

BALLUFF

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SGM[®]Producer

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Contents

1	Introduction	2
1.1	Prerequisites	2
2	Installation	4
2.1	Windows	4
2.2	Ubuntu	4
2.3	Other Linux Distributions	4
2.4	Environment Variables	5
3	Tools for setup and calibration of the 3D Stereo Camera BVS 3D-RV1	6
3.1	3D_check tool (3D Stereo Camera BVS 3D-RV1 only)	6
3.2	3D_calib tool (3D Stereo Camera BVS 3D-RV1 only)	6
3.3	3D_viewer tool	6
4	GenICam Nodemap	7
5	Using SGM® Producer in Applications	8
5.1	Halcon	8
5.2	C++ API	8
5.3	ROS	8
6	Troubleshooting	9
7	Appendix: Example Nodemap of a 3D Stereo Camera	11

1 Introduction

The SGM® Producer is a software library for running stereo matching on a graphics card of a host computer for significantly increasing the frequency and reducing the latency for computing disparity images. It supports the Smart 3D Camera BVS 3D-RV0 and 3D Stereo Camera BVS 3D-RV1 stereo sensors. About 12.5 Hz can be reached for matching 1.2 MPixel images on a Nvidia GeForce RTX 2070. 4.6 Hz can be reached for matching 3 MPixel images on the same GPU. Higher frame rates are possible on more powerful Nvidia GPUs. Stereo matching without a graphics card on the CPU is also possible but significantly slower.

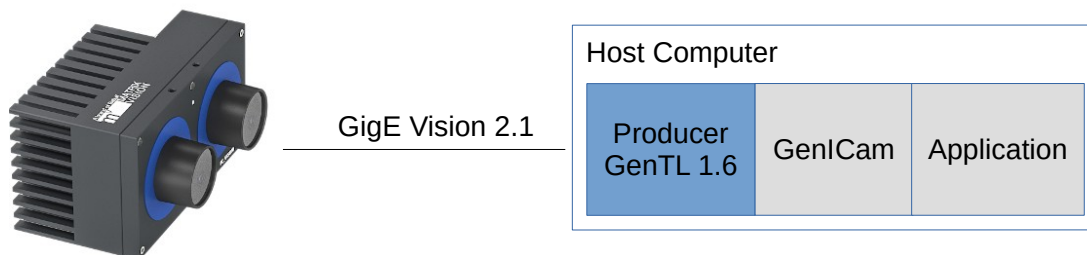


Figure 1: Overview of the rc_visard and host computer. The producer is highlighted in blue.

In a GenICam application, the producer is responsible for communicating with the device, which in case of the Smart 3D Camera BVS 3D-RV0 uses the GigE Vision 2.1 standard.

The SGM® Producer from Roboception replaces a standard GigE Vision producer. It is compatible with all GenICam applications that use the GenTL 1.6 standard, e.g. Halcon from MVTec.

1.1 Prerequisites

The requirements on the host computer are:

- Supported operating systems include Windows 10 (64 bit), Ubuntu 18.04 (64 bit), Ubuntu 20.04 (64 bit), Ubuntu 22.04 (64 bit) and other 64 bit Linux distributions
- On x86 architecture, the CPU must support the AVX2 instruction set. Almost all x86 CPUs that were manufactured from 2014 onward, especially the more powerful ones, provide this support.
- Nvidia GPU with compute capability 3.5 (i.e. Kepler architecture) or higher is highly recommended. The full functionality is also available without GPU support, but stereo matching will be very slow in this case.
- Supported sensor that is connected to the host computer.

Supported sensors are:

- Smart 3D Camera BVS 3D-RV0 with firmware version 21.04.0 or higher
- 3D Stereo Camera BVS 3D-RV1

The amount of required GPU memory and possible frame rates depend on the camera resolution, the configured depth quality, depth range and memory limitation using the RC_SGM_MAXMEM environment variable.

For the Smart 3D Camera BVS 3D-RV0, a depth image frame rate of 25 Hz can be reached on mid-range Nvidia GPUs. The maximum amount of required GPU memory is below 1200 MB in all modes.

For the 3D Stereo Camera BVS 3D-RV1, the following table shows the required GPU memory and resulting frame rates on an Nvidia GeForce RTX 2070 card for some example configurations. The 3D Stereo Camera BVS 3D-RV1 has an image resolution of 4112 x 3008 pixels and can deliver images with a maximum frame rate of 9 Hz.

DepthQuality	DepthMinDepth	DepthMaxDepth	RC_SGM_MAXMEM	GPU Memory	FPS
Low				553 MB	9 Hz
Medium				1057 MB	9 Hz
High				6043 MB	2.5 Hz
High	0.75 m			4343 MB	3.4 Hz
High	0.75 m	3 m	3312 MB	3639 MB	4.0 Hz
Full	1.6 m	3 m	7500 MB	7789 MB	1.8 Hz

Using HDR mode requires about 400 MB more GPU memory for the 3D Stereo Camera BVS 3D-RV1.

Please note that stereo matching in full quality (i.e. 12 Mpixel) is in most situations not needed and not recommended. Instead, we recommend using the high quality setting with appropriate limitations on the depth range and maximum SGM memory as shown in the table above.

2 Installation

2.1 Windows

The software for Windows is provided as a ZIP archive that can be downloaded from the respective product page at <https://www.balluff.com>.

The ZIP archive can be unpacked anywhere on the local hard drive. The main directory of the ZIP archive contains the file `rc_sgm_producer.cti`. This directory must be added to an environment variable named `GENICAM_GENTL64_PATH` so that third party applications can find the producer.

- Type “env” in the Windows search field (on a German Windows system type “Umgebung”)
- Select “Edit the system environment variables” (if you have administrator rights) or “Edit environment variables for your account”
- Check if `GENICAM_GENTL64_PATH` exists and create it as new if it does not exist
- Add the path to the directory in which `rc_sgm_producer.cti` is located to this environment variable
- Several paths can be specified with ‘;’ as separation character
- Leave the dialog with “OK”

Important: The main directory must also be added to the ‘PATH’ environment variable so that dependencies of the producer are found.

2.2 Ubuntu

The software for Ubuntu LTS consists of the debian package `rc-sgm-producer*.deb`. It can be downloaded from the respective product page at <https://www.balluff.com>. The package can be installed with:

```
sudo dpkg -i rc-sgm-producer*.deb
```

If there are errors due to missing packages, they can be installed by calling:

```
sudo apt install --fix-broken
```

The directory `/opt/rc_sgm_producer/lib` contains the file `librc_sgm_producer.cti`, which should be included in the environment variable `GENICAM_GENTL64_PATH` so that third party applications can find the producer. In the bash shell, this can be done by:

```
export GENICAM_GENTL64_PATH=$GENICAM_GENTL64_PATH:/opt/rc_sgm_producer/lib
```

The command line can be added to `.bashrc` for permanently including the path.

2.3 Other Linux Distributions

For other Linux distributions, the producer can be installed from the archive file `rc_sgm_producer*.tgz`. The producer in the TGZ package was built with minimal dependencies and GUI tools are provided as Applimages to support a wide range of Linux distributions. It can be downloaded from the respective product page at <https://www.balluff.com>.

The archive can be unpacked anywhere. It is recommended to unpack it under `/opt` as user root, e.g.

```
cd /opt
sudo tar xvfz <download-directory>/rc_sgm_producer*.tgz
```

The sub-directory `lib` contains the file `librc_sgm_producer.cti`, which must be included in the environment variable `GENICAM_GENTL64_PATH`. In the bash shell, this can be done by:

```
export GENICAM_GENTL64_PATH=$GENICAM_GENTL64_PATH:/opt/rc_sgm_producer/lib
```

The command line can be added to `.bashrc` for permanently including the path.

2.4 Environment Variables

The following environment variables influence the behavior of the producer:

- **RC_SGM_PRODUCER_LEVEL:** This variable enables printing log information. By default, logging is done on stdout of the application that uses the producer. See **RC_SGM_PRODUCER_LOG** for logging into a file. The possible log levels are given below. Higher levels include lower ones.
 - 0: Off (default)
 - 1: Fatal
 - 2: Error
 - 3: Warning
 - 4: Info
 - 5: Debug
 - 6: Trace (not recommended for general use as it can slow down the producer significantly)
- **RC_SGM_PRODUCER_LOG:** This variable can be defined with the full path and name of the log file. Logging into this file is done according to the log level (see **RC_SGM_PRODUCER_LEVEL**).
- **RC_SGM_MAXMEM:** Maximum amount of memory in MB that can be used as temporary memory for stereo matching. If a compatible GPU is available, this is memory on the GPU. The depth range will be reduced if this amount of memory is reached. The default is 0, which means unlimited.

3 Tools for setup and calibration of the 3D Stereo Camera BVS 3D-RV1

NOTE: The 3D_check, 3D_calib and 3D_viewer tools are not contained in the TGZ package for Linux ARM64. Use the Linux x86_64 or Windows packages for using these tools.

3.1 3D_check tool (3D Stereo Camera BVS 3D-RV1 only)

The tool 3D_check can be used for checking the network connection and basic setup of an 3D Stereo Camera BVS 3D-RV1 device. In case of a misconfiguration, the tool also helps to reset the 3D Stereo Camera BVS 3D-RV1 to factory defaults. The usage is self explanatory.

3.2 3D_calib tool (3D Stereo Camera BVS 3D-RV1 only)

The tool 3D_calib can be used for checking and adjusting the focus and calibration of 3D Stereo Camera BVS 3D-RV1 devices. Smart 3D Camera BVS 3D-RV0 devices allow calibration in the Web GUI.

After starting the tool, select *File / Connect sensor...*, choose the 3D Stereo Camera BVS 3D-RV1 from the list and specify the size of the calibration grid. Optionally limit the throughput, in case the cameras are connected via a 1 Gbit switch. After confirming the dialog, the tool will show the live images from the left and right cameras.

For checking and adjusting the focus, select *Adjust Focus* and follow the instructions.

For checking the calibration and recalibration, select the appropriate calibration option. .

It is mandatory to always check the calibration after mounting the 3D Stereo Camera BVS 3D-RV1, changing the focus or aperture.

3.3 3D_viewer tool

This is a live 3D viewer for Smart 3D Camera BVS 3D-RV0 and 3D Stereo Camera BVS 3D-RV1 devices. After starting the tool, select *File / Connect sensor...*. The dialog permits to choose between SGM producer and standard producer. For an 3D Stereo Camera BVS 3D-RV1, the SGM Producer must be used. For an Smart 3D Camera BVS 3D-RV0, stereo processing is done on the host computer with the SGM producer and on-board the Smart 3D Camera BVS 3D-RV0 with a standard producer. Optionally, for an 3D Stereo Camera BVS 3D-RV1 the bandwidth can be limited in case the cameras are connected via a 1 Gbit switch.

After confirming the connection dialog, the tool will show the live 3D view. If this is not the case, press the Reset to defaults button on the camera and depth tab panel.

Best results are retrieved by supporting 3D acquisition with the random dot projector. For continuous streaming, select ExposureAlternateActive for Out1 / Projector on the depth tab panel. For single shot acquisition with projector, select SingleFrameOut1 as Acquisition mode on the depth tab panel.

The framerate that is reached with 3D_viewer tool can be lower than with the SGM®Producer alone, especially for 3D Stereo Camera BVS 3D-RV1, due to computational overhead for on-the-fly 3D mesh creation and rendering.

4 GenICam Nodemap

The producer offers the same nodemap (i.e. parameters) for Smart 3D Camera BVS 3D-RV0 and 3D Stereo Camera BVS 3D-RV1 devices, although some may be disabled, depending on device capabilities. Most of the parameters are standard GenICam features. Their meaning and usage is described in the GenICam Standard Features Naming Convention (SFNC), e.g. https://www.emva.org/wp-content/uploads/GenICam_SFNC_v2_7.pdf.

There are also some proprietary parameters, which are described in the Smart 3D Camera BVS 3D-RV0 documentation.

The appendix shows the full nodemap of an 3D Stereo Camera BVS 3D-RV1 device as an example.

5 Using SGM[®]Producer in Applications

The producer is a software library that implements the GenTL 1.6 interface. A GenICam compatible application is required for using the producer.

5.1 Halcon

Halcon fully supports the Smart 3D Camera BVS 3D-RV0, 3D Stereo Camera BVS 3D-RV1 and the off-board producer. Halcon can only find the producer if the directory of the producer is specified in the environment variable `GENICAM_GENTL64_PATH` (see installation above). The GenICamTL package that is provided by MVTec must be installed additionally to Halcon.

For using the SGM[®]Producer in hdevelop, GenICamTL should be specified as the first parameter in the `open_framegrabber()` call. The device is identified either by the user-defined name or the device ID.

A good starting point to work with Halcon is the Smart 3D Camera BVS 3D-RV0 example program that is delivered with the Halcon GenICamTL package. The following modifications are needed for using it with the SGM[®]Producer:

- Specify 'GenICamTL' instead of 'GigEVision2' for the `open_framegrabber` command (the environment variable `GENICAM_GENTL64_PATH` must be set as described above).
- Remove or uncomment the line that is setting the parameter 'GevStreamDeliverIncompleteBlocks'. This parameter is not available in the SGM[®]Producer as it never publishes incomplete buffers.
- For color sensors, set the pixel format to 'RGB8'. The SGM[®]Producer does not support the pixel format 'YCbCr411_8'.

5.2 C++ API

C++ programmers can use the Balluff Vision Acquire SDK that can be downloaded from <https://www.balluff.com>. The standard producer can be replaced by the SGM[®]Producer by setting the environment variable `GENICAM_GENTL64_PATH` to the directory of the SGM[®]Producer (see installation above).

The package contains tools for getting and setting parameters and receiving images. The tools also serve as examples for demonstrating the use of the API.

5.3 ROS

A ROS driver for Balluff sensors is available for ROS 1 and ROS 2 on the ROS build farm. If ROS is already installed, the driver can be installed with:

```
sudo apt install ros-${ROS_DISTRO}-rc-genicam-driver
```

The SGM[®]Producer is used by setting the environment variable `GENICAM_GENTL64_PATH` to the directory of the SGM[®]Producer as discussed in the installation section above.

6 Troubleshooting

NOTE: The SGM® Producer will never forward disparity, confidence or error images that are processed on-board the Smart 3D Camera BVS 3D-RV0 to avoid confusion. A normal GigE Vision producer should be used for enabling on-board processing.

If the application does not find the producer:

- Check and correct the GENICAM_GENTL64_PATH variable. Restart the application after changing the variable.

If an Smart 3D Camera BVS 3D-RV0 device cannot be discovered:

- Check with the rcdiscover tool <https://github.com/roboception/rcdiscover> that the device is listed and marked as 'reachable'. You may also verify that the Web GUI can be reached by double-clicking on the device in the rcdiscover window.
- Under Windows, the firewall or an anti-virus package may block the communication to network devices. Try to temporarily disable the firewall or anti-virus package to see if this is the cause.

If an Smart 3D Camera BVS 3D-RV0 is discovered, but cannot be opened:

- Ensure that the firmware version of the Smart 3D Camera BVS 3D-RV0 is at least 21.04.0. This can be checked on the system page of the Smart 3D Camera BVS 3D-RV0 Web GUI. If the firmware version is too low, an update can be downloaded from the respective product page on <https://www.balluff.com> and uploaded via the Web GUI of the Smart 3D Camera BVS 3D-RV0.

If an 3D Stereo Camera BVS 3D-RV1 device cannot be discovered or cannot be opened:

- Check with the included 3D_check tool (see tools for the 3D Stereo Camera BVS 3D-RV1 above) that the device is listed and marked as 'ok'. Follow the hints that are provided by this tool.
- If 3D_check cannot find the 3D Stereo Camera BVS 3D-RV1 or any individual cameras of it, then the IP configuration might be wrong. By default, the cameras try to find a DHCP server. If they cannot find one, e.g. because the cameras are connected directly to a computer as recommended, they assign themselves a link local address. In this case, the host port must be configured accordingly, which is the default under Windows, but must be done manually under Linux. Alternatively, a temporary IP address can be manually assigned with the rcdiscover tool <https://github.com/roboception/rcdiscover>. After starting the tool, uncheck "Only rc_... devices" to see the individual cameras. The entry "Reachable" indicates if the IP configuration is correct. After setting a temporary IP address and making the cameras reachable, the IP configuration can be made permanent with the command line tool gc_config from the rc_genicam_api package https://github.com/roboception/rc_genicam_api.

If Smart 3D Camera BVS 3D-RV0 or 3D Stereo Camera BVS 3D-RV1 images cannot be received or if received buffers are incomplete:

- Try to connect the device directly (i.e. without switch) to the computer. In case of using a switch with an 3D Stereo Camera BVS 3D-RV1, the switch should be connected with at least 2.5 Gbit to the host computer. If the switch only has a bandwidth of 1 Gbit to the host computer, the throughput of the 3D Stereo Camera BVS 3D-RV1 must be limited by setting the GenICam parameters *DeviceLinkThroughputLimitMode=On* and *DeviceLinkThroughputLimit=110000000*. This limits the throughput to just under 1 Gbit.
- In case of an Smart 3D Camera BVS 3D-RV0, check on the system page of the Web GUI that the link speed is 1000 Mbit/s. Replace the network cable or check the network port settings on your host computer if the link speed is lower than 1000 Mbit/s.
- For avoiding incomplete buffers, the MTU should be set to 9000 if possible. Under Windows, this is often called jumbo frames. Increasing the receive buffer may also help.
- Under Windows, the firewall or an anti-virus package may block the communication to the device. Try to temporarily disable the firewall or anti-virus package to see if this is the cause.

If camera images can be received, but disparity, confidence and error images are not delivered:

- The most likely cause for never receiving disparity images is insufficient GPU memory. Try to reduce the depth quality with the GenICam parameter 'DepthQuality'. Additionally or alternatively, the disparity range can be reduced by the GenICam parameters 'DepthMinDepth' and 'DepthMaxDepth'. It is also possible to specify the maximum amount of memory with the environment variable RC_SGM_MAXMEM (see above). In this case, the producer increases the minimum depth as necessary in order to not exceed the given amount of memory.

If disparity, confidence and/or error images are delivered but the frequency is lower than expected:

- Check the display name of the producer (i.e. GenICam system) in your application. You may also install rc_genicam_api from https://github.com/roboception/rc_genicam_api and call 'gc_info -l' in the command line. It shows the display name in the first few lines of the output. Ensure that the display name reports your GPU. If not, then stereo matching is performed on the CPU, which is much slower than running it on the GPU. If an Nvidia GPU is installed on the computer, try updating the graphics card driver.
- Reducing the depth quality with the GenICam parameter 'DepthQuality' and/or reducing the disparity range with the GenICam parameters 'DepthMinDepth' and 'DepthMaxDepth' will increase the framerate.

Why are parameters reset when reconnecting to a sensor?

- The SGM producer provides a virtual device that runs on the host computer and vanishes when a connection is closed. In case of Smart 3D Camera BVS 3D-RV0, some parameters (e.g. for controlling exposure, gain, etc) are loaded from and stored on the sensor, while others (e.g. for depth image computation) are only kept in memory of the host computer. In case of an 3D Stereo Camera BVS 3D-RV1, all parameters start with default values when the connection is opened.

Still having problems?

- Create a log file by setting the environment variable RC_SGM_PRODUCER_LEVEL to 5 and RC_SGM_PRODUCER_LOG to the full path and name of the logfile to be generated. The log file is a normal text file that can be checked for errors or sent to Balluff support.
- Contact support via support.de@balluff.de. The support team may ask you for a log file (see above).

7 Appendix: Example Nodemap of a 3D Stereo Camera

Category: DeviceControl (RO)

Enumeration: DeviceType (RO) [Transmitter Receiver Transceiver Peripheral]: Transmitter
 Enumeration: DeviceScanType (RO) [Areascan Linescan Areascan3D Linescan3D]: Areascan3D
 String: DeviceVendorName (RO): Roboception GmbH
 String: DeviceModelName (RO): rc_viscore 210c-16-12M-H1
 String: DeviceManufacturerInfo (RO): Roboception GmbH
 String: DeviceVersion (RO): 23.01.1
 String: DeviceFirmwareVersion (RO): 23.01.1
 String: DeviceSerialNumber (RO): GX040862
 String: DeviceID (RO): GX040862
 String: DeviceUserID (RW): GX040862
 Integer: DeviceSFNCVersionMajor (RO) [-9223372036854775808, 9223372036854775807]: 2
 Integer: DeviceSFNCVersionMinor (RO) [-9223372036854775808, 9223372036854775807]: 5
 Integer: DeviceSFNCVersionSubMinor (RO) [-9223372036854775808, 9223372036854775807]: 0
 String: DeviceManifestPrimaryURL (RO): local:rc_sgm_producer_v1.zip;10000000;5b80
 String: DeviceManifestSecondaryURL (RO):
 Enumeration: DeviceTLType (RO) [GigEVision CameraLink CameraLinkHS CoaXPress USB3Vision Custom]: GigEVision
 Integer: DeviceTLVersionMajor (RO) [0, 65535]: 2
 Integer: DeviceTLVersionMinor (RO) [0, 65535]: 1
 Integer: DeviceTLVersionSubMinor (RO) [-9223372036854775808, 9223372036854775807]: 0
 Integer: DeviceLinkSelector (RO) [-9223372036854775808, 9223372036854775807]: 0
 Integer: DeviceLinkSpeed (RO) [0, 4294967295]: 125000000 Bps
 Enumeration: DeviceLinkThroughputLimitMode (RW) [Off On]: On
 Integer: DeviceLinkThroughputLimit (RW) [2000000, 250000000]: 112500000
 Integer: DeviceLinkConnectionCount (RO) [0, 4294967295]: 1
 Integer: DeviceStreamChannelCount (RO) [0, 4294967295]: 1
 Integer: DeviceStreamChannelSelector (RW) [0, 0]: 0
 Enumeration: DeviceStreamChannelType (RO) [Transmitter Receiver]: Transmitter
 Enumeration: DeviceStreamChannelEndianness (RO) [Big Little]: Little
 Integer: DeviceEventChannelCount (RO) [0, 4294967295]: 0
 Enumeration: DeviceCharacterSet (RO) [UTF8 ASCII]: UTF8
 Enumeration: DeviceRegistersEndianness (RO) [Big Little]: Big
 Command: TimestampLatch (WO)
 Integer: TimestampLatchValue (RO) [0, 9223372036854775807]: 0 ns
 Boolean: RcSystemReady (RO): 1
 Integer: RcError (RO) [0, 4294967295]: 0

Category: ImageFormatControl (RO)

Integer: WidthMax (RO) [0, 4294967295]: 4096
 Integer: HeightMax (RO) [0, 4294967295]: 6016
 Integer: Width (RO) [4, 4096]: 4096
 Integer: Height (RO) [4, 6016]: 3008
 Enumeration: PixelFormat (RW) [Mono8 RGB8]: RGB8
 Enumeration: ComponentSelector (RW) [Intensity IntensityCombined Disparity Confidence Error RawCombined Calibration]: Intensity
 Boolean: ComponentEnable (RW): 1
 Integer: ComponentIDValue (RO) [-9223372036854775808, 9223372036854775807]: 1
 Integer: DecimationHorizontal (RO) [-9223372036854775808, 9223372036854775807]: 1
 Integer: DecimationVertical (RO) [-9223372036854775808, 9223372036854775807]: 1

Category: AcquisitionControl (RO)

Enumeration: AcquisitionMode (RW) [SingleFrame Continuous MultiFrame]: Continuous
 Command: AcquisitionStart (RW)
 Command: AcquisitionStop (RW)
 Integer: AcquisitionFrameCount (RW) [1, 4294967295]: 0
 Float: AcquisitionFrameRate (RW) [1, 9]: 9 Hz
 Boolean: AcquisitionFrameRateEnable (RO): 1
 Float: ExposureTime (RW) [20, 2e+07]: 20000 us
 Enumeration: ExposureAuto (RW) [Off Continuous AdaptiveOut1 Out1High HDR]: Continuous
 Float: ExposureTimeAutoMax (RW) [20, 2e+07]: 111111 us
 Integer: ExposureRegionWidth (RW) [0, 4096]: 0

Integer: ExposureRegionHeight (RW) [0, 3008]: 0
 Integer: ExposureRegionOffsetX (RW) [0, 4096]: 0
 Integer: ExposureRegionOffsetY (RW) [0, 3008]: 0
 Enumeration: ExposureMode (RW) [Timed]: Timed
 Enumeration: TriggerSelector (RW) [FrameStart]: FrameStart
 Enumeration: TriggerSource (RW) [Software In1]: In1
 Enumeration: TriggerActivation (RW) [RisingEdge FallingEdge AnyEdge]: RisingEdge
 Float: TriggerDelay (RW) [0, 4.29497e+09]: 0 us
 Enumeration: TriggerMode (RW) [Off On]: Off
 Command: TriggerSoftware (RW)
 Enumeration: AcquisitionAlternateFilter (RW) [Off OnlyHigh OnlyLow]: Off
 Enumeration: AcquisitionMultiPartMode (RW) [SingleComponent SynchronizedComponents]:
 SingleComponent
 Float: RcExposureAutoAverageMax (RW) [0, 1]: 0.75
 Float: RcExposureAutoAverageMin (RW) [0, 1]: 0.25
 Category: AnalogControl (RO)
 Enumeration: GainSelector (RO) [All]: All
 Float: Gain (RW) [0, 48]: 0 dB
 Float: Gamma (RW) [0.01, 10]: 0.5
 Enumeration: BalanceRatioSelector (RW) [Red Blue]: Red
 Float: BalanceRatio (RW) [0.0625004, 15.9999]: 1.68
 Enumeration: BalanceWhiteAuto (RW) [Off Continuous]: Off
 Category: DigitalIOControl (RO)
 Enumeration: LineSelector (RW) [Out1 Out2 Out3 In1 In2 In3 In4]: Out1
 Enumeration: LineMode (RO) [Output]: Output
 Boolean: LineStatus (RO): 0
 Integer: LineStatusAll (RO) [0x0, 0xff]: 0x0
 Enumeration: LineSource (RW) [Low High ExposureActive ExposureAlternateActive]: Low
 Category: RcCalibration (RO)
 Float: RcCalibrationGridWidth (RW) [0, 5]: 0 m
 Float: RcCalibrationGridHeight (RW) [0, 5]: 0 m
 Float: RcCalibrationSensitiveAreaScale (RW) [0.5, 10]: 1
 Enumeration: RcCalibrationState (RW) [Focus]: Focus
 Boolean: RcCalibrationAvailable (RO): 1
 Category: FileAccessControl (RO)
 Enumeration: FileSelector (RW) [Calibration]: Calibration
 Enumeration: FileOperationSelector (RW) [Open Close Read Write Delete]: Open
 Enumeration: FileOpenMode (RW) [Read Write ReadWrite]: Read
 Command: FileOperationExecute (RW)
 Enumeration: FileOperationStatus (RO) [Success Failure Invalid]: Success
 Integer: FileOperationResult (RO) [0, 4294967295]: 0 B
 Integer: FileSize (RO) [0, 4294967295]: 0 B
 Integer: FileAccessOffset (RW) [0, 4294967295]: 0 B
 Integer: FileAccessLength (RW) [0, 4294967295]: 0 B
 Register: FileAccessBuffer (RW)
 Category: Scan3dControl (RO)
 Enumeration: Scan3dDistanceUnit (RO) [Pixel]: Pixel
 Enumeration: Scan3dOutputMode (RO) [DisparityC]: DisparityC
 Float: Scan3dCoordinateScale (RO) [-1.79769e+308, 1.79769e+308]: 0.0625
 Float: Scan3dCoordinateOffset (RO) [-1.79769e+308, 1.79769e+308]: 0
 Boolean: Scan3dInvalidDataFlag (RO): 1
 Float: Scan3dInvalidDataValue (RO) [-1.79769e+308, 1.79769e+308]: 0
 Float: Scan3dFocalLength (RO) [-1.79769e+308, 1.79769e+308]: 4756.46 Pixel
 Float: Scan3dBaseline (RO) [-3.40282e+38, 3.40282e+38]: 0.209251 m
 Float: Scan3dPrincipalPointU (RO) [-1.79769e+308, 1.79769e+308]: 2048 Pixel
 Float: Scan3dPrincipalPointV (RO) [-1.79769e+308, 1.79769e+308]: 1504 Pixel
 Float: FocalLengthFactor (RO) [-3.40282e+38, 3.40282e+38]: 1.16125
 Float: Baseline (RO) [-3.40282e+38, 3.40282e+38]: 0.209251 m
 Category: DepthControl (RO)
 Enumeration: DepthQuality (RW) [Low Medium High Full]: High
 Integer: DepthFill (RW) [0, 4]: 3 pixel
 Integer: DepthSeg (RW) [0, 4000]: 200 pixel
 Float: DepthMinConf (RW) [0, 1]: 0.5

Float: DepthMinDepth (RW) [0.1, 100]: 0.1 m
 Float: DepthMaxDepth (RW) [0.1, 100]: 100 m
 Float: DepthMaxDepthErr (RW) [0.01, 100]: 100 m
 Enumeration: DepthAcquisitionMode (RW) [SingleFrame SingleFrameOut1 Continuous]: Continuous
 Command: DepthAcquisitionTrigger (RW)
 Boolean: DepthSmooth (RW): 1
 Boolean: DepthStaticScene (RW): 0
 Boolean: DepthDoubleShot (RW): 0
 Float: DepthExposureAdaptTimeout (RW) [0, 2]: 0 s
 Category: ChunkDataControl (RO)
 Boolean: ChunkModeActive (RW): 0
 Enumeration: ChunkSelector (RW) [Image OffsetX OffsetY Width Height PixelFormat Timestamp
 LineStatusAll FrameID ComponentID ComponentIDValue Scan3dDistanceUnit Scan3dOutputMode
 Scan3dCoordinateScale Scan3dCoordinateOffset Scan3dInvalidDataFlag Scan3dInvalidDataValue
 Scan3dFocalLength Scan3dBaseline Scan3dPrincipalPointU Scan3dPrincipalPointV Components
 PartIndex DecimationHorizontal DecimationVertical LineSource]: Image
 Boolean: ChunkEnable (RO): 0
 Integer: ChunkFrameID (NA)
 Integer: ChunkTimestamp (NA)
 Integer: ChunkLineStatusAll (NA)
 Float: ChunkExposureTime (NA)
 Float: ChunkGain (NA)
 Integer: ChunkWidth (NA)
 Integer: ChunkHeight (NA)
 Integer: ChunkOffsetX (NA)
 Integer: ChunkOffsetY (NA)
 Enumeration: ChunkPixelFormat (NA) [Mono8 Mono16 RGB8 Confidence8 Coord3D_C16 Error8]:
 Enumeration: ChunkComponentID (NA) [Intensity IntensityCombined Disparity Confidence Error]:
 Integer: ChunkComponentIDValue (NA)
 Enumeration: ChunkComponentSelector (NA) []:
 Enumeration: ChunkScan3dDistanceUnit (NA) [Pixel]:
 Enumeration: ChunkScan3dOutputMode (NA) [DisparityC]:
 Enumeration: ChunkScan3dCoordinateSelector (RW) [CoordinateC]: CoordinateC
 Float: ChunkScan3dCoordinateScale (NA)
 Float: ChunkScan3dCoordinateOffset (NA)
 Boolean: ChunkScan3dInvalidDataFlag (NA)
 Float: ChunkScan3dInvalidDataValue (NA)
 Float: ChunkScan3dFocalLength (NA)
 Float: ChunkScan3dBaseline (NA)
 Float: ChunkScan3dPrincipalPointU (NA)
 Float: ChunkScan3dPrincipalPointV (NA)
 Integer: ChunkComponents (NA)
 Integer: ChunkPartIndex (NA)
 Integer: ChunkDecimationHorizontal (NA)
 Integer: ChunkDecimationVertical (NA)
 Enumeration: ChunkLineSelector (RW) [Out1 Out2 Out3 In1 In2 In3 In4]: Out1
 Enumeration: ChunkLineSource (NA) [Low High ExposureActive ExposureAlternateActive]:
 Boolean: ChunkLineStatus (NA)
 Float: ChunkRcNoise (NA)
 Float: ChunkRcOut1Reduction (NA)
 Boolean: ChunkRcTest (NA)
 Float: ChunkRcBrightness (NA)
 Boolean: ChunkRcAutoExposureAdapting (NA)
 Boolean: ChunkRcReducedDepthRange (NA)
 Float: ChunkRcMinDepth (NA)
 Float: ChunkRcMaxDepth (NA)
 Boolean: ChunkRcCalibrationDataCollectedFlag (NA)
 Float: ChunkRcCalibrationError (NA)
 Category: TestControl (RO)
 Enumeration: TestPayloadFormatMode (RW) [Off MultiPart]: Off
 Category: TransportLayerControl (RO)
 Integer: TLParamsLocked (RW) [-9223372036854775808, 9223372036854775807]: 0
 Integer: PayloadSize (RO) [0, 4294967295]: 320340468 B

Category: PtpControl (RO)
 Boolean: PtpEnable (RW): 0
 Command: PtpDataSetLatch (WO)
 Enumeration: PtpStatus (RO) [Initializing Faulty Disabled Listening PreMaster
 Master Passive Uncalibrated Slave]: Disabled
 Integer: PtpOffsetFromMaster (RO) [-2147483648, 2147483647]: 0 ns
Category: GigEVision (RO)
 Integer: GevStreamChannelSelector (RW) [0, 0]: 0
 Integer: GevSCPSPacketSize (RO) [0, 4294967295]: 1500
 Integer: GevSCPD (RW) [0, 0]: 0 ns
 Integer: GevInterfaceSelector (RW) [0, 1]: 0
 Integer: GevMACAddress (RO) [0:0:0:0:0:0, ff:ff:ff:ff:ff:ff]: 0:c:8d:60:9f:9e
 Boolean: GevCurrentIPConfigurationDHCP (RW): 1
 Boolean: GevCurrentIPConfigurationPersistentIP (RW): 0
 Boolean: GevCurrentIPConfigurationLLA (RO): 1
 Integer: GevCurrentIPAddress (RO) [0.0.0.0, 255.255.255.255]: 10.0.2.7
 Integer: GevCurrentSubnetMask (RO) [0.0.0.0, 255.255.255.255]: 255.255.252.0
 Integer: GevCurrentDefaultGateway (RO) [0.0.0.0, 255.255.255.255]: 10.0.3.254
 Integer: GevPersistentIPAddress (RW) [0.0.0.0, 255.255.255.255]: 172.23.42.4
 Integer: GevPersistentSubnetMask (RW) [0.0.0.0, 255.255.255.255]: 255.255.255.240
 Integer: GevPersistentDefaultGateway (RW) [0.0.0.0, 255.255.255.255]: 172.23.42.1