

**BECKHOFF** New Automation Technology

TwinCAT Vision:  
Integrating machine vision  
into automation.



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Version 3

# Integrated machine vision. Optimised machinery. Higher product quality.

## Competitive advantage.

Incorporating image processing into the overall control system can improve machine efficiency. Machine vision capabilities enhance superior real-time applications.

## Industrie 4.0 made easy.

Integrating PLC, motion control, measurement technology and machine vision functionality with IoT and analytics on a single control platform makes Industrie 4.0 applications much easier to implement.



PC-based control specialist Beckhoff has expanded its established, highly successful TwinCAT product range to include TwinCAT Vision, an integrated image processing solution. This addition underscores the increasing importance of image processing as a quality factor across mechanical engineering, particularly in applications like Industrie 4.0, quality optimisation, and track-and-trace. PC-based control offers an ideal solution here: TwinCAT Vision adds image processing to a universal control

### Increased production efficiency.

High-precision measurement and exact optical inspection ensure compliance with process parameters.

### Quality assurance.

Applications such as track-and-trace support complete traceability of product quality.



platform that incorporates PLC, motion control, robotics, high-end measurement technology, IoT and HMI. This simplifies engineering significantly in that it allows camera configuration and programming tasks to be carried out in the familiar PLC environment. In addition, all control functions related to image processing can be synchronised in the runtime system precisely, in real time. Latency is eliminated, and the image processing algorithms execute in real time. This marks a

major quality advance over conventional machine vision solutions. With TwinCAT Vision, machine builders can fully integrate image processing tasks into the central control system, paving the way for more advanced machine designs that are capable of satisfying tomorrow's marketplace demands, and offer enhanced competitiveness and investment security.

### A winning edge with TwinCAT Vision:

- increased competitiveness
- simplified Industrie 4.0 implementation
- enhanced production efficiency
- optimised product quality
- complete synchronisation

# TwinCAT Vision applications.

## Measurement

- Distances
- Diameters
- Roundness

DIAMETER:

10 mm

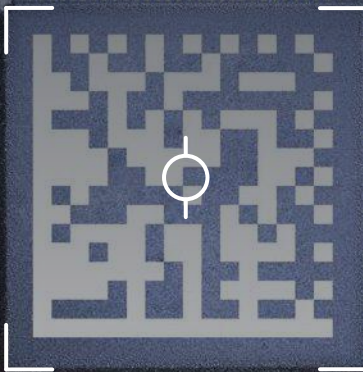


## Identification

- Data Matrix code
- Bar code
- QR code

DATA MATRIX CODE:

4-343399-876228



## Detection

- pattern recognition
- position detection
- colour recognition

## OBJECT DETECTION



## Monitoring

- view into the machine
- simplified service
- simplified maintenance

## PROCESS VISUALISATION

# Integrated: an end-to-end vision solution for automation.



## Openness

TwinCAT Vision follows the Beckhoff philosophy of open control technology. First, it is hardware-neutral: TwinCAT Vision works both with line-scan and area-scan cameras with GigE Vision interface. Second, it supports software extensions, allowing users to access raw camera data and incorporate their own image processing algorithms easily.

**GigE**<sup>®</sup>  
VISION

Power  
Hardware  
Trigger

### Cloud connectivity

Because TwinCAT Vision is integrated into the TwinCAT control platform, it can connect directly to TwinCAT IoT and TwinCAT Analytics. This ensures easy communication with the cloud, enables access to cloud-based services, and streamlines Industrie 4.0 applications.



EtherCAT®

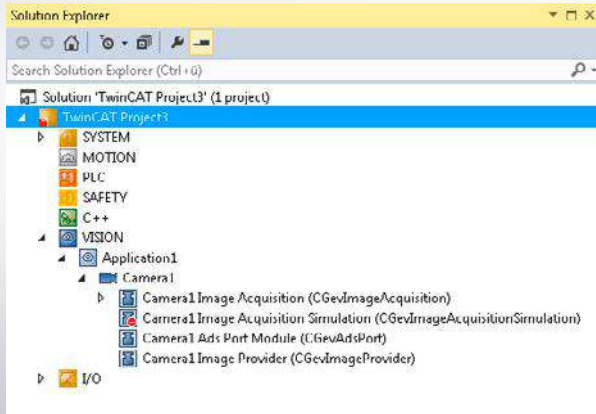


### In real time

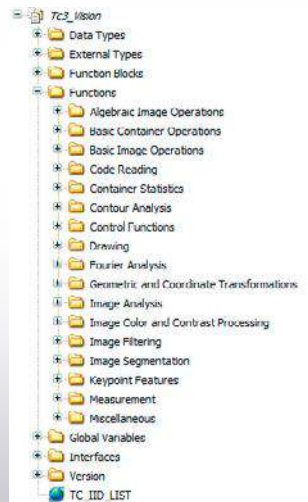
Integrating the PLC, motion control, robotics, high-end measurement technology and machine vision capabilities on a single platform enables superior real-time application performance and significant gains in machine efficiency. It also avoids unnecessary delays in motion and robotics.

# Modular by design: from engineering through to runtime.

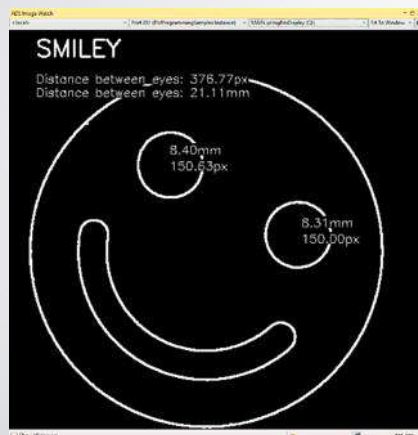
## System Manager



## TwinCAT Vision Library



## ADS Image Watch



## TwinCAT 3 Engineering Environment based on Visual Studio®

### System Manager

#### – Configuration

- TcVision Resource Management
  - Camera
  - Configuration
  - Calibration
  - Simulation
  - File Source Control

### Programming

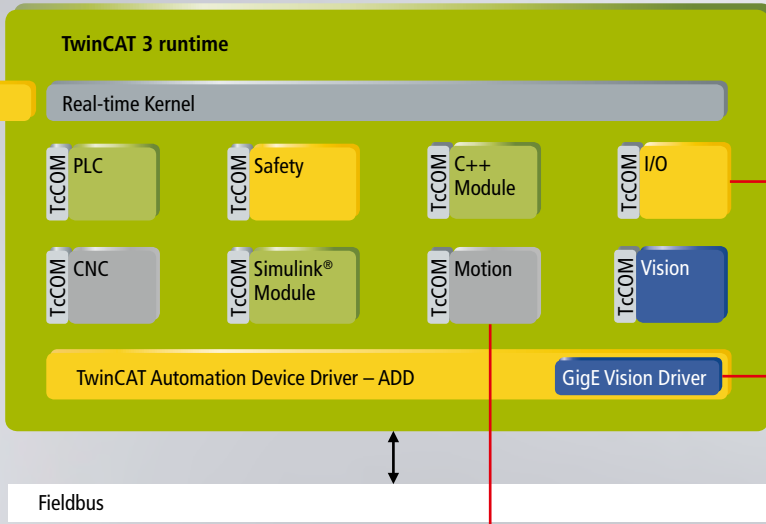
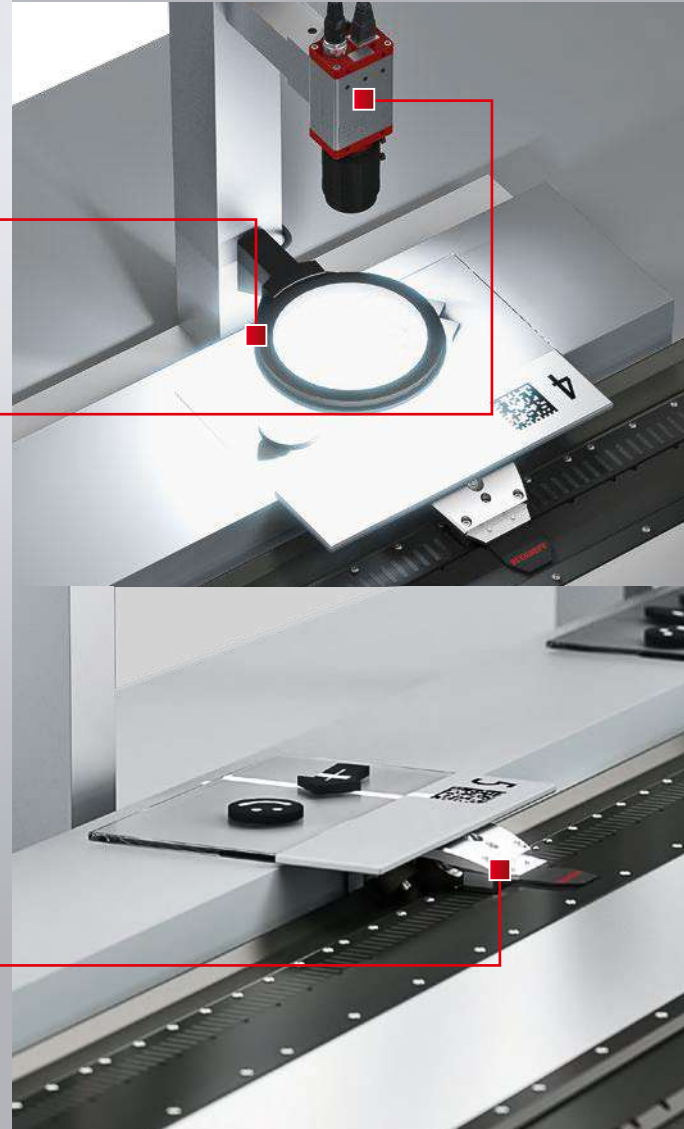
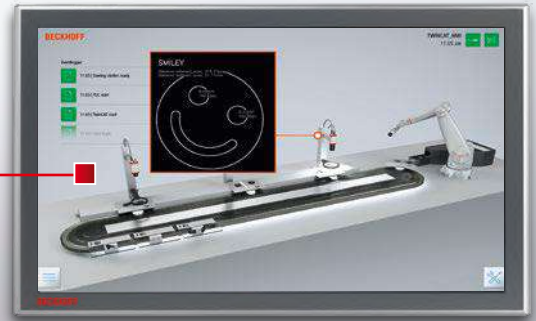
- IEC 61131-3
- object-oriented extensions
- C/C++

- TwinCAT Vision Library

ADS

TwinCAT Vision is directly integrated into the TwinCAT Engineering environment. Cameras can be added and configured easily under the new Vision node, and can be calibrated there as well. It is also possible to capture a camera image stream and to feed in the recording instead of live camera images. Alternatively, images in a range of formats can be loaded. This means that, even without camera access, users can still develop and implement image processing procedures.





The sequence of image processing is programmed directly in the PLC, in PLC programming languages and using the extensive library of image processing algorithms provided. Integrating image processing into the PLC means that the analysis chain executes in the TwinCAT runtime system, enabling communication with other processes running on the PLC, such as motion control, without latency. All debugging options known from PLC programming are avail-

able. Intermediate results can be displayed in the engineering environment or in TwinCAT HMI at any time.

**Simplified engineering, optimised runtime performance:**

- easy camera configuration
- engineering in PLC programming languages
- analysis chain fully contained in the PLC
- processing without latency

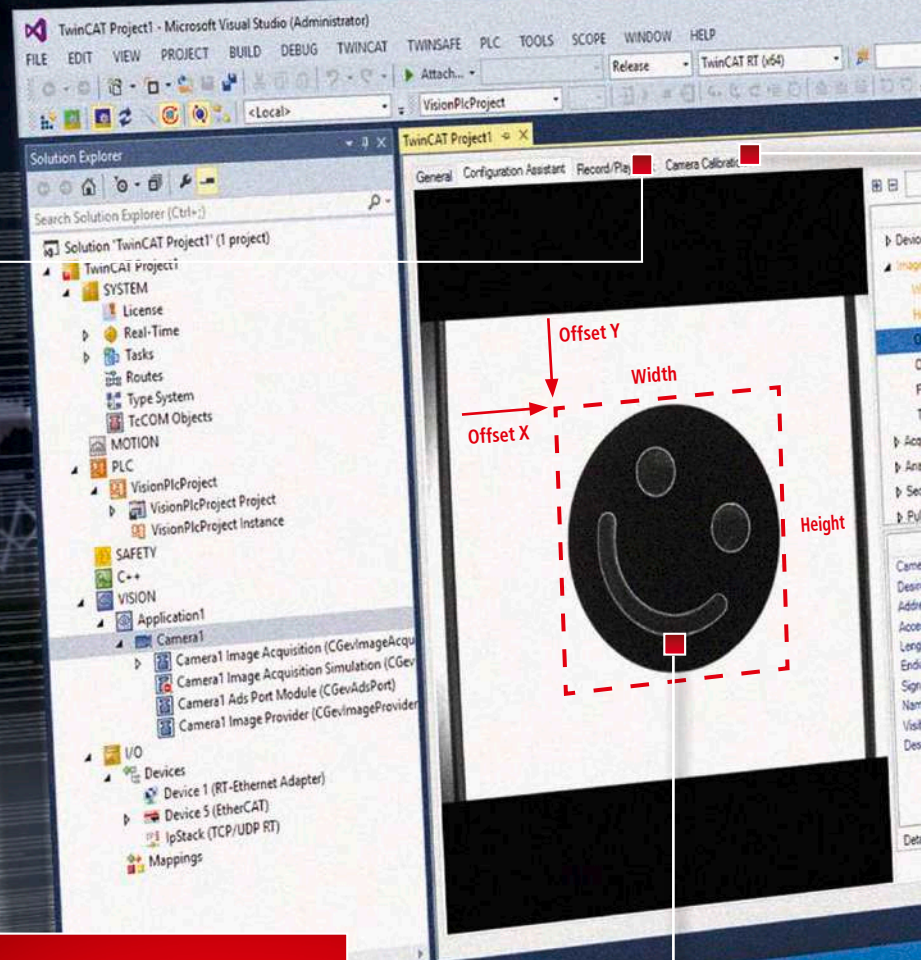
# Easy configuration of machine vision in a familiar environment.

## Camera simulation:

Switching between the live camera view and a recorded stream, or enabling stream capture, is easy, without changing a line of code.

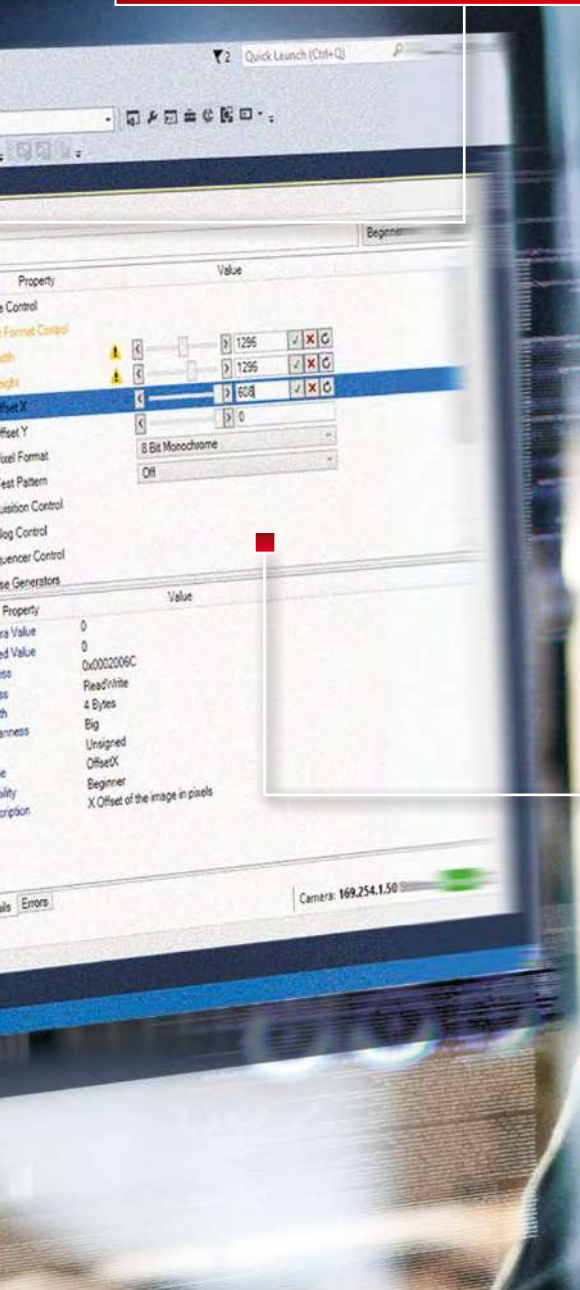
## Live view:

The live camera image allows configuration changes to be reviewed directly.



### Camera calibration:

For camera calibration, the imaging process is modelled and then described in terms of extrinsic, intrinsic and distortion parameters. This enables position determination and measurement tasks to be performed with high precision. Calibration can be conducted in the engineering as well as in the runtime environment.



### Camera configuration:

Integrated camera configuration according to the GenICam standard in TwinCAT Engineering ensures that no other tools are required. The image shows a region of interest being defined.

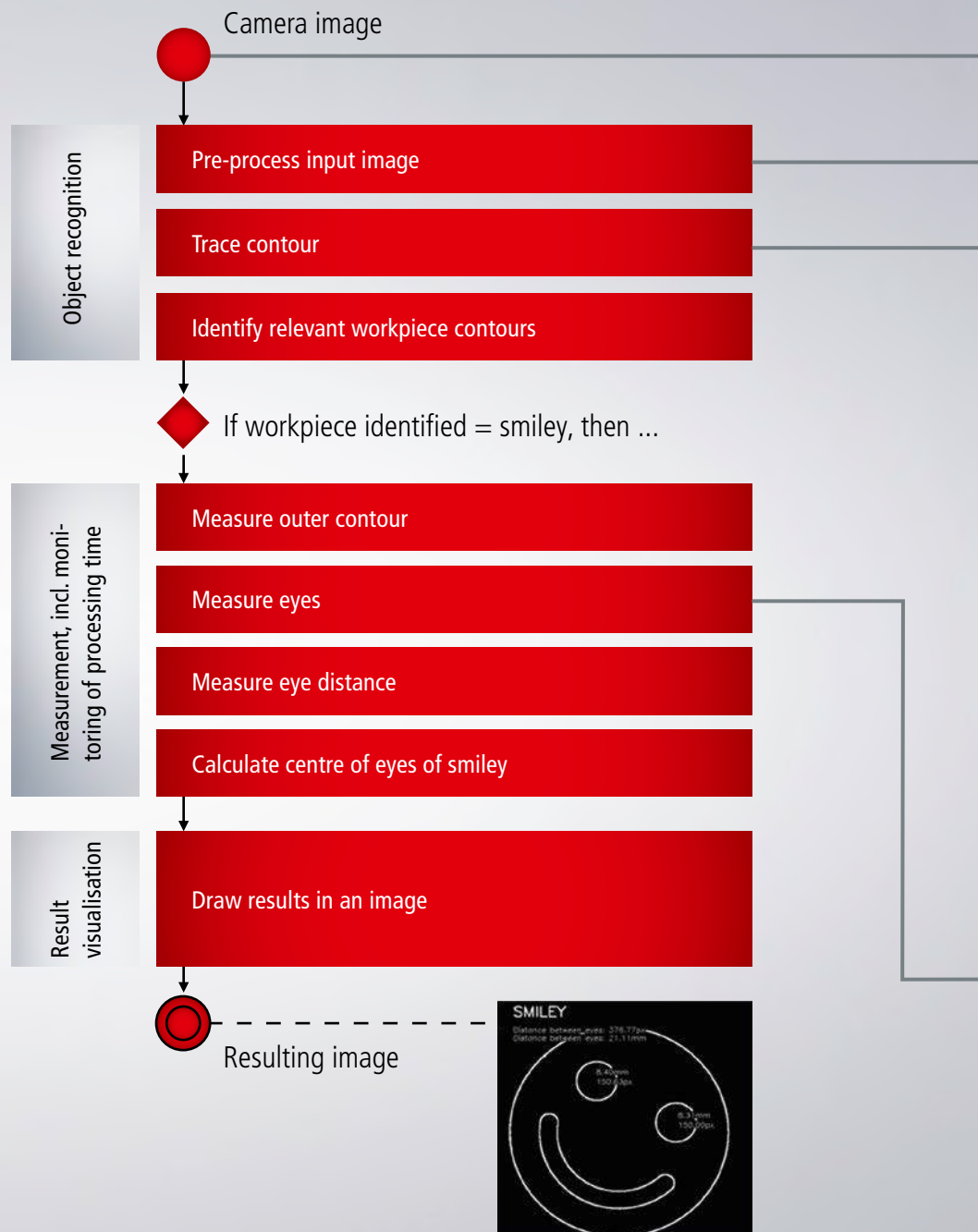
Apart from motion control and I/O configuration, TwinCAT Vision also enables cameras to be configured in TwinCAT Engineering. GigE Vision cameras can be integrated under the new TwinCAT Vision node to be configured according to the GenICam standard. Here, all camera settings can be defined and the results can be directly reviewed in the camera live image. Moreover, cameras can also be calibrated in the engineering environment. Users can choose from a range of calibration patterns,

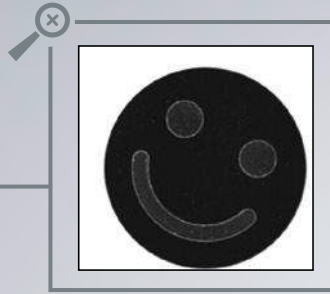
including their own user-specific patterns. Again, they can review the results directly. TwinCAT Vision is fully integrated with TwinCAT and Visual Studio. All known features such as docking windows and sourcecode management systems are supported.

### Configuration and programming in a single tool:

- vision resource management
- instant review of configuration changes
- integrated camera configuration functions
- camera calibration in engineering and runtime
- easy image stream control

# Vision and control functions: all programmed for a single platform.





```

hr := F_VN_ApplyThreshold(ipSrcImage      := ipImgIn,
                          ipDestImage     := ipImgWork,
                          fThreshold      := 45,
                          fMaxValue       := 255,
                          eThresholdType   := TCVN_TT_BINARY,
                          hrPrev          := hr);

```

```

hr := F_VN_FindContourHierarchyExp(ipSrcImage      := ipImgWork,
                                   ipContours      := ipContourList,
                                   ipHierarchy      := ipHierarchyList,
                                   eRetrievalMode   := TCVN_CRM_TREE,
                                   eApproximationMethod := TCVN_CAM_SIMPLE,
                                   aOffset         := aContourOffset,
                                   hrPrev         := hr);

```

```

hrWD := F_VN_StartRelWatchdog(5000, WATCHDOG_ACCUMULATION_TYPE_MEAN, S_OK);

hr := F_VN_LocateEllipseExp(ipImage,
                             stEye[nEyeCount],
                             aCenterPoint,
                             fSearchRadius,
                             TCVN_ED_DARK_TO_LIGHT,
                             20, 4, FALSE, 25, 45, 0.001,
                             TCVN_EDA_APPROX_GAUSSIAN,
                             ipContour,
                             hr);

hrWD := F_VN_StopWatchdog(hrWD, tRest => tRest, nFractionProcessed =>
nFractionProcessed);

```

Image analysis is programmed in the PLC itself. An extensive library of function blocks and functions is available that includes contour detection, colour recognition, key-point feature extraction and measurement functions. Additional information such as embedded lines or text can be inserted into images in the PLC. The intermediate status at any point along the analysis chain can be viewed as an image in the engineering environment or the TwinCAT HMI. Users can also work

with the usual debug options supported by the PLC (to monitor variables and set breakpoints, for instance) and make online changes to the code in image processing algorithms.

**All functions combined:**

- object detection
- measurement, including monitoring of processing time
- result visualisation

# All applications synchronised in real-time: Motion control, robotics and machine vision.

## Station 1: Mover/tablet ID scan

- Area-scan camera, bright field illumination
- Data Matrix code readout

## Station 2: Part recognition

- Line-scan camera, bright field illumination
- Object recognition (detection and type recognition)
- Position detection (position and orientation)



### Station 3: Inspection (dimensional accuracy check)

- Area-scan camera, dark field illumination
- Position and orientation correction
- Measurement of part-specific dimensions
- Comparison with reference dimensions



Because the image processing algorithms are executed within in the same environment as PLC, motion control and robotics, all tasks can be easily synchronised. Image capture timing is defined precisely – using triggers, for instance – and is easy to coordinate with the position of an axis or robot at a given point in time.

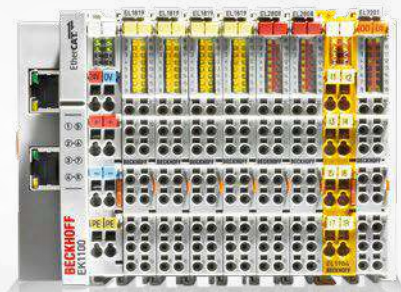
Integration of image processing into TwinCAT also simplifies the engineering process. A single tool can be used to configure and program all

tasks with ease. Integration also enables machine builders to keep their image processing expertise inhouse. Since all image processing algorithms are executed in the same runtime and in a synchronised manner, delays that would otherwise occur in communication can be completely eliminated. Overall, these enhancements enable substantial process optimisations.

#### Integrated image processing:

- detection
- identification
- measurement
- quality assurance
- accelerated time-to-market

# The Beckhoff control system: totally open, maximum scalability.



Automation

IPC

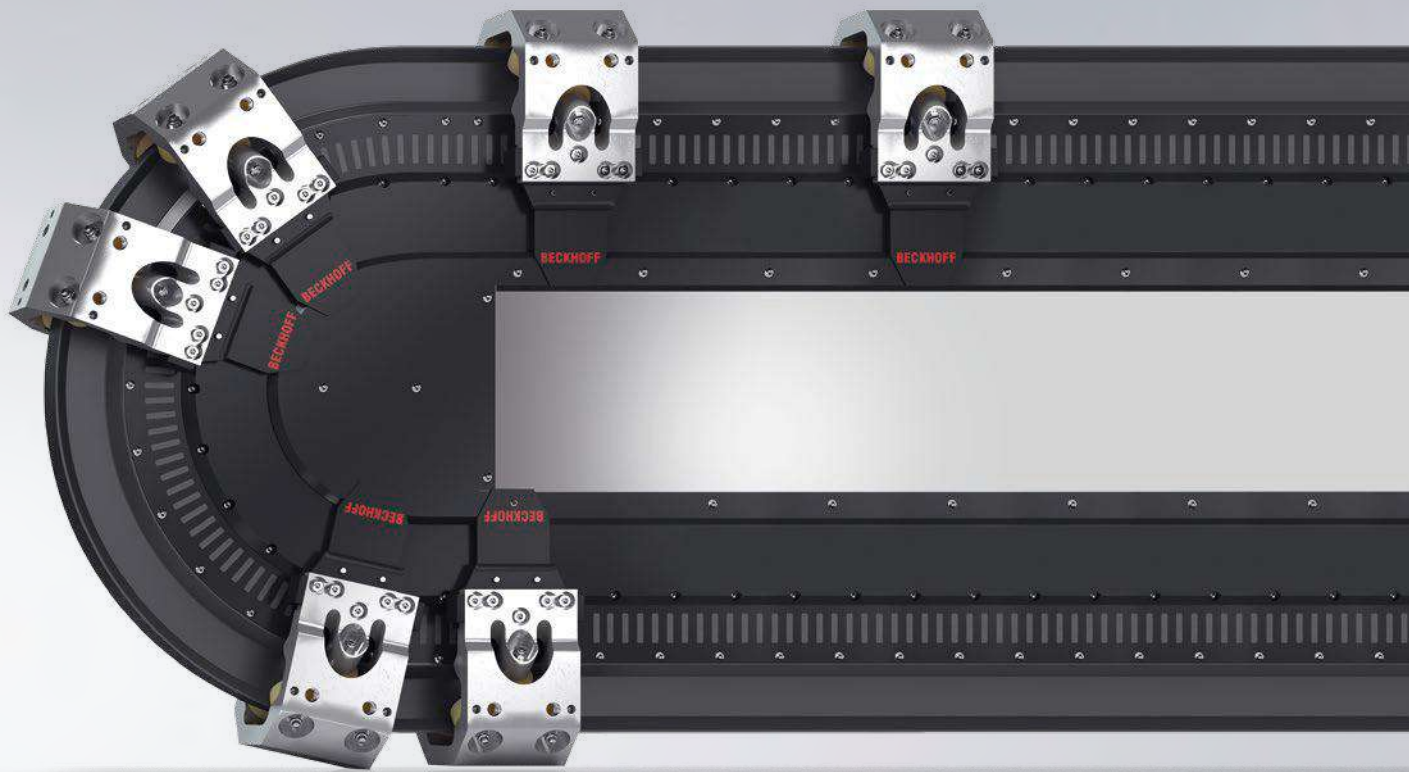
I/O



- Line-scan camera
- Area-scan camera

With the PC-based control philosophy, Beckhoff offers an exceptionally scalable solution to all kinds of automation challenges. Building on the core principle of combining all automation functions on a central control platform, the company offers an extensive portfolio of high-performance components designed to support modular control solutions covering a broad diversity of requirements. Central to this portfolio is a scale-to-fit selection of Industrial PCs with form factors





## Motion



- Line illumination
- Area illumination
- Bright field ring lights
- Dark field ring lights

and performance specifications ranging from ultra-compact IPCs to powerful multi-core servers. In addition, the portfolio includes fieldbus components for all common I/Os and fieldbus systems, highly dynamic drive solutions in all performance classes, and the proven, modular control software TwinCAT. As the inventor of EtherCAT, Beckhoff also has unparalleled knowledge when it comes to optimising EtherCAT connectivity between control components. In short, Beckhoff possesses

comprehensive technological expertise in every product area, combined with an in-depth understanding of specific automation requirements in more than 25 industry sectors.

### A comprehensive portfolio of control components:

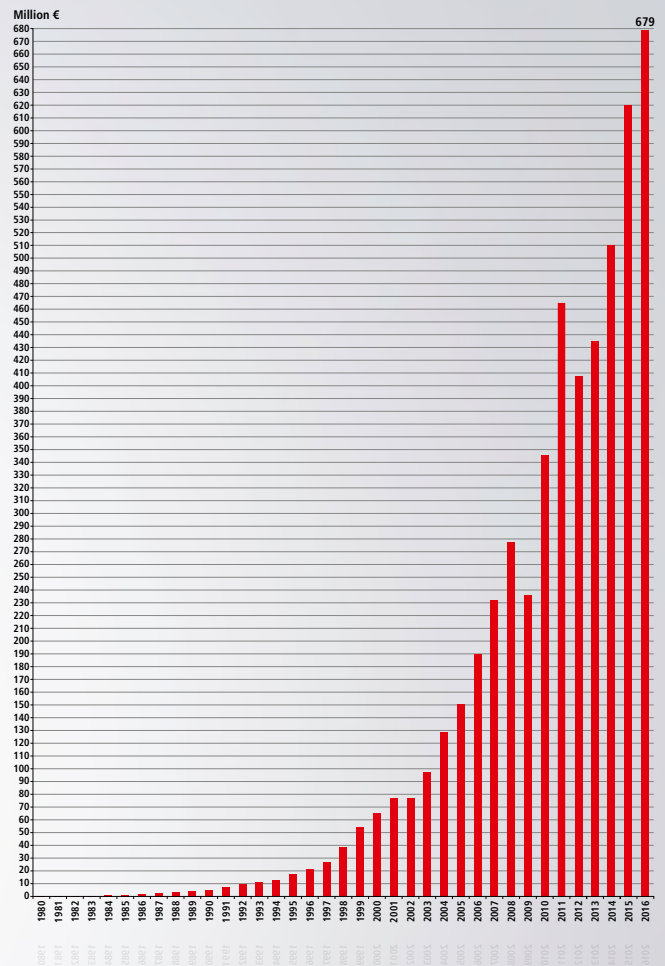
- exceptionally scalable Industrial PCs
- fieldbus components for all common I/Os
- highly dynamic drive solutions
- proven TwinCAT control software

# Globally available: the Beckhoff automation expertise.



- Headquarters
- Subsidiary
- Headquarters distributor
- Subsidiary distributor

**Beckhoff – New Automation Technology**  
 Beckhoff implements open automation systems based on PC Control technology for more than 35 years. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. For all areas of application, product series are available that can be used as separate components or integrated into a complete and seamless control system.



Sales development

The Beckhoff “New Automation Technology” philosophy represents innovative control and automation solutions that are used worldwide in a wide variety of different applications and industries, ranging from CNC-controlled machine tools and wind turbines to intelligent building automation.

### Worldwide presence on all continents

The worldwide presence of Beckhoff in more than 75 countries ensures fast service and support for globally operating customers in their local language. Moreover, geographical proximity helps us develop an in-depth understanding of the technical challenges our customers are faced with around the world.

### Beckhoff at a glance

- Headquarters Verl, Germany
- Sales 2016: 679 Mio. € (+9,5 %)
- Staff worldwide: over 3,350
- Sales/Technical Offices Germany: 18
- Subsidiaries/Branch Offices worldwide: 34
- Distributors worldwide: in more than 75 countries

(as of 04/2017)

▶ [www.beckhoff.com](http://www.beckhoff.com)

Optimise your machines with TwinCAT Vision.  
For full details visit:  
► [www.beckhoff.com/twincat-vision](http://www.beckhoff.com/twincat-vision)

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