Baumer
Passion for Sensors

Application Note

Thermal connection of industrial cameras and *VeriSens*® vision sensors

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Description
The present document explains why the data sheets of Baumer industrial cameras (in the following cameras) and vision sensors do not specify ambient temperature but housing temperature. Furthermore, we give recommendations for camera holder design for optimum heat dissipation.

Products
Baumer industrial cameras and *VeriSens*® vision sensors

Content

1 Background information

Reproducible image quality and high repeat accuracy are paramount in image processing applications, which is why the Baumer digital industrial cameras and vision sensors are designed for dependable 24/7 operation.

Ensuring specified quality, producing reproducible results, and maintainng flawless system operation depend on great many factors, among which one is fairly dominant: Operating temperature.

Unlike the common misconception, operating temperature does not mean the ambient or installation temperature, but rather the temperature at a certain measuring point on the camera housing. Why?

2 Temperature specifications in data sheets

2.1 Storage temperature

Not only for electronic appliances, temperature specifications refers to the temperature inside the device. Looking at the related component specifications one might think the maximum limit is easy to identify.

2.2 Operating temperature

However, in image processing it's different. Numerous parameters, component layouts as well as ambient conditions hamper conclusions on the maximum ambient temperature based on component core temperature.

Core temperature depends on power consumption, thermal connection and component interaction. Operating mode and load have an influence on the power consumption of sensor, FPGA, interface chip modules, etc. which results in a variety of core temperatures.

Reliable operation requires observing the maximum limit of thermal stress imposed on the electronic components. Temperature tests during development specify the maximum limit at a specific measuring point on the camera housing.

The temperature gradient between the outside and inside of housing is known - **at least when operating the device without any thermal connection or temperature-relevant measures** - i.e. in a "worst case" scenario.

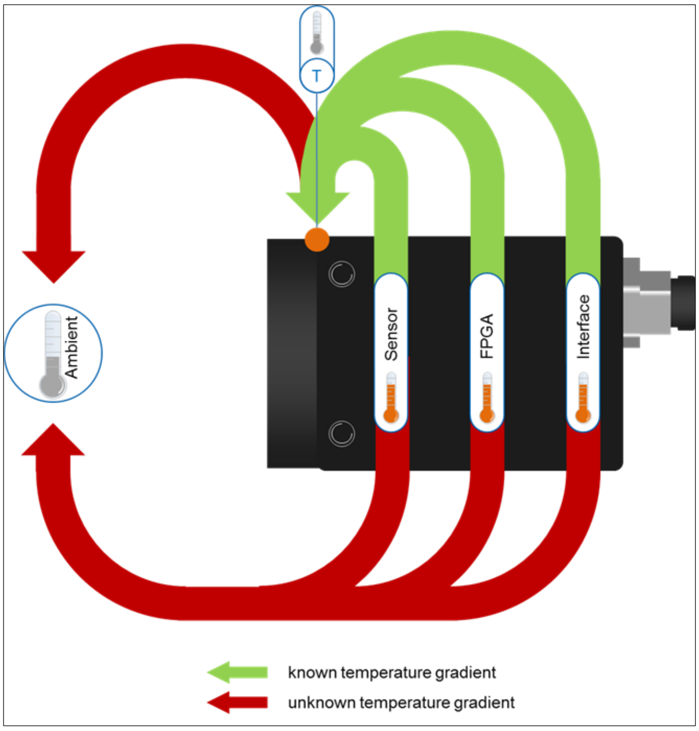

Fig 1: Known (green) and unknown (red) temperature gradient

As already mentioned and shown in Figure 1, no conclusions can be drawn between the temperature measuring point on the outside of the housing and the ambient temperature, nor between the component core temperature and the ambient temperature.

This is due to many unknowns in connection with the direct environment of camera or vision sensor:

- What is the thermal mass of the installation the component is mounted to?
  - What is the installation‘s heat capacity?
  - How long does it take the installation to thermally stabilize?
- How is the component installed?
  - What is the holder geometry like?
  - What material is it made of?
- Is there any ventilation around?

3 Heat dissipation at cameras and vision sensors

The heat generated in the device spreads in every direction. Heat conduction occurs on surfaces that are in contact with other components of the system. On the remaining surfaces, the heat is dissipated from the camera by means of radiation and convection (see Figure 2).

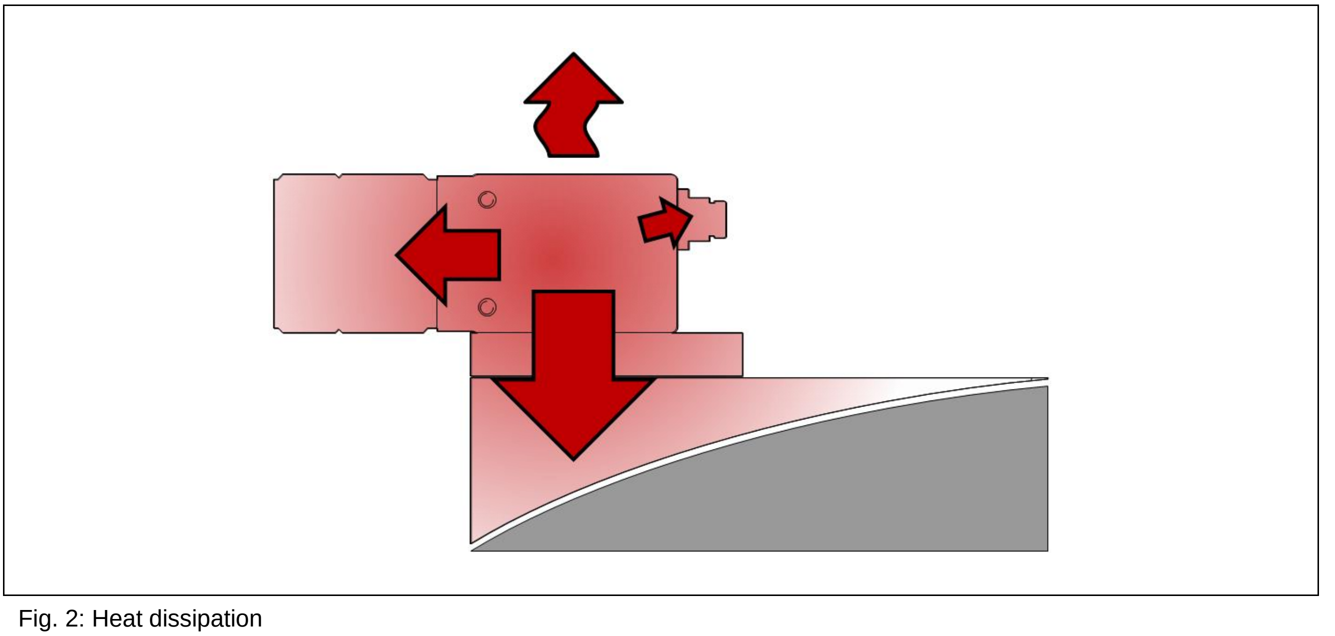

Fig. 2: Heat dissipation

Lens and cabling absorb part of the heat, but the major share is transported via the camera mounting.

4 Thermal connection

Temperature tests at design stage are performed without thermal connection. Such "worst case" scenarios do not represent true installation or operating conditions at all.

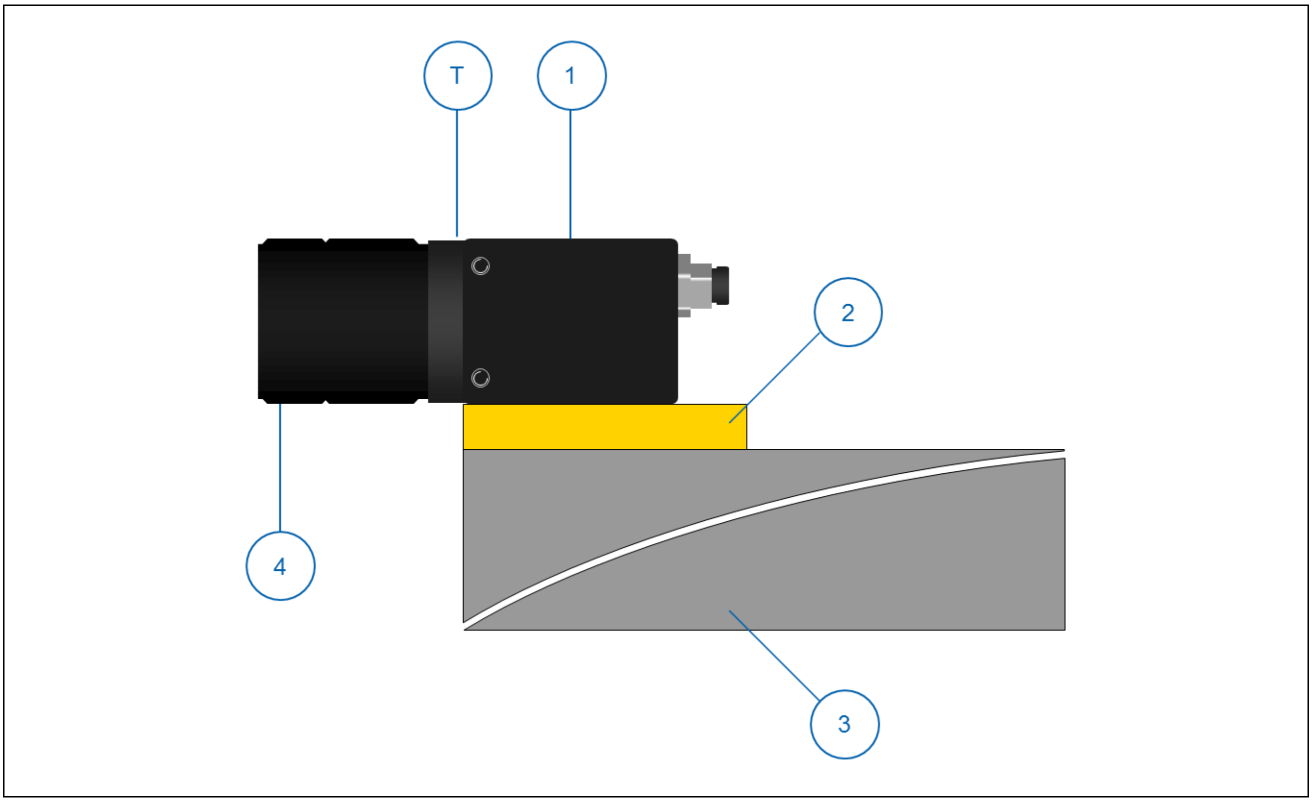

Fig.3: Camera installation example (without cabling)

Fig.3 shows camera (1) and optics (4) mounted to a metal contact surface (3) with the camera holder (2) in between.

Since the majority of the generated heat is dissipated through the device holder, this is the central element of the thermal connection.

5 Design recommendations for camera holders

5.1 Material

High-conductive material is ideal, whereas low-conductive material will hamper heat dissipation.

Notice
Select a well-conducting material such as aluminum, copper or brass. Do not use insulators!

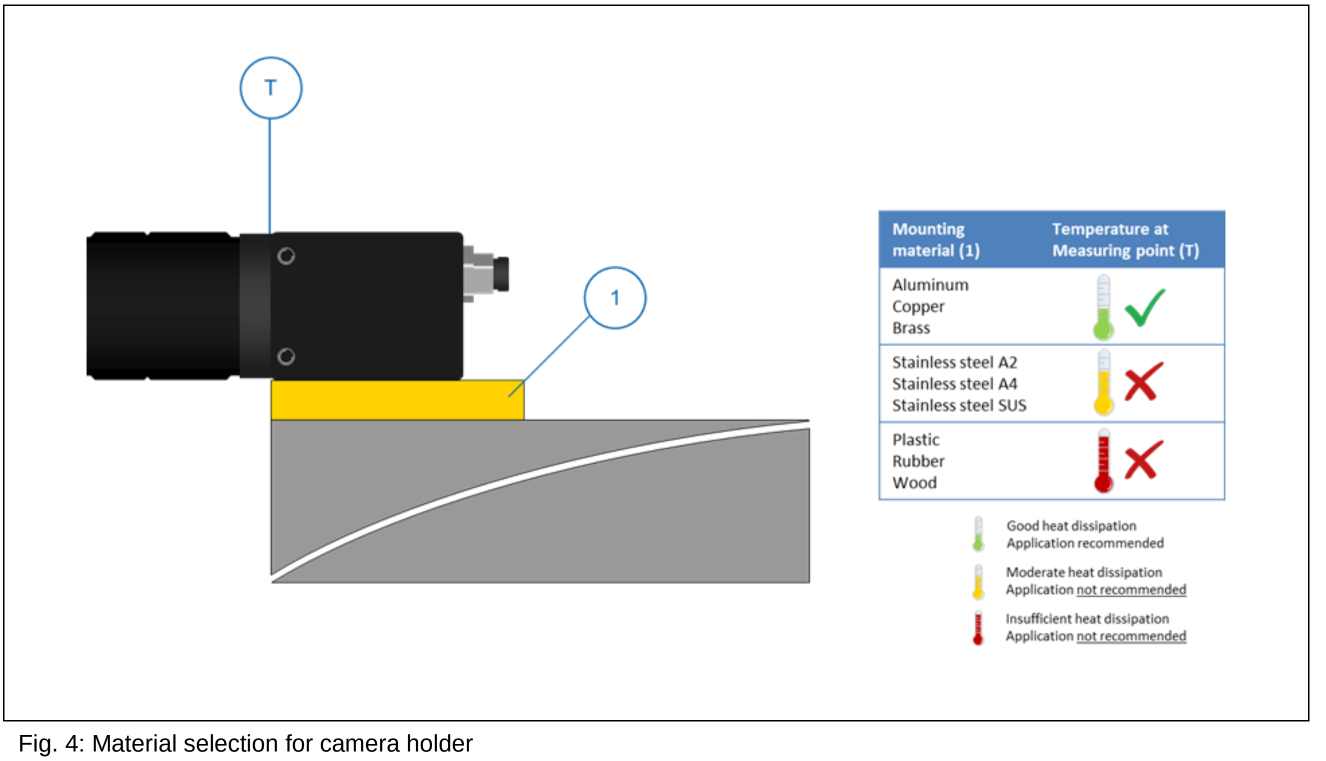

Fig. 4: Material selection for camera holder

5.2 Design geometry

In addition to the actual material, design geometry of the camera mounting also signifiantly influences heat dissipation. Besides the material's thermal conductivity, the contact surfaces of camera, holder and installation have a direct effect on thermal resistance and therefore heat dissipation.

5.2.1 Material thickness

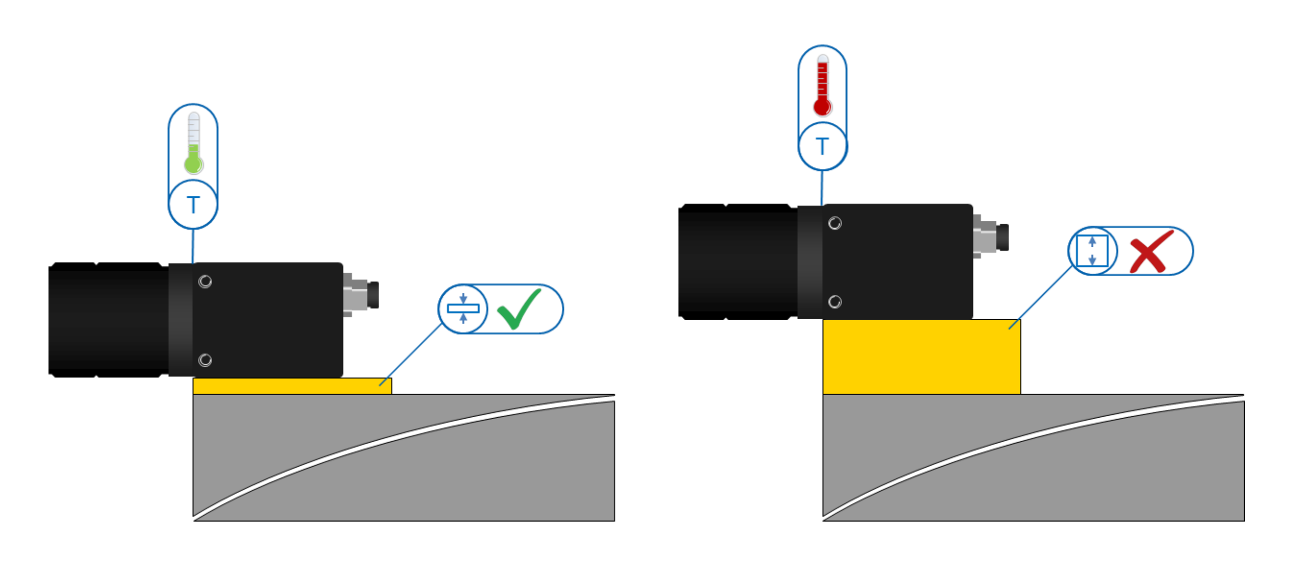

Fig. 5: Holder design and material thickness have an effect on heat dissipation (extended conductive path)

Notice

Surfaces with good thermal conductivity

Thin materials transport heat very well, which is why the camera holder should be as thin as possible for minimized conduction path between camera and installation.

Notice

Installations and machinery with insulating surface (e.g. plastic)

Here, camera holders may have a buffer effect and improve heat dissipation by

- absorbing and shortly retaining a certain amount of heat which
- dissipates via a poorly heat-conducting surface larger than the one of the camera

Additional cooling is recommended, e.g. by active cooling elements or ventilation.

5.2.2 Length

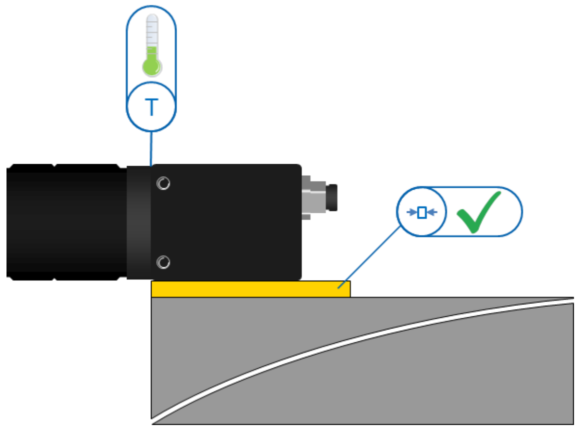

Fig 6: Short holder designs improve heat dissipation at installations with conductive surface

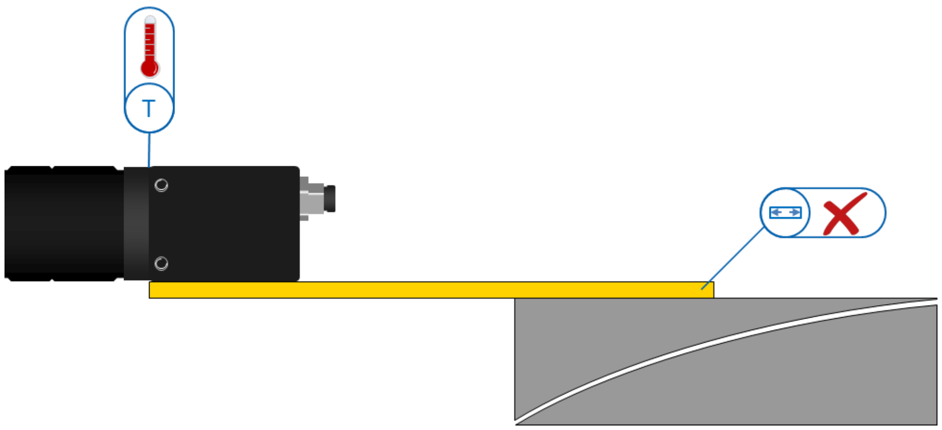

Fig.7: Long holder designs (extended path) will hamper heat dissipation

Notice
Thermal connection on high-conductive surfaces Ensure a short holder design to keep the conductive path between camera and installation as short as possible.

Notice
Thermal connection on low-conductive surfaces (e.g. plastic) Here, camera holders may improve heat dissipation by: a) Absorbing and shortly retaining a certain amount of heat which b) dissipates via the larger surface Additional cooling is recommended, e.g. by active cooling elements or ventilation.

5.2.3 Contact surface

Notice
The camera holder design should ensure sufficiently large contact surfaces between camera, holder and installation. The camera should fully rest on one lateral surface.

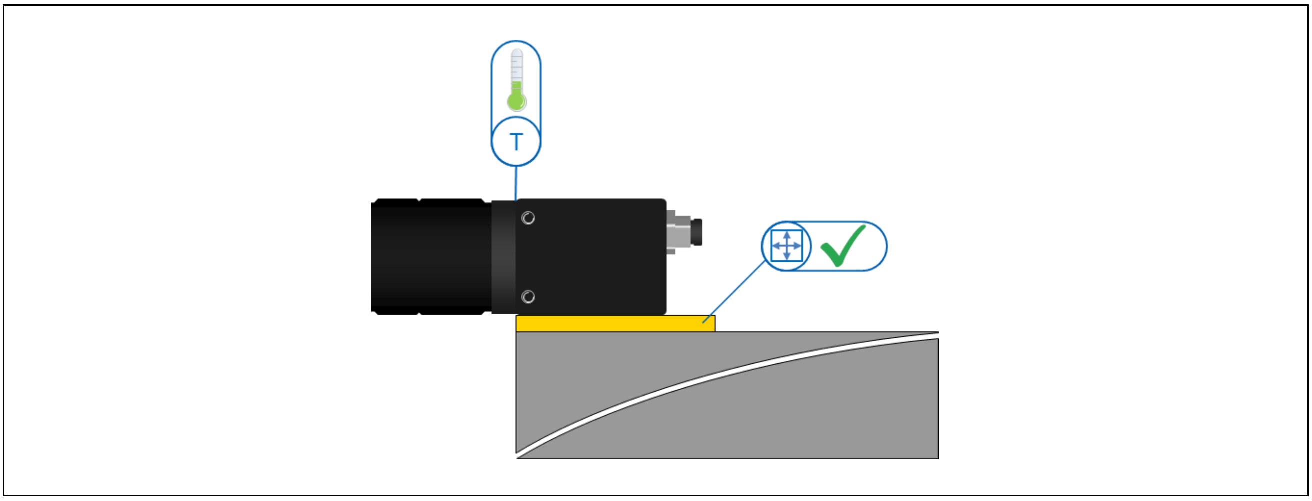

Fig 8: Large contact surfaces improve heat dissipation

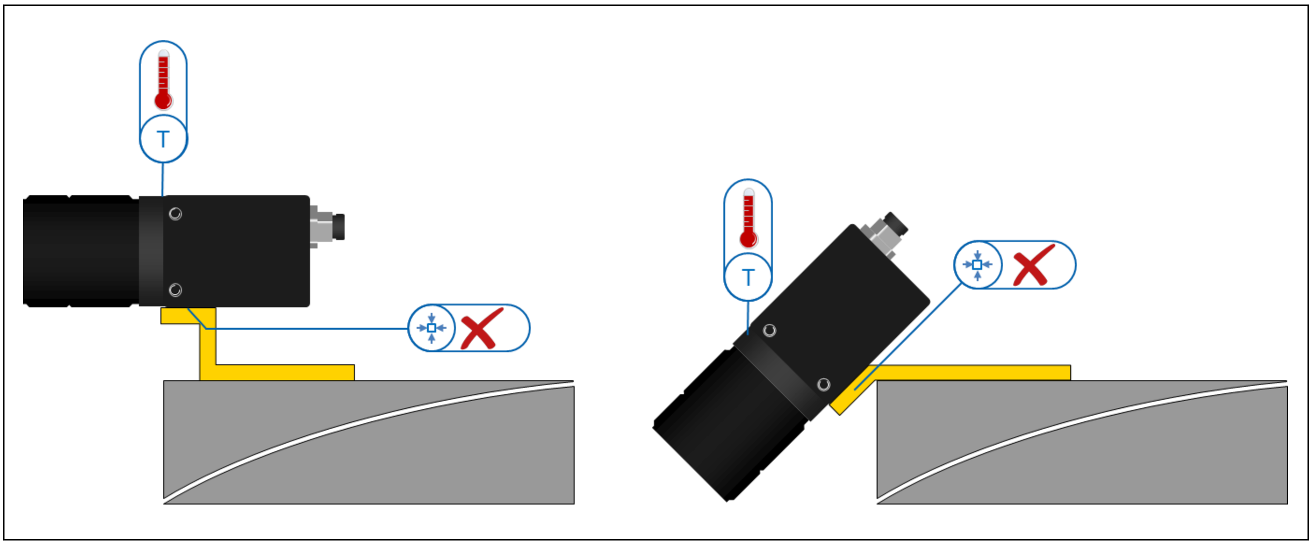

Fig. 9: Too small contact surfaces hamper heat dissipation

6 Support

Please contact our Technical & Application Support Center with any questions.

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7 Legal notes

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Baumer Group

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