APPLICATION NOTE

```
// Create an instant camera object with the firs
Camera_t camera( CTlFactory::GetInstance().Creat

// Register an image event handler that accesses
camera.RegisterImageEventHandler( new CSampleIma
Ownership_TakeOwnership);

// Open the camera.
camera.Open();
```

Compatibility of Basler Cameras with Third-Party Software Libraries

Applicable to Basler GigE Vision, USB3 Vision, Camera Link and IEEE 1394 cameras

R.J. Wilson, Inc.
Imaging Components for Industry & Science

www.rjwilson.com
sales@rjwilson.com
781-335-5500

BASLER
the power of sight

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1 Introduction

Basler is a leading global producer of digital cameras for industrial applications. Manufacturers of equipment, machines, and plants incorporate our cameras into their own products. Our premium cameras are predominantly used in industrial mass production, medical technology, the life sciences, retail applications, as well as in intelligent traffic systems.

For customers using digital cameras not only a superior image quality but also a perfect and easy interoperability between all components in a system plays a significant role, i.e. between cameras, software, cables, I/O devices etc. If interoperability is taken into account, a lot of work during the design-in phase can be saved and the flexibility of final applications can be guaranteed, i.e. software and hardware can be easily swapped if necessary.

In order to make it easier for customers to build their systems and to guarantee a perfect interoperability with so-called "third-party" software libraries, i.e. image processing software libraries developed and distributed by vendors other than Basler, Basler integrates and performs additional test procedures in the camera production and firmware release processes.
Some of the well-known third-party software library vendors in the Machine Vision market are e.g. Cognex (VisionPro), National Instruments (LabView), Matrox (MIL), MVTec (Halcon), Stemmer Imaging (Common Vision Blox), etc.

This application note provides information on how Basler's Machine Vision cameras are tested in order to guarantee a perfect compatibility with third-party software libraries according to the GenICam (http://www.emva.org/), GigE Vision, USB3 Vision and Camera Link standards (http://www.visiononline.org/).

For more information about Basler digital cameras, see www.baslerweb.com.

2 Machine Vision Standards

During the design of a camera a lot of work is going into the area of interoperability, because the final product has to work and interoperate perfectly in the customers' installations.

The key for a camera to work in different use cases is the standardization.

During the last years the Machine Vision industry and their trade organizations have developed a number of standards that ease the integration of cameras in a multitude of environments, be it protocols, software or hardware (like cables and hosts).
Those standards define the interfaces of a camera and the interaction of the environment with the camera.

Basler has been playing an active role in the development of Machine Vision standards and is committed to always deliver high-quality cameras complying with officially recognized industrial standards.

2.1   GenICam

The GenICam standard is hosted by the European Machine Vision Association (EMVA). Basler, together with a group of prominent camera, frame grabber, and software library manufacturers, is actively supporting the development of the standard.

The main objective of GenICam is to provide a generic programming (configuration) interface across a wide range of standard physical interfaces such as GigE Vision, USB3 Vision, Camera Link, and FireWire/IEEE 1394, regardless of the camera type and what features are implemented in a camera. The Application Programming Interface (API) should be always the same (see Figure 1). This approach makes it easy to connect cameras compliant with the GenICam standard without the need for camera-specific configurations.
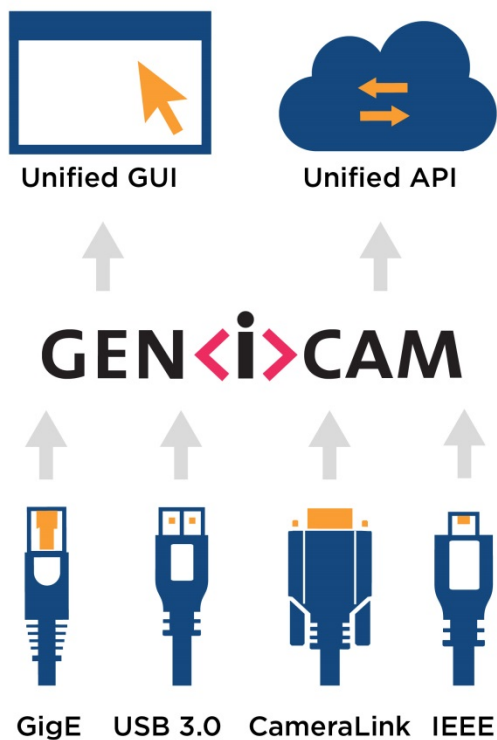

Figure 1: Idea of GenICam

The core of GenICam is a description of the camera's properties in an XML descriptor file. Using this file, a translator from XML to C++ directly generates an application programming interface, called GenAPI, or the elements of a Graphical User Interface (GUI). This lets the user easily access the features, e.g. gain, exposure time etc., and the functions available on the camera (see Figure 2). The GigE Vision and USB3 Vision standards require that cameras with a GigE or a USB 3.0 interface provide the XML descriptor file.
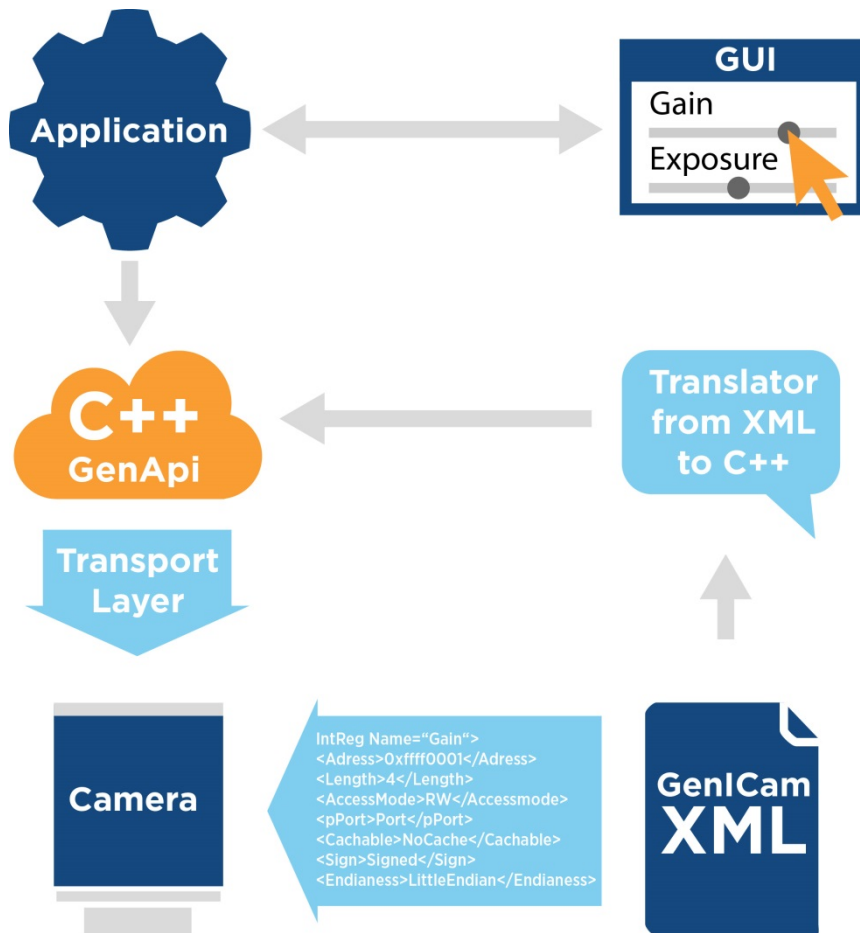
Figure 2: GenICam Functional Description

The configuration of Camera Link cameras by means of GenAPI is described in the so-called CLProtocol module of the GenICam standard. Latest Basler Camera Link cameras such as the Basler ace CL, Basler aviator CL, Basler beat and Basler racer CL are fully GenICam compliant.

To facilitate customers using Basler's IEEE 1394 compliant cameras, Basler also provides an XML descriptor file for our IEEE 1394 cameras in the Basler pylon Camera Software Suite.

For more information about

- the Basler's pylon Camera Software Suite and about Basler's digital cameras, see www.baslerweb.com.
- GenICam, see http://www.emva.org/.

2.2   Vision Standards

Machine Vision standards such as GigE Vision, USB3 Vision and Camera Link are hosted by the AIA (Automated Imaging Association). As one of the founding members of AIA, Basler plays a leading role in the development of those standards.

2.2.1   GigE Vision

Since its debut in 2006, GigE Vision and Gigabit Ethernet (GigE) has been the fastest growing interface for digital cameras in the field of industrial image processing. It is a universally applicable digital interface that offers the widest technological flexibility with regard to bandwidth (up to 115 MB/s), cable length (up to 100 m), and multi-camera functionality.

Figure 3: Official GigE Vision Logo

In addition to the physical interface defined by the Gigabit Ethernet standard, the especially clear and logical implementation of the GigE Vision standard supports easy integration in all image processing programs via the use of software libraries.

For more information about GigE Vision, see http://www.visiononline.org/.

2.2.2   USB3 Vision

USB3 Vision was officially ratified in January 2013. In the image processing industry it serves as the official standard for the USB 3.0 interface.

In recent years, USB3 Vision and USB 3.0 have developed to a major interface technology for industrial, medical and mass-market applications. USB 3.0 is known for transfer bandwidths of 350 to 450 MB/s. USB 3.0 is also completely plug-and-play-ready. Thanks to its real-time compatibility and high bandwidth, USB 3.0 is ready in the medium term to replace two old, slower interfaces on the vision market - FireWire and USB 2.0.

Figure 4: Official USB3 Vision Logo

The design of the USB3 Vision standard is based on the GenICam standard, the common programming interface for all modern industrial camera interfaces. USB3 Vision and GenICam offer users stability and low latency values during image transfer and camera control. The use of USB3 Vision-certified cameras, software and accessories offer many benefits to users: a variety of different cameras can be used, and it is easy to swap parts. There are also established communication protocols for the different hardware and software components in a system setup.

For more information about USB3 Vision, see http://www.visiononline.org/.

2.2.3 Camera Link

The Camera Link standard was initially released in 2000 and is maintained by the AIA. It is a robust communication link using a dedicated cable connection (up to 10 m) and a standardized communications protocol. Camera Link is a hardware specification that standardizes the connection between cameras and frame grabbers. It defines a complete interface which includes provisions for data transfer, camera timing, serial communications, and real time signaling to the camera.

Figure 5: Official Camera Link Logo

Camera Link was built for real time, high bandwidth (maximum 850 MB/s) parallel communication. It is a well-established and proven industry standard. There are hundreds of Camera Link products on the market today. These compliant products are interoperable, providing users with the flexibility to choose the best product for their needs without worrying about compatibility between different manufacturers. Camera Link has GenICam support for plug-and-play interoperability.

For more information about Camera Link, see http://www.visiononline.org/.

3 Test Concept at Basler

During production, each Basler camera undergoes extensive testing to meet the highest quality standards. Each Basler camera has an exclusive 3-year warranty.

Basler has different methods and test setups to ensure that our cameras are compatible with the given standard. However, the standard compliance depends also on aspects outside of Basler's control.

The following chapters describe how Basler is ensuring the compatibility of our cameras with Machine Vision standards and what other aspects have to be considered.

3.1 PlugFests

A common understanding in the Machine Vision industry is that products (cameras and software) that comply with a given standard are compatible with each other and their interoperability is guaranteed by default.

However, standards should be rather perceived as agreements without a specific product or technical implementation in mind. In other words, standards are pretty abstract.

To capture the differences of "real world" environments that a standardized interface has to handle in practice, the AIA organizes so-called "PlugFests" biannually.

During a PlugFest all companies that develop products or a technology observed by a standard meet and check that their implementation is compatible with the implementation of someone else. They really do plug components (cameras, cables, I/O devices) into hosts (hosts hardware and the application software and operating systems running on them) to verify that their implementation really interoperates with other products.

Basler is a regular participant and has been attending PlugFests since 2006.

3.2 Third-Party Libraries

To guarantee even higher interoperability and recognize and avoid any incompatibility issues with software products of other (none-Basler) vendors in the current development process, Basler performs additional compatibility tests, i.e. the so-called "third-party tests".

These third-party tests include testing of Basler cameras in combination with prominent third-party software library vendors like Cognex (VisionPro, http://www.cognex.com/), National Instruments (LabView; http://www.ni.com/), Matrox (MIL, http://www.matrox.com/), and MVTec (Halcon, http://www.mvtec.com/).

To fulfill the current requirements on interoperability between the latest camera firmware (features) and third-party software versions, Basler has established partner relationships with the most important vendors for Machine Vision software libraries. As part of this partnership Basler provides cameras with current firmware to selected software partner companies and receives in turn preliminary and/or officially released versions of a given software library for testing.

Basler's goal is to integrate those third-party libraries in the firmware release process and make sure that every single camera is tested accordingly.

To accommodate any possible issues a third-party may encounter while rolling-out new versions of their software, Basler continues to test any new camera firmware on the previous version of third-party software until the newly-released version is on the market for about one year. At that point Basler will update the testing system to the latest version.

For instance, if the third-party software upgrades from version 1.0 to 2.0, we test our new camera firmware with version 1.0 until version 2.0 is on the market for up to one year. Afterwards, we will cease testing our new firmware on version 1.0 and continue with 2.0.

Testing of older or newer versions of third-party libraries is optional. In each case, Basler decides whether this additional testing is realized or not.

As per the beginning of 2016 the following third-party libraries and versions are used for testing of Basler digital cameras with different interfaces (see Table 1):

Product	Current version	USB3 Vision	GigE Vision	Camera Link
GigE Vision Compliance [1]	2.0.2.3596		✓	
USB3 Vision Compliance [2]	SVN450	✓		
USB-IF Command Verifier Tests [2]	2.0.3.3	✓		
Cognex [3] *VisionPro*	9.0	✓	✓	
National Instruments [4] *Vision Acquisition Software, MAX*	14.5	✓	✓	✓
Matrox Imaging *MIL*	9.0			✓
MVTec *Halcon*	12.0.1	✓	✓	
BitFlow *BitFlow SDK*	5.70			✓
GigE adaptor card (NIC) used: *as recommended by Basler* (www.baslerweb.com) **USB 3.0 xHCI adaptor card used**: *as recommended by Basler* (www.baslerweb.com) **CL frame grabber used**: *NI PCIe-1430, NI PCIe-1433; Matrox Solios eV-CLF; BitFlow Karbon-CL4-F*				

Table 1: Third-party Software Libraries Tested at Basler

(1) GigE Vision Compliance

To use the GigE Vision name and logo, GigE Vision products (including software) must be registered with the AIA and must be tested for compliancy with the standard.

At Basler, every GigE Vision camera undergoes a so-called "GigE Vision Validation Framework" test, which is specified by the GigE Vision standard.

Basler always uses the latest version of the GigE Vision Validation Framework whenever a new camera firmware is released.

For more information about the GigE Vision standard and the GigE Vision Validation Framework, see http://www.visiononline.org/.

(2) USB3 Vision Compliance

To use the USB3 Vision name and logo, USB3 Vision products (including software) must be registered with the AIA and must be tested for compliancy with the standard.

At Basler, every USB3 Vision camera undergoes two groups of testing:

▪ **AIA USB3 Vision Validation Suite**

The AIA USB3 Vision Validation Suite tests specific protocol and behavioral requirements defined by the USB3 Vision standard. It is designed to be as comprehensive as possible, but should not be a substitute for ensuring a device meets every applicable requirement in the USB3 Vision specification.

▪ **USB-IF Command Verifier Tests**

The USB-IF provides a comprehensive test suite, i.e. the USB-IF Command Verifier, on basic USB device behavior. This covers standard USB behavior that is necessary for the device to be properly discovered and used by the system.

Basler always uses the latest versions of both, the AIA USB3 Vision Validation Suite and the USB-IF Command Verifier, whenever a new camera firmware is released.

For more information about the USB3 Vision standard, see http://www.visiononline.org/.

(3) Cognex VisionPro and USB3 Vision

To verify the compatibility of Basler USB3 Vision cameras with the Cognex VisionPro software, the Basler pylon USB 3.0 AIK Adapter is used.

For more information about the Basler pylon Camera Software Suite and about the Basler pylon USB 3.0 AIK Adapter, see www.baslerweb.com.

(4) National Instruments Camera Validator

To verify the compatibility of Basler GigE Vision and IEEE 1394 cameras with the NI Vision Acquisition Software and the NI-IMAQdx driver, in addition to the standard compliancy tests, Basler uses the NI Camera Validator utility to test each attribute of Basler cameras, and Basler generates a compatibility report.

For more information about the NI Vision Acquisition Software and the NI Camera Validator, see http://www.ni.com/.

3.3 General Feature Tests

To verify the general functionality of Basler cameras with third-party software libraries, the following features are tested whenever applicable and supported by the given third-party software, (see Table 2):

Test Type	Description
Table 2: General Features Tested with Third-party Libraries	
Test Type	**Description**
GigE Vision Driver	Check GigE Vision Device Driver
USB3 Vision Driver	Check USB3 Vision Device Driver
CL Driver	Check CL Driver
Configure CL Grabber	Configure CL Frame Grabber
Baud Rate	Check the Baud Rate
PoCL	Check PoCL
Clean Cache	Clean any software specific cache files on PC
Camera Access	Camera Access, Initialize
Device Info	Check Camera Name and ID
Firmware, Serial Number	Check Firmware and Serial Number
Sensor Size	Check Sensor Size and AOI
Control Channel	Setting of Parameters
Test Image	Check Test Image Selection
Grab Test Image	Check Test Image
Parameter Save	Save All Parameters
Reset	Reset to Factory Settings

Table 2: General Features Tested with Third-party Libraries	
Test Type	**Description**
Parameter Loading	Check Initial Loading of Parameters
Grab Live Image	Check Grab Bright Image
Grab Dark Image	Check Grab Dark Image
Reset, Test Image	Reset to Factory Settings; Set Throughput Limit (USB3 Vision); Set Test Image
BayerBG8	Check Pixel Format BayerBG8
BayerBG10	Check Pixel Format BayerBG10
BayerRG16	Check Pixel Format BayerRG16
BayerBG10p	Check Pixel Format BayerBG10p
YCbCr422_8	Check Pixel Format YCbCr422_8
YUV422_ YUYV_ Packed	Check Pixel Format YUV422_YUYV_Packed
Mono8	Check Pixel Format Mono8
RGB8	Check Pixel Format RGB8
BGR8	Check Pixel Format BGR8
Lost Frames	Check Lost Frames Count
Disconnection	Disconnect/ Reconnect Camera
Multiple Cameras	Test with multiple USB3 and GigE Vision Cameras
Maximal CL MHz	Check Maximal PixelClock Rate
CL 65MHz	Check PixelClock 65 MHz
CL 40MHz	Check PixelClock 40 MHz

Table 2: General Features Tested with Third-party Libraries

Test Type	Description
Minimal CL MHz	Check Minimal PixelClock Rate
CLBase	Check CL Base Configuration
CLMedium	Check CL Medium Configuration
CLFull	Check CL Full Configuration
CLDeca	Check CL Deca Configuration
Event Enable	Check Event Control
Chunk Enable	Check Chunk Control
Shutter Mode	Check Various Shutter Modes
ReverseX ReverseY	Check ReverseX and ReverseY
PixelFormat	Switch the Pixel Format
Misc	Depending on software functionalities perform further miscellaneous testing

NOTICE

The scope and intensity of testing of third-party software libraries is subject to change by Basler at any time.

Third-party tests are a core element of the firmware release process of Basler cameras and Basler is committed to do its best to guarantee the compatibility of Basler cameras with selected third-party software libraries.

Revision History

Document Number	Date	Changes
AW0011860**1**000	17 March 2016	Initial release version of this document.
AW0011860**2**000	26 March 2018	Removed text set to white from front page.