# APPLICATION NOTE


## How to Monitor the Camera Housing Temperature of Basler ace U and L USB3 and GigE Vision Cameras

*Applicable to Basler ace U and L USB3 and GigE Vision cameras with Sony IMX and ON Semiconductor PYTHON sensors only*


Document Number: AW001380
Version: 03 Language: 000 (English)
Release Date: 13 December 2019


BASLER
the power of sight

# Contacting Basler Support Worldwide


**Europe, Middle East, Africa**

Basler AG
An der Strusbek 60–62
22926 Ahrensburg
Germany

Tel. +49 4102 463 515
Fax +49 4102 463 599

support.europe@baslerweb.com

**The Americas**

Basler, Inc.
855 Springdale Drive, Suite 203
Exton, PA 19341
USA

Tel. +1 610 280 0171
Fax +1 610 280 7608

support.usa@baslerweb.com

**Asia-Pacific**

Basler Asia Pte. Ltd.
35 Marsiling Industrial Estate Road 3
#05–06
Singapore 739257

Tel. +65 6367 1355
Fax +65 6367 1255

support.asia@baslerweb.com

**www.baslerweb.com**

# Table of Contents

# 1 Introduction

Image quality is a key factor for every application and a top priority of Basler's digital cameras. The image quality of digital cameras depends on both the hardware design and on the components' quality used in the manufacturing process, but it also depends on the environmental conditions, and especially on the ambient and working temperatures.

This application note provides information about how to monitor the temperature development of Basler ace USB3 Vision and ace GigE Vision cameras of the ace U and L product lines, equipped with a temperature sensor. Currently, these cameras use Sony IMX or ON Semiconductor® PYTHON sensors. For more information about Basler ace U and L cameras, see www.baslerweb.com.

# 2 Temperature Requirements

## 2.1 Temperature Specification

Basler ace USB3 Vision and GigE Vision cameras of the ace U and ace L product lines are specified for the following housing temperature range during operation:

**0 °C – +50 °C (+32 °F – +122 °F)**.

For information about the temperature measurement point on the camera housing, see the *Basler Product Documentation* on www.baslerweb.com.

## 2.2 Heat Dissipation

You must provide sufficient heat dissipation to maintain the temperature of the camera housing at 50 °C or less. Since each installation is unique, Basler does not supply a strictly required technique for proper heat dissipation. Instead, Basler provides the following general guidelines:

- Always **mount an appropriate lens** before operating the camera (e.g. a 1" lens on a camera with a 1" sensor). This may provide sufficient heat dissipation depending on the ambient temperature. For more information about lenses provided by Basler, see www.baslerweb.com.
- If you mount your camera in your system **on a metal component that is large enough**, this may provide sufficient heat dissipation.
- The use of **a fan to provide an air flow** over the camera is an extremely efficient method of heat dissipation. The use of a fan provides the best heat dissipation.
- In all cases, you should **monitor the temperature of the camera housing** and make sure that the temperature does not exceed 50 °C. Keep in mind that the camera will gradually become warmer during the first hour of operation. After one hour, the housing temperature should stabilize and no longer increase, or only insignificantly.

The temperature also depends on the operating mode of the camera, i.e. it depends on whether the camera is in the idle mode or whether it is capturing images, for example at a high frame rate. Keep this in mind when you take measurements to provide heat dissipation.

| | |
|---|---|
|  | To ensure good image quality, Basler recommends not to operate the camera at elevated temperatures. |

## 2.3 Temperature Monitoring and Over Temperature Detection

When overheating is imminent, the cameras enter an over temperature mode. This mode includes several mechanisms to decrease the risk of overheating and to alert the user to take measures to cool the camera. If no action is taken, the camera can be damaged and image quality can decrease.

The mechanisms include e.g. reporting of temperature states, event notification, and powering down the camera. The mechanisms are activated at different device temperature thresholds and they depend on whether the camera follows a heating or cooling path.

The device temperature is measured inside the camera and reported in steps of 1 °C. You can monitor the device temperature by reading the temperature parameter value (see next page). Currently, only the core board temperature can be selected as the device temperature.

### 2.3.1 Core Board Temperature

The cameras are equipped with a temperature sensor mounted on the camera's core board. The temperature sensor lets you read the current temperature of the camera's core board in degrees C.

#### Reading the Core Board Temperature

You can use the pylon API to read the core board temperature in degrees C from within your application software.

**To read the core board temperature:**

1. Select the core board temperature sensor.
2. Read the temperature.

### For Basler ace GigE Vision cameras

The following code snippet illustrates using the API to read the temperature in degrees C:

```
// Select the core board temperature sensor
Camera.TemperatureSelector.SetValue (TemperatureSelector_Coreboard);
// Read the core board temperature
double d = Camera.TemperatureAbs.GetValue();
```

### For Basler ace USB3 Vision cameras

The following code snippet illustrates using the API to read the temperature in degrees C:

```
// Select the core board temperature sensor
Camera.DeviceTemperatureSelector.SetValue
(DeviceTemperatureSelector_Coreboard);
// Read the core board temperature
double d = Camera.DeviceTemperature.GetValue();
```

You can also use the Basler pylon Viewer application to easily read the temperature.

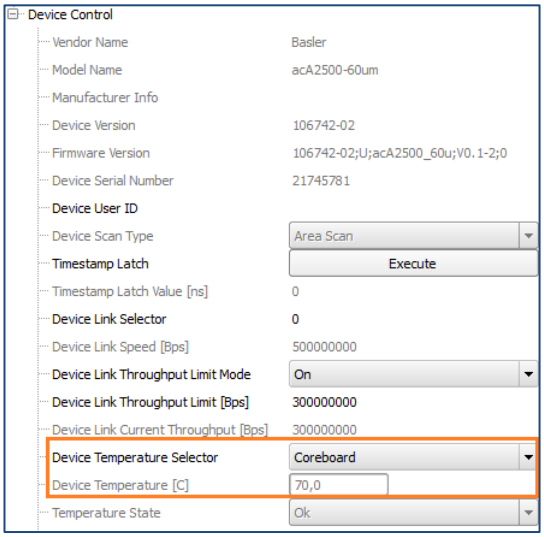



**Figure 1: pylon Viewer (ace USB Example)**

### 2.3.2 Core Board Temperature Conditions and Over Temperature Mode

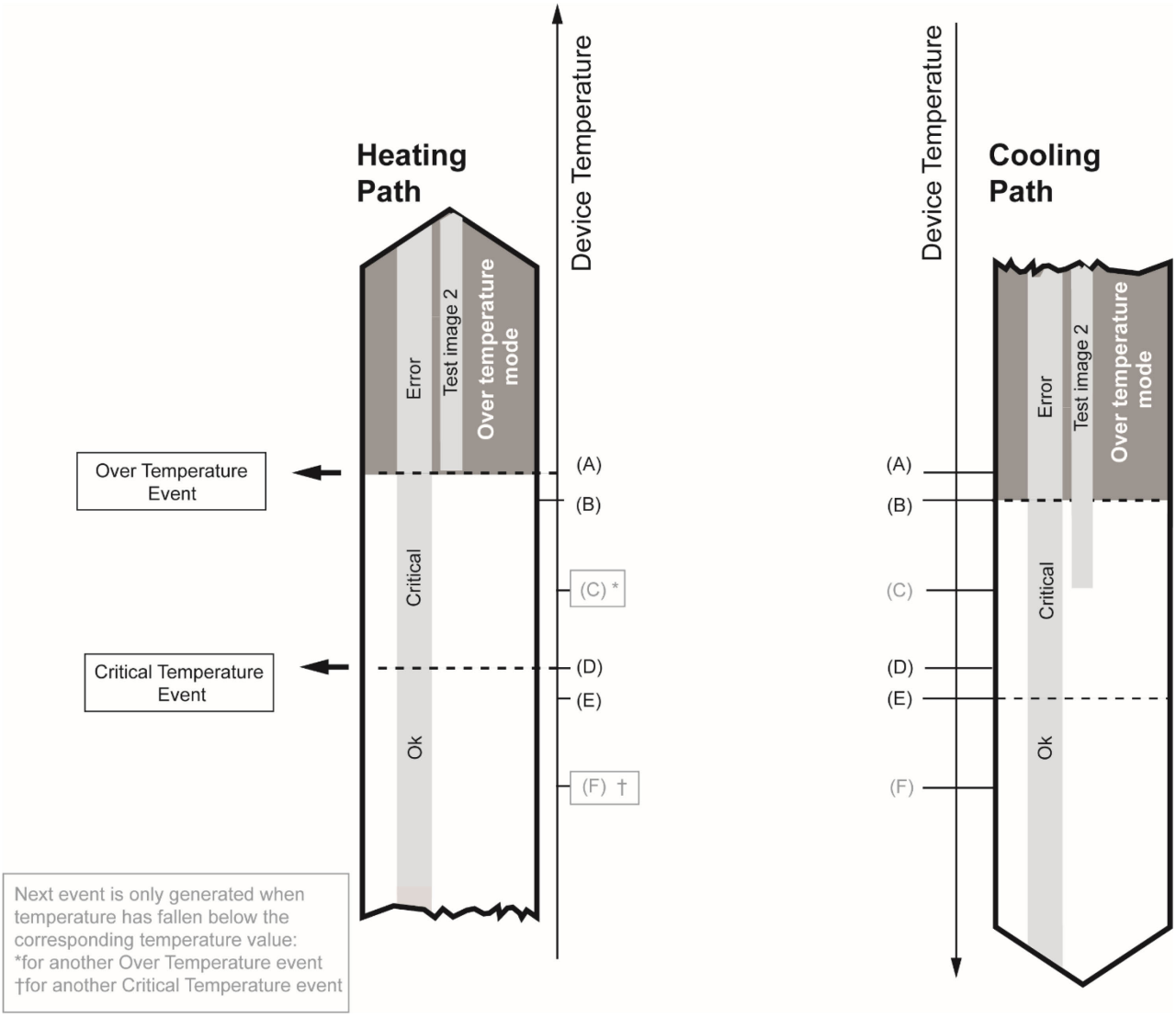



**Figure 2: Over Temperature Behavior for Heating and Cooling Paths**

| | |
|---|---|
|  | It depends on the camera model (ace GigE or ace USB) at what temperature a temperature-dependent event occurs and when the temperature status changes [Ok, Critical, Error (ace GigE)/Over Temperature (ace USB)].<br>The letters (A) to (F) in Figure 2 are placeholders for these temperature values that are relevant during the heating and cooling paths.<br>The following sections refer to these placeholders. |

| Letter in Figure 2 | ace USB | ace GigE |
|---|---|---|
| (A) Over Temperature | 81 °C (177.8 °F) | 78 °C (172.4 °F) |
| (B) | 80 °C (176 °F) | 77 °C (170.6 °F) |
| (C)* | 77 °C (170.6 °F) | 74 °C (165.2 °F) |
| (D) Critical Temperature | 75 °C (167 °F) | 72 °C (161.1 °F) |
| (E) | 74 °C (165.2 °F) | 71 °C (159.8 °F) |
| (F)† | 71 °C (159.8 °F) | 68 °C (154.4 °F) |
| Temperature Statuses | Ok, Critical, Error | Ok, Critical, Over Temperature |
| The next event is only generated when the temperature has fallen below the corresponding temperature value:<br>*For another Over Temperature event, the temperature must fall below this value.<br>†For another Critical Temperature event, the temperature must fall below this value. | | |

**Table 1: Temperature Values Depend on the Camera Model**

In the following the letters in the text represents certain temperatures; see Figure 2 and Table 2.

The temperature sensor is used to monitor the temperature of the camera's core board. The camera has a core board over temperature protection. An over temperature condition is detected, if the temperature of the core board rises above certain temperatures. Two stages can be distinguished:

- the critical temperature of (D)
- the over temperature of (A).

### Heating Path

- When the device temperature is below or equal to (E) the TemperatureState parameter value is Ok.
- When the device temperature rises above (E) the following occurs:
  - The TemperatureState parameter value changes to Critical.
  - The Critical Temperature event is sent.

  Note that another Critical Temperature event can only be sent after the device temperature has fallen to at least (F) and the device temperature subsequently rises above (E) again.
- When the device temperature rises to (A), the camera enters the over temperature mode.

**NOTICE**

**Over Temperature can Damage the Camera**

When a camera enters the over temperature mode, the camera must be cooled immediately. Otherwise, irreversible damage may occur to the camera.

In the over temperature mode, the following occurs at (A):

- The sensor is powered down as damage due to overheating is imminent.
- The TemperatureState parameter value changes to
  - Error (for ace GigE)
  - Over Temperature (for ace USB)
- The OverTemperature event is sent.
- Regular image acquisition stops. Instead, test image 2 is generated (see Figure 3).

  Note that another Over Temperature event can only be sent after the device temperature has fallen to at least (C) and the device temperature subsequently rises to (A) again.

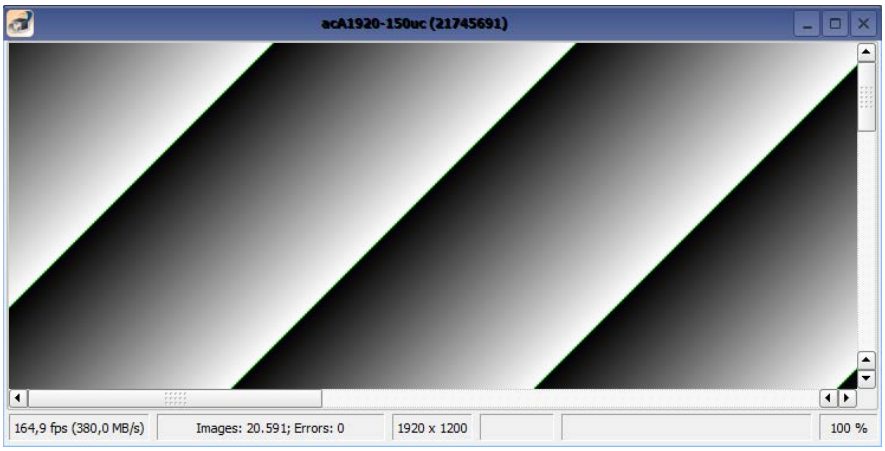



Figure 3: Test Image 2

### Cooling Path

- When the device temperature falls and reaches (B), the following occurs:
  - The camera leaves the over temperature mode and
  - the TemperatureState parameter value changes to Critical.
- When the device temperature reaches (C), the following occurs:
  - Test image 2 disappears.
  - Normal image acquisition resumes. The camera delivers live images again; however, the status is still critical.
    The camera continues with the same camera settings as before it entered the over temperature mode.

- When the device temperature reaches (E), the following occurs:
  - The TemperatureState parameter value changes to Ok.

  Note that the device temperature is reported in steps of 1 °C.

For more information about camera events refer to the *Basler Product Documentation* on www.baslerweb.com.

Note that regular operation of the camera requires both:

- It requires that the camera's internal temperature is below (E) **and**
- it requires that the housing temperature stays within the specified range of "housing temperature during operation".

Note that elevated temperatures will worsen the image quality and shorten the camera's lifetime. If the number of over temperature conditions increases, this will also shorten the camera's lifetime.

You can use the pylon API to obtain the critical temperature and over temperature values in degrees C from within your application software.

### For Basler ace GigE Vision cameras only

```
bool a = camera.CriticalTemperature.GetValue();
bool b = camera.OverTemperature.GetValue();
```

### For Basler ace GigE and USB3 Vision cameras

If you want to get informed about the temperature status of the camera's coreboard, you can also use the pylon API:

```
TemperatureStateEnums e = camera.TemperatureState.GetValue();
```

The following temperature states can be read:

| Possible values of temperature status readout | Meaning:<br>The internal temperature on the coreboard ... |
|---|---|
| Ok | ... is below the critical temperature. This is the normal operation condition. |
| Critical | ... has reached the critical temperature of (D). |
| Error (ace GigE)<br>Over Temperature (ace USB) | ... has reached the over temperature (A). |

### 2.3.3 Getting Information about the Temperature Status via Events

You can set up event notification to get informed about the different temperature conditions in the camera. Two "temperature" events can be generated:

- CriticalTemperatureEvent
  When the camera models indicated above reach a temperature of (D), the so-called critical temperature is reached and the camera can issue the CriticalTemperature event.
- OverTemperatureEvent
  When the camera models indicated above reach a temperature of (A), the camera can issue the OverTemperature event.

In both cases you should sufficiently decrease the camera's temperature to prevent the camera from overheating.

You can enable the "temperature" events in the software:

```
// Enable the CriticalTemperature event
camera.EventSelector.SetValue(EventSelector_CriticalTemperature);
camera.EventNotification.SetValue(EventNotification_On);

// Enable the OverTemperature event
camera.EventSelector.SetValue(EventSelector_OverTemperature);
camera.EventNotification.SetValue(EventNotification_On);
```

For more information about event reporting, refer to the *Basler Product Documentation* on www.baslerweb.com.

You can enable event notification and make the additional settings from within your application software by using the pylon API. The pylon software development kit (SDK) includes a "Grab_CameraEvents" code sample that illustrates the entire process.

For more detailed information about using the pylon API, refer to the *Basler pylon Programmer's Guide and API Reference*.

## 2.4 Test of Different Use Cases

Basler has carried out different tests with demanding camera models in terms of power consumption and performance, i.e. acA2500-20gc and acA2500-60uc, in order to evaluate the temperature development inside the camera and the temperature development of the camera housing.

The tests analyze

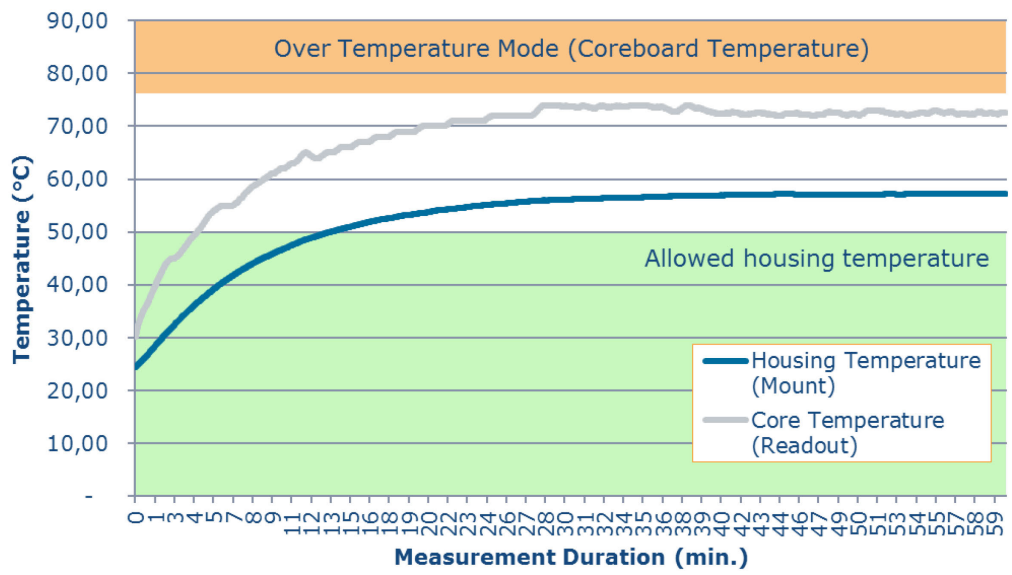
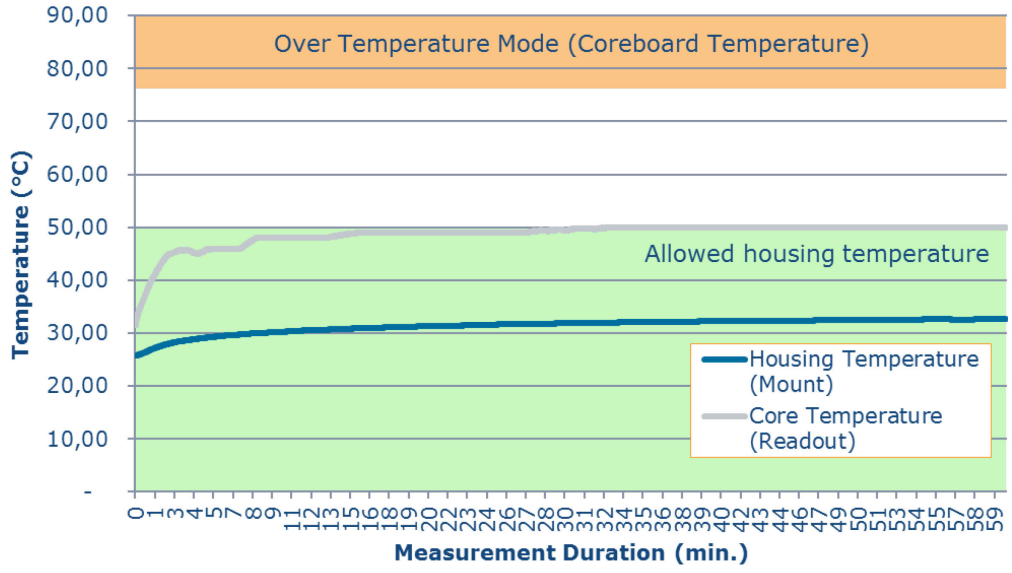
- four typical use cases:
  stress test, factory automation, ITS (intelligent traffic systems) and microscopy, and
- three different mounting options:
  with/without lens, camera mounting and use of an additional housing:

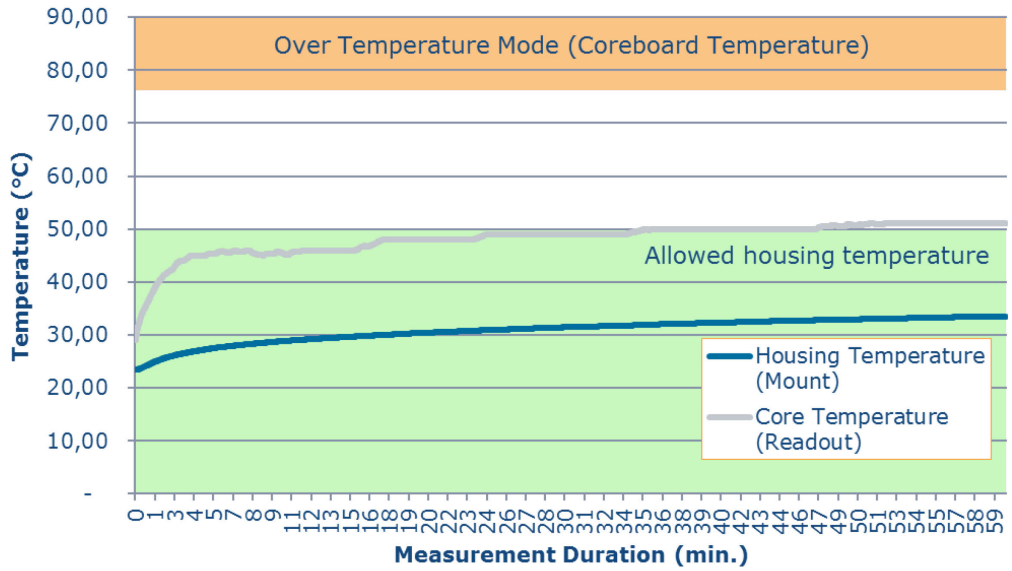
| | Stress Test | Factory Automation | ITS | Microscopy |
|---|---|---|---|---|
| **Lens mounted** | No | Yes | Yes | No |
| **Mounting** | None (camera hangs in the air) | Metal plate | Metal plate | Mounted to a metal plate via the camera mount |
| **With additional housing** | No | No | Yes (box around the camera) | No |

In all test scenarios the camera internal core board temperature and the camera housing temperature were measured at an ambient temperature of 24°C (75.2 °F).

### 2.4.1 Test Results for ace GigE Vision acA2500-20gc

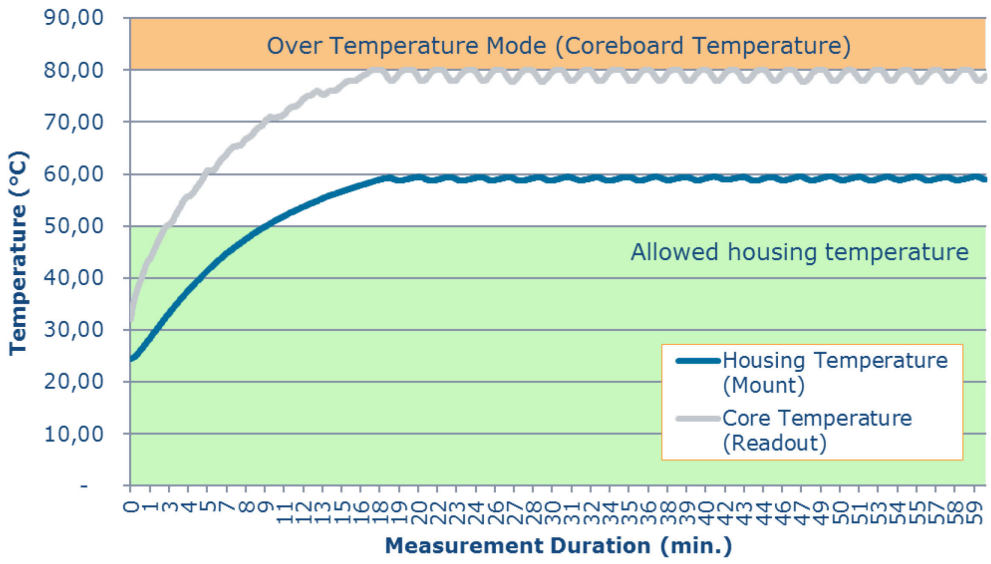
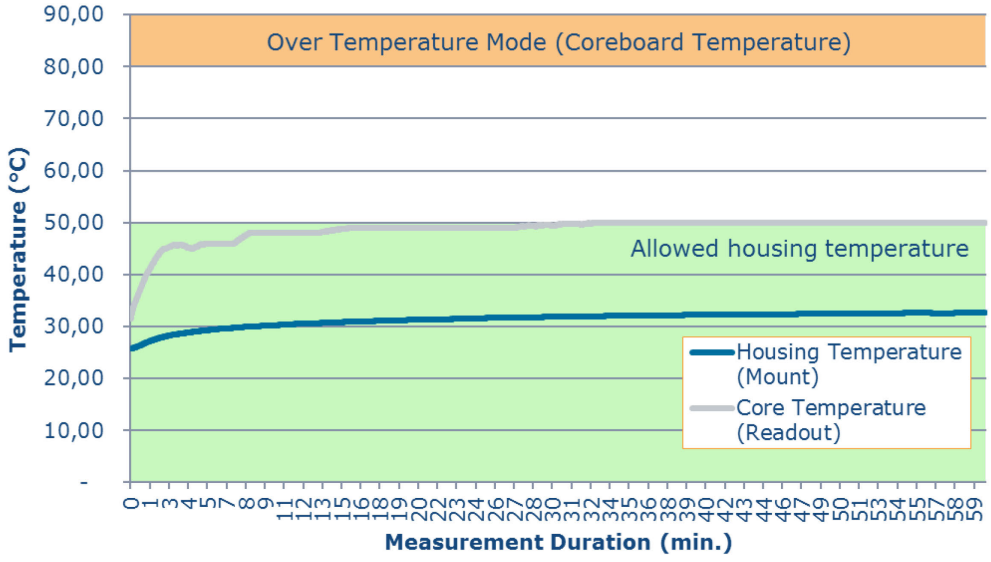
In the following the test results for the ace GigE Vision acA2500-20gc camera model are shown:

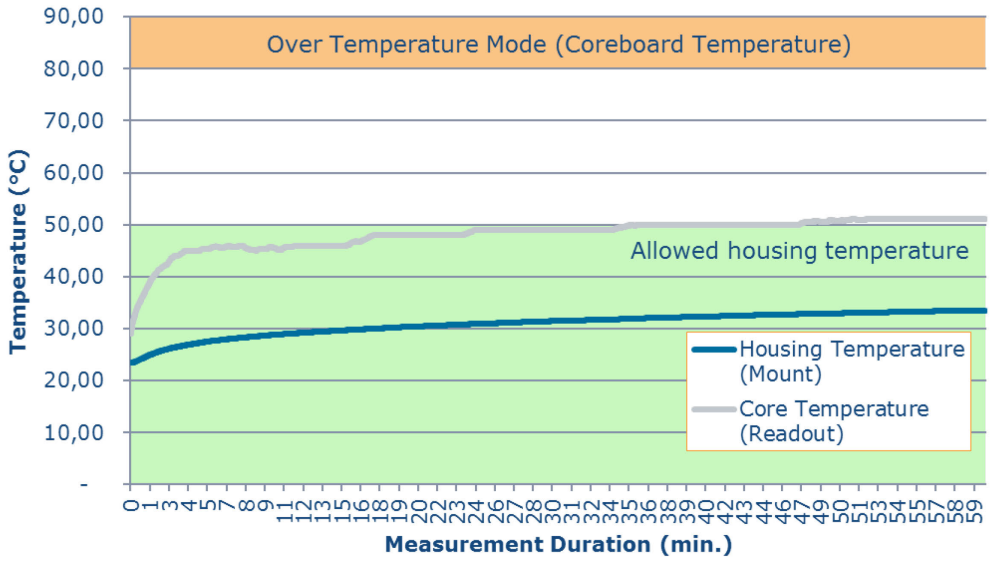
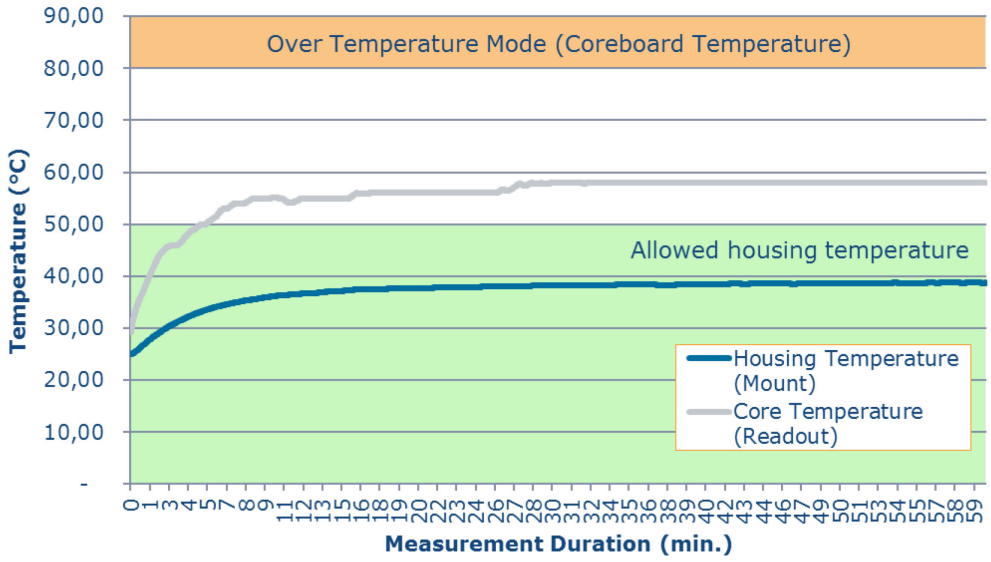
| acA2500-20gc | |
|---|---|
| **Stress Test** |  |
| **Factory Automation** |  |

| acA2500-20gc | |
|---|---|
| **ITS** |  |

### 2.4.2 Test Results for ace USB3 Vision acA2500-60uc

In the following the test results for the ace USB3 Vision acA2500-60uc camera model are shown:

| acA2500-60uc | |
|---|---|
| **Stress Test** |  |
| **Factory Automation** |  |

| acA2500-60uc | |
|---|---|
| **ITS** |  |
| **Microscopy** |  |

### 2.4.3 Conclusion

The test results in sections 2.4.1 and 2.4.2 show that the internal camera heat dissipation is extremely efficient and that it prevents the camera from entering the over temperature mode. This is even true when the camera is operated beyond the camera specification, i.e. when the camera housing temperature exceeds 50 °C (see the stress test measurements).

| | |
|---|---|
|  | Note that the described test scenarios in sections 2.4.1 and 2.4.2 cannot be directly applied to real applications without adjustment, because the test results depend on different factors such as ambient temperature, camera mounting, camera settings etc.<br>Instead, these test results should be treated as for information purposes only. |

## 2.5 Correlation between Core Board and Camera Housing Temperature

As Basler officially specifies the camera housing temperature during operation (0 °C to 50 °C), and as the camera temperature sensor may be used to monitor the temperature of the camera's core board, you may wonder whether there is any correlation between both temperatures.

Although the camera housing temperature may vary during operation depending on the environmental conditions, used lens, applied heat dissipation measures, current camera parameter settings etc., you may apply the following unofficial approach as a rule of thumb in order to estimate the current camera's housing temperature based on the core board temperature:

Camera Housing Temperature = Core Board Temperature - Approximately T

where T represents a temperature in the interval 15 – 20 °C (27 – 36 °F)

For instance, if the measured core board temperature is above 70 °C you may assume that the current camera housing temperature is above 50 °C.

| | |
|---|---|
|  | Note that if the camera's core board temperature exceeds 70 °C, you are about to operate the camera beyond the camera specification.<br>In this case Basler recommends applying immediate heat dissipation measures to guarantee proper camera operation. |

# Revision History

| Document Number | Date | Changes |
|---|---|---|
| AW001380**01**000 | 29 Apr 2016 | Initial release version of this document. |
| AW001380**02**000 | 3 Nov 2016 | Added camera models acA2040-35g, acA2440-20g, acA2040-55u, acA2040-120u, acA2440-34u, acA2440-75u.<br>Adapted the description. This includes updating the temperature values and the test result graphs. |
| AW001380**03**000 | 13 Dec 2019 | Limited applicability of the document to ace cameras of the U and L product lines (document title, within document).<br>Removed Table 1 indicating individual camera models.<br>Corrected the Fahrenheit values for the algorithm in section 2.5 |