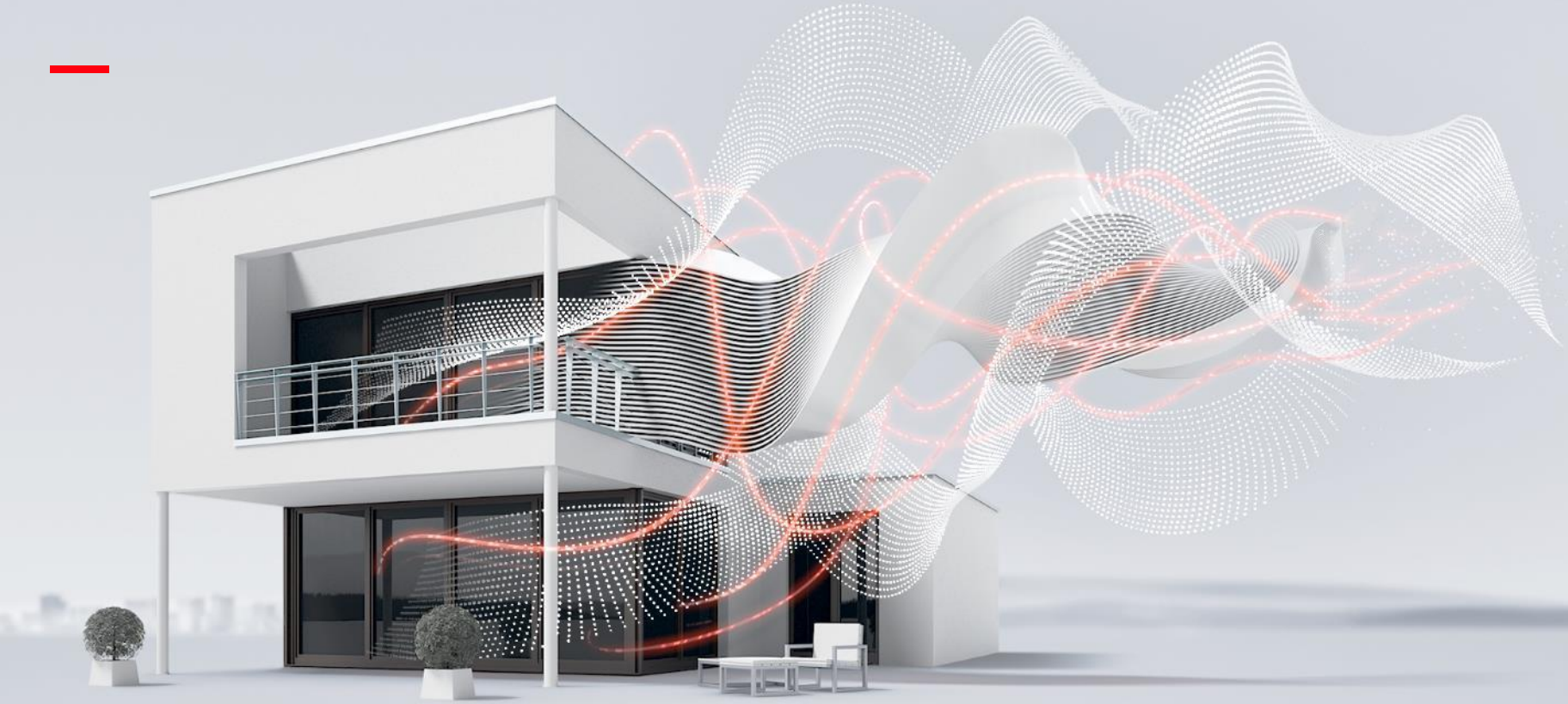


MAY 2020

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Online Learning Session – Competence Center Europe – Smart Buildings

Thorsten Reibel, Jürgen Schilder, Stefan Grosse, Martin Wichary & Olaf Stutzenberger

 Document ID.: Rev.:

Online Learning Session – Competence Center Europe - Smart Buildings

From home office to home office

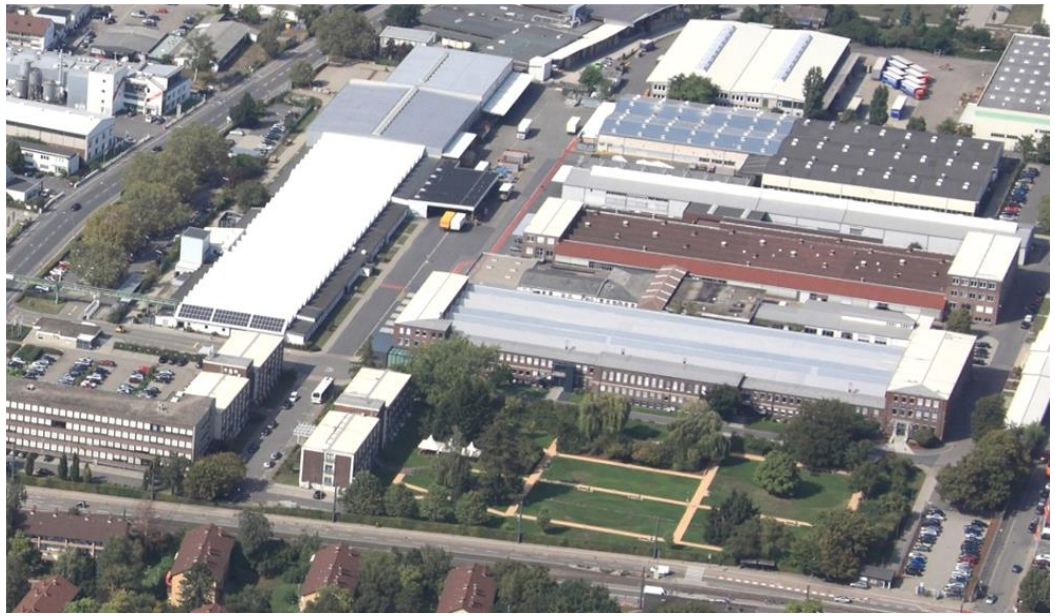
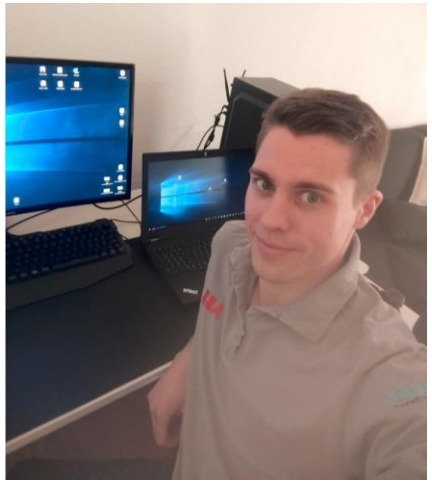


ABB STOTZ-KONTAKT GmbH
Heidelberg / Germany



Agenda

Introduction

Temperature and ventilation control of a BBQ Smoker

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter in a BBQ Grill

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

KNX Smart home and building solutions

KNX for every kind of project

KNX is the Standard (CEN, US, GB/T, ISO/IEC,…)

Guaranteed Interoperability through neutral certification

One Tool – the Engineering Tool Software ETS

Support for different transmission media

Easy coupling to other systems

Worldwide more than 91,000 partners and 500 training centres

Fit for use in **ALL** applications in home and building control

- Lighting
- Shutter and blinds
- HVAC
- …
- BBQ Grilling & Smoking

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Introduction

Outdoor grilling and smoking is becoming increasingly popular

Smoking takes place over several hours at low temperatures

Smoking meat or fish in a BBQ Smoker can take up to 12 hours and requires supervision (e.g. manual temperature control)

The following shows how a BBQ Smoker can be conveniently integrated into ABB i-bus KNX

- Temperature measurement
- Blower control depending on the temperature (threshold function)
- Display and control with the mobile phone (Busch-ControlTouch®)

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

BBQ Smoker – low and slow

A barbecue smoker is a wood or coal-fired oven in which food is cooked or smoked in hot smoke

Unlike when grilling, the food is not directly over the embers or fire

The typical cooking space temperature for a barbecue is between 90° and 130° Celsius

Classic dishes that are prepared in a barbecue smoker are, above all, spare ribs (pork ribs), pulled pork (pork shredded or chopped from the neck or shoulder after cooking) and beef brisket

- Barrel Smoker (the most common form of BBQ smoker)
- Reverse Flow Smoker
- Ugly Drum Smoker UDS
- Water Smoker
- …

Original barbecue in the pit 18th and 19th centuries

Barrel Smoker with side firebox and cooking chamber

Smoker truck

Water Smoker

UDS

Source: Internet

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

How a UDS – Ugly Drum Smoker works

The UDS consists of a steel barrel (200 liters)

The smoker is created by installing a charcoal basket, adjustable ventilation openings (ball valve) and one or more grill grates

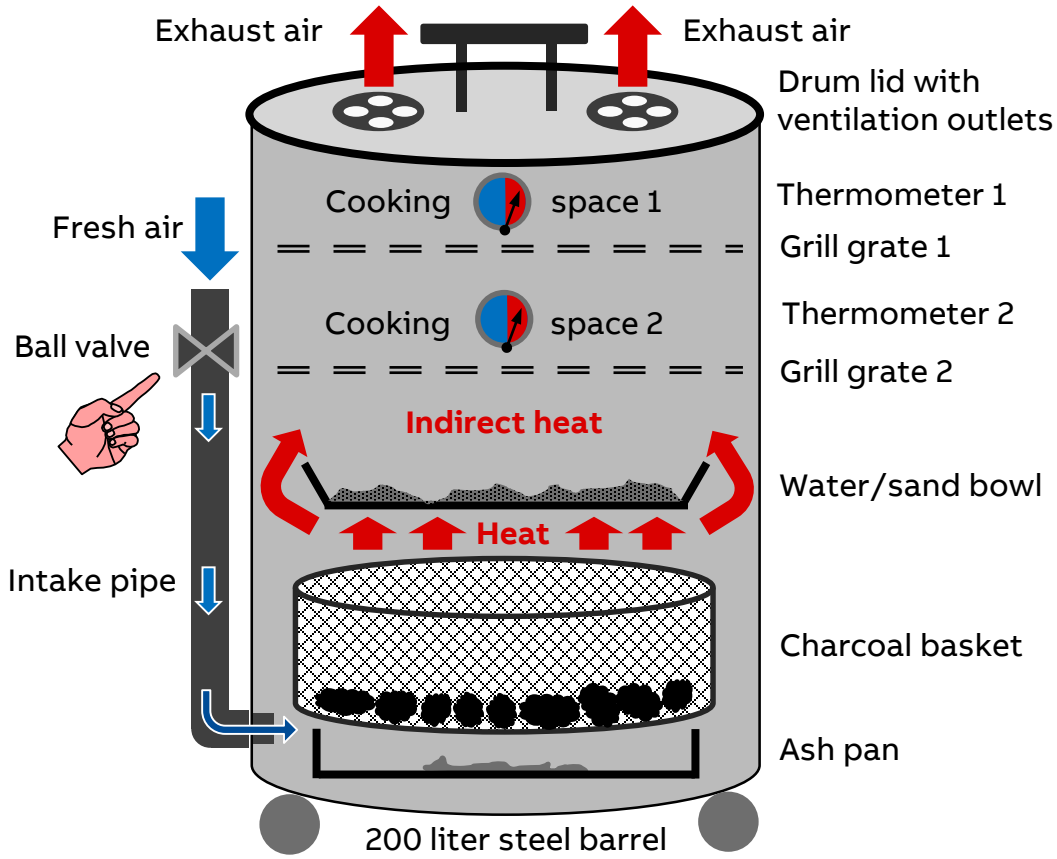
A water or sand bowl serves as a heat store and to compensate for temperature fluctuations

The cooking space temperature is checked with thermometers

The lighting is done with charcoal or briquettes

The coals slowly glow for hours

By controlling the air supply at the adjustable air inlets at floor level of the barrel, often ball valves arranged evenly around the barrel are used, the temperature inside can be regulated relatively accurately and stably



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

How a UDS – Ugly Drum Smoker works

The UDS consists of a steel barrel (200 liters)

The smoker is created by installing a charcoal basket, adjustable ventilation openings (ball valve) and one or more grill grates

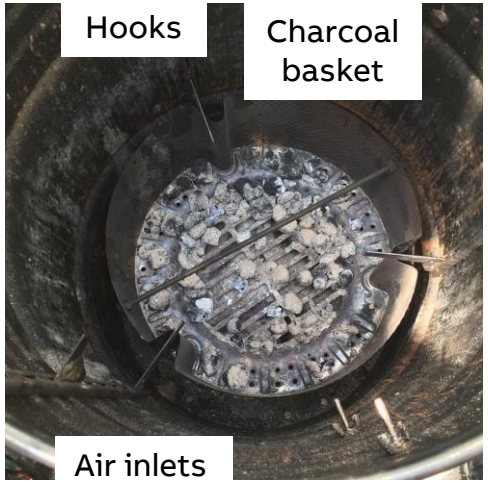
A water or sand bowl serves as a heat store and to compensate for temperature fluctuations

The cooking space temperature is checked with thermometers

The lighting is done with charcoal or briquettes

The coals slowly glow for hours

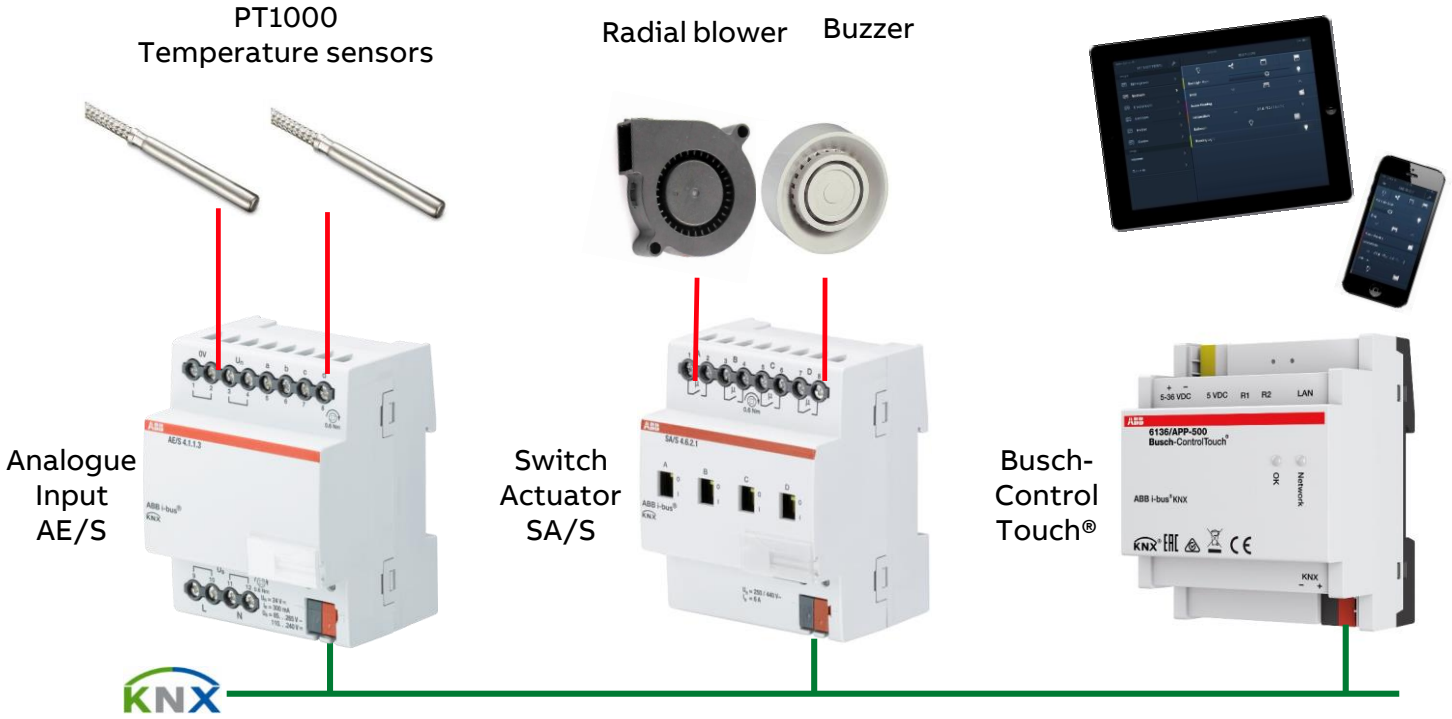
By controlling the air supply at the adjustable air inlets at floor level of the barrel, often ball valves arranged evenly around the barrel are used, the temperature inside can be regulated relatively accurately and stably



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Device overview



UDS – Ugly Drum Smoker

Temperature Control of a BBQ Smoker with ABB i-bus KNX

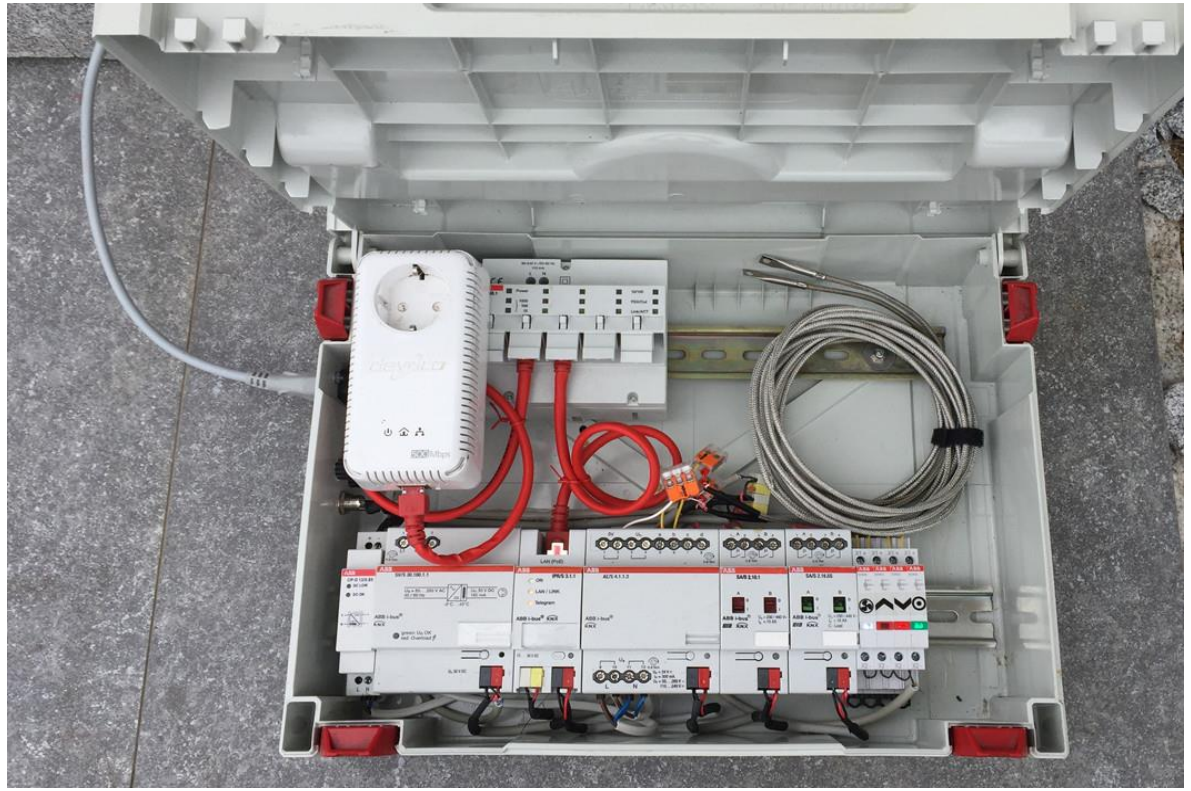
Temperature and ventilation control

KNX BBQ Controller Box

Separate KNX line (outside the building)

Communication takes place with powerline adapter via the existing power network (PowerLAN)

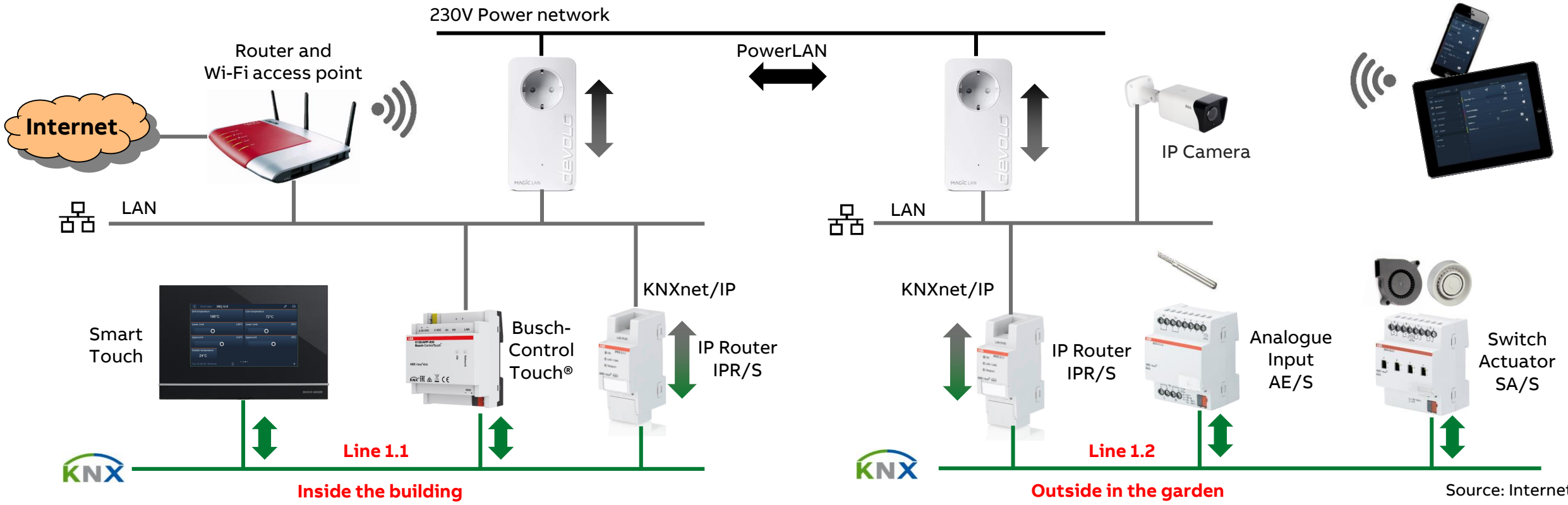
- KNX Power Supply SV/S
- 12V Power Supply CP-D
- IP Router IPR/S
- Analogue Input AE/S
- Switch Actuator SA/S
- Indicator lights E219



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

KNX outside of the building – Powerline LAN adapter: Internet in any room and in the garden



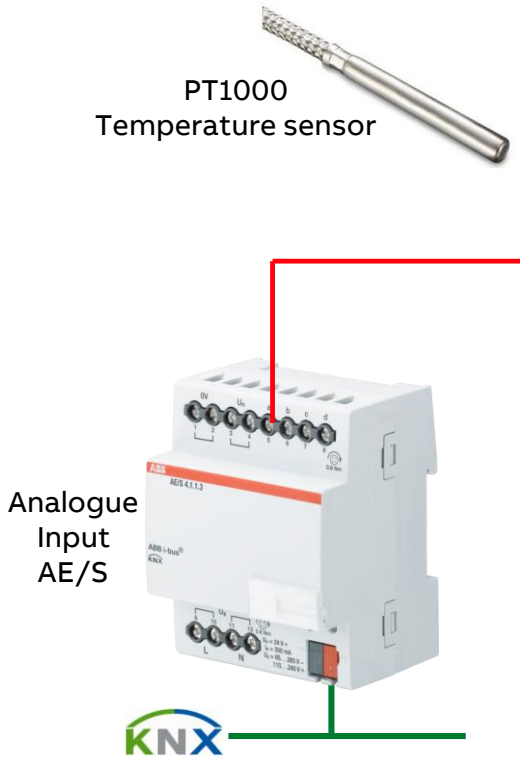
Source: Internet

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Analog Input: Measuring temperatures

The temperature in a BBQ Smoker can be measured with temperature sensors on an Analogue Input AE/S or AE/A



Temperature Control of a BBQ Smoker with ABB i-bus KNX

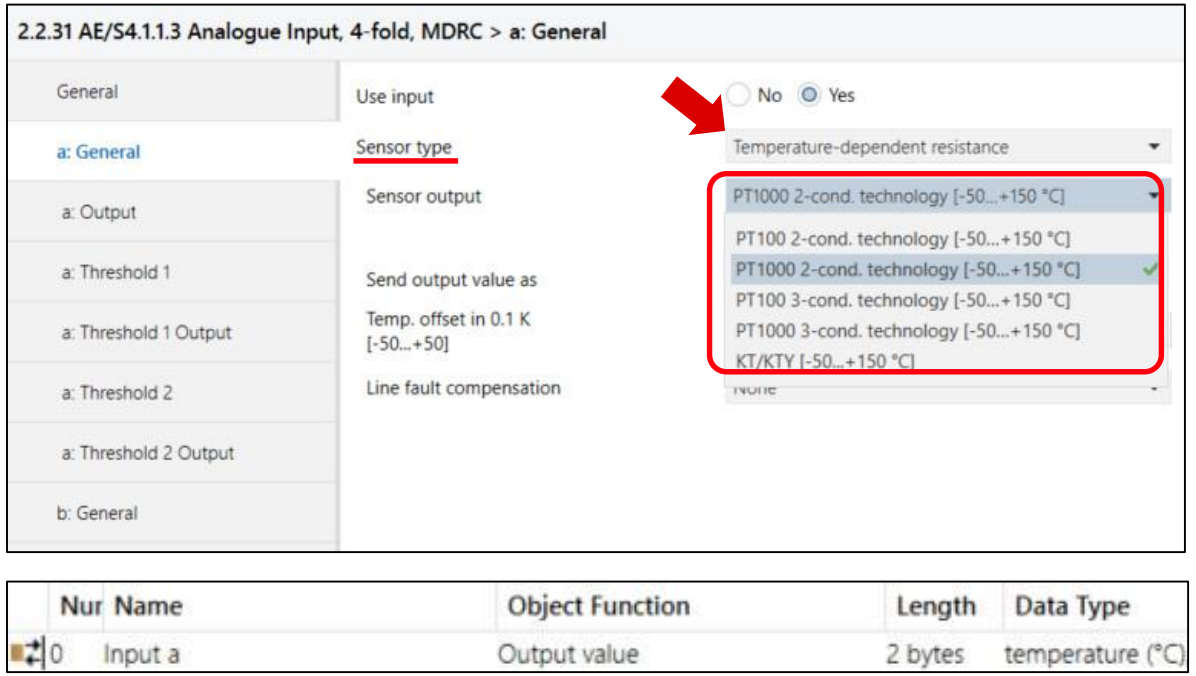
Temperature and ventilation control

Analog Input: Measuring temperatures

The temperature in a BBQ Smoker can be measured with temperature sensors on an Analogue Input AE/S or AE/A

When directly connecting temperature sensors (PT100, PT1000, KTY,…) to an Analogue Input, temperatures between -50°C … +150°C can be measured
This is sufficient for low temperature smokers (90°C … 130°C)

The temperature is sent to the KNX as a 2-byte float value (DPT 9.001 temperature °C)



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Analog Input: Threshold functions

It is possible to set two thresholds per input

The thresholds each have an upper and lower limit which can be set independently

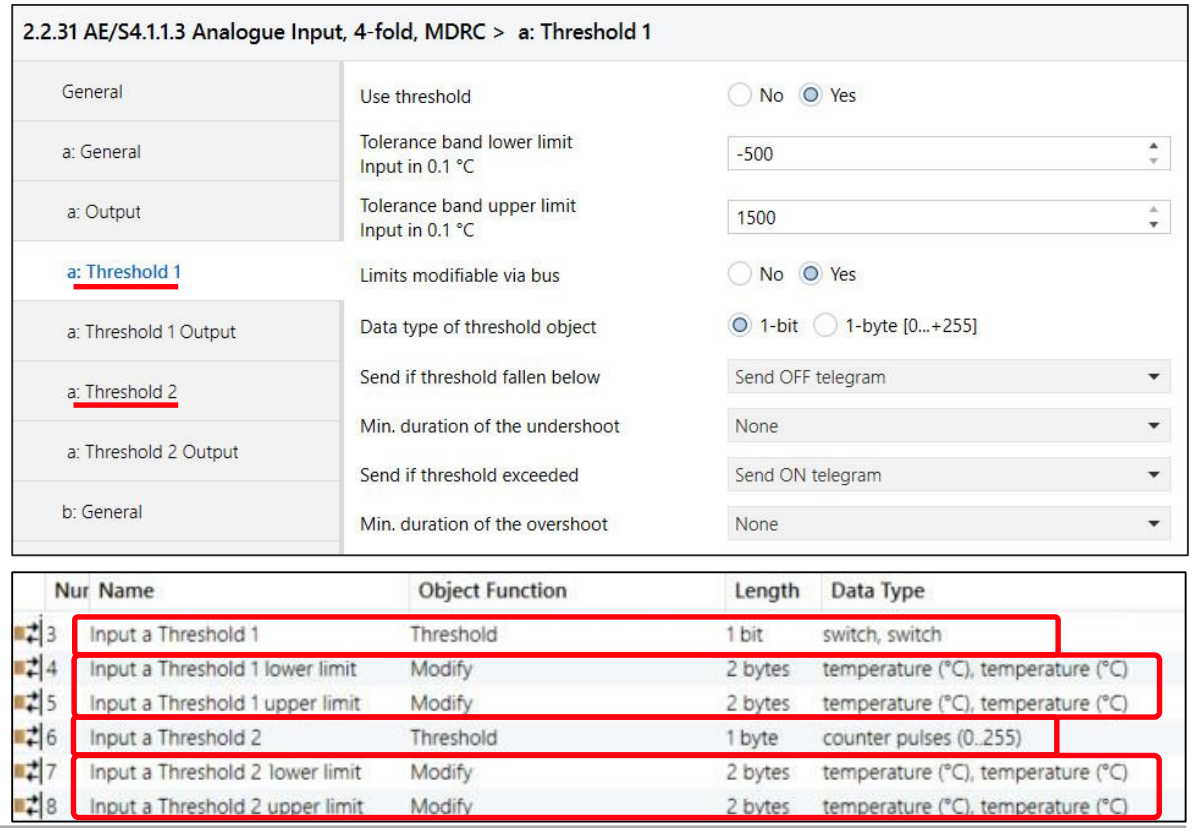
The sending behavior when falling below/exceeding can be set

Data type of threshold object can be a 1-bit or 1-byte value

→ The group object *”Input x Threshold”* appears

The thresholds themselves can be changed via KNX

→ The group objects *”Input x Threshold lower limit - Modify”* and *”Input x Threshold upper limit - Modify”* appears



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

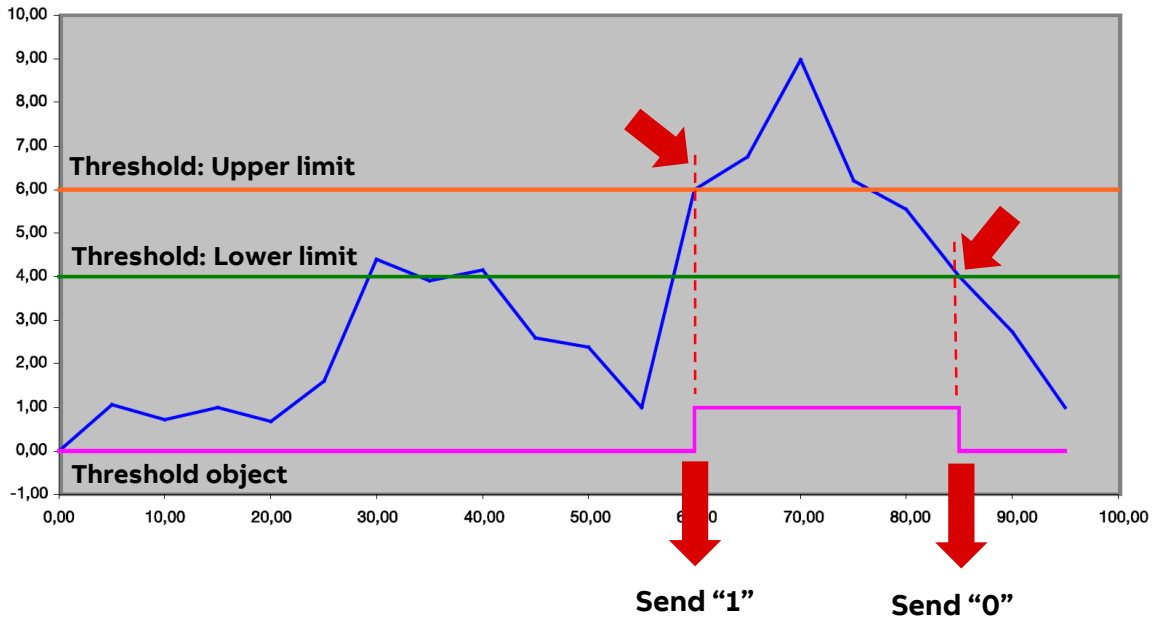
Analog Input: How does the threshold function work?

ETS default settings

- Data type of threshold object is set to a 1-bit value
- An “ON” telegram is sent with an overshoot of the threshold and an “OFF” telegram is sent with an undershoot of the threshold

As soon as the measured value exceeds the upper limit of threshold 1, the group object *”Threshold – Input a Threshold 1”* will change value to “1”

The group object *”Threshold – Input a Threshold 1”* will remain “1” until the measured value falls back below the lower limit of threshold 1



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Analog Input - Threshold function: Blower control

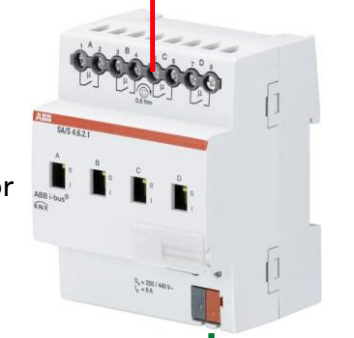
The temperature is regulated by blowing in air

A blower is switched via a Switch Actuator SA/S and controlled via the threshold function of the Analog Input AE/S

If the temperature falls below the lower limit, a blower is switched on and blows air into the smoker → the temperature rises

If the temperature exceeds the upper limit, a blower is switched off → temperature falls down

Radial blower
(3D-printer)



Switch
Actuator
SA/S

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Analog Input - Threshold function: Blower control

The temperature is regulated by blowing in air

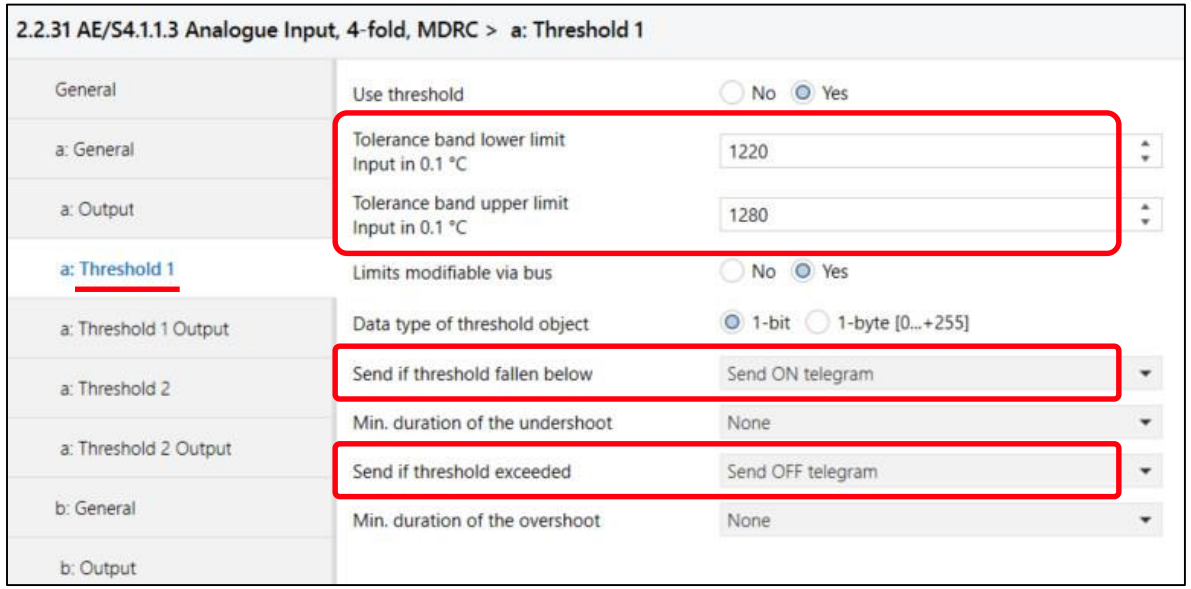
A blower is switched via a Switch Actuator SA/S and controlled via the threshold function of the Analog Input AE/S

If the temperature falls below the lower limit, a blower is switched on and blows air into the smoker → the temperature rises

If the temperature exceeds the upper limit, a blower is switched off → temperature falls down

ETS parameter

- Tolerance band lower limit Input: 122°C
- Tolerance band upper limit Input in 128°C
- Send if threshold fallen below: Send “ON” telegram → blower ON
- Send if threshold exceeded: Send “OFF” telegram → blower OFF



Temperature Control of a BBQ Smoker with ABB i-bus KNX

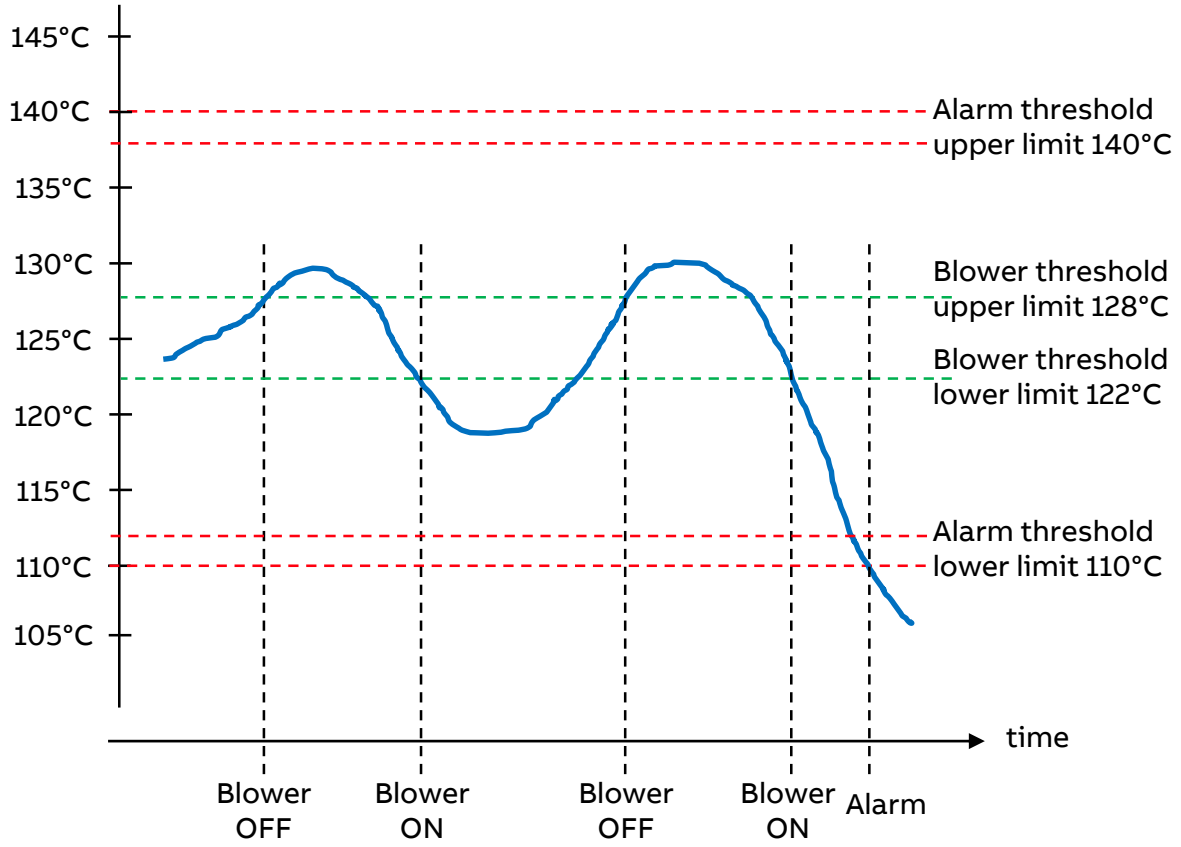
Temperature and ventilation control

Analog Input - Threshold function: Alarm notification

The temperature limit values are also monitored with further threshold functions

Alarm messages are sent to the smartphone via push notifications and a buzzer is switched on via a switch actuator

- If the upper temperature limit is exceeded 140°C → blower does not switch off and continues to blow air into the smoker
- When the temperature falls below the lower temperature limit 110°C → fire goes out



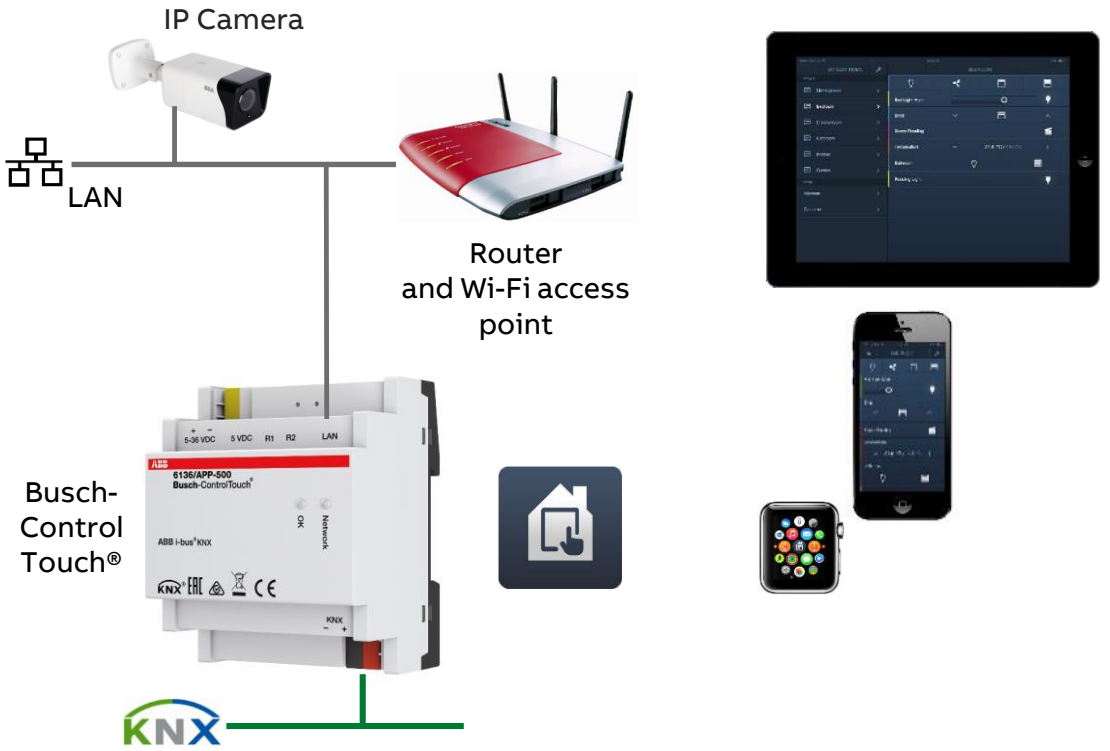
Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Busch-ControlTouch®

KNX visualization for smartphones, tablets and Windows computers

- Display of
  - Temperature
  - Threshold upper or lower limit
  - ON/OFF status of the blower
  - IP cameras
- Set the threshold limits
  - Lower limit: Switch blower ON
  - Upper limit: Switch blower OFF
- Messages via push notifications to the smartphone
  - Alarm when the limit temperatures are exceeded
  - Information when the core temperature is reached



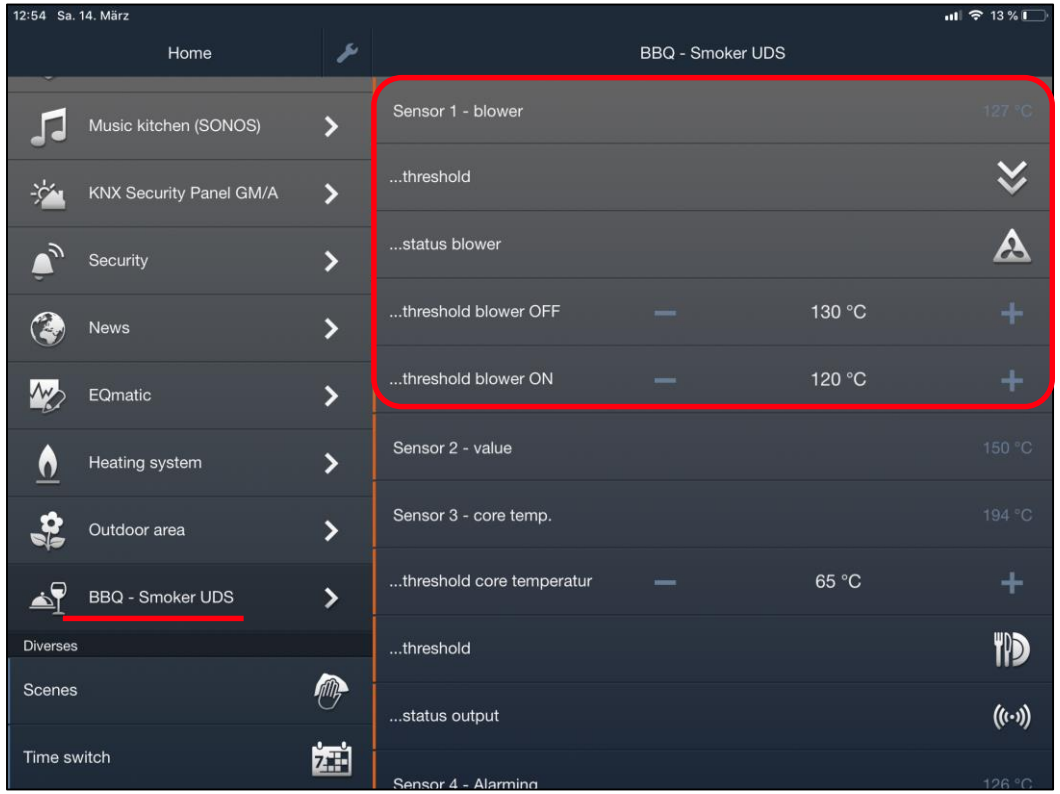
Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Busch-ControlTouch®

KNX visualization for smartphones, tablets and Windows computers

- Display of
  - Temperature
  - Threshold upper or lower limit
  - ON/OFF status of the blower
  - IP cameras
- Set the threshold limits
  - Lower limit: Switch blower ON
  - Upper limit: Switch blower OFF
- Messages via push notifications to the smartphone
  - Alarm when the limit temperatures are exceeded
  - Information when the core temperature is reached



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Busch-ControlTouch®

KNX visualization for smartphones, tablets and Windows computers

- Display of
  - Temperature
  - Threshold upper or lower limit
  - ON/OFF status of the blower
  - IP cameras
- Set the threshold limits
  - Lower limit: Switch blower ON
  - Upper limit: Switch blower OFF
- Messages via push notifications to the smartphone
  - Alarm when the limit temperatures are exceeded
  - Information when the core temperature is reached

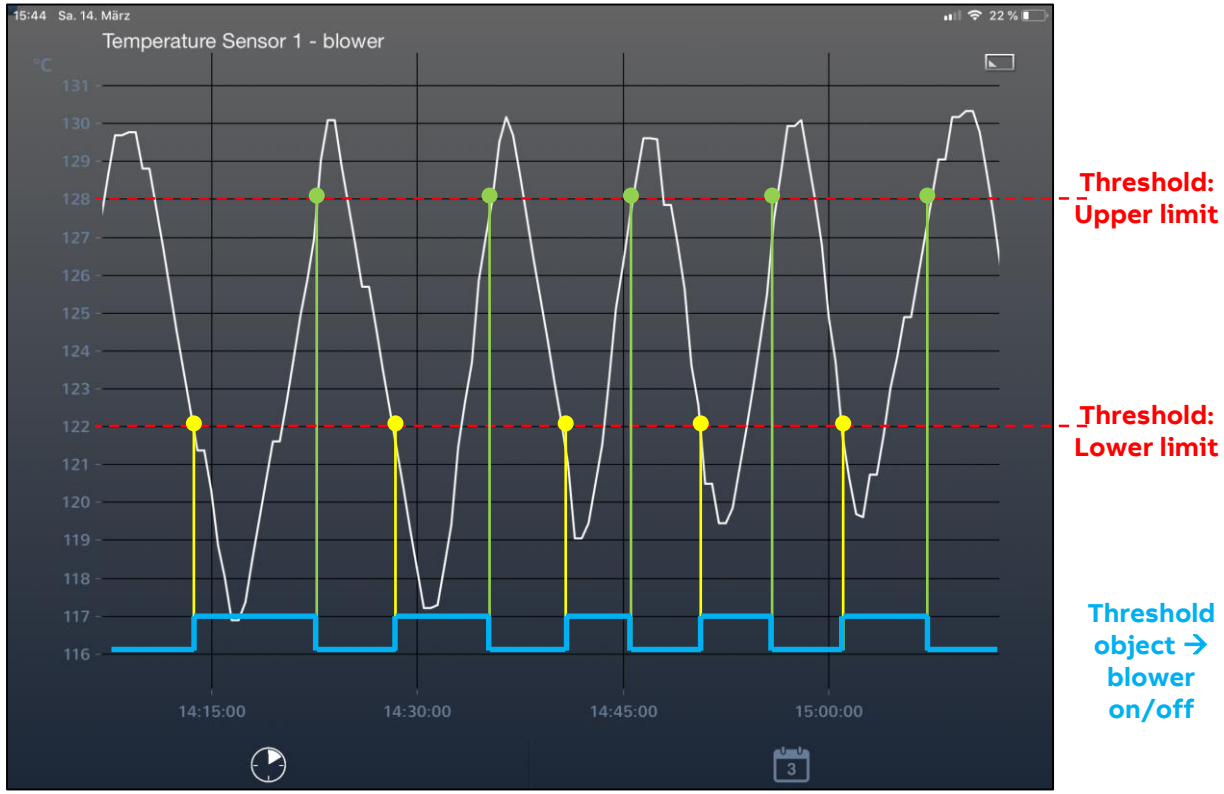
Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Busch-ControlTouch®

KNX visualization for smartphones, tablets and Windows computers

- Display of
  - Temperature
  - Threshold upper or lower limit
  - ON/OFF status of the blower
  - IP cameras
- Set the threshold limits
  - Lower limit: Switch blower ON
  - Upper limit: Switch blower OFF
- Messages via push notifications to the smartphone
  - Alarm when the limit temperatures are exceeded
  - Information when the core temperature is reached



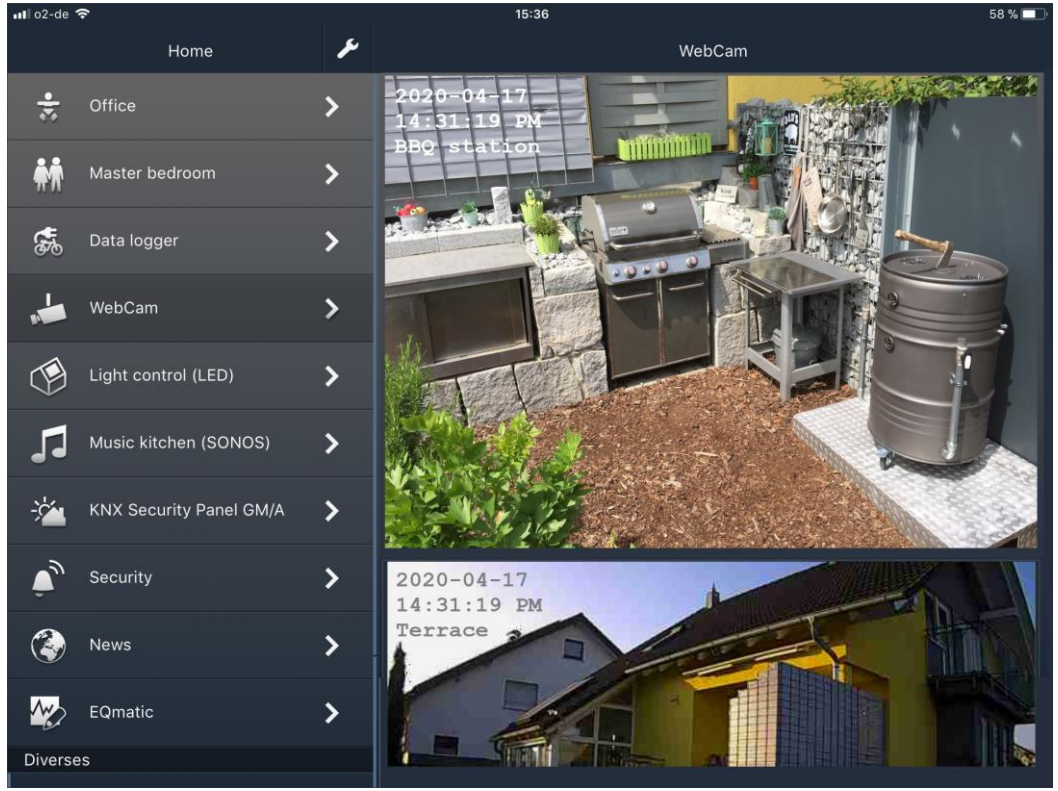
Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control

Busch-ControlTouch®

KNX visualization for smartphones, tablets and Windows computers

- Display of
  - Temperature
  - Threshold upper or lower limit
  - ON/OFF status of the blower
  - IP cameras
- Set the threshold limits
  - Lower limit: Switch blower ON
  - Upper limit: Switch blower OFF
- Messages via push notifications to the smartphone
  - Alarm when the limit temperatures are exceeded
  - Information when the core temperature is reached



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3	Input A	Output value (2 byte)
		Threshold 1 (1 bit)
		Threshold 1 lower limit – modify (2 byte)
		Threshold 1 upper limit – modify (2 byte)
		…
	Input B	Output value (2 byte)
		Threshold 1 (1 bit)
		Threshold 1 lower limit – modify (2 byte)
		Threshold 1 upper limit – modify (2 byte)
		Threshold 2 (1 bit)
		Threshold 2 lower limit – modify (2 byte)
		Threshold 2 upper limit – modify (2 byte)
		…

Input A: Blower control
Input B: Alarm notification

Switch Actuator SA/S	Output A	Switch (1 bit)
		Status Switch (1 bit)
		…
	Output B	Switch (1 bit)
		Status Switch (1 bit)
		…

Busch-ControlTouch®

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3	Input A	Output value (2 byte)
		Threshold 1 (1 bit)
		Threshold 1 lower limit – modify (2 byte)
		Threshold 1 upper limit – modify (2 byte)
		…
	Input B	Output value (2 byte)
		Threshold 1 (1 bit)
		Threshold 1 lower limit – modify (2 byte)
		Threshold 1 upper limit – modify (2 byte)
		Threshold 2 (1 bit)
		Threshold 2 lower limit – modify (2 byte)
		Threshold 2 upper limit – modify (2 byte)
		…

Input A: Blower control
Input B: Alarm notification

Switch Actuator SA/S	Output A	Switch (1 bit)
		Status Switch (1 bit)
		…
	Output B	Switch (1 bit)
		Status Switch (1 bit)
		…

Busch-ControlTouch®

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3		
Input A	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	…	
Input B	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	Threshold 2 (1 bit)	
	Threshold 2 lower limit – modify (2 byte)	
	Threshold 2 upper limit – modify (2 byte)	
	…	

Switch Actuator SA/S		
Output A	Switch (1 bit)	
	Status Switch (1 bit)	
	…	
Output B	Switch (1 bit)	
	Status Switch (1 bit)	
	…	

Input A: Blower control
Input B: Alarm notification

Busch-ControlTouch®

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3		
Input A	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	…	
Input B	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	Threshold 2 (1 bit)	
	Threshold 2 lower limit – modify (2 byte)	
	Threshold 2 upper limit – modify (2 byte)	
	…	

Switch Actuator SA/S		
Output A	Switch (1 bit)	
	Status Switch (1 bit)	
	…	
Output B	Switch (1 bit)	
	Status Switch (1 bit)	
	…	

Busch-ControlTouch®

Input A: Blower control
Input B: Alarm notification

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3		
	Input A	Output value (2 byte)
		Threshold 1 (1 bit)
		Threshold 1 lower limit – modify (2 byte)
		Threshold 1 upper limit – modify (2 byte)
		…
	Input B	Output value (2 byte)
		Threshold 1 (1 bit)
		Threshold 1 lower limit – modify (2 byte)
		Threshold 1 upper limit – modify (2 byte)
		Threshold 2 (1 bit)
		Threshold 2 lower limit – modify (2 byte)
		Threshold 2 upper limit – modify (2 byte)
		…

Switch Actuator SA/S		
	Output A	Switch (1 bit)
		Status Switch (1 bit)
		…
	Output B	Switch (1 bit)
		Status Switch (1 bit)
		…

Busch-ControlTouch®

Input A: Blower control
Input B: Alarm notification

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3		
Input A	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	…	
Input B	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	Threshold 2 (1 bit)	
	Threshold 2 lower limit – modify (2 byte)	
	Threshold 2 upper limit – modify (2 byte)	
	…	

Switch Actuator SA/S		
Output A	Switch (1 bit)	
	Status Switch (1 bit)	
	…	
Output B	Switch (1 bit)	
	Status Switch (1 bit)	
	…	

Busch-ControlTouch®

Input A: Blower control
Input B: Alarm notification

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Temperature and ventilation control – Example: Assignment of Group Addresses

Analogue Input AE/S 4.1.1.3		
Input A	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	…	
Input B	Output value (2 byte)	
	Threshold 1 (1 bit)	
	Threshold 1 lower limit – modify (2 byte)	
	Threshold 1 upper limit – modify (2 byte)	
	Threshold 2 (1 bit)	
	Threshold 2 lower limit – modify (2 byte)	
	Threshold 2 upper limit – modify (2 byte)	
	…	

Switch Actuator SA/S		
Output A	Switch (1 bit)	
	Status Switch (1 bit)	
	…	
Output B	Switch (1 bit)	
	Status Switch (1 bit)	
	…	

Input A: Blower control
Input B: Alarm notification

Busch-ControlTouch®

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input and additional analogue transmitter in a BBQ Grill

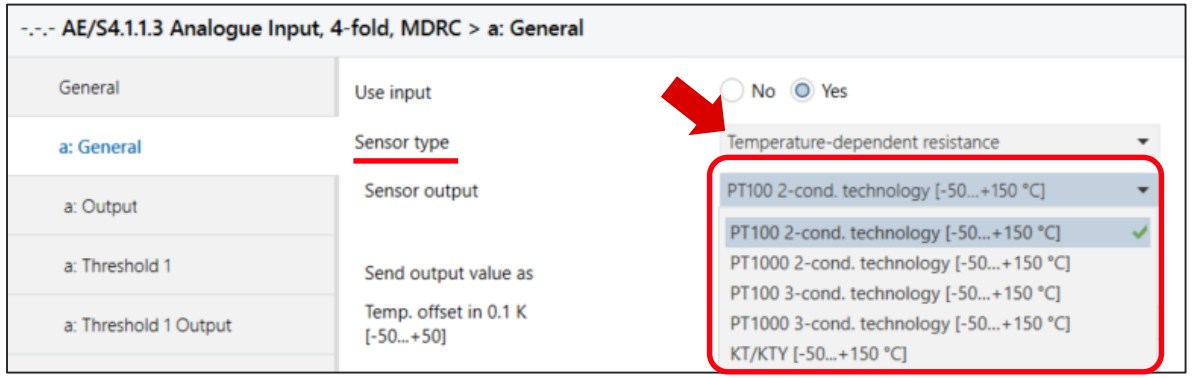
Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Temperature measurement in a BBQ Grill

When directly connecting temperature sensors (PT100, PT1000, KTY,…) to a KNX Analogue Input AE/S, temperatures between -50°C … +150°C can be measured

In special applications, temperatures above 150°C must be measured, e.g. 200°C grill temperature of chicken drumsticks, cherry cheese cake, salmon, bread, …



Source: Internet

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Temperature measurement in a BBQ Grill

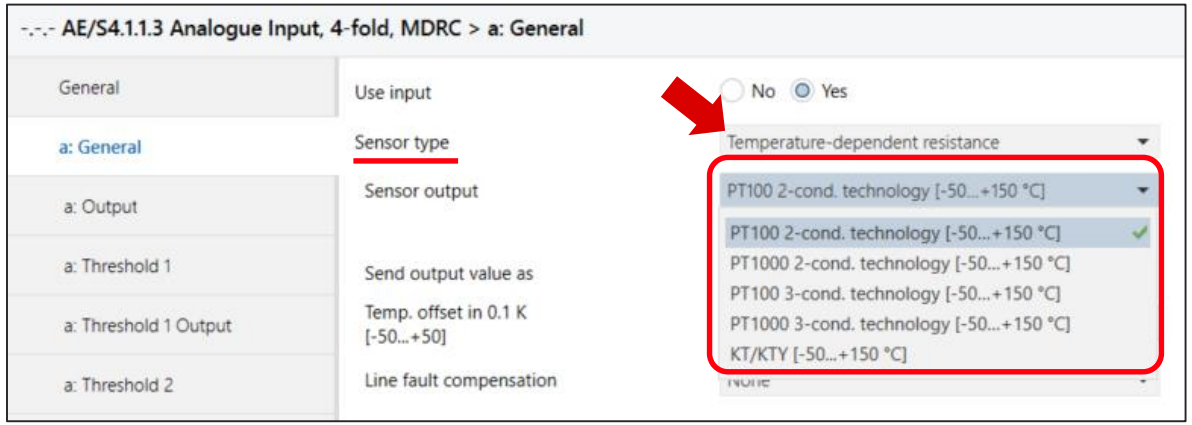
When directly connecting temperature sensors (PT100, PT1000, KTY,…) to a KNX Analogue Input AE/S, temperatures between -50°C … +150°C can be measured

In special applications, temperatures above 150°C must be measured, e.g. 200°C grill temperature of chicken drumsticks, cherry cheese cake, salmon, bread, …

Measuring high temperatures is also reuired in other applications, e.g. combustion engines

The temperature range of an Analogue Input AE/S can be expanded with analogue transmitter

Depending on the temperature sensor used, temperatures in a measuring range of e.g. -100°C … +50°C, 0°C … +200°C or 0°C … +400°C can be measured



Source: www.sensorshop24.de

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Analogue transmitters

Analogue transmitters are available with various analog output signals, e.g.

– 0 … 10 V

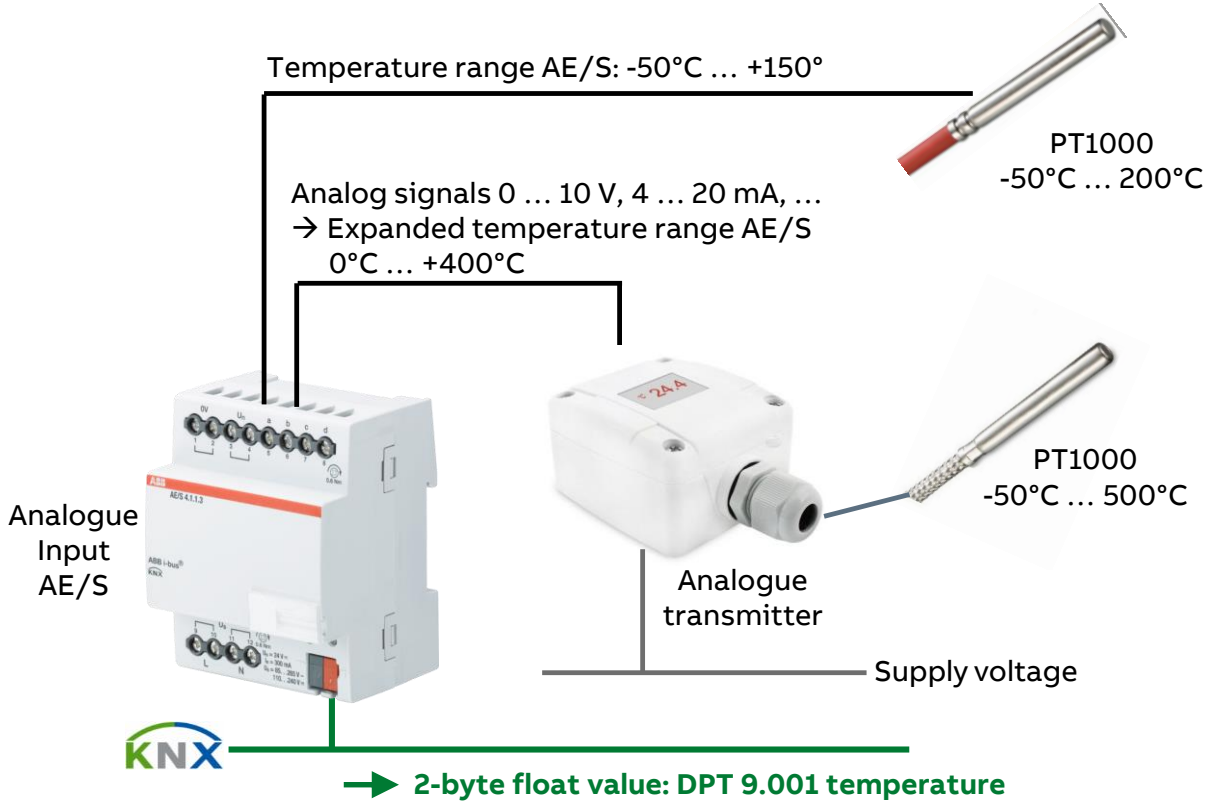
– 4 … 20 mA

They must be supplied with a voltage (12/24 V AC/DC)

Depending on the measuring range of the sensor, different measuring ranges can be set using DIP switches

The set measuring range is mapped to the analog signal

Measuring range	1	2	3	4	5
-100°C … +50°C	OFF	OFF	OFF	OFF	OFF
-30°C … +70°C	OFF	ON	ON	OFF	OFF
0°C … +400°C	**ON**	**OFF**	**ON**	**OFF**	**ON**
…	…	…	…	…	…



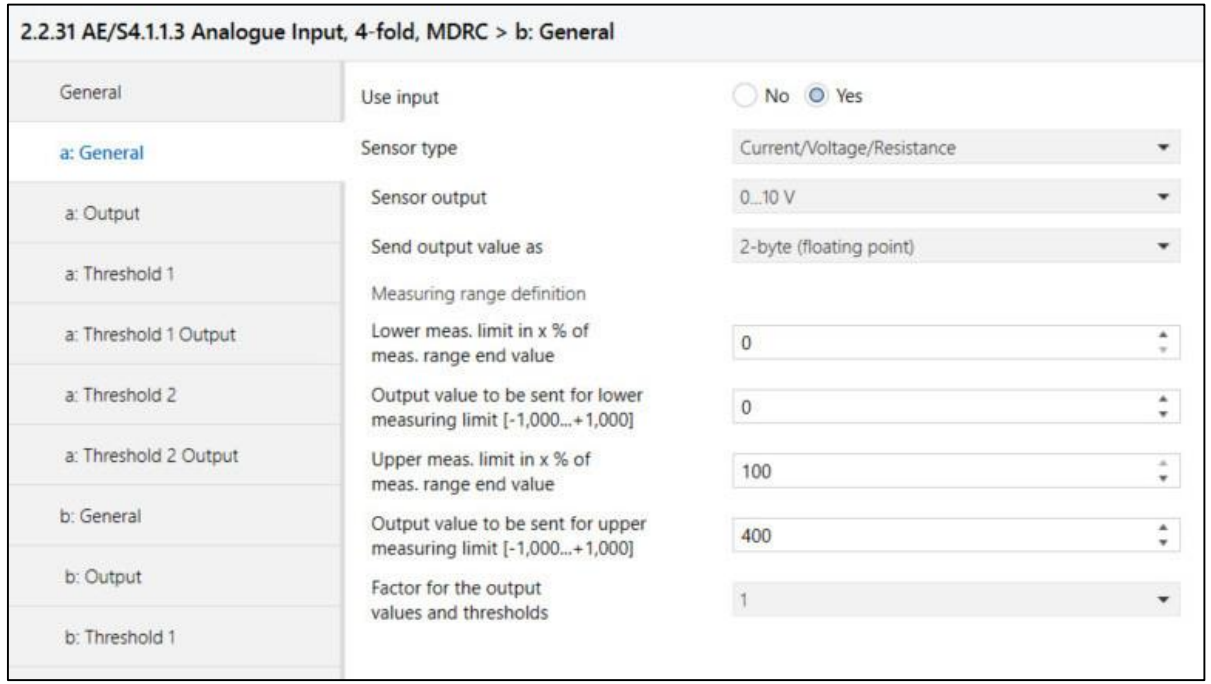
Source: www.sensorshop24.de

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Analogue Input AE/S: Parameter settings

– Set measuring range of the analogue transmitter
  e.g. 0°C … +400°C

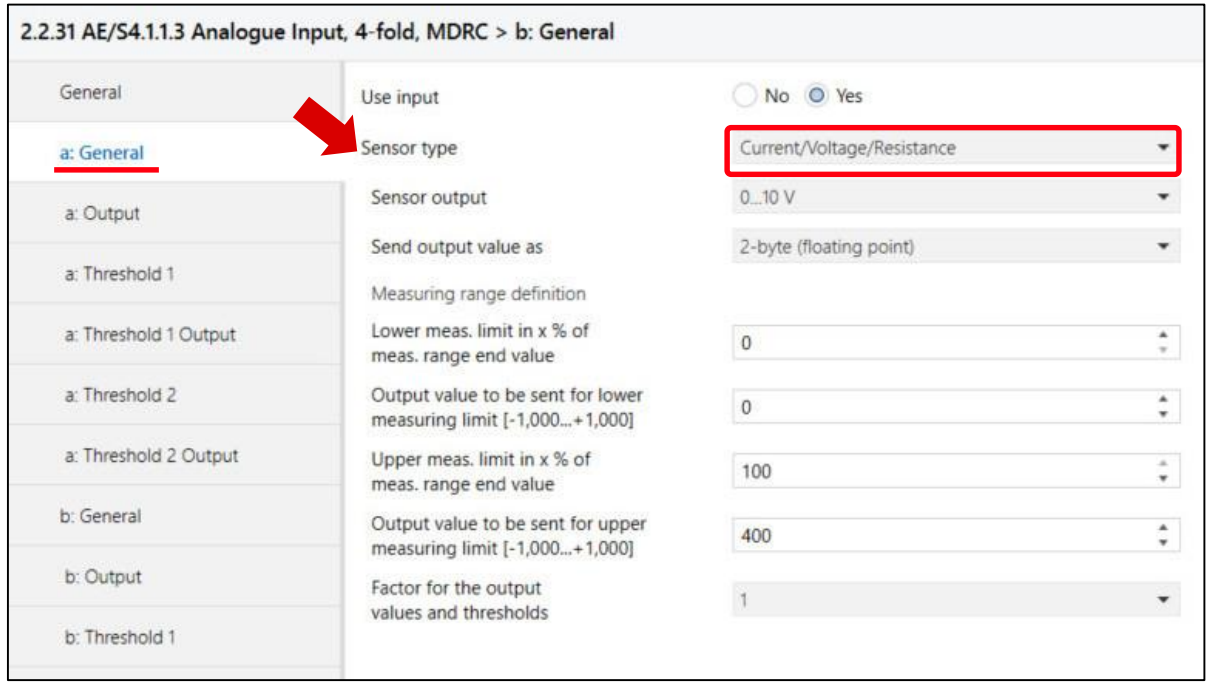


Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Analogue Input AE/S: Parameter settings

- Set measuring range of the analogue transmitter
  e.g. 0°C … +400°C
- Sensor type “Current/Voltage/Resistance”

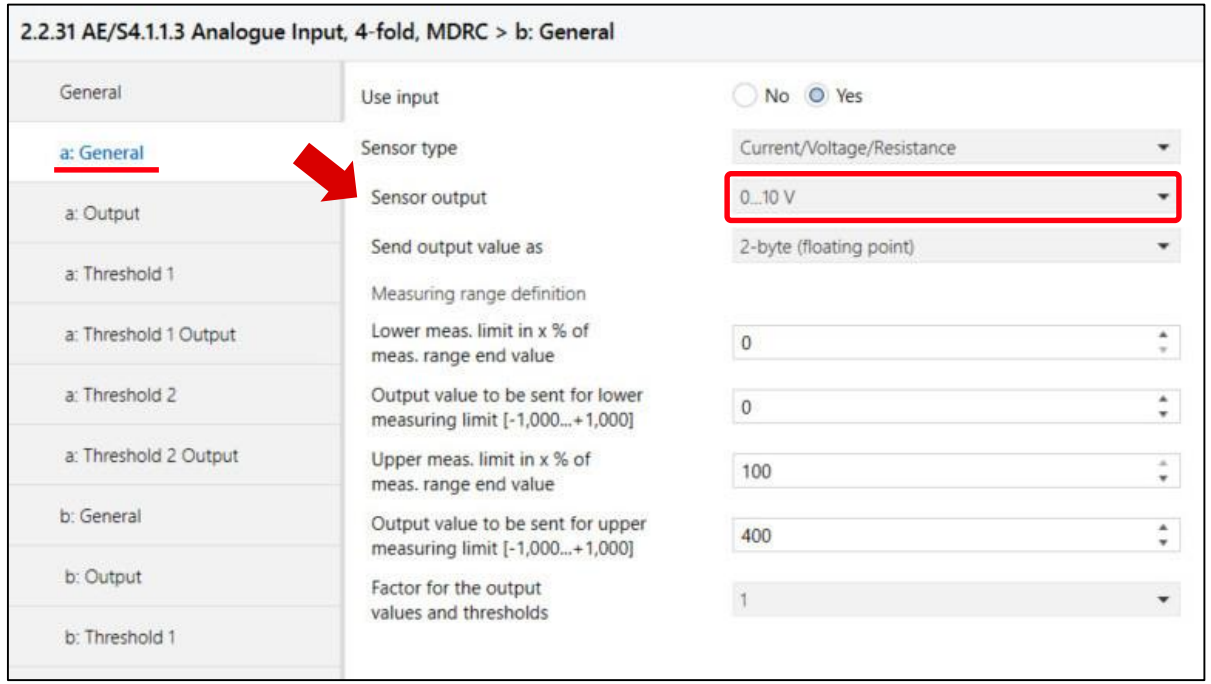


Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Analogue Input AE/S: Parameter settings

- Set measuring range of the analogue transmitter
  e.g. 0°C … +400°C
- Sensor type “Current/Voltage/Resistance”
- Sensor output (voltage or current) depends on the device variant of the analogue transmitter (0…10V)

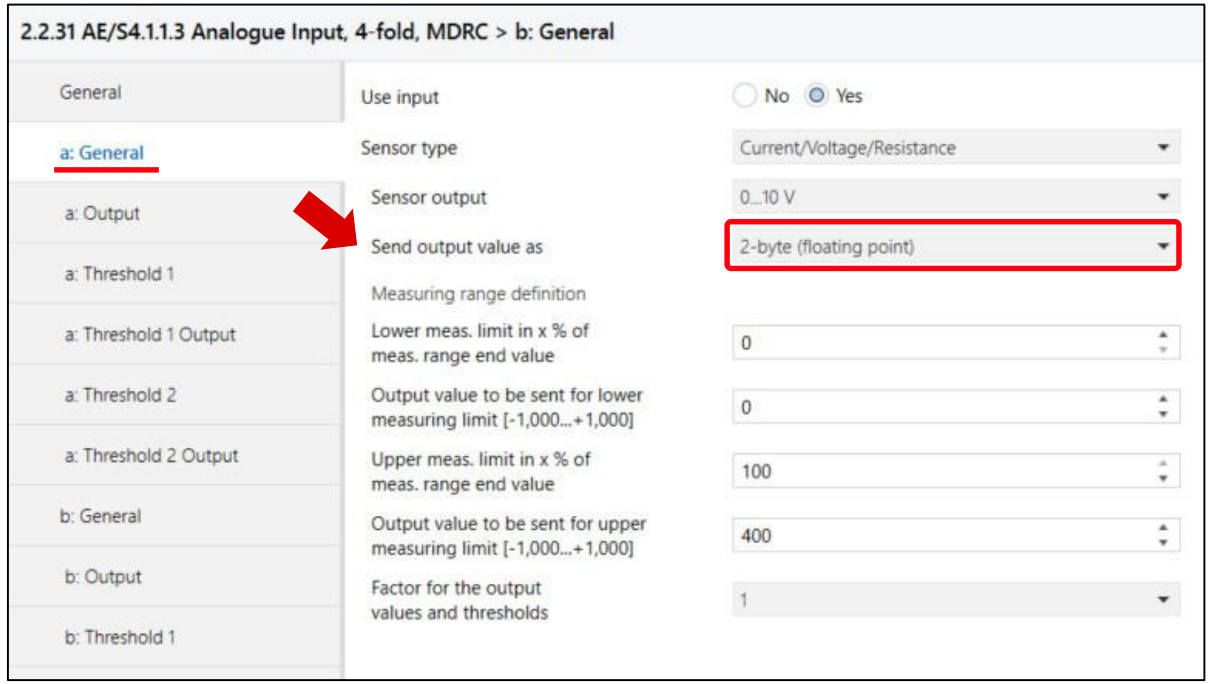


Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Analogue Input AE/S: Parameter settings

- Set measuring range of the analogue transmitter
  e.g. 0°C … +400°C
- Sensor type “Current/Voltage/Resistance”
- Sensor output (voltage or current) depends on the device variant of the analogue transmitter (0…10V)
- The output value is sent as “2-byte float value” (DPT 9.001 temp.)

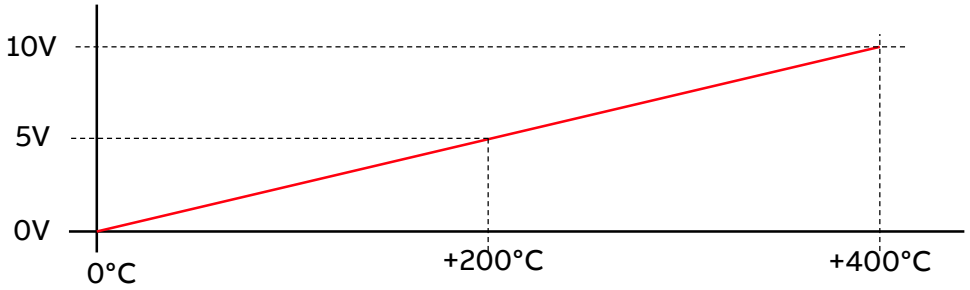


Temperature Control of a BBQ Smoker with ABB i-bus KNX

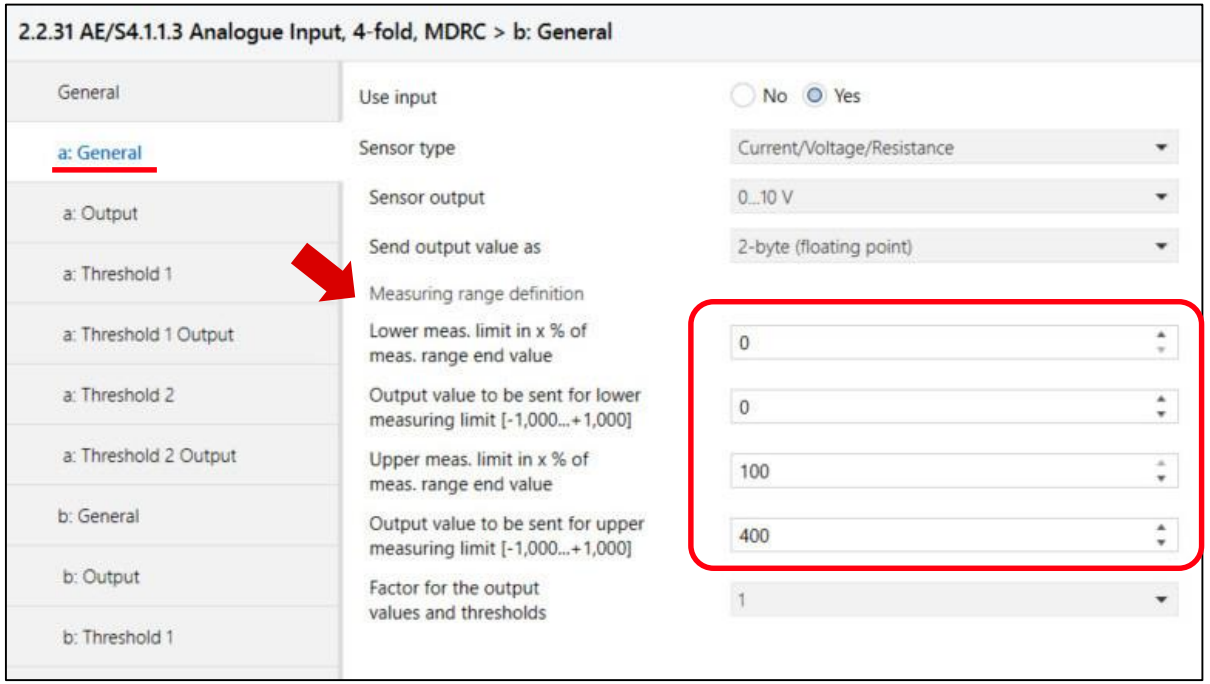
Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

Analogue Input AE/S: Parameter settings

- Set measuring range of the analogue transmitter
  e.g. 0°C … +400°C
- Sensor type “Current/Voltage/Resistance”
- Sensor output (voltage or current) depends on the device variant of the analogue transmitter (0…10V)
- The output value is sent as “2-byte float value” (DPT 9.001 temp.)
- Define measuring range: 0V = 0°C and 10V = +400°C



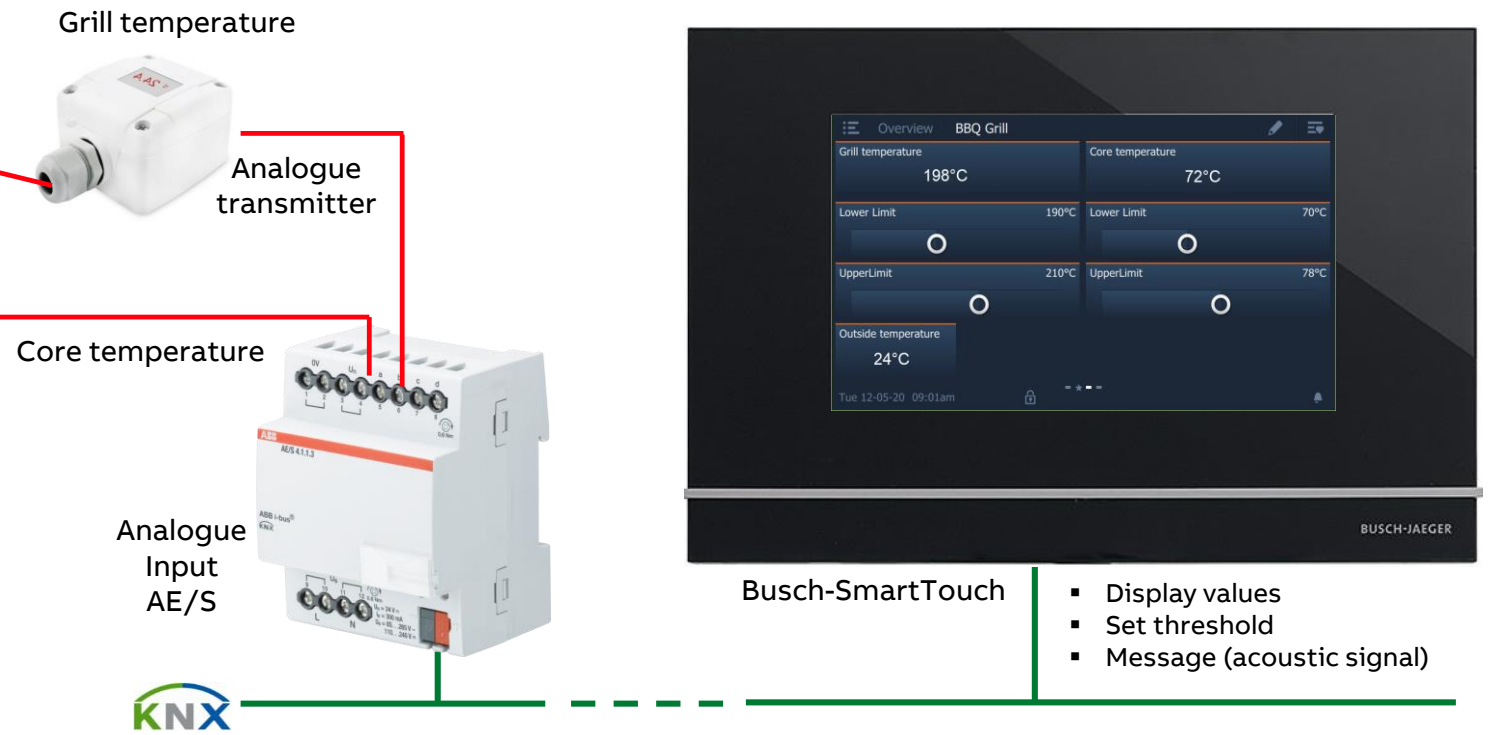
- Furthermore, the threshold functions can also be used



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of high temperatures with an Analogue Input AE/S and additional analogue transmitter

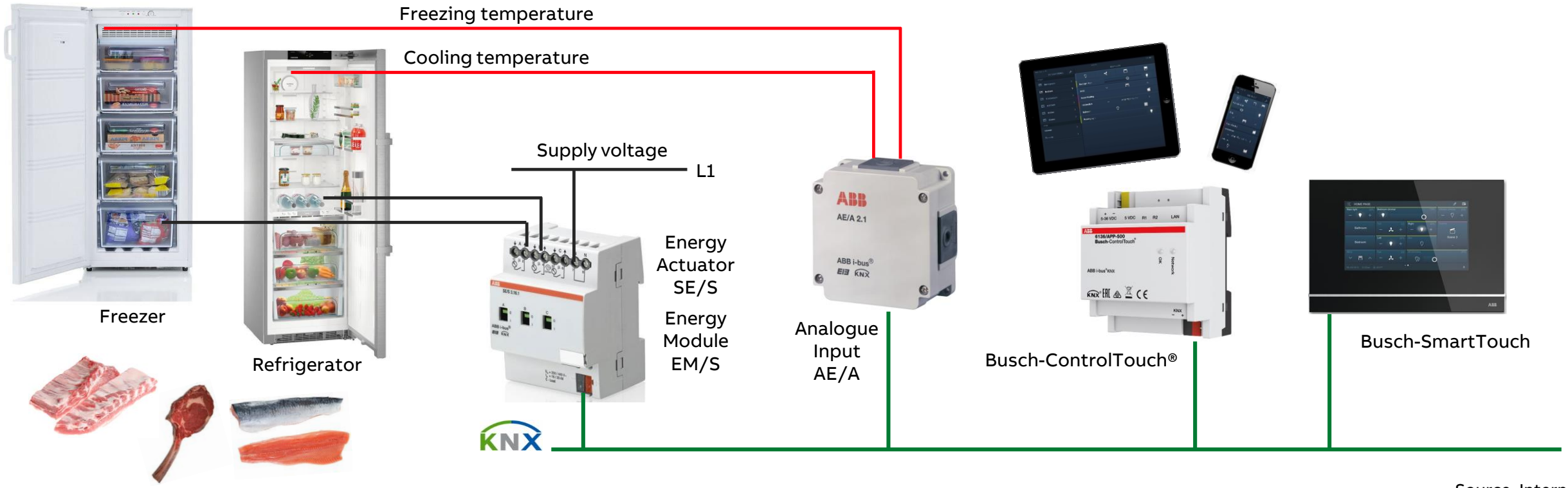
Overview – Temperature measurement in a BBQ Grill



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Measurement of temperatures with an Analogue Input AE/S and Energy Actuator/Energy Module

Overview – Temperature and energy monitoring of a refrigerator and freezer (threshold of power consumption, …)



Source: Internet

Temperature Control of a BBQ Smoker with ABB i-bus KNX

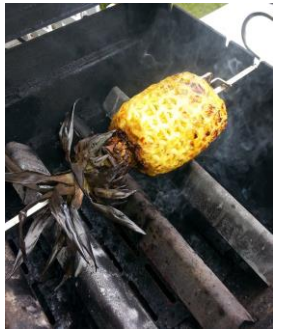
Online Learning Session

Summary – Grilling is more fun thanks to KNX

- High level of comfort
  Automatic temperature control does not require manual supervision and operation
- Energy efficiency
  Reduce your energy consumption for charcoal
- A safe system
  Thresholds monitor the temperature and send push notifications to protect your meat from harm
- Increased flexibility
  Depending on the type and quantity of meat, the threshold values for the grill temperature can be adjusted
- Keep an eye on everything
  Busch-ControlTouch® visualisation for smartphones and tablets shows all states






Temperature Control of a BBQ Smoker with ABB i-bus KNX

Online Learning Session

Temperature Control of a BBQ Smoker with ABB i-bus KNX

Online Learning Session

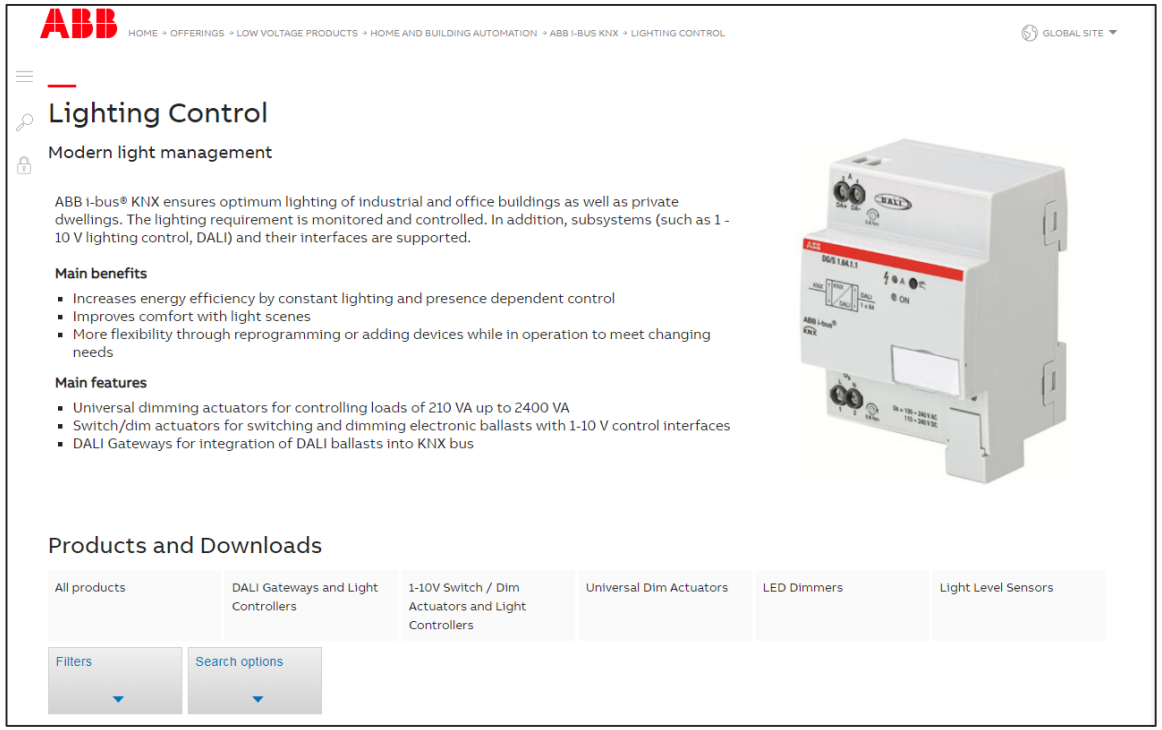
Homepage

www.abb.com/KNX

→ Products and Downloads

→ …

- Product Manual
- CAD Drawing
- Installation and Operating Instructions
- Specification Text
- ETS Application
- Selection Table
- CE & RoHS Declaration of Conformity
- • •



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Online Learning Session

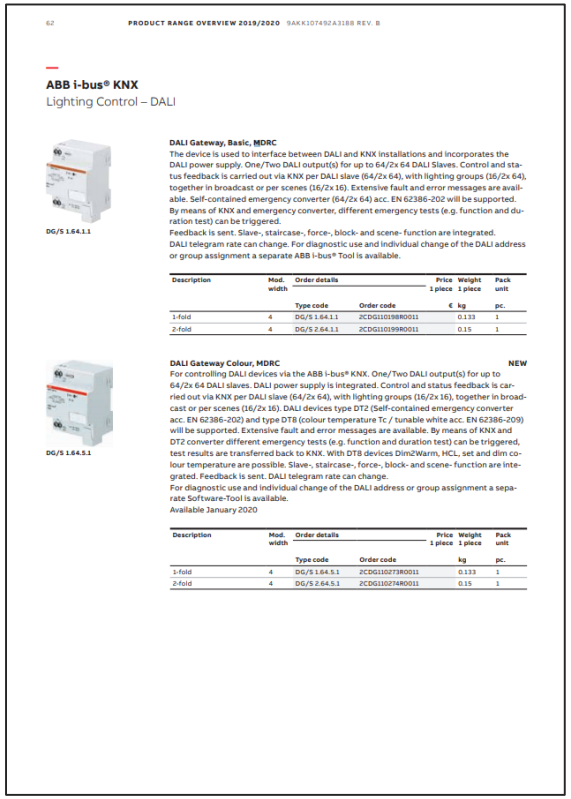
Product Range Overview

Smarter Solutions for Home and Building Automation

ABB i-bus KNX

Product Range Overview 2019/2020

LINK



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Online Learning Session

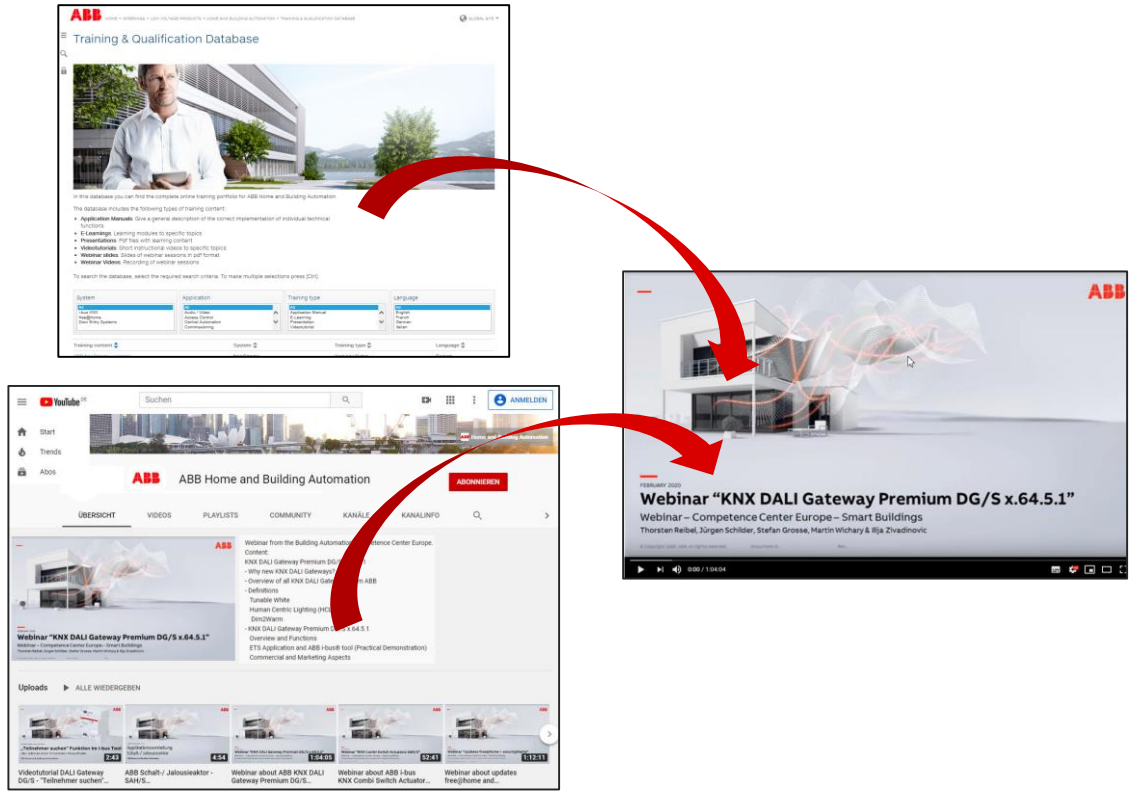
Further information

Training & Qualification Database

– The database includes the following types of training content:
  - Application Manuals
  - E-Learnings
  - Presentations
  - Video tutorials
  - Webinar slides and videos
  - ww.abb.com/knx or https://go.abb/ba-training

Youtube

– Channel “ABB Home and Building Automation”
  - https://www.youtube.com/user/ABBibusKNX



Temperature Control of a BBQ Smoker with ABB i-bus KNX

Online Learning Session

Training & Qualification Calendar

In addition to the online modules and the traditional training programs offered by your local ABB sales team, we offer a variety of on-site trainings conducted by our specialists at different ABB training facilities

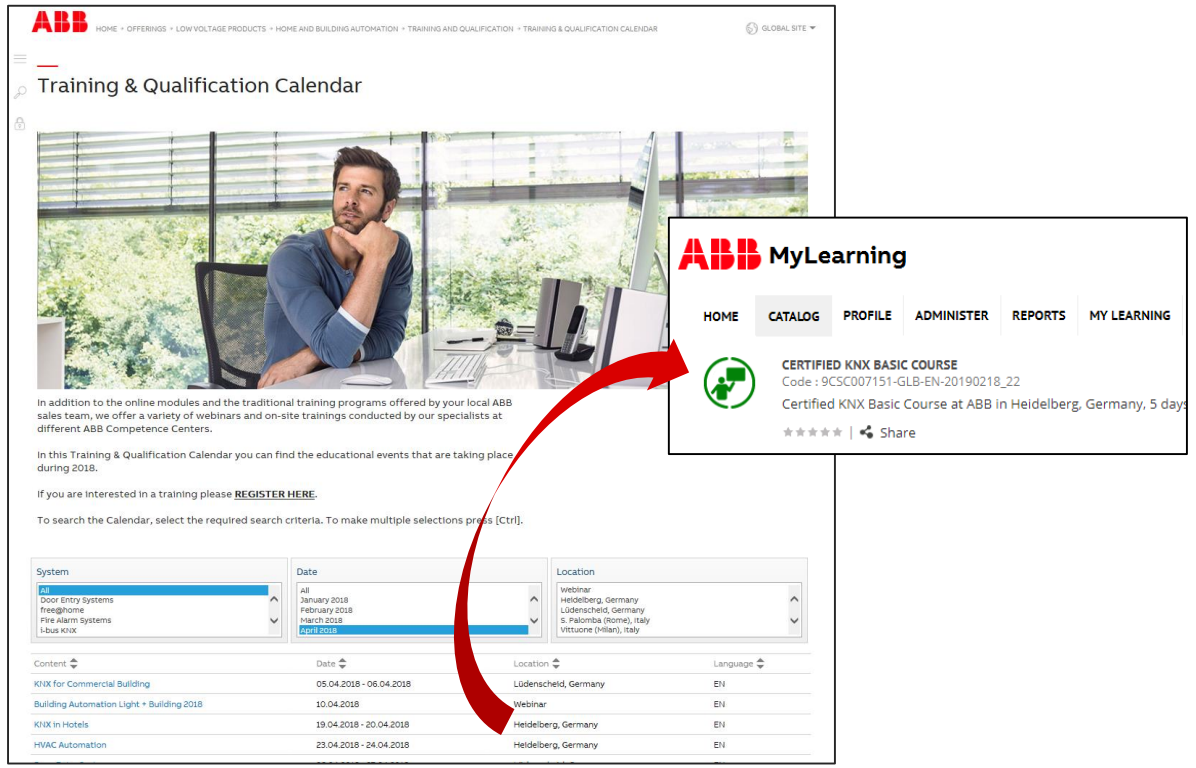
In this Training & Qualification Calendar you can find the educational events that are taking place during 2020

If you are interested in a training please click the training und you will be forwarded to register in “ABB MyLearning”

www.abb.com/knx or https://go.abb/ba-training

→ Training and Qualification

→ Training Calendar



Disclaimer

The information in this document is subject to change without notice and should not be construed as a commitment by ABB. ABB assumes no responsibility for any errors that may appear in this document.

In no event shall ABB be liable for direct, indirect, special, incidental or consequential damages of any nature or kind arising from the use of this document, nor shall ABB be liable for incidental or consequential damages arising from use of any software or hardware described in this document.


ABB