

GigE Vision

ShapeDrive 3D Sensors G4 MLASx1x/MLBSx1x



Interface Description

Table of contents

- 1. Introduction 3
- 2. System Requirements and Network Setup 3
- 3. Starting the ShapeDriveGigEInterface as a Service..... 4
- 4. GigE Vision Features..... 6
 - 4.1 Image Format Control 6
 - 4.2 Acquisition Control 8
 - 4.3 Transport Layer Control 10
 - 4.4 Device Control 10
 - 4.5 Analog Control 11
 - 4.6 Light Control..... 11
 - 4.7 Digital I/O Control..... 12
 - 4.8 Counter and Timer Control 12
 - 4.9 Scan3d Control 13
 - 4.10 Filter Control 14
 - 4.10.1 Contrast Comparison 14
 - 4.10.2 Median Filter 14
 - 4.10.3 Statistical Outlier Filter 14
- 5. Troubleshooting 16
 - 5.1 No Connection to the Sensor..... 16
 - 5.2 The ShapeDriveGigEInterface Is Not Available Online..... 16
 - 5.3 The GigE Vision Client does not Receive Images 16
 - 5.4 Connection to GigE client is broken..... 16
 - 5.5 The GigE client throws a receive timeout error message 16
- 6. Change Index 17

1. Introduction

This document describes the commands and the supported features of the ShapeDriveGigEInterface for ShapeDrive 3D Sensors G4 MLASx1x / MLBSx1x with any compatible GigE Vision client.

2. System Requirements and Network Setup

The interface has been developed as an external terminal-based application that can run on any computer with Windows 10, x64.

Executing any 3D processing application normally requires a powerful PC. The more resources the PC has, the better and faster processing 3D data is.

The ShapeDriveGigEInterface requires two network interface cards "NIC" (1 Gbit or 10 Gbit (recommended)).

The jumbo frames for both NICs should be activated and setup to the maximum value.

In order to have a stable connection between the ShapeDriveGigEInterface and the GigE Vision client, it is recommended to have the hardware setup as shown in the diagram below:

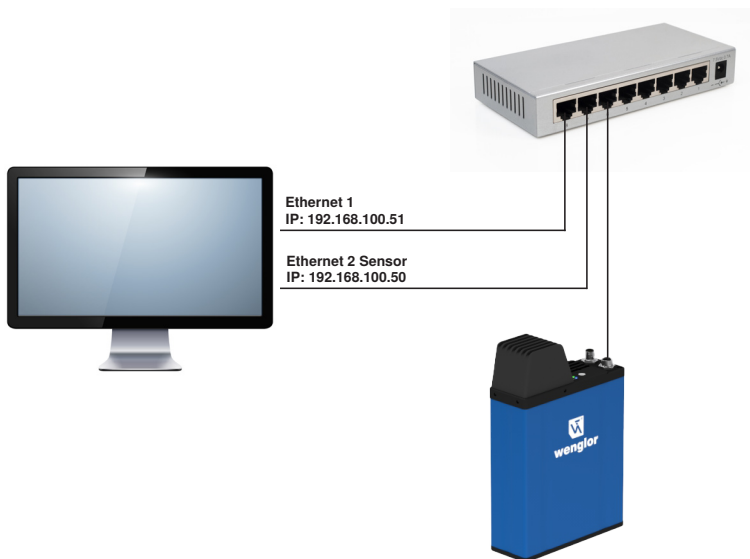


Figure 1: Network setup

The idea is to run the ShapeDriveGigEInterface on one of the NICs (in the example above it would be Ethernet 2 with the IP 192.168.100.50).



NOTE!

Please refer to the option `-s GIGE_SERVER_IP` below in section 3 to see how to run the ShapeDriveGigEInterface on a specific NIC.

On the NIC Ethernet 1 the GigE streaming filter from the GigE client software provider should be activated. In this case the GigE client would detect the ShapeDrive 3D sensor through both NICs (Ethernet 1 and Ethernet 2). Select the GigE vision software client to connect to the ShapeDrive 3D sensor through the NIC Ethernet 1 (where the GigE streaming filter from the GigE client software provider is activated). In this case, the GigE client will be able to utilize the GigE streaming filter to improve the reception of the frame in the client. The provided Halcon example in the release package shows how to select the ShapeDrive 3D sensor from a specific NIC.

3. Starting the ShapeDriveGigEInterface as a Service

Copy the folder ShapeDriveGigEInterface and its contents into a dedicated folder.



NOTE!

It is recommended to run the ShapeDriveGigEInterface application as administrator to guarantee the full right of adding the IP address into the system and writing debug data into external file (see -n and -f options below).

Go to the directory in the console window of your operating system where the ShapeDriveGigEInterface is saved and run the interface with the following command:

Syntax: `ShapeDriveGigEInterface.exe -s GIGE_SERVER_IP -i 3D_SENSOR_IP`

`3D_SENSOR_IP` is the IP of the ShapeDrive 3D Sensor you want to connect to.

`GIGE_SERVER_IP` is the IP for the connection between the interface and the network.

After that the interface will run as a server.

Example:

```
Connecting to ShapeDrive 3D Sensor...Plaese wait!
ShapeDrive 3D Sensor is connected
GigeServer is online
```

Figure 2: ShapeDriveGigEInterface

The interface connects to the sensor through the given ShapeDrive 3D Sensor IP (`3D_SENSOR_IP`). Once the interface connects to the specified sensor, it reads the sensor's registers and updates the corresponding GigE Vision features. Finally, the interface connects to the network through the given server IP (`GIGE_SERVER_IP`).



NOTE!

The server IP should match the static IP for the 1 Gigabit network interface card.

To get a list of all available IPs from the computer, just start the ShapeDriveGigEInterface without any input arguments or with the input argument (`-h`).

If the `GIGE_SERVER_IP` is not available in the system, the ShapeDriveGigEInterface will add this IP temporarily to the chosen network interface card (see option `-n`). The IP will be removed after a system restart. The ShapeDriveGigEInterface should run as administrator to be able to add the IP into the system.

The ShapeDriveGigEInterface also supports multiple options:

```
The ShapeDriveGigEInterface is an application that makes the shapeDrive 3D Sensor compatible with any GigE compatible client. The application is terminal-based.

Available options:

-i [3D_SENSOR_IP] the IP address of the ShapeDrive 3D Sensor.
-s [GigE_SERVER_IP] the IP address of the server, to which the application connects.
-n [X] the Network Interface Card index, thorough which the application connects.
If the GigE_SERVER_IP given by the option -s is not registered in the system, the application will add this IP to the system
(requires to run the application as system administrator).

-d print out in the console debug messages. The debug messages are the commands sent and received from the client.
-f [FILENAME] print the debug messages into an external file. The debug messages are the commands sent and received from the client.
-h print out the help text.

For more Info, please refer to the ShapeDriveGigEInterface user manual

Below is a list of interface indexes and their main IPs in this system:
Interface 0 IP: 172.20.112.132
Interface 1 IP: 192.168.100.197
Interface 2 IP: 192.168.56.1
Interface 3 IP: 169.254.223.76
Interface 4 IP: 169.254.84.119
Interface 5 IP: 127.0.0.1
press ENTER to exit.
```

Figure 3: ShapeDriveGigEInterface - Options

- **-i 3D_SENSOR_IP**: Describes the IP address of the ShapeDrive 3D Sensor (default is 192.168.100.1)
- **-s GIGE_SERVER_IP**: Gives the server's IP address to which the application is connected. Windows users have to define the interface to which the server should be connected (see also option **-n**).
- **-n INTERFACE**: Defines the network interface card index where the interface adds the IP given in the option **-s**. Start the interface with option **-h** to see the index of your NIC.



NOTE!

This option requires to run the application as administrator.

- **-d**: Prints debug messages in the console. The debug messages are the commands sent and received from the GigE Vision client.
- **-f FILENAME**: Saves the debug messages in an external file.



ATTENTION!

"**-d**" and "**-f**" options decrease the performance and the communication time of the ShapeDriveGigEInterface with the GigE client. It should be used only for debugging purpose. In a normal running mode, "**-d**" and "**-f**" options should not be used.

- **-h**: Displays a help text on how to use the interface in the console.

4. GigE Vision Features

The ShapeDrive GigE Vision interface provides several features organized into different categories:

- Image Format Control
- Acquisition Control
- Transport Layer Control
- Device Control
- Analog Control
- Light Control
- Scan3D Control



NOTE!

Some features and categories are only visible in Expert or Guru mode.

4.1 Image Format Control

Command	Width
Access Mode	Read only
Description	Returns the width of the expected image in pixel. The width of the image is automatically adjusted based on the value of StackAcquisition-Mode feature in Acquisition Control.

Command	Height
Access Mode	Read only
Description	The height of the image is automatically adjusted based on the value of StackAcquisition-Mode feature in Acquisition Control.

Command	OffsetX
Access Mode	Read only
Description	The offset of the image is automatically adjusted based on the value of StackAcquisition-Mode feature in Acquisition Control.

Command	OffsetY
Access Mode	Read only
Description	The offset of the image is automatically adjusted based on the value of StackAcquisition-Mode feature in Acquisition Control.

Command	Subsampling
Access Mode	Read/write
Parameter	True/false
Description	Enabling and disabling Subsampling . If Subsampling is enabled only every 2nd pixel is processed. The new resolution can be read via Width and Height .

Command	ComponentSelector
Access Mode	Read/write
Parameter	CameraImage/Intensity/Range
Description	Selects the component to be transmitted in the output frame. • CameraImage: The interface sends live camera image from the integrated camera in the ShapeDrive 3D Sensor. • Intensity: The interface sends an intensity image of the computed point cloud from the ShapeDrive 3D Sensor. • Range: The interface sends the point cloud computed from the ShapeDrive 3D Sensor as defined in the new GigE Vision standard 2.0 or higher.

Command	ComponentEnable
Access Mode	Read/write
Parameter	0/1
Description	Enables (1)/disables (0) sending the selected component in the output frame.

Activating Intensity or Range components will deactivate the CameraImage component automatically. Also, activating CameraImage component will deactivate both Intensity and Range component. The user can activate both Intensity and Range component if the user wants to receive both components in one frame.



NOTE!

The GigE Vision client software should support the GigE Vision standard 2.1 (Multipart data type) to be able to decode the multi component frame correctly.

Command	ComponentIDValue
Access Mode	Read only
Parameter	Device specific
Description	Describes the ID of the selected component. Used by the GigE Vision client software to identify the components in multi component frame.

Command	PixelFormat
Access Mode	Read/write
Parameter	Mono8/Mono16/Coord3D_ABC32f
Description	This command defines the pixel format of the selected component. Each component supports specific pixel format. • Mono8: Available if the CameraImage component is selected. • Mono16: Available if the Intensity component is selected. • Coord3D_ABC32f: Available if the Range component is selected.

Command	SensorWidth		
Access Mode	Read only		
Description	Delivers the effective width of the integrated camera in pixel.		

Command	SensorHeight		
Access Mode	Read only		
Description	Delivers the effective height of the integrated camera in pixel.		

4.2 Acquisition Control

Command	AcquisitionMode		
Access Mode	Read/write		
Parameter	Continuous/SingleFrame		
Description	Defines the acquisition mode of the interface: In continuous mode, once the interface receives the command StartAcquisition from the client, it keeps sending images until the client sends a StopAcquisition command. In SingleFrame mode, the interface sends only one image per StartAcquisition command and the client does not need to send a StopAcquisition command.		

Command	PatternMode		
Access Mode	Read/write		
Parameter	28/16		
Description	Sets the sensors projection pattern in 3D point cloud mode. 28: Higher accuracy - higher acquisition time 16: Lower accuracy - lower acquisition time		

Command	HDRMode		
Access Mode	Read/write		
Parameter	Off/GreyImage		
Description	Enables/disables selected HDR mode. GreyImage has effect only on the 2D image, not on the pointcloud.		

Command	ExposureTime		
Access Mode	Read/write		
Parameter	Device specific	Default	Device specific
Description	Sets the exposure time of the integrated camera in μ s.		

Command	ExposureTimeLimit		
Access Mode	Read/write		
Parameter	MaximumExposureTime in μ s		
Description	Defines the maximum required ExposureTime. The sensor's projection frequency is adjusted accordingly.		

Command	AcquisitionStart
Access Mode	Command button
Description	The command starts the acquisition of data (image) from the ShapeDrive 3D Sensor (command button).

Command	AcquisitionStop
Access Mode	Command button
Description	The command stops the acquisition of data (image) from the ShapeDrive 3D Sensor (command button).

Command	AcquisitionStatusSelector
Access Mode	Read/write
Parameter	AcquisitionActive
Description	Selects the internal acquisition signal to read using AcquisitionStatus .

Command	AcquisitionStatus
Access Mode	Read only
Description	Shows the status of the activated acquisition signal.

Command	TriggerSelector
Access Mode	Read/write
Parameter	FrameStart/AcquisitionActive
Description	Selects the trigger to configure with the associated commands listed below.



NOTE!

If trigger is AcquisitionActive software trigger is not available.
Each line can only be set to one trigger.

Command	TriggerMode
Access Mode	Read/write
Parameter	On/Off
Description	Enabling and disabling external triggering. If On, the sensor can be triggered by the source selected by the feature TriggerSource . If Off, the sensor is triggered internally by the frequency set by the feature AcquisitionFrameRate .

Command	AcquisitionFrameRate
Access Mode	Read/write
Description	Controls the acquisition rate (in Hertz) at which the scans/images are captured.

Command	TriggerSource
Access Mode	Read / write
Parameter	Software, Line1, Line2, Line3, Line4
Description	Sets the trigger source used if external triggering is enabled.

Command	TriggerSoftware
Access Mode	Command button
Description	Sends a software trigger command to the ShapeDrive 3D Sensor.

4.3 Transport Layer Control

Command	PayloadSize
Access Mode	Read only
Description	Returns the size of the expected payload in bytes.

4.4 Device Control

Most of the features in the Device Control category are for displaying information about the connected sensor, thus they are hardware dependent.

Command	DeviceType
Access Mode	Read only
Response	Transmitter
Description	General info about the device

Command	DeviceModelName
Access Mode	Read only
Response	Sensor specific
Description	General info about the device

Command	DeviceVendorName
Access Mode	Read only
Response	wenglor sensoric GmbH
Description	Name of the device vendor

Command	DeviceVersion
Access Mode	Read only
Response	Sensor specific
Description	General Info about the device

Command	DeviceFirmwareVersion
Access Mode	Read only
Response	Sensor specific
Description	General info about the device

Command	DeviceSerialNumber
Access Mode	Read only
Response	Sensor specific
Description	General Info about the device

Command	DeviceTLType
Access Mode	Read only
Response	GigEVision
Description	General Info about the transport layer type of the device.

Command	DeviceTemperature
Access Mode	Read only
Description	Returns the device temperature every 10 seconds.



ATTENTION!

If the device is overheated, the power LED will be switched off and the ShapeDriveGigE-Interface will send an empty point cloud in point cloud mode and a black image in image mode.

The ShapeDrive 3D Sensor is overheated if the device tempture exceeds 80 °C. Please refer to the Operating Instructions of ShapeDrive 3D Sensors for more information about the overheating behaviour.

4.5 Analog Control

Command	Gain
Access Mode	Read/write
Parameter	Device specific
Description	Controls the gain of the integrated camera in the ShapeDrive 3D Sensor.

4.6 Light Control

Command	LightBrightness
Access Mode	Read/write
Parameter	Device specific
Description	Controls the LED power in the ShapeDrive 3D Sensor.

4.7 Digital I/O Control

Command	LineSelector
Access Mode	Read/write
Parameter	Line1, Line2, Line3, Line4
Description	Selects the line (pin) to configure.
Command	LineMode
Access Mode	Read/write
Parameter	Input, Output
Description	Sets the selected line as Input or Output.
Command	LineSource
Access Mode	Read/write
Parameter	FrameActive/SensorBusy/Timer0
Description	Selects which internal acquisition or I/O source signal to output on the selected line. LineMode must be Output.

4.8 Counter and Timer Control

Command	TimerSelector
Access Mode	Read only
Parameter	Timer0
Description	Selects which timer to configure (currently only Timer0)
Command	TimerTriggerSource
Access Mode	Read/write
Parameter	FrameStart/FrameEnd
Description	Selects the source of the trigger to start the Timer.
Command	TimerDuration
Access Mode	Read/write
Parameter	Duration (in μs)
Description	Sets the duration (in μs) of the timer pulse.
Command	TimerDelay
Access Mode	Read/write
Parameter	Delay (in μs)
Description	Sets the duration (in μs) of the delay to apply at the reception of a trigger before starting the timer.

4.9 Scan3d Control

Command	Scan3dCoordinateSelector
Access Mode	Read/write
Parameter	CoordinateA /CoordinateB / CoordinateC
Description	Selects the individual axis for 3D information/transformation.

Command	Scan3dCoordinateScale
Access Mode	Read only
Parameter	Device/pixelFormat specific
Description	Scale factor when transforming a pixel from relative coordinates to sensor coordinates.

Command	Scan3dCoordinateOffset
Access Mode	Read only
Parameter	Device/pixelFormat specific
Description	Offset factor when transforming a pixel from relative coordinates to sensor coordinates.

Command	Scan3dInvalidDataFlag
Access Mode	Read only
Parameter	Device/pixelFormat specific
Description	Enables the definition of a non-valid flag value in the data stream.

Command	Scan3dInvalidDataValue
Access Mode	Read only
Parameter	Device/pixelFormat specific
Description	Value which identifies a non-valid pixel if Scan3dInvalidDataFlag is enabled.

Command	Scan3dAxisMin
Access Mode	Read only
Parameter	Device/pixelFormat specific
Description	Minimum valid transmitted coordinate value of the selected axis.

Command	Scan3dAxisMax
Access Mode	Read only
Parameter	Device/pixelFormat specific
Description	Maximum valid transmitted coordinate value of the selected axis.

4.10 Filter Control

4.10.1 Contrast Comparison

Command	MinPhase
Access Mode	Read/write
Parameter	Contrast value threshold (between 1 and 0)
Description	The contrast comparison filter calculates a pixelwise contrast value from the acquired phase mages. If this value is below the MinPhase threshold the point related to that pixel is considered invalid and neglected.

4.10.2 Median Filter

Command	MedianFilterEnabled
Access Mode	Read/write
Parameter	True/false
Description	Enabling and disabling Median Smoothing Filter

Command	MedianFilterKernelSize
Access Mode	Read/write
Parameter	3 or 5
Description	Sets the width of the median filters filtering kernel. Only odd values allowed.

4.10.3 Statistical Outlier Filter

Command	SOutlierFilterEnabled
Access Mode	Read/write
Parameter	True/false
Description	Enabling and disabling Statistical Outlier Filter

Command	SOutlierFilterSigma
Access Mode	Read/write
Parameter	Sigma Value (multiple of standard deviation)
Description	Sets the multiple of the standard deviation of all points distances to their direct neighbours above which points are considered outliers.

Command	SOutlierFilterMinClusterSize
Access Mode	Read/write
Parameter	Minimum Cluster Size
Description	Sets the minimum number of points a cluster is allowed to have to not be considered outliers.

Explanation:

Statistical Outlier Filter consists of 2 filtering mechanisms.

1. The distance of a point in regard to its neighbours.
2. The number of points inside a connected region of points. Whereby the belonging of a point to a certain region is defined by the distance to his neighbouring point inside this region.

The first mechanism is determined by the sigma value. The algorithm computes the standard deviation for the distance of all points to their direct neighbours. The sigma value is a relative threshold as a multiple of this computed standard deviation. If a point's distance to its neighbours is bigger than $\sigma \cdot \text{standardDeviation}$ it is considered an outlier.

Assuming points are normally distributed this would mean:

68% of the data falls within one standard deviation of the mean.

95% of the data falls within two standard deviations of the mean.

99.7% of the data falls within three standard deviations of the mean.

According to this a SigmaValue of 1 would mean 32% of all points are filtered out. (5% for 2σ , 0.3% for 3σ respectively)

The cluster mechanism aims to reject whole regions of points which are grouped together by their spatial proximity. The minimum cluster size threshold thereby determines the minimum number of points under which the whole cluster should be neglected.

In conclusion the sigma value targets sparse outliers which stand out by the distance to their direct neighbours. The MinClusterSize threshold in contrast is meant to filter out artifacts which build groups of close points.

5. Troubleshooting

5.1 No Connection to the Sensor

In the case that the ShapeDriveGigEInterface fails to connect to the sensor, the interface will not start and the GigE Vision server will not be available online! This case happens when the ShapeDrive 3D Sensor is already connected to another ShapeDriveGigEInterface or when the given 3D_SENSOR_IP is wrong.

It is possible to check the connection status of the ShapeDrive 3D Sensor by the web interface. Refer to Operating Instructions ShapeDrive 3D Sensors.

5.2 The ShapeDriveGigEInterface Is Not Available Online

If the given server IP is not available in the system, the interface will fail to go online. As a result, the client can not detect the interface (to see a list of available IPs just start the ShapeDriveGigEInterface without any input parameters or with the input argument “-h”).

Possible solutions are either to add the IP address manually into the operating system or to start the application with the option “-n” (see section 3).

5.3 The GigE Vision Client does not Receive Images

If the ShapeDriveGigEInterface is located and running on the same machine where the GigE client software is running, then in some cases it is necessary to

1. Make sure that any firewall is deactivated.
2. Make sure that the gigevision streaming filter is active on both NICs.

5.4 Connection to GigE client is broken

Make sure that the connection to the ShapeDrive 3D Sensor is stable. If the connection to the ShapeDrive 3D Sensor is broken for any reason (network connection is broken or power supply is down) the ShapeDriveGigE-Interface ends, and thus, the connection to the client will be lost.

5.5 The GigE client throws a receive timeout error message

In long time operation it might happen that the GigE client fails to receive a frame, thus throws an error or exception (the occurrence of the error depends highly on the camera resolution in the ShapeDrive 3D sensor, the hardware setup of the host PC itself and the softwares running in the background on the host PC).

To overcome this issue, it is recommended to connect the ShapeDrive 3D sensor to the host PC as given in section 3.

6. Change Index

Version	Release Date	Description	Software Version
1.0.0	17.05.2023	Initial document	3.0.0
1.1.0	23.01.2024	• HDRMode • TriggerSelector • Digital I/O control • Counter and timer control • Filter control	3.1.0
1.2.0	25.06.2024	• Subsampling • MedianFilter • StatisticalOutlierFilter	3.2.0