



AVT SOFTWARE DEVELOPMENT KIT

## **AVT Image Transform Programmer's Manual**

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## **Allied Vision Technologies GmbH 08/2014**

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Managing Director: Mr. Frank Grube

Tax ID: DE 184383113

Headquarters:

Taschenweg 2a

D-07646 Stadtroda, Germany

Tel.: +49 (0)36428 6770

Fax: +49 (0)36428 677-28

e-mail: [info@alliedvisiontec.com](mailto:info@alliedvisiontec.com)

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# 1 Contacting Allied Vision Technologies

## Note



- **Technical Information**  
<http://www.alliedvisiontec.com>
- **Support**  
[support@alliedvisiontec.com](mailto:support@alliedvisiontec.com)

### **Allied Vision Technologies GmbH (Headquarters)**

Taschenweg 2a  
07646 Stadtroda, Germany  
Tel.: +49 36428-677-0  
Fax.: +49 36428-677-28  
Email: [info@alliedvisiontec.com](mailto:info@alliedvisiontec.com)

### **Allied Vision Technologies Canada Inc.**

101-3750 North Fraser Way  
Burnaby, BC, V5J 5E9, Canada  
Tel: +1 604-875-8855  
Fax: +1 604-875-8856  
Email: [info@alliedvisiontec.com](mailto:info@alliedvisiontec.com)

### **Allied Vision Technologies Inc.**

38 Washington Street  
Newburyport, MA 01950, USA  
Toll Free number +1 877-USA-1394  
Tel.: +1 978-225-2030  
Fax: +1 978-225-2029  
Email: [info@alliedvisiontec.com](mailto:info@alliedvisiontec.com)

### **Allied Vision Technologies Asia Pte. Ltd.**

82 Playfair Road  
#07-02 D'Lithium  
Singapore 368001  
Tel. +65 6634-9027  
Fax: +65 6634-9029  
Email: [info@alliedvisiontec.com](mailto:info@alliedvisiontec.com)

### **Allied Vision Technologies (Shanghai) Co., Ltd.**

2-2109 Hongwell International Plaza  
1602# ZhongShanXi Road  
Shanghai 200235, China  
Tel: +86 (21) 64861133  
Fax: +86 (21) 54233670  
Email: [info@alliedvisiontec.com](mailto:info@alliedvisiontec.com)

## 2 Introduction

### 2.1 Document history

Version	Date	Changes
1.0	2013-03-22	Initial version
1.2	2013-06-18	Small corrections, layout changes
1.3	2014-08-12	Rework of the whole document

### 2.2 Conventions used in this manual

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols are used:

#### 2.2.1 Styles

Style	Function	Example
Bold	Programs, inputs or highlighting important things	<b>bold</b>
Courier	Code listings etc.	Input
Upper case	Constants	CONSTANT
Italics	Modes, fields, features	<i>Mode</i>
Blue and/or parentheses	Links	( <a href="#">Link</a> )

#### 2.2.2 Symbols

##### Note



This symbol highlights important information.

##### Caution



This symbol highlights important instructions. You have to follow these instructions to avoid malfunctions.

##### www



This symbol highlights URLs for further information. The URL itself is shown in blue.

Example: <http://www.alliedvisiontec.com>

## 3 General aspects of the Library

The purpose of the AVT Image Transform library is to transform images received via Vimba APIs into common image formats. It is part of Vimba and doesn't require a separate installation.

Applications using Vimba C or C++ APIs may need to integrate AVT Image Transform library as an additional library, whereas a subset of it is seamlessly integrated into the AVT Vimba .NET API via method `Frame.Fill()`. (See the [Vimba.NET Programmer's Manual](#))

### 3.1 Technologies

The AVT Image Transform Library is available in two versions: The standard version executes a method call in a single thread. The OpenMP version is recommended for achieving a high performance with multi-core PCs, since the function calls are distributed over the cores of the processor. Although additional time is required to schedule the sub tasks, its performance roughly scales by the number of free cores.

Both libraries have the same interface and the same name, but are delivered in different folders in the Vimba installation, allowing you to use the library you want.

The OpenMP version of the library can be found in the subdirectory `OpenMP` beneath the standard library.

### 3.2 Supported image data formats

In contrast to image *file* formats, image *data* formats contain no embedded meta-data, but only pure images as rectangular arrays of pixels. These pixels have certain characteristics, e.g. a certain color or bit depth and the endianness for a bit depth of more than eight, and they may appear in a certain order. All this is described in a pixel format name.

#### Note



All implemented image transformations only accept multi-byte pixel formats in little-endian byte order.

For this library, pixel formats from the interface specifications IIDC and GigE Vision as well as common display formats on Windows and Linux platforms have been selected. The names of the pixel formats mainly match the list of values of the "PixelFormat" feature in the [Standard Features Naming Convention](#) of GenICam.

Since the following pixel formats span a few bytes or in some cases several lines, their width and height or size (in pixels) must be divisible by the following values:

Pixel format	Width	Height	Size
Mono12Packed	1	1	2
Bayer . . . .	2	2	1
Yuv411	4	1	1
Yuv422	2	1	1

### 3.3 Supported transformations

Source	Target	Mono8	Mono16	Rgb8	Bgr8	Argb8	Bgra8	Yuv422
Mono8		✓	-	✓	✓	✓	✓	✓
Mono10		✓	✓	✓	✓	✓	✓	-
Mono12		✓	✓	✓	✓	✓	✓	-
Mono12Packed		✓	-	✓	✓	✓	✓	-
Mono14		✓	✓	✓	✓	✓	✓	-
Mono16		✓	✓	✓	✓	✓	✓	-
BayerXX <sup>1</sup> 8		✓	✓	✓	✓	✓	✓	✓
BayerXX <sup>1</sup> 10		✓	✓	✓	✓	✓	✓	-
BayerXX <sup>1</sup> 12		✓	✓	✓	✓	✓	✓	-
BayerXX <sup>1</sup> 12Packed		✓	✓	✓	✓	✓	✓	-
BayerXX <sup>1</sup> 16		✓	✓	✓	✓	✓	✓	-
Rgb8		✓	-	✓	✓	✓	✓	-
Bgr8		✓	-	✓	✓	✓	✓	-
Argb8		✓	-	✓	✓	✓	✓	-
Bgra8		✓	-	✓	✓	✓	✓	-
Yuv411		✓	-	✓	✓	✓	✓	-
Yuv422		✓	-	✓	✓	✓	✓	✓
Yuv444		✓	-	✓	✓	✓	✓	-

<sup>1</sup>BayerXX is any of BayerGR, BayerRG, BayerGB or BayerBG

## 4 API usage

### 4.1 General

Every concrete image transformation must specify its three parameters:

- The fully-qualified input image (including complete format specification)
- The complete output format (plus a pointer to enough memory to hold the transformed image)
- The transformation itself (including transformation options if there is more than one possible way from the input format to the output format)

`VmbImageTransform()` is the main function, which covers all three transformation parameters. It uses two `VmbImage` pointers to specify the source and destination image and a list of `VmbTransformInfo` structs to specify the transformation.

To ease filling the structs that are needed for a successful call of `VmbImageTransform()`, several helper functions for initializing them are available:

- Methods for filling the necessary format information of either the input or the output image (described in chapter [Filling Image Information](#)).
- Methods for filling optional transformation parameters to invoke special and additional functionality, as can be seen in chapter [Specifying Transformation Options](#).

### 4.2 Filling Image Information

There are three ways to fill `VmbImage` structs:

1. Filling the fields explicitly one by one (not recommended)
2. Using the function `VmbSetImageInfoFromPixelFormat()` by providing a `VmbPixelFormat_t` value and the size
3. Using the function `VmbSetImageInfoFromString()` by providing a string that describes the pixel format and the size

With the first approach, you have to specify many fields (that are important for the transformation process, but very possibly not for you), while the latter two approaches only require knowing either the name or the enumeration value of the image format.

### 4.3 Specifying Transformation Options

Depending on your application and the desired image characteristics, you can choose between several transformation options. A common way to transform color images is using a 3x3 matrix with method `VmbSetColorCorrectionMatrix3x3()`. The Matrix you have to specify is a 3x3 row order float matrix.

$$\begin{pmatrix} rr & rg & rb \\ gr & gg & gb \\ br & bg & bb \end{pmatrix}$$



Every transformation of a Bayer image requires defining how to interpolate or combine the color pixels. This can be done with the help of an additional transformation parameter to `VmbImageTransform()`, which can be filled with the help of function `VmbSetDebayerMode()` (using a `VmbDebayerMode` as input).

`VmbDebayerMode` can be one of the following values:

Value	Description
<code>VmbDebayerMode2x2</code>	2x2 with green averaging
<code>VmbDebayerMode3x3</code>	3x3 with equal green weighting per line
<code>VmbDebayerModeLCAA</code>	Debayering with horizontal local color anti-aliasing
<code>VmbDebayerModeLCAAV</code>	Debayering with horizontal and vertical local color anti-aliasing
<code>VmbDebayerModeYUV422</code>	Debayering with YUV422-alike sub-sampling

## 4.4 Transforming images

When you've prepared all the parameters of a transformation, use the pre-filled structs and call `VmbImageTransform()`.

## 5 Transformation examples

### 5.1 Debayering into an Rgb8 image

Example for a transformation of a BayerGR8 image with 640x480 pixels into an Rgb8 image of the same size:

```
VmbImage          sourceImage;
VmbImage          destinationImage;
VmbTransformInfo  info;

// set size member for verification inside API
sourceImage.Size  = sizeof ( sourceImage );
destinationImage.Size  = sizeof ( destinationImage );

// attach the data buffers
sourceImage.Data   = pInBuffer;
destinationImage.Data   = pOutBuffer;

// fill image info from pixel format
VmbSetImageInfoFromPixelFormat ( VmbPixelFormatBayerGR8,
                                640,
                                480,
                                &sourceImage);

// fill image info from pixel format string
std::string name ( "RGB8" );
VmbSetImageInfoFromString ( name.c_str(),
                            static_cast<VmbUInt32_t>( name.size() ) ,
                            640,
                            480,
                            &destinationImage );

// set the debayering algorithm to simple 2 by 2
VmbSetDebayerMode ( VmbDebayerMode2x2, &info );

// perform the transformation
VmbImageTransform ( &sourceImage, &destinationImage, &info, 1 );
```

### 5.2 Debayering into a Mono8 image

Example for preparing a transformation of a BayerRG8 image with 640x480 pixels into a Mono8 image of the same size:

```
VmbImage          sourceImage;
VmbImage          destinationImage;
VmbTransformInfo  info;

// set size member for verification inside API
sourceImage.Size  = sizeof ( sourceImage );
destinationImage.Size  = sizeof ( destinationImage );

// attach the data buffers
sourceImage.Data   = pInBuffer;
```

```

destinationImage.Data    = pOutBuffer;

// fill image info from pixel format string
std::string name ( "PixelFormatBayerRG8" );
VmbSetImageInfoFromString ( name.c_str(),
                           static_cast<VmbUInt32_t>( name.size() ),
                           640,
                           480,
                           &sourceImage );

// fill image info from pixel format
VmbSetImageInfoFromPixelFormat ( VmbPixelFormatMono8,
                                640,
                                480,
                                &destinationImage );

// set the debayering algorithm to 3 by 3
VmbSetDebayerMode ( VmbDebayerMode3x3, &info );

// perform the transformation
VmbImageTransform ( &sourceImage, &destinationImage, &info, 1 );

```

## 5.3 Applying a color correction to an Rgb8 image

Example for applying a color correction to an Rgb8 image with 640x480 pixels:

```

VmbImage      sourceImage;
VmbImage      destinationImage;
VmbTransformInfo  info;
const VmbFloat_t  mat[] = { 1.0f, 0.0f, 0.0f,
                           0.0f, 1.0f, 0.0f,
                           0.0f, 0.0f, 1.0f };

// set size member for verification inside API
sourceImage.Size      = sizeof ( sourceImage );
destinationImage.Size = sizeof ( destinationImage );

// attach the data buffers
sourceImage.Data      = pInBuffer;
destinationImage.Data = pOutBuffer;

// fill image info from pixel format
VmbSetImageInfoFromPixelFormat ( VmbPixelFormatRgb8,
                                640,
                                480,
                                &sourceImage );

// fill image info from pixel format
VmbSetImageInfoFromPixelFormat ( VmbPixelFormatRgb8,
                                640,
                                480,
                                &destinationImage );

// set the transformation matrix

```

```
VmbSetColorCorrectionMatrix3x3 ( mat, &info );

// perform the transformation
VmbImageTransform ( &sourceImage, &destinationImage, &info, 1 );
```

## 5.4 Debayering a 12-bit image into a Mono16 image with additional color correction

Example for preparing a transformation of a BayerGR12 image with 640x480 pixels into a Mono16 image of the same size:

```
VmbImage      sourceImage;
VmbImage      destinationImage;
VmbTransformInfo info[2];
const VmbFloat_t mat[] = { 1.0f, 0.0f, 0.0f,
                           0.0f, 1.0f, 0.0f,
                           0.0f, 0.0f, 1.0f };

// set size member for verification inside API
sourceImage.Size      = sizeof ( sourceImage );
destinationImage.Size  = sizeof ( destinationImage );

// attach the data buffers
sourceImage.Data       = pInBuffer;
destinationImage.Data   = pOutBuffer;

// fill image info from pixel format
VmbSetImageInfoFromPixelFormat ( VmbPixelFormatBayerGR12Packed,
                                640,
                                480,
                                &sourceImage );

// fill image info from pixel format string
std::string name ( "MONO16" );
VmbSetImageInfoFromString ( name.c_str(),
                            static_cast<VmbUInt32_t>( name.size() ) ,
                            640,
                            480,
                            &destinationImage );

// set the debayering algorithm to 2 by 2
VmbSetDebayerMode ( VmbDebayerMode2x2, &info[0] );

// set the transformation matrix
VmbSetColorCorrectionMatrix3x3 ( mat, &info[1] );

// perform the transformation
VmbImageTransform ( &sourceImage, &destinationImage, &info, 2 );
```

## 6 Function reference

### 6.1 Information

#### 6.1.1 VmbGetVersion()

Inquire the library version.

Type	Name	Description
<b>out</b> VmbUInt32Ptr_t	Value	Contains the library version (Major,Minor,Sub,Build)

#### 6.1.2 VmbGetErrorInfo()

Translate Vimba error codes into a human-readable string.

Type	Name	Description
<b>in</b> VmbError_t	ErrorCode	The error code to get a readable string for
<b>out</b> VmbANSIChar_t*	InfoString	Pointer to a zero terminated string that will contain the error information on return
<b>in</b> VmbUInt32_t	MaxInfoLength	The length of the InfoString buffer

#### 6.1.3 VmbGetApiInfoString()

Get information about the currently loaded Vimba ImageTransform API.

Type	Name	Description
<b>in</b> VmbAPIInfo_t	InfoType	Type of information to return
<b>out</b> VmbANSIChar_t*	Info	Pointer to a zero terminated string that will contain the information on return
<b>in</b> VmbUInt32_t	MaxInfoLength	The length of the Info buffer

InfoType may be one of the following values:

Value	Description
VmbAPIInfoAll	Returns all information about the API
VmbAPIInfoPlatform	Returns information about the platform the API was built for (x86 or x64)
VmbAPIInfoBuild	Returns info about the API built (debug or release).
VmbApiInfoTechnology	Returns info about the supported technologies the API was built for (OpenMP or OpenCL).

## 6.2 Transformation

### 6.3 VmbImageTransform()

Images are transformed using the `VmbImageTransform()` function. The transformation is defined by the images used and the desired transformation. If a transformation is not supported, `VmbErrorBadParameter` is returned.

Type	Name	Description
<b>in</b> VmbImage*	source	Image to transform
<b>out</b> VmbImage*	destination	Destination image
<b>in</b> VmbTransformInfo*	parameter	Optional transform parameters
<b>in</b> VmbUInt32_t	parameterCount	Number of transform parameters

## 6.4 Helper functions

### 6.4.1 VmbSetImageInfoFromPixelFormat()

Set image info member values in `VmbImage` from pixel format or string.

Type	Name	Description
<b>in</b> VmbPixelFormat_t	PixelFormat	PixelFormat describes the pixel format used by the image data member.
<b>in</b> VmbUInt32_t	width	Width of the image in pixels
<b>in</b> VmbUInt32_t	height	Height of the image in pixels
<b>in/out</b> VmbImage*	image	Pointer to Vimba image to set the info to

#### Note



`VmbPixelFormat_t` can be obtained from Vimba C/C++ APIs frame or from the *PixelFormat* feature. For displaying images, it is suggested to use `VmbSetImageInfoFromString()` or to look up a matching `VmbPixelFormat`

### 6.4.2 VmbSetImageInfoFromString()

Set image info member values in `VmbImage` from pixel format or string.

Type	Name	Description
<b>in</b> VmbANSIChar_t*	imageFormat	Image format as a (const) case insensitive string that is either a PixelFormat (Vmb is optional) or a pixel struct name
<b>in</b> VmbUInt32_t	stringLength	The length of the pixel format string
<b>in</b> VmbUInt32_t	width	Width of the image in pixels
<b>in</b> VmbUInt32_t	height	Height of the image in pixels
<b>in/out</b> VmbImage*	image	Pointer to Vimba image to set the info to

### 6.4.3 VmbSetDebayerMode()

Set transformation options to a predefined debayering mode.

Type	Name	Description
<b>in</b> VmbDebayerMode_t	debayerMode	The mode used for debayering the source raw image, default mode is 2x2 debayering. Debayering modes only work for image widths and heights divisible by two.
<b>in/out</b> VmbTransformInfo_t*	transformInfo	Parameter that contains information about special transform functionality.

#### Note



Debayering is only applicable to image formats with both an even width and an even height.

### 6.4.4 VmbSetColorCorrectionMatrix3x3()

Set transformation options to a 3x3 color matrix transformation.

Type	Name	Description
<b>in</b> VmbFloat_t*	matrix	Color correction matrix
<b>in/out</b> VmbTransformInfo_t*	transformInfo	Parameter that is filled with information about special transform functionality.

## 7 Structs

### 7.1 VmbImage

VmbImage encapsulates image data for the transformation function.

Struct entry	Purpose
VmbUInt32_t size	Size of the structure
void* data	Pointer to the payload received from AVT Vimba C/C++ API or to the display image data
VmbImageInfo imageInfo	Internal information data used for mapping the images to the correct transformation, imageInfo data can be set with VmbSetImageInfo() helper functions from VmbPixelFormat_t or format string

### 7.2 VmbImageInfo

VmbImageInfo contains image information needed for the transformation function.

Struct entry	Purpose
VmbUInt32_t width	The width of the image in pixels. For macro pixel formats like YUV, it is the width in sub pixels
VmbUInt32_t height	The height of the image in pixels
VmbInt32_t stride	The offset from the current line to the next line, a value not equal to width is currently not supported
VmbPixelInfo pixelInfo	Information about the pixel format

### 7.3 VmbPixelInfo

VmbPixelInfo describes the pixel format of an image.

Struct entry	Purpose
VmbUInt32_t bitsPerPixel	Number of bits for one image pixel, or sub pixel in macro pixel formats
VmbUInt32_t bitsUsed	Number of bits used per pixel, e.g. RGB12 has 48 bits per pixel and 36 bits used
VmbAlignment_t alignment	For image formats where bitsPerPixel is not equal to bitsUsed, the alignment specifies the bit layout of the pixel
VmbEndianness_t endianness	Specifies the endianness of pixels that are larger than one byte
VmbPixelLayout_t pixelLayout	Describes the layout of the pixel component, e.g., RGB or BGR layout
VmbBayerPattern_t bayerPattern	For raw image data, this field specifies the color filter array layout of the sensor



## 7.4 VmbTransformInfo

Transformation parameters given as a pointer to a `VmbTransformInfo` struct are used to invoke special and additional functionality, which is applied while interpreting the source image (debayering) or transforming the images (color correction).

Struct entry	Purpose
<code>VmbTransformType_t transformType</code>	Transform info type, may be <code>VmbTransformTypeDebayer-Mode</code> or <code>VmbTransformTypeColorCorrectionMatrix</code>
<code>VmbTransformParameter parameter</code>	Transform info variant, may be <code>VmbTransformParameter-Debayer</code> or <code>VmbTransformParameterMatrix3x3</code>