Interface documentation LLT.dll

Visual Basic



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1. About this document

The purpose of this document is to enable the reader to integrate a scanCONTROL laser profile sensor into dedicated software applications via C#. This document is based upon the application interface provided by the LLT.dll.

To get a general overview, a general introduction to the LLT.dll and the measurement principles are given at the beginning. Then the resulting measurement values are specified. This is necessary to get a basic understanding of the measurement data used in the Software. Further, the different measurement and profile data formats are explained and the data transmission types are illustrated. The general part finishes with an illustration of the limitations regarding measurement speed.

For detailed introduction into programming with the scanCONTROL SDK basic programming tasks are illustrated via example code. Detailed programming examples and a full documentation of the API support the actual implementation.

1. Versions

|  |  |  |  |
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| Version | Date | Author | State |
| 1.0 | 21.10.2019 | THl | Initial draft |

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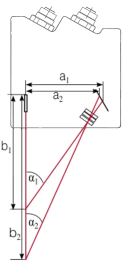
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# Introduction

## Measurement principle and data

### Principle of optical triangulation

Like conventional laser distance sensors, scanCONTROL laser profile sensors make use of the principle of optical triangulation. The beam of a laser diode is widened by special optics and projected onto a measurement target. The receiver optic focuses the diffuse reflected light, which is then detected by a CMOS sensor matrix. To ensure that only the reflection of the projected laser line is detected, a bandpass filter is embedded right before the sensor matrix. This filter allows only light to pass, which correlates to the wavelength of the laser diode.

Based on the position of the detected laser beam within one column of the sensor matrix, the distance of one measuring point to a defined reference in the sensor (z axis) can be calculated via triangulation. Usually the bottom of the sensor is chosen as reference. The basic calculation relies on the following formula:

The resolution in z direction is determined by the number of pixels in the z axis of the sensor matrix. As reflections are detected by more than one pixel, the center of gravity of the reflection is used to calculate the position (subpixel resolution).

According to the position of a measuring point within one row of the matrix, a distance value can be assigned to an x value (i.e. position). The number of pixels in a sensor row determines how many single measurement points are available.

The resulting measuring data is a two dimensional profile, which is calibrated to a dimensional unit ([mm]) by the sensor. This allows for either a relative or an absolute measurement. 3D measurements can be done via movement of the sensor or the target along the y axis. If a steady movement can be accomplished or if an encoder is used, a data grid with equidistantly distributed points can be generated.

### Available measuring values

In addition to the distance and position values (Z / X) scanCONTROL sensors generate and send further information about the current measurement. This includes the intensity, reflection width, moment 0 and moment 1. Additionally the threshold used for every single point is transmitted. These values are described below:

|  |  |
| --- | --- |
| C:\Users\11000590\Desktop\videobild.png | G:\c#\Doku\Illu_Messdaten.png |

Fig. 1: How to get a measuring value from a reflection (evaluation of one sensor column)

* Distance: To get the distance (i.e. z value) of a measuring point, the center of gravity of the reflection detected by the CMOS sensor column is calculated. Based on a calibration table this value is converted to a real distance coordinate in the sensor. The value is transmitted as 16 bit unsigned integer field which has to be scaled by the sensor specific scaling factors.
* Position: The position (x value) corresponds to a pixel row of the CMOS sensor. For every column one position value is detected. Calibration to the real position is achieved by the calibration table saved on the sensor. A 16 bit unsigned integer field is transmitted which has to be scaled, too.
* Intensity: The transmitted value is the difference between the detected intensity maximum and the currently used threshold. Intensity correlates to how much light one pixel of the matrix has detected while the shutter was open. Prerequisite for detection of a reflection is that the intensity is above the threshold. A 10 bit unsigned integer field is transmitted.
* Reflection width: The reflection width correlates to the number of contiguous pixels the intensity of the current reflection is above the threshold. A 10 bit unsigned integer field is transmitted.
* Moment 0: Corresponds to the integral intensity (“area of reflection”) of the current reflection. The moment is thus defined by the integral of the intensity over the reflection width; see Fig. 1 (G). The value is transmitted as 32 bit unsigned integer field.
* Moment 1: Corresponds to the center of gravity of the reflection, which is used as foundation for calculation of positon and distance according to the calibration table. It is transmitted as 32 bit unsigned integer.
* Threshold: The Threshold used for the single measuring point, which consists of the absolute or dynamically calculated threshold and the determined backlight suppression. A 10 bit unsigned integer field is transmitted.

All of these values are in respect to the current reflection detection setting of the sensor. You can choose to detect the first or last reflection over the threshold (detected for each sensor column), the reflection with the maximum intensity or the reflection with the biggest integral intensity (“largest area”) (Fig. 2).

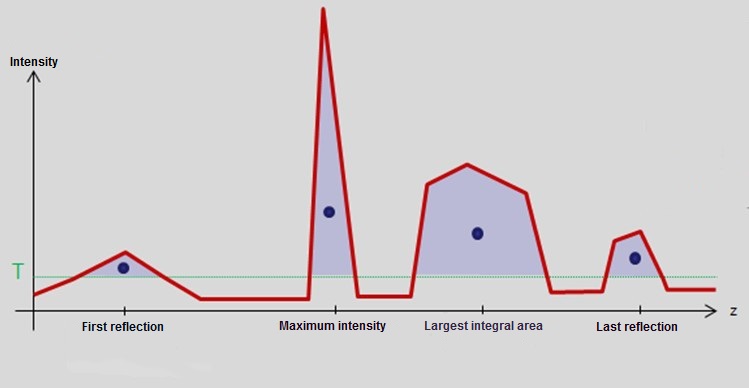


Fig. 2: Detected reflections

## LLT.dll

The LLT.dll is a *Dynamic Link Library* (DLL) for the simple integration of scanCONTROL sensors into own applications. It provides an abstraction level above the direct responses of the scanCONTROL by Ethernet or the serial interface. The focus of the design of the DLL has been set on the simplicity of the interface and high performance.

The functionality includes the complete parametrization and control of the sensor, the transmission, saving and converting of measurement data in all different transmission modes. Additionally the connection monitoring between PC and scanCONTROL can be done via the DLL. Furthermore the integration of several sensors into one application is possible.

To make the DLL compatible with as many different application development systems and compilers as possible, the DDL interface has been realized with pure C functions of the *cdecl* and *stdcall* call convention. Thus the DLL may be used under C, Delphi or other programming languages which provide compatibility to the used data types or if the implementation takes care of the differences (e.g. enums in Delphi). For C++ applications an additional wrapper exists, which maps the C functions to methods of an interface class. Visual Basic applications can be realized by wrapping the DLL with P/Invoke.

This documentation shows the DLL integration with the provided Visual Basic wrapper class. The integration in C or another programming language may be derived from this documentation. For the implementation with C++ another document is available.

## Loading the DLL in Visual Basic (VB)

The integration with VB is based on the Platform Invocation Services (P/Invoke), which wrap the C functions of the DLL. The necessary calls are defined in the class *CLLTI.cs*. P/Invoke enables the execution or call of native *unmanaged code* in the *managed code* environment stated by .NET. This must be considered during the software implementation process, because invocation of C functions has direct influence on garbage collection and type safety of VB.

The DLL can only be loaded dynamically, which means, the LLT.dll can be replaced by a newer version without recompiling the project. Additionally you can check if the requested function is available in the DLL. This is only necessary for the functions added after the first release. If new functions of the LLT.dll are to be used, the project has to be recompiled with the current *CLLTI.vb* class.

# Operating Modes for profile generation (only scanCONTROL 30xx)

The scanCONTROL 30xx series provides three Operating Modes for the profile generation. Depending on the needs of the measurement task one of these can be selected.

## High Resolution mode

The High Resolution mode is the standard mode for profile acquisition. The High Resolution mode provides profile data with the best Z linearity compared to the other modes.

## High Speed mode

In the High Speed mode profiles can be acquired at double profile frequency (in comparison to the High Resolution mode at the same measuring field size) while losing a small degree of Z linearity.

## High Dynamic Range mode (HDR)

The High Dynamic Range mode is used for target surfaces that have inhomogenous surface properties (e.g. very dark and very bright parts). Therefore a special sensor matrix feature is used to optimize the profile data of difficult surfaces while not being prone of in-motion unsharpness.

Like in the High Speed mode, the Z linearity is slightly worse than in the High Resolution mode.

# Measurement data format

## Video Mode

The Video Mode is used for transmitting the 8 bit greyscale bitmaps detected by the CMOS sensor matrix (Fig. 3). Only the actual image data is transmitted – header and mirroring of the image has to be realized externally if necessary. This data format does not have a timestamp. The measurement frequency must not exceed 25 Hz. It has to be considered that scanner of the 29xx series require a Gigabit Ethernet connection to transmit the image data with the minimal internal frequency of 25 Hz. The reason is the big image size, which leads to a necessary bandwidth of 262 Mbps (25 Hz \* 1024 \* 1280 \* 8 bit).

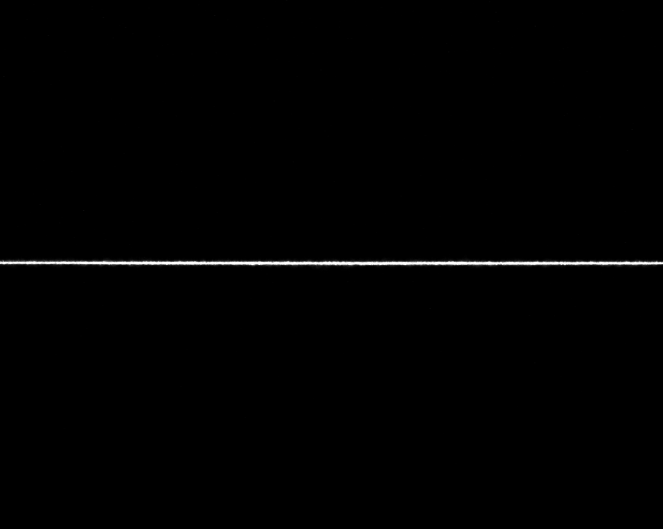


Fig. 3: Example Video Mode

Scanners of the 30xx series provide a high resolution video mode that requires a bandwidth of 445 Mbps (25 Hz \* 1088 \* 2048 \* 8 bit) and a low resolution video mode that operates at 28 Mbps (25 Hz \* 272 \* 512 \* 8 bit) for 100 Mbit Ethernet connections.

## Single profile transmission



### General format of profile data

By default a 64 byte wide data field is transmitted for each measuring point in single profile transmission mode. The height of the data field is determined by the set number of points per profile. The 64 bytes are divided into four stripes (peaks) with 16 bytes each. Every stripe can consist of one complete profile, but usually only the first stripe contains valid profile data. If multiple reflections are detected, the other stripes are filled as well. The last 16 bytes of each transmission contains the timestamp. That means in *Full Set* data transmission (default) the last point of the fourth stripe is overwritten.

For every point in each stripe, all information described in the previous chapter is transmitted. It is structured as following:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 0..7 | | 8..15 | | 16..23 | | 24..31 |
| Res. (2 bit) | Reflection width (10 bit) | | Max. Intensity (10 bit) | | Threshold (10 bit) | |
| Position (16 bit) | | | | Distance (16 bit) | | |
| Moment 0 (32 bit) | | | | | | |
| Moment 1 (32 bit) | | | | | | |

Single measurement values are encoded in the big endian byte format. As mentioned previously position and distance data (x/z) has to be scaled with measuring range specific scaling factors. A basic illustration of the data arrangement is shown in Fig. 4.

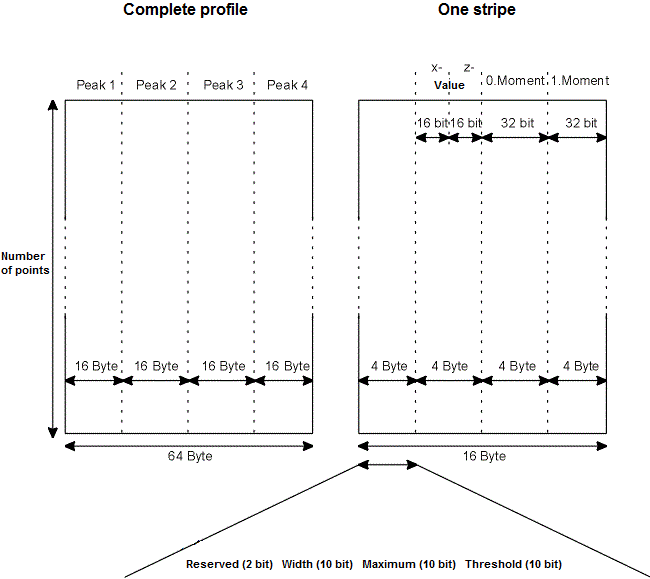


Fig. 4: Data arrangement single profile transmission

### Timestamp information

The timestamp transmitted in the last 16 bytes includes the following key data of a measured profile (data format: unsigned integer; big endian):

* Profile counter: Incremental counter for identification of profiles; is increased by one after each measurement. The field consists of 24 bit and is thus able to count until 16777215 profiles. After that the counter is set back to zero.
* Shutter open: Contains the absolute time at which the exposure was started. The internal clock has a period of 128 seconds. The 32 bit wide field consists of a second counter, a cycle counter and a cycle offset. From these values the moment of shutter opening can be calculated.
* Edge counter: Depending on the scanner settings two times the detected encoder edges or the state of the digital inputs is transmitted. The field is 16 bit wide.
* Shutter close: Contains the absolute time at which the exposure was stopped. It is equivalent to the *shutter open* field.

The timestamp is structured like this:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 0..7 | | 8..15 | | 16..23 | 24..31 |
| Flags (2 bit) | Reserved (6 bit) | | Profile counter (24 bit) | | |
| Shutter open (32 bit) | | | | | |
| Edge counter or DigIn (16 bit) | | | | Reserved (16 bit) | |
| Shutter close (32 bit) | | | | | |

The parts of the timestamp for shutter open/closed are compounded as following:

|  |  |  |
| --- | --- | --- |
| Seconds counter (7 bit) | Cycle counter (13 bit) | Cycle offset (12 bit) |

The absolute time can be calculated via:

(Remark: The cycle count is overflowing at 8000 and the cycle offset at 3072!)

### CMM timestamp

If the *Coordinate Measuring Machine* (CMM) trigger is activated the format of the timestamp changes. Instead of the 16 bit encoder edge counter / the reserved field, following CMM specific information is transmitted:

|  |  |  |  |
| --- | --- | --- | --- |
| CMM edge counter  (16 bit) | CMM trigger flag (1 bit) | CMM active flag  (1 bit) | CMM trigger impulse count  (14 bit) |

### Complete measurement data set (Full Set, PROFILE)

By default all key data values described previously are transmitted. The predefined profile configuration format *Full Set* extracts all of this data from the transmission buffer. The amount of data in this configuration is represented by 64 bytes for every point of the profile. In context of the DLL this configuration is called *PROFILE*. The output encoding is big endian.

### One stripe (QUARTER\_PROFILE)

The profile configuration *QUARTER\_PROFILE* extracts one stripe of the *Full Set* data. Consequently the amount of data to be evaluated is decreased. The timestamp information is attached to the measurement data, which means the amount of data is 16 byte per profile point plus 16 byte timestamp. Is has to be mentioned that the amount of transmitted data is not reduced, instead only the specified part (the selected stripe) of the data buffer is evaluated and passed to the application. Thus the data is still transmitted completely. This configuration is also encoded in big endian.

### X/Z data (PURE\_PROFILE)

With the profile configuration *PURE\_PROFILE* onlyposition and distance values are extracted from the currently set stripe. The behavior is same as in *QUARTER\_PROFILE* configuration, which means the transmitted amount of data is not reduced. The data to be evaluated is reduced to 4 bytes per profile point plus 16 byte timestamp. The values are extracted in little endian encoding.

### Partial profile (PARTIAL\_PROFILE)

A partial profile (*PARTIAL\_PROFILE*) is a custom cropped profile generated directly on the scanner. It is therefore possible to reduce the amount of transmitted data significantly. Also on-scanner data processing is accelerated, which is important while operating with high data rates. The size of the profile can be defined by the following four parameters:

1. *StartPoint*: First measuring point included in the profile
2. *StartPointData*: Data offset, from which byte the data of a point should be included in the profile
3. *PointCount*: Number of measuring points included in the profile counted from the *StartPoint*
4. *PointDataWidth*: Number of bytes from the *StartPointData* offset which should be included in the profile

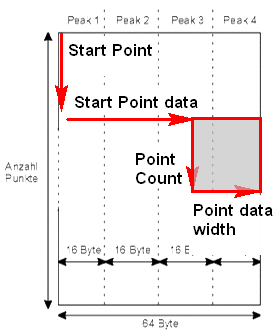


Fig. 5: Illustration Partial Profile

The reference point for setting the *StartPoint* or the *StartPointData* is the upper left edge. Counting starts with the index 0. The timestamp overwrites the last 16 bytes of the partial profile. The transmitted amount of data is reduced to (PointDataWidth x PointCount) bytes. This configuration is encoded in big endian.

## Container Mode

The container mode allows combining data from several profiles into one big transmission container. The advantages of this mode include reduction of the necessary reaction intervals of the software application and of data overhead.



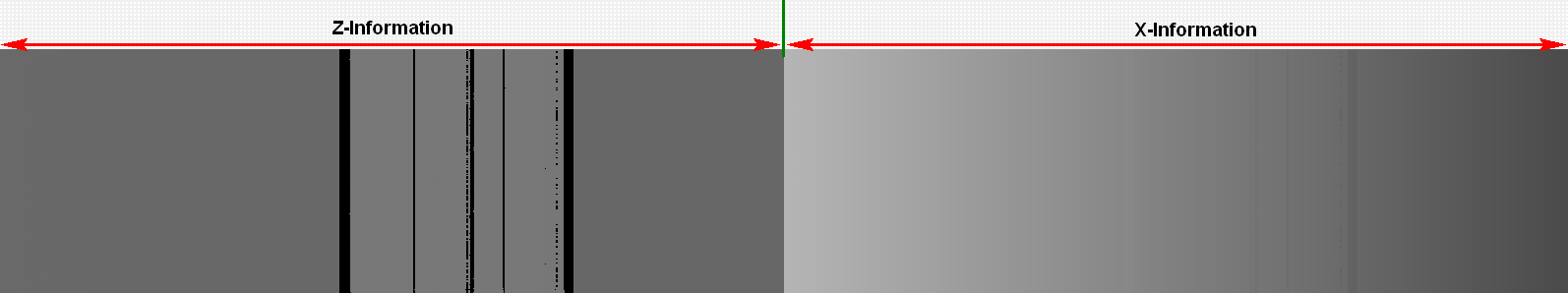
### Standard Container Mode

In Standard Container Mode profiles are combined into one logical transmission container. The sensor collects data until the requested amount is reached and transmits it as one package. The maximum container size depends on the sensor (128 Mbyte / 4096 profiles). In this case the main advantage is the longer reaction time intervals in the software.

### Rearranged Container Mode (Transposed Container Mode)

The *Rearrangement* feature enables the sensor to send only the really necessary data. The user can freely define from which stripe which measuring values should be transmitted. These values are saved continuously per profile. The timestamp can be saved in an additional field. The chosen values are collected for the set amount of profiles and then transmitted.

One rearrangement configuration often used is the so called transposed container mode. Here only the distance data is transmitted (optional: position as well). This data is then arranged as a 16-bit grey scale bitmap, which can be analyzed with standard vision tools. The width of the bitmap is determined by the number of points per profile; the height by the number of profiles in the container. The default data format is big endian, but can be changed to little endian.



Measure-ments

Points on x-axis

Fig. 6: Example image transposed container mode

# Data transmission scanCONTROL sensor



## Data transmission

Data transmission is started and stopped by the user application. If the transmission is active, received data is written into the receiving buffer according to the profile frequency. It can be chosen between continuous data extraction from the profile buffer (NORMAL\_TRANSFER) and shot wise data extraction from the profile buffer (transmission of a defined number of profiles = SHOT\_TRANSFER).

## Polling of measurement data

For non-time critical application or applications which do not need all profiles or video images to be evaluated, it is possible to extract the data actively from the receiving buffer. For every poll the last profile/container/image received is copied from the buffer to an additional buffer reserved by the application, which then can be used for further evaluation. If there is no new profile since the last poll, the application is noticed.

## Using callbacks

The second way of fetching data is by using a callback: For every received profile or container the callback function is executed. If the callback is finished an event is to be set. One parameter of the callback is a pointer to the currently received profile/container. The data size depends on the profile configuration set. The pointer enables the callback to copy the received data into an evaluation buffer. The callback function has to be very fast to make sure the next buffer can be fetched by the driver.

# Measuring speed

The maximum measuring speed depends on several sensor parameters and is different for every sensor type. Additionally the given network infrastructure can be a limiting factor. If the maximum speed is exceeded data is lost and/or corrupted and thus should be completely avoided.

To avoid performance problems resulting from the network environment a Gigabit Ethernet connection should be established between PC and Sensor. Especially if sensors of the 29xx series or the 30xx series are used, 100 Mbps networks are quickly at their bandwidth limitations. Furthermore a PC with a sufficient hardware performance should be used, as a huge amount of data has to be analyzed – especially if there is more than one sensor connected.

Most of the time, the sensor speed is limited by the measuring field used by the sensor. The measuring field corresponds to the part of sensor matrix which is read out by the scanCONTROL sensor. The smaller the read out area, the faster is the maximal measuring frequency. A detailed listing of possible frequencies for each measuring field is given in the scanCONTROL *Quick Reference*, which is part of the sensor documentation. In general, only the necessary part of the matrix should be evaluated, especially during high frequency measurements.

An important parameter to consider in regard of measuring speed is the exposure time. The maximum frequency of a measuring task can be determined by calculation the reciprocal value of the exposure time. If there are advanced post processing operations configured on the sensor (SMART or GAP sensors), which can be a bottle neck as well. The duration of the current post processing can be seen in the *scanCONTROL Configuration Tools.* If the sensors are operated with higher frequencies, the basic processing can limit the speed, even without having configured post processing tasks. This can be countered by only reading out the area of the matrix which contains the points of interest and reducing the transmitted data using the partial profile configuration (e.g. only one stripe or x/z data). If the maximum sensor speed is used, it is especially important to use a configuration for lowest possible data transmission. This has no influence on the quality of measurements, because all additional points are not in the measuring field and would just contain invalid values.

# Typical code examples with references to the SDK

The following chapter shows basic code examples for different integration steps. Complete projects with e.g. error handling can be found in the project folder of the SDK. Except for example 5.1 the sensor has to be connected prior of code execution. In some examples, registers are set (*CLLTI.SetFeature(…)*) – note that register addresses are mapped to constants in the SDK (e.g. FEATURE\_FUNCTION\_EXPOSURE\_TIME for exposure time register). Detailed description of the registers can be found in Operation Manual Part B (see chapter 8.3), which is part of the scanner documentation.



## Connect to the sensor

This example shows how to find a sensor and how to connect to it.



See API: [CreateLLTDevice](#_Instanz-Funktionen)(), [GetDeviceInterfaces](#_Auswahl-Funktionen)(), [GetDeviceInterfacesFast](#_Auswahl-Funktionen)(), [SetDeviceInterface](#_Auswahl-Funktionen)(), [Connect](#_Verbindungs-Funktionen)()

## Set profile frequency and exposure time (only scanCONTROL 30xx)

This example shows how to change the profile frequency and the exposure time (shutter time) for scanCONTROL 30xx. The set value marks the time in 1 µs steps. The profile frequency cannot be set directly but is composed from the exposure time (*ExposureTime*) and the idle time (*IdleTime*). Calculation:



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_EXPOSURE\_TIME](#Shuttertime), [FEATURE\_FUNCTION\_IDLE\_TIME](#Idletime)

See Operation Manual Part B: *OpManPartB.html#exposuretime, OpManPartB.html#idletime*

The example code sets the exposure time to 1.005 ms and the profile frequency to 100 Hz. Please take a look at the SDK examples (sc30xx\_HighSpeed).

## Set profile frequency and exposure time

This example shows how to change the profile frequency and the exposure time (shutter time). The set value marks the time in 10 µs steps. The profile frequency cannot be set directly but is composed from the exposure time (*ExposureTime*) and the idle time (*IdleTime*). Calculation:



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_EXPOSURE\_TIME](#Shuttertime), [FEATURE\_FUNCTION\_IDLE\_TIME](#Idletime)

See Operation Manual Part B: *OpManPartB.html#exposuretime, OpManPartB.html#idletime*

The example code sets the exposure time to 1 ms and the profile frequency to 100 Hz.

## Poll measurement data

This example shows how to fetch data from the sensor via active polling. To poll data the function *GetActualProfile()* copies the last received profile from the receiving buffer to an application buffer for further evaluation. After that the function *ConvertProfile2Values()* extracts the x/z data from the buffer. This function automatically calculates the position and distance values in mm according to the scaling factors.





See API: [GetLLTType](#_Identifikations-Funktionen)(), [TransferProfiles](#_Profilübertragung_starten/stoppen)(), [GetActualProfile](#_Abholen_des_aktuellen)(), [ConvertProfiles2Values](#_Konvertieren_von_Profil-Daten)()

## Get measurement data via callback

This example shows how to fetch profile data via callback. For this purpose a callback is registered, which is executed for every received profile. The callback function copies the data from the receiving buffer and emits an event after one profile. After the profile is received the transmission is stopped.





See API: [RegisterCallback](#_Registrieren_des_Callbacks)(), [TransferProfiles](#_Profilübertragung_starten/stoppen)()

## Set profile filter

This example shows how to set resampling, median and average filter.



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_PROFILE\_FILTER](#Profilefilter)

See Operation Manual Part B: *OpManPartB.html#profilefilter*

## Encoder

This example shows how to activate encoder triggering via digital inputs.





See API: [SetFeature()](#_Set-/Get-Funktionen), [GetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_TRIGGER](#Trigger), [FEATURE\_FUNCTION\_MAINTENANCE](#Maintenancefunctions), [FEATURE\_FUNCTION\_DIGITAL\_IO](#RS422)

See Operation Manual Part B: *OpManPartB.html#trigger, OpManPartB.html#maintenance, OpManPartB.html#ioconfig*

## External triggering

This example shows how to activate external triggering via digital inputs.



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_TRIGGER](#Trigger) , [FEATURE\_FUNCTION\_DIGITAL\_IO](#RS422)

See Operation Manual Part B: *OpManPartB.html#trigger, OpManPartB.html#ioconfig*

## Software profile trigger

This example shows how to trigger a profile via software profile trigger.



See API: [SetFeature()](#_Set-/Get-Funktionen), [TriggerProfile()](#_Software_trigger), [FEATURE\_FUNCTION\_TRIGGER](#Trigger)

See Operation Manual Part B: *OpManPartB.html#trigger*

Please take a look at the SDK examples (TriggerProfile).

## Software container trigger

This example shows how to trigger a container via software container trigger. To use this function, the sensor either has to be in frametrigger mode (see Digital IO configuration) or the functionality has to be activated separately by TriggerContainerEnable() / TriggerContainerDisable().



See API: [SetFeature()](#_Set-/Get-Funktionen), [TriggerContainer()](#_Software_trigger), [FEATURE\_FUNCTION\_TRIGGER](#Trigger)

See Operation Manual Part B: *OpManPartB.html#trigger*

Requires: Frimware version v46 or newer

Please take a look at the SDK examples (TriggerContainer).

## Set peak filter

This example shows how to set the peak filters of the scanner. These filters exclude points which are not in a certain range of intensity and/or reflection width from the profile. To activate a 0 must be written to FEATURE\_FUNCTION\_EXTRA\_PARAMETER.

See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_PEAKFITLTER](#Sharpness), [FEATURE\_FUNCTION\_EXTRA\_PARAMETER](#Sharpness)

See Operation Manual Part B: *OpManPartB.html#extraparameter*

Note for scanCONTROL 27xx and scanCONTROL 26xx/29xx (Firmware version < v43):

The peak filter has to be set via the EXTRA\_PARAMETER register. Please take a look at the SDK examples (advanced/LLTPeakFilter).

## Compute sensor matrix regions

To set a free measuring field (Firmware versions < v43, see chapter 6.13) a region of interest (see chapter 6.14), a region of no interest or a reference region for the automatic exposure time on the sensor matrix, the percentage on the correctly rotated sensor matrix (cf. scanCONTROL Configuration Tools) have to be converted to the correct matrix values. The formulas to be used depend on the used sensor type.



## Set free measuring field

This example shows how to set the free measuring field. This setting makes it possible to define a custom size for the measuring field. It can be set via sequential register. To activate a 0 must be written to FEATURE\_FUNCTION\_EXTRA\_PARAMETER.



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_ROI1\_PRESET](#MeasField), [FEATURE\_FUNCTION\_EXTRA\_PARAMETER](#Sharpness)

See Operation Manual Part B: *OpManPartB.html#roi1, OpManPartB.html#extraparameter*

See chapter 6.12 how to compute the correct matrix region values. Please take a look at the SDK examples (SetROIs).

## Set region of interest 1 (measuring field)

This example shows how to set the region of interest 1 (free measuring field 1) on the sensor matrix. This setting makes it possible to define a custom size for the measuring field.



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_ROI1\_PRESET](#MeasField), [FEATURE\_FUNCTION\_EXTRA\_PARAMETER](#Sharpness)

See Operation Manual Part B: *OpManPartB.html#roi1*, *OpManPartB.html#extraparameter*

See chapter 6.12 how to compute the correct matrix region values.

Note for scanCONTROL 27xx and scanCONTROL 26xx/29xx (Firmware version < v43):

Set free measuring field has to be used instead, see 6.13. Please take a look at the SDK examples (SetROIs).

## Calibrate sensor position

This example shows how to calibrate the sensor position. This is useful if a horizontal mounting position cannot be achieved, but the profile has to be straight. It is possible to calibrate the x/z offset and angle. The functions *SetCustomCalibration()* and *ResetCustomCalibration()* are not integrated into the DLL, but implemented in the example program for position calibration.



See example program: [CSharp\_Calibration](#_SDK_examples_overview)

Please take a look at the SDK examples (Calibration).

## Use CMM trigger

With CMM triggering the scanCONTROL sensor can communicate the exact point of time at which the profile was generated. This happens via the sensor’s RS422 interface.

Configuration of the CMM trigger signal can be done via the following parameters:

* Polarity: Polarity of trigger signal
* Divisor: Trigger divisor (0 deactivates CMM triggering)
* Mark-Space ratio: Mark space ratio (duty cycle) of the signal
* Skew Correction: Correction of the trigger signal offset (in 0.5 µs steps; must be smaller than half of the sensor cycle (1/profile frequency))





See API: [SetFeature()](#_Set-/Get-Funktionen), [Timestamp2CmmAndInCounter](#_Funktionen_zur_Extrahierung)(), [FEATURE\_FUNCTION\_DIGITAL\_IO,](#RS422) [FEATURE\_FUNCTION\_CMM\_TRIGGER](#CMM)

See Operation Manual Part B: *OpManPartB.html#cmmtrigger, OpManPartB.html#ioconfig*

Before activating the trigger by setting the divisor, the CMM trigger should be configured completely. After activation the CMM trigger must not be reconfigured. Additionally the CMM trigger is not saved in the user modes, thus it has to be configured by the connected software.

Note: only supported by the scanCONTROL 26xx/27xx/29xx/30xx series.

## Save profile data

This example shows how to save profile data for subsequent offline evaluation. The profiles are saved as .AVI file.



See API: [TransferProfiles](#_Profilübertragung_starten/stoppen)(), [SaveProfiles](#_Speichern_von_Profilen)()

## Container Mode for evaluation with vision tools

This example shows how to configure the data transmission for further evaluation with standard vision tools. The resulting data format enables the vision tool to work directly with the data.





See API: [SetFeature()](#_Set-/Get-Funktionen), [SetProfileContainerSize(),](#_Container-Größe) [TransferProfiles](#_Profilübertragung_starten/stoppen)(), [GetActualProfile](#_Abholen_des_aktuellen)(), [FEATURE\_FUNCTION\_PROFILE\_REARRANGEMENT](#Rearrangemetn)

See Operation Manual Part B: *OpManPartB.html#profilerearrangement*

## Transmission of partial profiles

This example shows how to set up transmission of partial profiles. The transmitted profile corresponds to the profile configuration PURE\_PROFILE with a reduced number of points. This means only the x/z data of a defined range of points is transmitted.



See API: [SetPartialProfile](#_Funktionen_zur_Übertragung)(), [TransferProfiles](#_Profilübertragung_starten/stoppen)(), [GetActualProfile](#_Abholen_des_aktuellen)(), [ConvertPartProfile2Values()](#_Konvertieren_von_Profil-Daten)

Eventual change of the profile resolution has to be done before the partial profile configuration is sent to the sensor because calling *setResolution()* resets the partial profile setting.

## Use several sensors in one application

This example shows how to use two sensors in one application.





See API: [CreateLLTDevice](#_Instanz-Funktionen)(), [GetDeviceInterfacesFast](#_Auswahl-Funktionen)(), [SetDeviceInterface](#_Auswahl-Funktionen)(), [Connect](#_Verbindungs-Funktionen)(), [RegisterCallback](#_Registrieren_des_Callbacks)(),

Please take a look at the SDK examples (MultiLLTs).

## Error message if sensor connection is lost

This example shows how to register a callback for error message handling. This is especially important in case of a lost sensor connection. In this context a Message Box is generated in a Windows Forms application.



See API: [RegisterErrorMsg()](#_Registrieren_einer_Fehlermeldung,)

## Read temperature

This example shows how to read the core temperature of the sensor. The value describes the temperature in 0.1 K steps.



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_TEMPERATURE](#Temp)

See : *OpManPartB.html#temperature*

## Calculate and set packet delay

This example shows how to determine the minimal and maximal packet delay times for a sensor. This is necessary for network infrastructures with more than one scanner connected to a switch. The packet delay depends on the parameters packet size, network bandwidth, the amount of data to be transmitted and the number of sensors. The amount of data can be calculated from the profile configuration used and the profile frequency set. The minimal packet delay can be calculated as following:

The maximum delay is calculated like this:

The value to be configured has to be within these borders. For every connected sensor the same packet delay must be set. The scanners then are trying to find a transmission slot on their own. Once a sensor finds a free slot, it uses it permanently for sending packets.

To set the value, the following code has to be executed (here a value of 50 µs is set):



See API: [SetFeature()](#_Set-/Get-Funktionen), [FEATURE\_FUNCTION\_PACKET\_DELAY](#PD)

# API



This chapter lists the complete API (Application Program Interface). Every function is illustrated with its parameters and return values.

## Instance functions

* **CreateLLTDevice ()**



Set and return a device handle (sensor instance) in the DLL for scanCONTROL communication – depending on the connection interface.

Parameter

*iInterfaceType* Type of interface (InterfaceType)

Return value

New device handle (0x0 or 0xFFFFFFFF 🡪 Error: No device handle created)

*General error codes*

* **GetInterfaceType ()**



Query the currently assigned interface type for a sensor instance.

Parameter

*pLLT* Device handle

Return value

*Value InterfaceType* (0x0 or 0xFFFFFFFF 🡪 Error)

*General error codes*

* **InterfaceType**

Available interface types:

|  |  |  |
| --- | --- | --- |
| InterfaceType | Value | Description |
| INTF\_TYPE\_UNKNOWN | 0 | Error value if GetInterfaceType () fails; not to be set with CreateLLTDevice() |
| INTF\_TYPE\_SERIAL | 1 | Connection via serial interface |
| INTF\_TYPE\_FIREWIRE | 2 | Connection via Firewire bus (deprecated) |
| INTF\_TYPE\_ETHERNET | 3 | Connection via Ethernet interface |

* **DelDevice ()**

  
Delete sensor instance prior to unloading of the DLL. All currently set parameters are preserved on the sensor, except the driver parameters *Packet size*, *Buffer* *count* and *Profile config*.

Parameter

*pLLT* Device handle

Return value

*General return values*

## Interface functions

* **GetDeviceInterfaces () / GetDeviceInterfacesFast ()**



Query the available scanCONTROL device interfaces at the PCs interface cards. The returned device interfaces are IP addresses of the connected sensors. *GetDeviceInterfacesFast()* (Ethernet interface only) is significantly faster in small Ethernet networks.

Parameter

*pLLT* Device handle

*pInterfaces* Array for available interfaces (IP; Node ID)

*nSize* Size of array

Return value

*Number of device interfaces found*

*General error codes*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_GETDEVINTERFACES\_WIN\_NOT\_SUPPORTED | -250 | Function is only available for Windows 2000 or higher |
| ERROR\_GETDEVINTERFACES\_REQUEST\_COUNT | -251 | The size of the passed field is to small |
| ERROR\_GETDEVINTERFACES  \_INTERNAL | -253 | A error occurred during the scanCONTROL enumeration |

* **SetDeviceInterface ()**



Assign a scanCONTROL device interface to a sensor instance in the DLL. The additional parameter may optionally include which host IP address to use. This is useful if more than one network interface card is available.

Parameter

*pLLT* Device handle

*nInterface* Interface of scanCONTROL to be connected

*nAdditional* IP address of host (optional)

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_GETDEVINTERFACES  \_CONNECTED | -252 | The scanCONTROL is connected, call *Disconnect()* |

* **SetDiscoveryBroadcastTarget ()**

  
Set the local sender address that is used for discovery packets in context of the Ethernet broadcast. Useful if more than one network interface card is available.

Parameter

*pLLT* Device handle

*nNetworkAddress* Sender IP address

*nSubnetMask* Sender subnet mask

Return value

*General return values*

## Connection functions

* **Connect ()**

  
Connect to the scanCONTROL sensor assigned to the device handle. Only possible if a valid device interface is assigned (via *SetDeviceInterface()*).

Parameter

*pLLT* Device handle

Return value

*General return values*

*Specific return values*:

|  |  |  |
| --- | --- | --- |
| ERROR\_CONNECT\_LLT\_COUNT | -300 | There is no scanCONTROL connected to the computer or the driver is not installed correctly. |
| ERROR\_CONNECT\_SELECTED\_LLT | -301 | The selected interface is not available -> choose a new interface with *SetDeviceInterface()* |
| ERROR\_CONNECT\_ALREADY\_CONNECTED | -302 | There is already a scanCONTROL connected with this ID |
| ERROR\_CONNECT\_LLT\_NUMBER\_ALREADY\_USED | -303 | The requested scanCONTROL is already used by another instance -> choose another scanCONTROL with  *SetDeviceInterface()* |
| ERROR\_CONNECT\_SERIAL\_CONNECTION | -304 | The scanCONTROL by serial interface could not be connected -> choose another scanCONTROL with *SetDeviceInterface()* |

* **Disconnect ()**

  
Disconnect from scanCONTROL sensor. All set parameters are preserved on the sensor, except the driver parameters *Packet size*, *Buffer* *count* and *Profile config*.

Parameter

*pLLT* Device handle

Return value

*General return values*

## Identification functions

* **GetDeviceName ()**

  
Query device name and vendor name of scanCONTROL sensor.

Parameter

*pLLT* Device handle

*sbDevName* Device name array

*sbDevNameSize* Size of DevName buffer

*sbVenName* Vendor name array

*sbVenNameSize* Size of VenName buffer

Return value

*General return values*

*Specific return values*:

|  |  |  |
| --- | --- | --- |
| ERROR\_GETDEVICENAME\_SIZE\_TOO  \_LOW | -1 | The size of a buffer is too small |
| ERROR\_GETDEVICENAME\_NO\_BUFFER | -2 | No buffer has been passed |

* **GetLLTVersions ()**



Query Firmware version of scanCONTROL sensor.

Parameter

*pLLT* Device handle

*uiDSP* Firmware version DSP

*uiFPGA1* Firmware version FPGA1

*uiFPGA2* Firmware version FPGA2

Return value

*General return values*

* **GetLLTType ()**



Query measuring range and type of scanCONTROL sensor.

Parameter

*pLLT* Device handle

*ScannerType* Scanner type and measuring range

Return value

*General return values*

* **ScannerType**

|  |  |  |  |
| --- | --- | --- | --- |
| ScannerType | Value | scanCONTROL type | Measuring range |
| StandardType | -1 | - | - |
| scanCONTROL27xx\_25 | 1000 | 27xx | 25 mm |
| scanCONTROL27xx\_100 | 1001 | 27xx | 100 mm |
| scanCONTROL27xx\_50 | 1002 | 27xx | 50 mm |
| scanCONTROL26xx\_25 | 2000 | 26xx | 25 mm |
| scanCONTROL26xx\_50 | 2002 | 26xx | 50 mm |
| scanCONTROL26xx\_100 | 2001 | 26xx | 100 mm |
| scanCONTROL29xx\_25 | 3000 | 29xx | 25 mm |
| scanCONTROL29xx\_50 | 3002 | 29xx | 50 mm |
| scanCONTROL29xx\_100 | 3001 | 29xx | 100 mm |
| scanCONTROL29xx\_10 | 3003 | 29xx | 10 mm |
| scanCONTROL30xx\_25 | 4000 | 30xx | 25mm |
| scanCONTROL30xx\_50 | 4001 | 30xx | 50mm |
| scanCONTROL25xx\_25 | 5000 | 25xx | 25mm |
| scanCONTROL25xx\_50 | 5002 | 25xx | 50mm |
| scanCONTROL25xx\_100 | 5001 | 25xx | 100mm |

## Feature functions



### Features / Parameter

* **GetFeature ()**



Query currently set parameter value / Check availability of a feature according to the table in chapter 7.5.2.

Parameter

*pLLT* Device handle

*Function* Register address of function (FEATURE or INQUIRY)

*pValue* Value read from sensor

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_WRONG  \_FEATURE\_ADRESS | -155 | The address of the selected property is wrong |

* **SetFeature ()**



Set feature parameter.

Parameter

*pLLT* Device handle

*Function* Register address of function (FEATURE)

*Value* Value to be written to sensor

Return value

*General return values*

*Specific return value:*

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_WRONG  \_FEATURE\_ADRESS | -155 | The address of the selected property is wrong |

### Features / Parameter

The following paragraph illustrates how to use the FEATURE and INQUIRY registers. INQUIRY registers are used for confirmation of function availability and feature classification. FEATURE registers are used for querying and setting parameter values. The LSB is Bit 0.

The value read from the INQUIRY register can classify a parameter of the FEATURE register. To do so, the register defines the minimum and maximum value of the feature, if there is an automatic functionality and if the feature is available for the connected sensor type:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 31 | 30..26 | 25 | 24 | 23..12 | 11..0 |
| Feature avail.  (1 bit) | Res.  (5 bit) | Auto  (1 bit) | Res. (1 bit) | Min. value  (12 bit) | Max. value  (12 bit) |

The value of the FEATURE register can be interpreted aided by the Operation Manual Part B.

Example: Laser



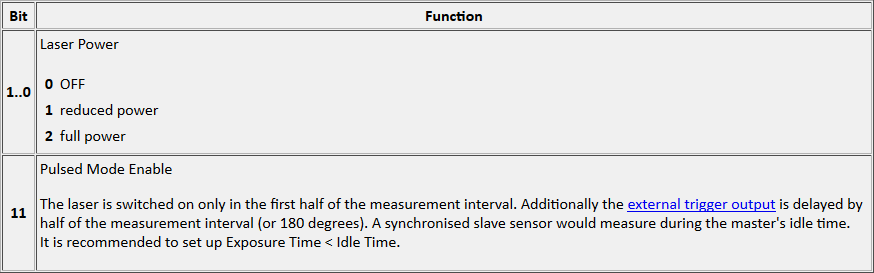


Fig. 7: Excerpt from Operation Manual Part B

Thus the register address to be written to for changing the laser power is 0xf0f00824. Bits for adjusting the laser power are 0 and 1. The value corresponds with laser off, with reduced and with full laser power. Bit 11 activates the laser pulse mode.

* **SERIAL\_NUMBER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_SERIAL\_NUMBER FEATURE\_FUNCTION\_SERIAL (deprecated) | &HF0000410UI |

Query the serial number of the connected sensor. This register is read-only.

* **CALIBRATION\_SCALE and CALIBRATION\_OFFSET**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_CALIBRATION\_SCALE | &HF0A00000UI |
| FEATURE\_FUNCTION\_CALIBRATION\_OFFSET | &HF0A00004UI |

Query the scaling and the offset value of the connected sensor. This register is read-only.

Note: Only supported by scanCONTROL 30xx series.

* **LASER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_LASER FEATURE\_FUNCTION\_LASERPOWER (deprecated) | &HF0F00824UI |
| INQUIRY\_FUNCTION\_LASER INQUIRY\_FUNCTION\_LASERPOWER (deprecated) | &HF0F00524UI |

Query and control of the laser power: 0 (off), 1 (reduced), 2 (full). Depending on the device, the polarity of the external laser switch-off or the laser pulse mode can be set. The profile transmitted directly after setting the laser power might be corrupted.

See *OpManPartB.html#laser* or *#laserpower* for the specific type of sensor.

* **ROI1\_PRESET**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_ROI1\_PRESET FEATURE\_FUNCTION\_MEASURINGFIELD (deprecated) | &HF0F00880UI |
| INQUIRY\_FUNCTION\_ROI\_PRESET INQUIRY\_FUNCTION\_MEASURINGFIELD (deprecated) | &HF0F00580UI |

Querying or setting of a region of interest on the sensor array or activation of the advanced region of interest configuration. The profile transmitted directly after setting the ROI might be corrupted.

See *OpManPartB.html#roi1* or *#zoom* for the specific type of sensor.

An overview over available predefined measuring fields and the corresponding maximum frequencies can be found in the sensor specific QuickReference.html.

* **ROI1**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_ROI1\_POSITION FEATURE\_FUNCTION\_FREE\_MEASURINGFIELD\_X (depr.) | &HF0B0200CUI |
| FEATURE\_FUNCTION\_ROI1\_DISTANCE FEATURE\_FUNCTION\_FREE\_MEASURINGFIELD\_Z (depr.) | &HF0B02008UI |

Set the start point and size of the X and Z axis of the region of interest 1. Values can go from 0 to 65535. The sensors matrix rotation has to be considered. To activate a 0 has to be written to FEATURE\_FUNCTION\_EXTRA\_PARAMETER.

Requires: Firmware v43 or newer (with Firmware < v43 use EXTRA\_PARAMETER register to set the ROI)

See *OpManPartB.html#roi1 or #extraparameter* for the specific type of sensor.

* **ROI1\_TRACKING**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_ROI1\_TRACKING\_DIVISOR FEATURE\_FUNCTION\_DYNAMIC\_TRACK\_DIVISOR (depr.) | &HF0B02010UI |
| FEATURE\_FUNCTION\_ROI1\_TRACKING\_FACTOR FEATURE\_FUNCTION\_DYNAMIC\_TRACK\_FACTOR (depr.) | &HF0B02014UI |

Set the encoder-controlled measuring field tracking function. To activate a 0 has to be written to FEATURE\_FUNCTION\_EXTRA\_PARAMETER.

Requires: Firmware v43 or newer (with Firmware < v43 use EXTRA\_PARAMETER register)

See *OpManPartB.html#roi1 or #extraparameter* for the specific type of sensor.

* **IMAGE\_FEATURES**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_IMAGE\_FEATURES | &HF0B02100UI |

Register to activate/deactivate region of interest 2, region of no interest, exposure automatic reference region on the sensor matrix. Set the operating mode of the sensor.

Note: Only supported by scanCONTROL 30xx series.

See *OpManPartB.html#image\_sensor\_features* for the specific type of sensor.

* **ROI2**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_ROI2\_POSITION | &HF0B02108UI |
| FEATURE\_FUNCTION\_ROI2\_DISTANCE | &HF0B02104UI |

Set the start point and size of the X and Z axis of the region of interest 2. Values can go from 0 to 65535. The sensors matrix rotation has to be considered.

Note: Only supported by scanCONTROL 30xx series.

See *OpManPartB.html#roi2* for the specific type of sensor.

* **RONI**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_RONI\_POSITION | &HF0B02110UI |
| FEATURE\_FUNCTION\_RONI\_DISTANCE | &HF0B0210CUI |

Set the start point and size of the X and Z axis of the region of no interest. Values can go from 0 to 65535. The sensors matrix rotation has to be considered.

Note: Only supported by scanCONTROL 30xx series.

See *OpManPartB.html#roni* for the specific type of sensor.

* **TRIGGER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_TRIGGER | &HF0F00830UI |
| INQUIRY\_FUNCTION\_TRIGGER | &HF0F00530UI |

Query and control of the trigger mode setting. The profile transmitted directly after setting the trigger mode can be corrupted. In context of changing the trigger mode, the trigger interface is to be changed (see *DIGITAL\_IO*). Changing the trigger settings resets the profile counter.

See *OpManPartB.html#trigger* for the specific type of sensor.

* **EXPOSURE­\_TIME**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_EXPOSURE\_TIME FEATURE\_FUNCTION\_SHUTTERTIME (deprecated) | &HF0F0081CUI |
| INQUIRY\_FUNCTION\_EXPOSURE\_TIME INQUIRY\_FUNCTION\_SHUTTERTIME (deprecated) | &HF0F0051CUI |

Query and control of the exposure time in 10 µs steps. The value can be set between 1 and 4095. The automatic exposure mode can be set with this register as well.

See *OpManPartB.html#exposuretime* or *#shutter* for the specific type of sensor.

* **EA\_REFERENCE\_REGION**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_EA\_REFERENCE\_REGION\_POSITION | &HF0B02118UI |
| FEATURE\_FUNCTION\_EA\_REFERENCE\_REGION\_DISTANCE | &HF0B02114UI |

Set the start point and size of the X and Z axis of the reference region for the automatic exposure time. Values can go from 0 to 65535. The sensors matrix rotation has to be considered.

Note: Only supported by scanCONTROL 30xx series.

See *OpManPartB.html#exposureautomatic* for the specific type of sensor.

* **EXPOSURE\_AUTOMATIC\_LIMITS**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_EXPOSURE\_AUTOMATIC\_LIMITS | &HF0F00834UI |
| INQUIRY\_FUNCTION\_EXPOSURE\_AUTOMATIC\_LIMITS | &HF0F00534UI |

Set the lower and upper limit for the automatic exposure algorithm. Values can go from 0 to 4095 (in 10 µs steps).

Note: Only supported by scanCONTROL 30xx series.

See *OpManPartB.html#exposureautomatic* for the specific type of sensor.

* **IDLE\_TIME**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_IDLE\_TIME FEATURE\_FUNCTION\_IDLETIME (deprecated) | &HF0F00800UI |
| INQUIRY\_FUNCTION\_IDLE\_TIME INQUIRY\_FUNCTION\_IDLETIME (deprecated) | &HF0F00500UI |

Query and control of the idle time in 10 µs steps. The value can be set between 1 and 4095. If the automatic exposure mode is activated, the idle time is automatically adjusted to match the intended profile frequency.

See *OpManPartB.html#idletime* for the specific type of sensor.

* **PROFILE\_PROCESSING**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_PROFILE\_PROCESSING FEATURE\_FUNCTION\_PROCESSING\_PROFILEDATA (depr.) | &HF0F00804UI |
| INQUIRY\_FUNCTION\_PROFILE\_PROCESSING INQUIRY\_FUNCTION\_PROCESSING\_PROFILEDATA (depr.) | &HF0F00504UI |

Query and control of profile processing parameter, like e.g. deactivation of the calibration, profile mirroring, measurement data post-processing, reflection determination or advanced exposure settings.

See *OpManPartB.html#profileprocessing* or *#processingprofile* for the specific type of sensor.

* **THRESHOLD**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_THRESHOLD | &HF0F00810UI |
| INQUIRY\_FUNCTION\_THRESHOLD | &HF0F00510UI |

Query and control of the threshold for measurement data acquisition. For targets with multiple reflections, increasing the threshold can improve the raw data. Optionally the dynamic threshold can be activated in this context.

See *OpManPartB.html#threshold* for the specific type of sensor.

* **MAINTENANCE**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_MAINTENANCE FEATURE\_FUNCTION\_MAINTENANCEFUNCTIONS (depr.) | &HF0F0088CUI |
| INQUIRY\_FUNCTION\_MAINTENANCE INQUIRY\_FUNCTION\_MAINTENANCEFUNCTIONS (depr.) | &HF0F0058CUI |

Query and control of internal maintenance settings (e.g. encoder counter).

See *OpManPartB.html#maintenance* for the specific type of sensor.

* **ANALOGFREQUENCY**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_ANALOGFREQUENCY | &HF0F00828UI |
| INQUIRY\_FUNCTION\_ANALOGFREQUENCY | &HF0F00528UI |

Interrogating and setting of the frequency for the analogue output (only scanCONTROL 28xx). The frequency may be set between 0 and 150 whereat the counting value is equal to the frequency in kHz. At the setting of 0 kHz the analogue output will be turned off which is reasonable at profile frequencies higher than 500 Hz for avoiding an overflow in the analogue output.

Note: Only supported by scanCONTROL 28xx series.

See *OpManPartB.html#focus* for the specific type of sensor.

* **ANALOGOUTPUTMODES**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_ANALOGOUTPUTMODES | &HF0F00820UI |
| INQUIRY\_FUNCTION\_ANALOGOUTPUTMODES | &HF0F00520UI |

Setting of the analogue output modes (only scanCONTROL 28xx). E.g. the voltage range and the polarity of the analogue outputs may be shifted.

Note: Only supported by scanCONTROL 28xx series.

See *OpManPartB.html#gain* for the specific type of sensor.

* **CMM\_TRIGGER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_CMM\_TRIGGER FEATURE\_FUNCTION\_CMMTRIGGER (deprecated) | &HF0F00888UI |
| INQUIRY\_FUNCTION\_CMM\_TRIGGER INQUIRY\_FUNCTION\_CMMTRIGGER (deprecated) | &HF0F00588UI |

Configuration of the optional CMM triggers. The configuration of the CMM triggers consists of 4 instruction words. These instruction words have to be written successively. Only the last written instruction word can be read from the sensor.

Note: only supported by the scanCONTROL 26xx/27xx/29xx/30xx series

See *OpManPartB.html#cmmtrigger* for the specific type of sensor.

* **PROFILE\_REARRANGEMENT**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_PROFILE\_REARRANGEMENT  FEATURE\_FUNCTION\_REARRANGEMENT\_PROFILE (depr.) | &HF0F0080CUI |
| INQUIRY\_FUNCTION\_PROFILE\_REARRANGEMENT  INQUIRY\_FUNCTION\_REARRANGEMENT\_PROFILE (depr.) | &HF0F0050CUI |

Parametrization of profile information to be transmitted in the transposed Container Mode.

See *OpManPartB.html#profilerearrangement* or *#rearrangementprofile* for the specific type of sensor.

* **PROFILE\_FILTER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_PROFILE\_FILTER | &HF0F00818UI |
| INQUIRY\_FUNCTION\_PROFILE\_FILTER | &HF0F00518UI |

Applying Resampling, Median-Filter and/or Average-Filter.

See *OpManPartB.html#profilefilter* for the specific type of sensor.

* **DIGITAL\_IO**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_DIGITAL\_IO FEATURE\_FUNCTION\_RS422\_INTERFACE\_FUNCTION (depr.) | &HF0F008C0UI |
| INQUIRY\_FUNCTION\_DIGITAL\_IO INQUIRY\_FUNCTION\_RS422\_INTERFACE\_FUNCTION (depr.) | &HF0F005C0UI |

Parameter to configure the RS422 interface or digital inputs.

See *OpManPartB.html#ioconfig or #capturesize* for the specific type of sensor.

* **PACKET\_DELAY**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_PACKET\_DELAY | &HD08UI |

Ethernet packet delay to operate several scanners connected to a switch. The parameter is set in µs. The range is from 0 to 1000µs.

* **TEMPERATURE**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_TEMPERATURE | &HF0F0082CUI |
| INQUIRY\_FUNCTION\_TEMPERATURE | &HF0F0052CUI |

Read sensor temperature in 0.1 K steps. Before the temperature can be read, the temperature measurement has to be triggered by writing 0x86000000 to the feature register.

See *OpManPartB.html#temperature* for the specific type of sensor.

* **EXTRA\_PARAMETER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_EXTRA\_PARAMETER FEATURE\_FUNCTION\_SHARPNESS (deprecated) | &HF0F00808UI |
| INQUIRY\_FUNCTION\_EXTRA\_PARAMETER INQUIRY\_FUNCTION\_SHARPNESS (deprecated) | &HF0F00508UI |

Register for setting the peak filter, free measuring field and angle/offset calibration. The values are set via multiple write operations to the register. Only the last written value can be read back. Since DLL version 3.7 / sensor firmware v43, this register is mainly used to activate certain register settings.

See *OpManPartB.html#extraparameter or #sharpness* for the specific type of sensor.

* **PEAKFILTER**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_PEAKFILTER\_WIDTH | &HF0B02000UI |
| FEATURE\_FUNCTION\_PEAKFILTER\_HEIGHT | &HF0B02004UI |

Set the minimum and maximum width/height of the peak filter. Values can go from 0 to 1023.

Requires: Firmware v43 or newer (with Firmware < v43 use EXTRA\_PARAMETER register)

* **CALIBRATION**

|  |  |
| --- | --- |
| FEATURE\_FUNCTION\_CALIBRATION\_0 - 7 | &HF0B02020UI - &HF0B0203CUI |

Set the calibration offset and angle. To activate a 0 has to be written to FEATURE\_FUNCTION\_EXTRA\_PARAMETER.

Requires: Firmware v43 or newer (with Firmware < v43 use EXTRA\_PARAMETER register)

## Special feature functions



### Software trigger

* **TriggerProfile ()**



Execute a software trigger signal to trigger one profile.

Parameter

*pLLT* Device handle

Return value

*General return values*

* **TriggerContainer ()**



Execute a software trigger signal to trigger one container.

Parameter

*pLLT* Device handle

Return value

*General return values*

Requires: Firmware v46 or newer

The sensor has to be in frametrigger mode (see Digital IO) to be able to use this function. Otherwise, the trigger container mode has to be activated with the subsequent function calls.

* **TriggerContainerEnable ()**
* **TriggerContainerDisable ()**



Activate/deactivate the trigger container mode to be able to use TriggerContainer() without set frametrigger mode (see Digital IO).

Parameter

*pLLT* Device handle

Return value

*General return values*

### Profile configuration

* **GetProfileConfig ()**



Query of the current profile configuration.

Parameter

*pLLT* Device handle

*pValue* Profile configuration read from sensor

Return value

*General return values*

* **SetProfileConfig ()**

Profile configuration to be set for data transmission.

Parameter

*pLLT* Device handle

*Value* Profile configuration to be set

Return value

*General return values*

Specific return value:

|  |  |  |
| --- | --- | --- |
| ERROR\_ SETGETFUNCTIONS\_WRONG  \_PROFILE\_CONFIG | -152 | The requested profile configuration is not available |

* **ProfileConfig**

*Available ProfileConfig* settings:

|  |  |  |
| --- | --- | --- |
| Value name | Value | Description |
| PROFILE | 1 | Profile data of all four stripes |
| PURE\_PROFILE | 2 | Reduced profile data of one stripe (only position and distance values) |
| QUARTER\_PROFILE | 3 | Profile data of one stripe |
| PARTIAL\_PROFILE | 5 | Partial profile which has been restricted by *SetPartialProfile()* |
| CONTAINER | 1 | Container data |
| VIDEO\_IMAGE | 1 | Video image of the scanCONTROL |

### Profile resolution / Points per profile

* **GetResolution ()**

Query of the currently set profile resolution / measuring points per profile.

Parameter

*pLLT* Device handle

*pValue* Profile resolution queried

Return value

*General return values*

* **SetResolution ()**



Set the profile resolution / points per profile. For changing the resolution, the profile data transmission has to be stopped. After changing the resolution all partial profile settings are lost.

Parameter

*pLLT* Device handle

*Value* Profile resolution to be set

Return value

*General return values*

*Specific return value:*

|  |  |  |
| --- | --- | --- |
| ERROR\_ SETGETFUNCTIONS\_NOT  \_SUPPORTED\_RESOLUTION | -153 | The requested resolution is not supported |

* **GetResolutions ()**



Query of available profile resolutions.

Parameter

*pLLT* Device handle

*pValue* Array with available profile resolutions

*nSize* Size of array

Return value

*Number of available resolutions*

*General return values*

|  |  |  |
| --- | --- | --- |
| ERROR\_ SETGETFUNCTIONS\_NOT  \_SUPPORTED\_RESOLUTION | -156 | The size of the passed field is too small |

### Container size

* **GetProfileContainerSize ()**



Query of currently set container size.

Parameter

*pLLT* Device handle

*pWidth* Container width queried

*pHeight* Container height queried

Return value

*General return values*

* **SetProfileContainerSize ()**

Set container size. The container width is set automatically if *SetFeature(FEATURE\_FUNCTION\_PROFILE\_REARRANGEMENT)* is called. The height can be freely set from 0 to the maximum container height and determines how many profiles are transmitted within one container. The container height shouldn’t be higher than three times the profile frequency.

If the “connection of successive profiles” (see *OpManPartB.html#profilerearrangement or OpManPartB.html#rearrangementprofile)* is activated, the height \* width of an image has to be an integral multiple of 16384. If it is tried to set up another height value, the height will be adjusted automatically to the next matching value. Additionally the error value GENERAL\_FUNCTION\_CONTAINER\_MODE\_HEIGHT\_CHANGED will be returned for indicating the changes.

Parameter

*pLLT* Device handle

*Width* Container width to be set

*Height* Container height to be set

Return value

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_WRONG  \_PROFILE\_SIZE | -157 | The size for the container is wrong |
| ERROR\_SETGETFUNCTIONS\_MOD\_4 | -158 | The container width is not divisible by 4 |

* **GetMaxProfileContainerSize ()**



Query the maximal possible container size. If the maximum width is 64, the container mode is not supported by the connected scanCONTROL.

Parameter

*pLLT* Device handle

*pMaxWidth* Maximum container width

*pMaxHeight* Maximum container height

Return value

*General return values*

### Main reflection

* **GetMainReflection ()**



Query the currently set main reflection, to be extracted by the profile configurations *PURE\_PROFILE* or *QUARTER\_PROFILE*.

Parameter

pLLT Device handle

pValue Value of main reflection queried

Return value

*General return values*

* **SetMainReflection ()**



Set the main reflection (stripe), from which the profile data is extracted if *PURE\_PROFILE* or *QUARTER\_PROFILE* is used. The index of the stripe to be used ranges from 0 for the 1st stripe to 3 for the 4th stripe.

Parameter

*pLLT* Device handle

*Value* Main reflection to be set

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS  \_REFLECTION\_NUMBER\_TOO\_HIGH | -154 | The index of the stripe to be put out is greater than 3 |

### Number of buffers

A high buffer count is useful when using high profile frequencies, slow computing hardware and/or a PC with a lot of background activity. For container and video mode transmission maximum four buffers are recommended.

* **GetBufferCount ()**



Query the set number of buffers in the driver for data transmission.

Parameter

*pLLT* Device handle

*Value* Buffer count queried

Return value

*General return values*

* **SetBufferCount ()**



Set the number of buffers in the driver for data transmission.

Parameter

*pLLT* Device handle

*Value* Buffer count to be set

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_WRONG  \_BUFFER\_COUNT | -150 | Count of the required buffer does not lie in the range of >=2 and <= 200 |

### Allocated buffer for profile polling

* **GetHoldBuffersForPolling ()**



Query the number of buffers allocated for polling profile with *GetActualProfile().*

Parameter

*pLLT* Device handle

*puiHoldBuffersForPolling* Buffer count queried

Return value

*General return values*

* **SetHoldBuffersForPolling ()**



Setting the profile count that the llt.dll may hold for *GetActualProfile()*; the buffer is set up as FIFO in case the set value is greater than 0. A larger count lets the LLT.dll hold more profiles before profiles will be dropped. This decreases the risk of profile loss. The count must not be higher than half the total buffer count. Default value: 1.

Parameter

*pLLT* Device handle

*uiHoldBuffersForPolling* Buffer count set

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_WRONG  \_BUFFER\_COUNT | -150 | Bufer count is not in the range of >=2 and <= 200 |

### Packet size

scanCONTROL supports the packet sizes 128, 256, 512, 1024, 2048 and 4096 bytes. For Ethernet connections, packets larger than 1024 bytes require the support of jumbo frames by all devices, especially by the receiving network card.

* **GetPacketSize ()**



Query the active packet size of the Ethernet streaming packets.

Parameter

*pLLT* Device handle

*pValue* Packet size queried

Return value

*General return values*

* **SetPacketSize ()**



Set the active packet size of the Ethernet streaming packets. This packet size has to be between the minimum and maximum packet size.

Parameter

*pLLT* Device handle

*Value* Packet size to be set

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_PACKET  \_SIZE | -151 | The requested packet size is not supported |

* **GetMinMaxPacketSize ()**

Query the minimum and maximum packet sizes of the Ethernet streaming packets.

Parameter

*pLLT* Device handle

*pMinPacketSize* Minimal packet size settable

*pMaxPacketSize* Maximal packet size settable

Return value

*General return values*

### Loading and saving of user modes

Loading and storing the user mode. All settings of a scanCONTROL can be stored in a user mode so that all settings become active again immediately after a reset or restart. This is particularly expedient for post processing applications. Loading the user mode cannot be performed during an active profile / container transmission. User mode 0 can only be loaded as it contains the factory settings.

* **GetActualUserMode ()**

Query the last loaded user mode / parameter queue. The scanCONTROL 25xx/26xx/27xx/29xx/30xx series support 16 user modes.

Parameter

*pLLT* Device handle

*pActualUserMode* Currently loaded user mode

*pUserModeCount* Available user modes

Return value

*General return values*

* **ReadWriteUserModes ()**

Loading or storing a user mode. If nWrite is 0, the user mode specified by nUserMode is loaded; otherwise the current settings are stored to this user mode. After loading of a user mode the sensor must be reconnected.

Parameter

*pLLT* Device handle

*nWrite* Loading (0) or saving (other than 0) of an user mode

*nUserMode* User mode to be loaded or saved

Return value

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS\_USER  \_MODE\_TOO\_HIGH | -160 | The specified user mode number is not available |
| ERROR\_SETGETFUNCTIONS\_USER  \_MODE\_FACTORY\_DEFAULT | -161 | User mode 0 cannot be overwritten (factory settings) |

### Timeout for communication supervision to the sensor

Setting and reading the heartbeat timeout in milliseconds to monitor the connection between LLT.dll and scanCONTROL device. This is the time between two monitoring packets. A connection abort will occur if the device does not receive packets after three times the set up value. Especially while debugging, a heartbeat timeout set too small is reason for connection loss.

* **GetEthernetHeartbeatTimeout ()**

Query the set heartbeat timeout.

Parameter

*pLLT* Device handle

*pValue* Heartbeat timeout queried

Return value

*General return values*

* **SetEthernetHeartbeatTimeout ()**



Set the heartbeat timeout in ms. Values between 500 and 1.000.000.000 ms are allowed.

Parameter

*pLLT* Device handle

*Value* Heartbeat timeout to be set

Return value

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_SETGETFUNCTIONS  \_HEARTBEAT\_TOO\_HIGH | -162 | Parameter value too large |

### Set file size for saving data

* **GetMaxFileSize ()**



Query the maximum file size for saving profile data in byte.

Parameter

*pLLT* Device handle

*pValue* Maximum file size queried

Return value

*General return values*

* **SetMaxFileSize ()**



Set maximum file size for saving profile data in byte. If this size is reached the saving process is stopped.

Parameter

*pLLT* Device handle

*Value* Maximum file size to be set

Return value

*General return values*

## Register functions



### Register callback for profile reception

These callbacks are, after they have been registered, called after the receipt of a profile/ container and have as parameter a pointer to the profile/container data, the corresponding

size of a data field and an pUserData parameter.

The callback is intended for the processing of profiles / containers with a high profile frequency. During the callback profiles / container may be copied in a buffer for a later or a processing synchrony or asynchrony to the callback. A processing during the callback is not recommendable as for the time the callback needs for processing the LLT.dll is not able to fetch new profiles / container from the driver. Possibly by this it may amount to profile/container failures.

The profile / container data in the buffer passed by the callback must not be changed.

* **RegisterCallback ()**



Register the callback which is called every time a profile is received.

Parameter

*pLLT* Device handle

*tCallbackType* Call convention (0: stdcall; 1: c\_decl)

*tReceiveProfiles* Callback function to be registered

*pUserData* Userdata for distinguishing sensors

Return value

*General return values*

* **CallbackType**

|  |  |  |
| --- | --- | --- |
| Callback Type | Value | Description |
| STD\_CALL | 0 | The callback is working with stdcall (TNewProfile\_s) |
| C\_DECL | 1 | The callback is working with cdecl (TNewProfile\_c) |

### Register error message for error handling

* **RegisterErrorMsg ()**

Register an error message.

Parameter

*pLLT* Device handle

*Msg* Message ID

*hWnd* Handle (e.g. Window)

*WParam* Identification parameter

Return value

*General return values*

* **WParam (error ID)**

Available error parameter:

|  |  |  |
| --- | --- | --- |
| Constant of return value | Value | Description |
| ERROR\_SERIAL\_COMM | 1 | Error during the serial data transfer. Possibly the profile frequency is too high. |
| ERROR\_SERIAL\_LLT | 7 | ScanCONTROL could not interpret the commando or a parameter out of the validity area has been send. |
| ERROR\_CONNECTIONLOST | 10 | The connection to the scanCONTROL has been interrupted (scanCONTROL has been switched off, reset or the Ethernet cable has been removed). Please send a *Disconnect()* for being able to reconnect. This message is only send at a connection by Ethernet |
| ERROR\_STOPSAVING | 100 | The saving of the profiles is finished (maximum data size reached) |

## Profile transmission functions



### Start/stop profiles transmission

* **TransferProfiles ()**

Start or stop profile transmission. After the first start of a transfer it may take up to 100 ms before the first profiles/container arrive via callback or can be fetched via *GetActualProfile()*. If a transfer is terminated, the function waits automatically till the driver has returned all buffers.

Parameter

*pLLT* Device handle

*TransferProfileType* Profile transfer type

*nEnable* Start (1) or stop (0) transmission

Return value

Size of profile/container

*General return values*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_PROFTRANS\_PACKET\_SIZE\_TOO\_HIGH | -107 | Packet size is too high |
| ERROR\_PROFTRANS\_CREATE\_BUFFERS | -108 | Buffers could not be reserved 🡪 restart PC |
| ERROR\_PROFTRANS\_WRONG\_PACKET\_SIZE\_FOR\_CONTAINER | -109 | Packet size does not match container settings, see *setPacketSize()* |

* **TransferProfileType**

Available TransferProfileTypes:

|  |  |  |
| --- | --- | --- |
| Constant return value | Value | Description |
| NORMAL\_TRANSFER | 0 | Activation of a continuous transfer of profiles |
| SHOT\_TRANSFER | 1 | Activation of a demand-based transfer of profiles (the transfer is always activated by *MultiShot()*) |
| NORMAL\_CONTAINER\_MODE | 2 | Activation of a continuous transfer in the container mode |
| SHOT\_CONTAINER\_MODE | 3 | Activation of a demand-based transfer in the container mode (the transfer is always activated by *MultiShot()*) |

### Transmission of sensor matrix image / start/stop Video Mode

* **TransferVideoStream ()**



Start or stop transmission of video images of the sensor matrix (Video Mode). Maximum video frame rate is 25 pictures per second. Video pictures are fetched per *GetActualProfile()*. The Callback cannot be used for video image transmission.

Parameter

*pLLT* Device handle

*videoType* Video transmission type

*nEnable* Start (1) or stop (0) transmission

*pWidth* Width of received image

*pHeight* Height of received image

Return value

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_PROFTRANS\_PACKET\_SIZE  \_TOO\_HIGH | -107 | The packet size is bigger than the available one -> adjust a smaller packet size by *SetPacketSize()* |
| ERROR\_PROFTRANS\_CREATE\_BUFFERS | -108 | The buffer for the driver could not be created duly -> possibly restart the PC |

* **TransferVideoType**

Available TransferVideoTypes:

|  |  |  |
| --- | --- | --- |
| Constant return value | Value | Description |
| VIDEO\_MODE\_0 | 0 | Low resolution image of matrix |
| VIDEO\_MODE\_1 | 1 | Full size image of matrix |

### Transmission of a specified number of profiles / container

* **MultiShot ()**

Request the transmission of a specified number of profiles / containers. The amount of profiles / container is passed in the parameter nCount. You can fetch between 1 and 65535 profiles / container.

Note: MultiShot() does not trigger the sensor to deliver a profile or a container. It only passes the most recent profile(s)/container(s) in the buffer to the application so that GetActualProfile or the Callback deliver only the number of specified profile(s)/container(s) instead of a continuous sequence of profile(s)/container(s).

Parameter

*pLLT* Device handle

*nCount* Number of requested profiles/container

Return value

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_PROFTRANS\_SHOTS\_NOT  \_ACTIVE | -100 | The SHOT\_TRANSFER mode or the SHOT\_CONTAINER\_MODE mode is not activated -> restart profile transfer |
| ERROR\_PROFTRANS\_SHOTS\_COUNT  \_TOO\_HIGH | -101 | The number of requested profiles / container is bigger than 65535 |
| ERROR\_PROFTRANS\_MULTIPLE\_SHOTS\_ACTIV | -111 | A MultiShot request is active -> call *MultiShot(0)* for abort |

### Transmission of profiles via serial interface

* **GetProfile ()**



Profile transfer via serial interface. This function is only available for the serial interface.

Parameter

*pLLT* Device handle

Return value

*General return values*

### Fetch current profile / container / video image

* **GetActualProfile ()**



Fetching the active profile/container/video image from the LLT.dll.

Parameter

*pLLT* Device handle

*pBuffer* Transmission buffer

*nBuffersize* Size of transmission buffer

*ProfileConfig* Profile configuration of transmission

*pLostProfiles* Lost profiles

Return value

*Number of bytes copied into buffer*

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_PROFTRANS\_WRONG\_PROFILE  \_CONFIG | -102 | Not able to convert the loaded profile into the requested profile configuration |
| ERROR\_PROFTRANS\_FILE\_EOF | -103 | The end-of-file during the loading of profiles has been reached |
| ERROR\_PROFTRANS\_NO\_NEW\_PROFILE | -104 | Since the last call of *GetActualProfile()* no new profile has been received |
| ERROR\_PROFTRANS\_BUFFER\_SIZE\_TOO\_LOW | -105 | The buffer size of the passed buffer is too small |
| ERROR\_PROFTRANS\_NO\_PROFILE  \_TRANSFER | -106 | The profile transfer has not been started and no file is loaded |

### Convert profile data

* **ConvertProfile2Values ()**

Conversion of profile data in coordinates and further measuring point information. The size of the data arrays must correspond to the profile resolution.

Parameter

*pLLT* Device handle

*pProfile* Profile buffer

*nResolution* Points per profile

*ProfileConfig* Profile configuration of transmission

*ScannerType* Scanner type

*nReflection* Profile stripe to be evaluated

*nConvertToMM* Convert x/z data to millimeters

*pWidth* Array for reflection width

*pMaximum* Array for maximum intensity

*pThreshold* Array for threshold setting

*pX* Array for position values

*pZ* Array for distance values

*pM0* Array for moment 0

*pM1* Array for moment 1

Return value

*General return values*

*Additional return values in case of success*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_PROFTRANS\_REFLECTION  \_NUMBER\_TOO\_HIGH | -110 | The count of the requested stripes is bigger than 3 |

* **ConvertPartProfile2Values ()**

Conversion of partial profile data in coordinates and further measuring point information. The size of the data arrays must correspond to the PointCount of the PARTIAL\_PROFILE parameter.

Parameter

*pLLT* Device handle

*pProfile* Profile buffer

*PartialProfile* Partial profile

*ScannerType* Scanner type

*nReflection* Profile stripe to be evaluated

*nConvertToMM* Convert x/z data to millimeters

*pWidth* Array for reflection width

*pMaximum* Array for maximum intensity

*pThreshold* Array for threshold setting

*pX* Array for position values

*pZ* Array for distance values

*pM0* Array for moment 0

*pM1* Array for moment 1

Return value

*General return values*

*Additional return values in case of success*

*Specific return value:*

|  |  |  |
| --- | --- | --- |
| ERROR\_PROFTRANS\_REFLECTION  \_NUMBER\_TOO\_HIGH | -110 | The count of the requested stripes is bigger than 3 |

* **Return values in case of success**

If the return value was >0, the set bits of the value describe which arrays have been filled:

|  |  |  |
| --- | --- | --- |
| Bit | Constant | Description |
| 8 | CONVERT\_WIDTH | The array for the reflection width has been filled with data |
| 9 | CONVERT\_MAXIMUM | The array for the maximum intensity has been filled with data |
| 10 | CONVERT\_THRESHOLD | The array for the threshold has been filled with data |
| 11 | CONVERT\_X | The array for the position coordinates has been filled with data |
| 12 | CONVERT\_Z | The array for the distance coordinates has been filled with data |
| 13 | CONVERT\_M0 | The array for the M0 has been filled with data |
| 14 | CONVERT\_M1 | The array for the M1 has been filled with data |

## Is functions

* **IsInterfaceType ()**

  
Query of currently used interface.

Parameter

*pLLT* Device handle

*iInterfaceType* Integer value of interface type

Return value

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| IS\_FUNC\_YES | 1 | Interrogated state or connection is active |
| IS\_FUNC\_NO | 0 | Interrogated state or connection is not active |

* **IsTransferingProfiles()**



Query of transmission state, i.e. if the transmission is active or not.

Parameter

*pLLT* Device handle

Return value

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| IS\_FUNC\_YES | 1 | Interrogated state or connection is active |
| IS\_FUNC\_NO | 0 | Interrogated state or connection is not active |

## Functions for transmission of partial profiles

The scanCONTROL offers the possibility to restrict the transferred profile. The advantage of this procedure is the reduced size of the transferred data. Furthermore, the unused ranges of a profile may be cut out already directly in the scanCONTROL.

* **GetPartialProfile ()**



Query the current partial profile setting set on the scanCONTROL.

Parameter

*pLLT* Device handle

*pPartialProfile* Reference to partial profile structure

Return value

*General return values*

* **SetPartialProfile ()**

By using this function the partial profile transfer of the scanCONTROL can be adjusted. Before setting the partial profile parameters, the profile configuration has to be set to PARTIAL\_PROFILE. All parameter of the *SetPartialProfile()* function always have to be a multiple of the respective nUnitSize of the function *GetPartialProfileUnitSize()*.

Parameter

*pLLT* Device handle

*pPartialProfile* Reference to partial profile structure to be set

Return value

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_PARTPROFILE\_NO\_PART\_PROF | -350 | The profile configuration is not set to PARTIAL\_PROFILE -> call SetProfileConfig(PARTIAL\_PROFILE); |
| ERROR\_PARTPROFILE\_TOO\_MUCH  \_BYTES | -351 | The count of bytes per point is too high -> change nStartPointData or nPointDataWidth |
| ERROR\_PARTPROFILE\_TOO\_MUCH  \_POINTS | -352 | The count of points is too high -> change nStartPoint or nPointCount |
| ERROR\_PARTPROFILE\_NO\_POINT  \_COUNT | -353 | nPointCount or nPointDataWidth is 0 |
| ERROR\_PARTPROFILE\_NOT\_MOD  \_UNITSIZE\_POINT | -354 | nStartPoint or nPointCount are not a multiple of nUnitSizePoint |
| ERROR\_PARTPROFILE\_NOT\_MOD  \_UNITSIZE\_DATA | -355 | nStartPointData or nPointDataWidth are not a multiple of nUnitSizePointData |

* **GetPartialProfileUnitSize ()**

This function returns the increments for adjusting the partial profile.

Parameter

*pLLT* Device handle

*pUnitSizePoint* UnitSizePoint size

*pUnitSizePointData* UnitSizePointData size

Return value

*General return values*

## Timestamp extraction functions

* **Timestamp2TimeAndCount ()**



This function evaluates the whole timestamp of a profile. It returns the internal timestamp of the beginning and the end of the shutter interval and the consecutive profile numbers.

Parameter

*pBuffer* Reference to timestamp bytes of profile buffer

*dTimeShutterOpen* Timestamp shutter open

*dTimeShutterClosed* Timestamp shutter closed

*uiProfileCount* Profile count

Return value

*General return values*

* **Timestamp2CmmTriggerAndInCounter ()**



This function evaluates only the optional part of the timestamp of a profile. It returns the reading of the internal counter, the CmmTrigger and CmmActive flags as well as the CMM trigger counter.

Parameter

*pBuffer* Reference to timestamp bytes of profile buffer

*pInCounter* Internal counter

*pCmmTrigger* Flag CMM trigger *active*

*pCmmActive Flag CMM active*

*pCmmCount* Trigger count

Return value

*General return values*

## Post processing functions

In context of post processing the scanCONTROL may apply several modules to the profiles. These modules are only available in the SMART / GAP options of the sensor.



### Read and write Post-Processing parameters

* **ReadPostProcessingParameter ()**



Read post processing parameters.

Parameter

*pLLT* Device handle

*pParameter* Post processing parameter array

*nSize* Size of post processing parameter array (max. 1024 DWORDs)

Return value

*General return values*

* **WritePostProcessingParameter ()**



Write post processing parameters.

Parameter

*pLLT* Device handle

*pParameter* Post processing parameter array

*nSize* Size of post processing parameter array (max. 1024 DWORDs)

Return value

*General return values*

### Extract post processing results

* **ConvertProfile2ModuleResult ()**

  
Extract post processing results from profile data. These overwrite the position and distance coordinates of the fourth stripe.

Parameter

*pLLT* Device handle

*pProfileBuffer* Profile buffer

*nProfileBufferSize* Size of profile buffer

*pModuleResultBuffer* Result buffer

*nResultBufferSize* Size of result buffer

*pPartialProfile* Reference to partial profile (optional)

Return value

*Number of bytes copied into buffer*

*General error codes*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_POSTPROCESSING\_NO\_PROF  \_BUFFER | -200 | No profile buffer has been passed |
| ERROR\_POSTPROCESSING\_MOD\_4 | -201 | The parameter nStartPointData or nPointDataWidth is not divisible by 4 |
| ERROR\_POSTPROCESSING\_NO\_RESULT | -202 | No result block could be found in the profile |
| ERROR\_POSTPROCESSING\_LOW  \_BUFFERSIZE | -203 | The buffer size for the result is too small |
| ERROR\_POSTPROCESSING\_WRONG  \_RESULT\_SIZE | -204 | The size of the result block in the profile is not correct |

## Functions for loading and saving profile data



### Save profile data

* **SaveProfiles ()**

  
Saving of profiles. The profiles thereby are saved with the active profile configuration. The file name has to be indicated including extension. For finishing the saving *SaveProfiles(NULL, 0)* has to be called. If the maximum file size is reached during saving, an error message with the ERROR\_STOPSAVING (see [RegisterErrorMsg](#_Register_error_message)) value is sent.

Parameter

*pLLT* Device handle

*pFileName* Name of file to be saved

*FileType* File type

Return value

*General return values*

*Specific return values*:

|  |  |  |
| --- | --- | --- |
| ERROR\_LOADSAVE\_WRITING\_LAST  \_BUFFER | -50 | Error in the deactivation of the saving the last profile of the file could be damaged or not all have been saved |
| ERROR\_LOADSAVE\_AVI\_NOT  \_SUPPORTED | -58 | The operating system don’t support the AVI format, please use windows 2000 or better |
| ERROR\_LOADSAVE\_WRONG\_PROFILE  \_CONFIG | -60 | The profile configuration or the file type mismatch to the transferred  profiles/containers/video-pictures |
| ERROR\_LOADSAVE\_NOT\_TRANSFERING | -61 | The profile transfer is not active |

* **FileType**

Available FileTypes. It is recommended to use the AVI-file format, this format is supported by the scanCONTROL Software from Micro-Epsilon:

|  |  |  |
| --- | --- | --- |
| FileType | Value | Description |
| AVI | 0 | AVI file |
| CSV | 1 | CSV file (profile data only) |
| BMP | 2 | BMP file (video image data only) |
| CSV\_NEG | 3 | CSV file (profile data only) with mirrored z axis |

### Load profile data

* **LoadProfiles ()**



Loading of profiles from an \*.AVI file. All \*.AVI files can be loaded which are saved with the LLT.dll or the scanCONTROL programs from Micro-Epsilon. After loading the file, the single profiles in the file may be read out by the function *GetActualProfile()*. For terminating the file load LoadProfiles(NULL, NULL, NULL, NULL, NULL) has to be called.

The profile configuration of the loaded profile should always correspond to the profile configuration of the LoadProfiles function. Additionally at saved profile configuration of PROFILE also QUARTER\_PROFILE and PURE\_PROFILE or at QUARTER\_PROFILE also PURE\_PROFILE may be read out.

Parameter

*pLLT* Device handle

*pFileName* Name of file to be loaded

*pPartialProfile* Partial profile (optional)

*pProfileConfig* Profile configuration

*pScannerType* Scanner type

*pRearrangementProfile* Rearrangement register value

Return value

*Number of loaded profiles/container*

*General error codes*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_LOADSAVE\_WHILE\_SAVE  \_PROFILE | -51 | File cannot be loaded, as saving is active |
| ERROR\_LOADSAVE\_NO  \_PROFILELENGTH\_POINTER | -52 | No pointer for the profile length has been passed |
| ERROR\_LOADSAVE\_NO\_LOAD\_PROFILE | -53 | The filename is NULL, but no file is currently loaded |
| ERROR\_LOADSAVE\_STOP\_ALREADY  \_LOAD | -54 | On file has already been loaded, the loading has been stopped |
| ERROR\_LOADSAVE\_CANT\_OPEN\_FILE | -55 | Cannot open file |
| ERROR\_LOADSAVE\_INVALID\_FILE  \_HEADER | -56 | The file header of the file to be loaded is wrong |
| ERROR\_LOADSAVE\_AVI\_NOT  \_SUPPORTED | -58 | The operating system don’t support the AVI format, please use windows 2000 or better |
| ERROR\_LOADSAVE\_NO  \_REARRANGEMENT\_POINTER | -59 | The reference to pRearrengementProfile is NULL |

### Navigation in a loaded file

* **LoadProfilesGetPos ()**

Query the number of profiles in a file and the current reading position.

Parameter

*pLLT* Device handle

*pActualPosition* Current reading position

*pMaxPosition* Maximum reading position

Return value

*General return values*

* **LoadProfilesSetPos ()**



Set reading position in a loaded file.

Parameter

*pLLT* Device handle

*pNewPosition* Position from which should be read (0 sets the first profile)

Return value

*General return values*

*Specific return value:*

|  |  |  |
| --- | --- | --- |
| ERROR\_LOADSAVE\_FILE\_POSITION  \_TOO\_HIGH | -57 | The requested position is bigger than or equal to the maximum position |

## Special CMM trigger functions

The special CMM trigger functions simplify the starting and terminating of the profile transfer with activated CMM trigger. Additionally the profiles with active CMM trigger may be saved in a file. The CMM trigger is only available for certain options of the scanCONTROL.

Note: only supported by the scanCONTROL 26xx/27xx/29xx/30xx series

* **StartTransmissionAndCmmTrigger ()**

Start profile transmission with activated CMM trigger.

The StartTransmissionAndCmmTrigger function starts first profile transfer without forwarding the profiles thereby by callback. If the transmission was successful, i.e. the requested count of profiles has been transferred without failure, the first CMM trigger command with the divisor is sent to the scanCONTROL. Afterwards it is waiting for the first profile with active CMM trigger flag. From this profile on all further profiles are forwarded by callback. Additionally, if a file name has been passed, the saving of the profiles with the passed file name is started.

If a timeout occurs during the waiting for the profile, the function will be aborted. It is recommended to set nProfilesForerun to half the profile rate (e.g. 500 profiles at 1000 Hz) and the nTimeout to 3000 ms.

Parameter

*pLLT* Device handle

*nCmmTrigger* First indicator word of the CMM trigger, which contains the divisor and the polarity

*TransferProfileType* Profile type of transmission

*nProfilesForerun* Count of the continuous received profiles from which a stable data transfer is adopted

*pFileName* File name for the file to be saved

*pFileType* File format of the saved file

*nTimeout* Timeout in ms

Return value

*General return values*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_CMMTRIGGER\_NO\_DIVISOR | -400 | Divisor has to be > 0 |
| ERROR\_CMMTRIGGER\_TIMEOUT\_AFTER\_TRANSFERPROFILES | -401 | After *TransferProfiles()* no profiles have been received |
| ERROR\_CMMTRIGGER\_TIMEOUT\_AFTER\_SETCMMTRIGGER | -402 | After setting of the CMM trigger not enough profiles with active CMM trigger have been received |

* **StopTransmissionAndCmmTrigger ()**

Stop profile transmission with activated CMM trigger.

The *StopTransmissionAndCmmTrigger()* function first stops the CMM trigger, by setting the divisor to 0 (but thereby taking into account the passed polarity). Afterwards it is waiting for the first profile without active CMM trigger flag. This profile and all the following will not be forwarded by callback, the profile transfer will be stopped and in case of active saving the saving will be terminated.

If a timeout occurs during waiting for the first profile without active CMM trigger flag, the function will be aborted. It is reasonable to indicate a time between 100 and 500 ms for the nTimeout.

Parameter

*pLLT* Device handle

*nCmmTriggerPolarity* Polarity of CMM triggers

(0 = low active, 1 = high active)

*nTimeout* Timeout in ms

Return value

*General return values*

*Specific return value:*

|  |  |  |
| --- | --- | --- |
| ERROR\_CMMTRIGGER\_TIMEOUT  \_AFTER\_SETCMMTRIGGER | - 402 | After setting the CMM trigger no profile with deactivated CMM trigger has been received |

## Error value conversion function

* **TranslateErrorValue ()**



Conversion of an error value to an error text.

Parameter

*pLLT* Device handle

*ErrorValue* Error value

*pString* Buffer for output string

*nStringSize S*tring size

Return value

*Number of characters copied to the buffer*

*General error codes*

*Specific return values:*

|  |  |  |
| --- | --- | --- |
| ERROR\_TRANSERRORVALUE\_WRONG  \_ERROR\_VALUE | - 450 | A wrong error value has been passed |
| ERROR\_TRANSERRORVALUE\_BUFFER  \_SIZE\_TO\_LOW | -451 | The size of the passed buffer is too small for the string |

## Save configuration

* **ExportLLTConfig ()**

Exporting the current configuration of the scanCONTROL. This configuration file contains all relevant parameters and is primarily intended for post processing applications. The file format complies with the communications protocol for the serial connection with the scanCONTROL. The configuration files created thus can be transmitted to the scanCONTROL without changes via the serial port using a terminal program or via ImportLLTConfig.

Parameter

*pLLT* Device handle

*pFileName* Name of file to be exported

Return value

*General return values*

*Return values of GetFeature()*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_READWRITECONFIG\_CANT  \_CREATE\_FILE | -500 | The specified file cannot be created |

* **ExportLLTConfigString ()**

Exporting the current configuration of the scanCONTROL. This configuration string contains all relevant parameters and is primarily intended for post processing applications. The string format complies with the communications protocol for the serial connection with the scanCONTROL. The configuration string created thus can be transmitted to the scanCONTROL without changes via the serial port using a terminal program or via ImportLLTConfigString.

Parameter

*pLLT* Device handle

*bConfigData* byte array for config data

*nSize* byte array size

Return value

*General return values*

*Return values of GetFeature()*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_READWRITECONFIG\_QUEUE\_TO\_SMALL | -502 | Data array to small |

* **ImportLLTConfig ()**

Reads and sets the sensor parameters exported by ExportLLTConfig and is also able to read .sc1-files as long as they’ve been saved with scanCONTROL Configuration Tools Version 5.2 or newer. The ignore calibration flag specifies if the custom calibration of the sensor is also imported from the file.

Parameter

*pLLT* Device handle

*pFileName* Name of file to be exported

*bIgnoreCalibration* if true, do not import calibration data from file

Return value

*General return values*

*Specific return value*:

*Return values of SetFeature()*

|  |  |  |
| --- | --- | --- |
| ERROR\_READWRITECONFIG\_CANT\_OPEN\_FILE | -502 | The specified file cannot be opened |
| ERROR\_READWRITECONFIG\_FILE\_EMPTY | -503 | The specified file is empty |
| ERROR\_READWRITE\_UNKNOWN\_FILE | -504 | The imported data has not the expected format |

* **ImportLLTConfigString ()**

Reads and sets the sensor parameters exported by ExportLLTConfigString. The ignore calibration flag specifies if the custom calibration of the sensor is also imported from the string.

Parameter

*pLLT* Device handle

*bConfigData* byte array with config data

*nSize* byte array size

*bIgnoreCalibration* if true, do not import calibration data from file

Return value

*General return values*

*Return values of SetFeature()*

*Specific return value*:

|  |  |  |
| --- | --- | --- |
| ERROR\_READWRITE\_UNKNOWN\_FILE | -504 | The imported data has not the expected format |

* **SaveGlobalParameter ()**

Save IP configuration and calibration independent of user mode.

Parameter

*pLLT* Device handle

Return value

*General return values*



# Appendix



## General return values

All functions of the interface return an int value as return value. If the return value of a function is greater than or equal to GENERAL\_FUNCTION\_OK respectively ’1’, the function has been successful; if the return value is GENERAL\_FUNCTION\_NOT\_AVAILABLE respectively ’0’ or negative, an error occurred.

Some functions may also return GENERAL\_FUNCTION\_CONTAINER\_MODE\_HEIGHT\_CHANGED respectively ’2’. If this return value appears, the size of the image in the container mode has changed.

For the differentiation of the single return values several constants are available. In the following table all general return values which may be returned by functions are listed. For the single functional groups additionally there may also be special return / error values.

|  |  |  |
| --- | --- | --- |
| Constant return value | Value | Description |
| GENERAL\_FUNCTION\_CONTAINER\_MODE  \_HEIGHT\_CHANGED | 2 | Function successfully executed, but the image size for the container mode has changed |
| GENERAL\_FUNCTION\_OK | 1 | Function successfully executed |
| GENERAL\_FUNCTION\_NOT\_AVAILABLE | 0 | This function is not available, possibly using a new DLL or switching to the Ethernet mode |
| ERROR\_GENERAL\_WHILE\_LOAD\_PROFILE | -1000 | Function could not be executed as the loading of profiles is active |
| ERROR\_GENERAL\_NOT\_CONNECTED | -1001 | There is no connection to the  scanCONTROL -> call *Connect()* |
| ERROR\_GENERAL\_DEVICE\_BUSY | -1002 | The connection to the scanCONTROL is interfered or disconnected -> reconnect and check interface of the scanCONTROL |
| ERROR\_GENERAL\_WHILE\_LOAD\_PROFILE  \_OR\_GET\_PROFILES | -1003 | Function could not be executed as either the loading of profiles or the profile transfer is active |
| ERROR\_GENERAL\_WHILE\_GET\_PROFILES | -1004 | Function could not be executed as the profile transfer is active |
| ERROR\_GENERAL\_GET\_SET\_ADDRESS | -1005 | The address could not be read or written. Possibly a too old firmware is used |
| ERROR\_GENERAL\_POINTER\_MISSING | -1006 | A required pointer is set NULL |
| ERROR\_GENERAL\_WHILE\_SAVE\_PROFILES | -1007 | Function could not be executed as the saving of profiles is active |
| ERROR\_GENERAL\_SECOND\_CONNECTION  \_TO\_LLT | -1008 | A second instance is connected to this scanCONTROL via Ethernet or the serial port. Please close the second instance |

## SDK examples overview

The sample programs in the project directory are intended as examples for the integration of the scanCONTROL in own projects. They are available as executable projects with the complete source code.

|  |  |
| --- | --- |
| Name | Description |
| GetProfiles\_Poll | Transfer of profiles to the LLT.dll and pick up of profiles in polling mode |
| GetProfiles\_Callback | Transfer of profiles to the LLT.dll and pick up of profiles with a callback |
| GetProfiles\_Callback\_Extended | Transfer of profiles to the LLT.dll and pick up of profiles with a callback with advanced scanner configuration |
| MultiShot | Transfer of a defined count of profiles from the scanCONTROL |
| PartialProfile | Transfer of partial profiles |
| LoadSave | Loading and saving of profiles |
| ContainerMode | Transfer of profile containers respectively grey scale maps |
| VideoMode | Transfer of video images from the sensor matrix |
| MultiLLT | Usage of more than one scanCONTROL in one program |
| CMMTrigger | Usage of the optional programmable trigger (CMM trigger) |
| LLTPeakFilter | Set peak filter, free measuring field and dynamic, encoder defined measuring field |
| RegisterErrorMessage\_Minimal | Register error message for lost connection. Notice via Message Box. |
| RegisterErrorMessageWPF | Register error message for lost connection. Notice via Windows presentation foundation. |
| Calibration | Set sensor calibration (angle, offset) |
| SetROIs | Set ROIs on sensor array |
| sC30xx\_HighSpeed | Configure scanCONTROL 30xx in High-Speed mode |
| TriggerProfile | Shows how to software-trigger one profile |
| TriggerContainer | Shows how to software-trigger one container |
| ReadPPPResults | Shows how to read out post processing results from profiles |

## Supporting documentation

[1] Operation Manual PartB 2600: Interface Specification for scanCONTROL 2600 Device

Family; Ethernet and Serial Port; Supplement B to the scanCONTROL 2600 Manual; MICRO-

EPSILON Optronic GmbH;

[2] Operation Manual PartB 2700: Interface Specification for scanCONTROL 2700 Device

Family; Firewire (IEEE 1394) Bus, Ethernet and Serial Port; Supplement B to the

scanCONTROL 2700 Manual; MICRO-EPSILON Optronic GmbH;

[3] Operation Manual PartB 2800: Interface Specification for scanCONTROL 2800 Device

Family; Firewire (IEEE 1394) Bus and Serial Port; Supplement B to the scanCONTROL 2800

Manual; MICRO-EPSILON Optronic GmbH;

[4] Operation Manual PartB 2900: Interface Specification for scanCONTROL 2900 Device

Family; Ethernet and Serial Port; Supplement B to the scanCONTROL 2900 Manual; MICRO-

EPSILON Optronic GmbH;

[5] scanCONTROL 2600 Quick Reference; Brief Introduction to scanCONTROL 2600 Device Family;

MICRO-EPSILON Optronic GmbH;

[6] scanCONTROL 2700 Quick Reference; Brief Introduction to scanCONTROL 2700 Device Family;

MICRO-EPSILON Optronic GmbH;

[7] scanCONTROL 2800 Quick Reference; Brief Introduction to scanCONTROL 2800 Device Family;

MICRO-EPSILON Optronic GmbH;

[8] scanCONTROL 2900 Quick Reference; Brief Introduction to scanCONTROL 2900 Device Family;

MICRO-EPSILON Optronic GmbH;

[9] Interface documentation for LLT-DLL; MICRO-EPSILON Optronic GmbH;

[10] Operation Manual PartB 3000: Interface Specification for scanCONTROL 3000 Device

Family; Ethernet and Serial Port; Supplement B to the scanCONTROL 3000 Manual; MICRO-

EPSILON Optronic GmbH;

[11] scanCONTROL 3000 Quick Reference; Brief Introduction to scanCONTROL 3000 Device Family;

MICRO-EPSILON Optronic GmbH;

[12] Operation Manual PartB 2500: Interface Specification for scanCONTROL 2500 Device

Family; Ethernet and Serial Port; Supplement B to the scanCONTROL 2500 Manual; MICRO-

EPSILON Optronic GmbH;

[13] scanCONTROL 2500 Quick Reference; Brief Introduction to scanCONTROL 2500 Device Family;

MICRO-EPSILON Optronic GmbH;