Interface documentation linLLT

C/C++
Linux

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I. About this document

The purpose of this document is to enable the reader to integrate a scanCONTROL laser profile sensor into dedicated Linux applications via C/C++. This document is based upon the application interface provided by the linLLT libraries.

To get a general overview, a general introduction to the linLLT library 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.

II. Versions

Versions	Date	Author	State
0.1	10.09.2015	DRa	Initial draft
1.0	27.10.2015	UEi, DRa	Reviewed Version 1
1.1	08.11.2015	DRa	Extensions
1.2	06.11.2017	Dra	Updated for v0.2.0

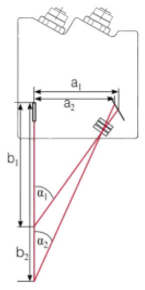
III. Content

1 Introduction

1.1 Measurement principle and data

1.1.1 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:

$$b_1 = \frac{a_1}{\tan \alpha_1}$$

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.

1.1.2 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:

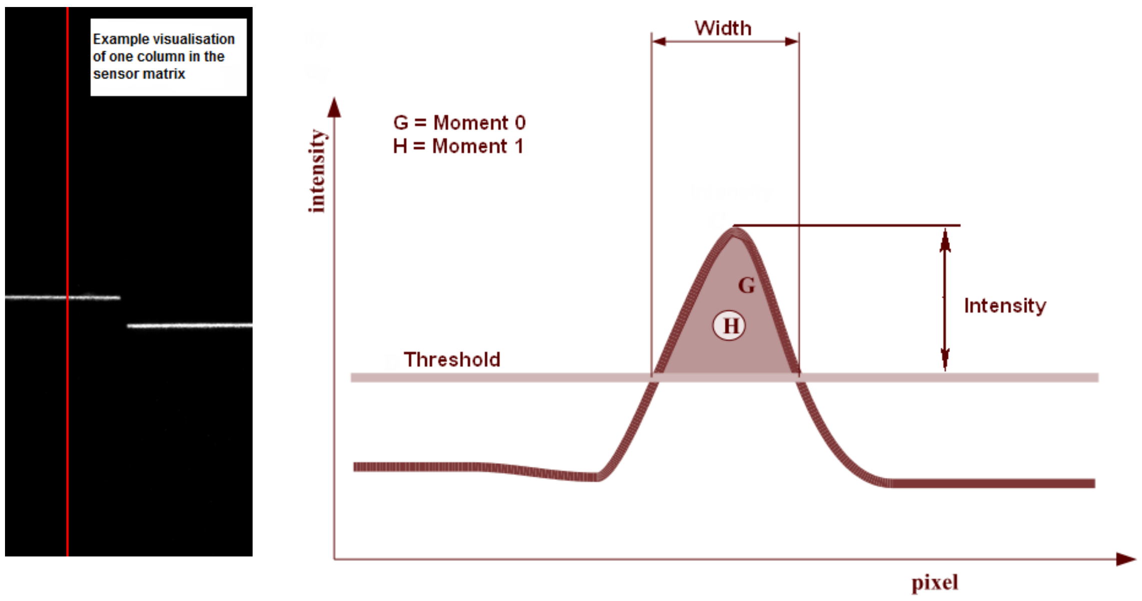


Fig. 1: How to get a measuring value from a reflection (evaluation of one sensor column)

- 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).

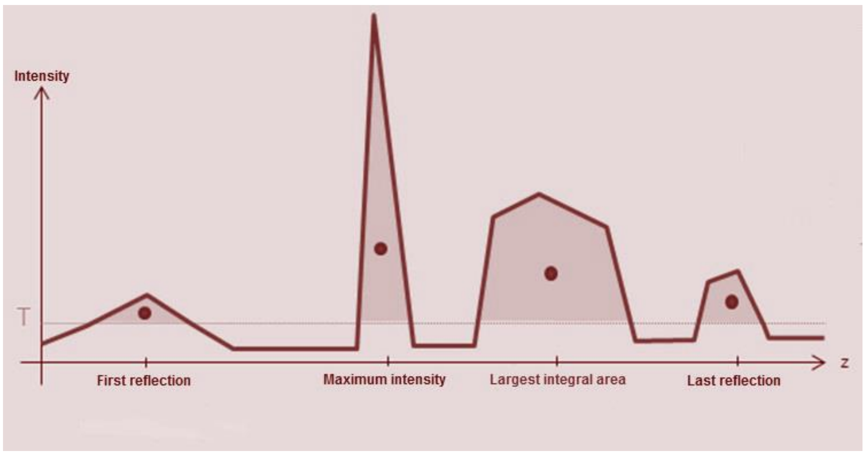


Fig. 2: Detected reflections

1.2 linLLT libraries

1.2.1 Overview

The linLLT interfaces consists of two *shared objects*, the main C library libmescan and the wrapper library libLLT. A shared object is a library, which is loaded automatically while starting an application it is linked to. It has to be available at compile time, but can be exchanged/updated without recompiling a project, as long as the ABI is consistent.

Both available libraries are based on the Open Source (LGPL) interface library aravis [7]. Aravis makes it possible to transmit a video image data over Ethernet, as well as the evaluation of the GeniCam XML. Tested and recommended version is 0.5.9 (06/2017). libmescan offers C-functions to search, initialize and control scanners, as well as for measurement data transmission and data conversion. This functionality is all needed to fully operate a scanner and enables the user to build own flexible C applications. Calling convention is *cdecl*. libLLT wraps libmescan and aravis in a own C++ API and is thus a comfortable way to use both libraries for building own applications. The API is similar to the ME Windows SDK (LLT.dll) to allow for seamless transition.

1.2.2 Compile

To compile an application with linLLT, further libraries are necessary on the computer. Specifically these are aravis-0.6 and the libraries aravis is depending on (e.g. libxml2, glib, ...). A Makefile is not available at the moment. These are the necessary linker flags for compiling an application with linLLT:

```
-lpthread -lglib-2.0 -lxml2 -lgthread-2.0 -lgio-2.0 -lgobject-2.0 -lm -lllt
                                                 -laravis-0.6  -lmescan
```

2 Measurement data format

2.1 Video Mode

The Video Mode is used for transmitting the unprocessed 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 and the internal transmission buffer has to be set to a value between 3 and 5. 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

2.2 Single profile transmission

2.2.1 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.

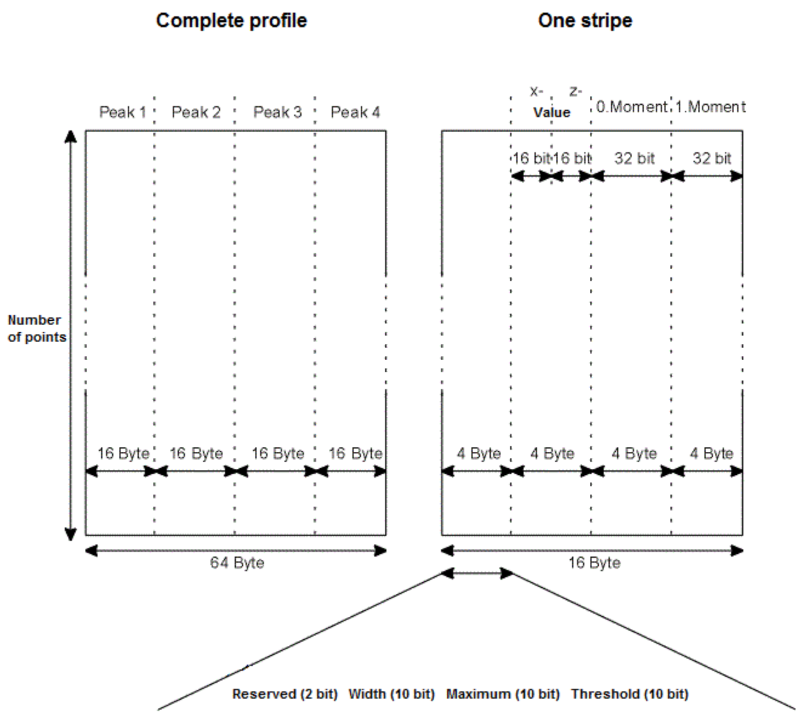


Fig. 4: Data arrangement single profile transmission

2.2.2 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:

$$\text{Timestamp} = \text{seconds counter} + \frac{\text{cycle counter}}{8000} + \frac{\text{cycle offset}}{8000*3072}$$

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

2.2.3 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)

2.2.4 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.

2.2.5 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.

2.2.6 X/Z data (PURE_PROFILE)

With the profile configuration *PURE_PROFILE* only position 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.

2.2.7 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

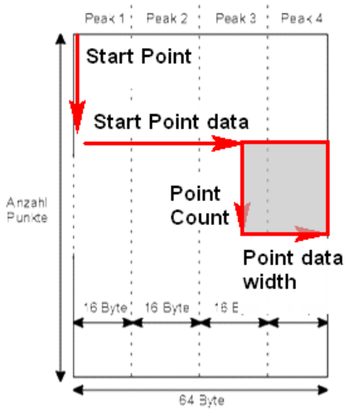


Fig. 5: Illustration Partial Profile

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.

2.3 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.

2.3.1 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 / 4095 profiles). In this case the main advantage is the longer reaction time intervals in the software.

2.3.2 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.

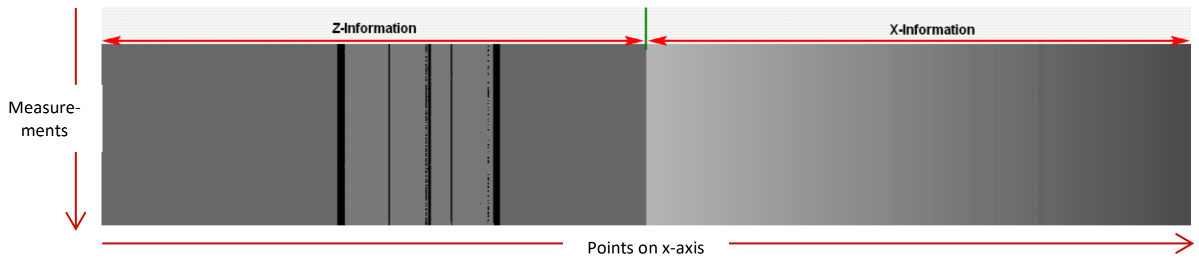


Fig. 6: Example image transposed container mode

3 Data transmission scanCONTROL sensor

3.1 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 transmission (NORMAL_TRANSFER) and shot wise data transmission (transmission of a defined number of profiles = SHOT_TRANSFER).

3.2 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.

3.3 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.

4 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 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* [5-8], 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.

5 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 (*SetFeature(...)*) – note that register addresses and function values are partly mapped to macros in the SDK (e.g. `FEATURE_FUNCTION_SHUTTERTIME` for exposure time). Detailed description of the registers can be found in Operation Manual Part B [1-3], which is part of the scanner documentation.

5.1 Connect to the sensor

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

```
std::vector<char *> Interfaces(5);

// Create a device handle
CInterfaceLLT pLLT = new CInterfaceLLT();  // (C) LLT *pLLT = create_llt_device();

// Search for scanners on interface
CInterfaceLLT::GetDeviceInterfaces(&Interfaces[0], Interfaces.size());

// Set Path to device_properties.dat (optional)
pLLT->SetPathtoDeviceProperties("./device_properties.dat");

// Set device interface to handle
pLLT->SetDeviceInterface(Interfaces[0]);

// Connect sensor
pLLT->Connect();
```

See API: GetDeviceInterfaces(), SetPathToDeviceProperties(), SetDeviceInterface(), Connect()

5.2 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 (*ShutterTime*) and the idle time (*IdleTime*). Calculation:

$$Profile\ frequency = \frac{1}{(ShutterTime + IdleTime) * 10\ \mu s}$$

```
unsigned int ShutterTime= 100;
unsigned int IdleTime    = 900;

// Set shutter time to 1 ms (100*10 us)
pLLT->SetFeature(FEATURE_FUNCTION_SHUTTERTIME, ShutterTime);

// Set idle time to 9 ms (900*10 us)
pLLT->SetFeature(FEATURE_FUNCTION_IDLETIME, IdleTime);
```

See API: SetFeature(), FEATURE_FUNCTION_SHUTTERTIME, FEATURE_FUNCTION_IDLETIME
See Operation Manual Part B: *OpManPartB.html#shutter, OpManPartB.html#idletime*

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

5.3 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.

```
unsigned int Resolution = vdwResolutions[0];
TScannerType LLTType;
unsigned int LostProfiles = 0;

// Set buffer for complete profile and x/z values
std::vector<unsigned char>ProfileBuffer(Resolution * 64);
std::vector<double>ValueX(Resolution);
std::vector<double>ValueZ(Resolution);

// Query scanner type
pLLT->GetLLTType(&LLTType);

// Poll a profile from receiving buffer
// Hint: If no new profile has been received since the last call, the function
// returns -104. This may be used to constantly query for new data in a loop.
pLLT->GetActualProfile(&ProfileBuffer[0], (unsigned int)ProfileBuffer.size(),
                                                     PROFILE, &LostProfiles));

// Convert buffer values into x/z data
CInterfaceLLT::ConvertProfile2Values(&ProfileBuffer[0], ProfileBuffer.size(),
     Resolution, PROFILE, LLTType, 0, NULL, NULL, NULL, &ValueX[0], &ValueZ[0],
     NULL, NULL);
```

See API: GetLLTType(), TransferProfiles(), GetActualProfile(), ConvertProfiles2Values()

5.4 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.

```
unsigned int Resolution;
unsigned int ProfileBufferSize;
TScannerType scanCONTROLType;
void NewProfile (const void *data, size_t data_size, gpointer ptr);
// Event handle
EHANDLE *event;

[…] // Init, Connect und read out of Resolution and TScannerType

// Allocate Buffers
std::vector<double> ValueX(Resolution);
std::vector<double> ValueZ (Resolution);
std::vector<unsigned char>ProfileBuffer(Resolution * 64);

event = CInterfaceLLT::CreateEvent();

// Register Callback function
pLLT->RegisterBufferCallback((gpointer)&NewProfile, NULL)

// Start profile transmission
pLLT->TransferProfiles(NORMAL_TRANSFER, true);

CInterfaceLLT::ResetEvent(event);

// Wait for Event
if (CInterfaceLLT::WaitForSingleObject(event, 5000) != WAIT_OBJECT_0)
{
   cout << "Timeout!" << endl;
}

// Stop profile transmission
pLLT->TransferProfiles(NORMAL_TRANSFER, false);

// Convert raw data to mm
CInterfaceLLT::ConvertProfile2Values(&ProfileBuffer[0], ProfileBuffer.size(),
   Resolution, PROFILE, LLTType, 0, NULL, NULL, NULL, &ValueX[0], &ValueZ[0],
   NULL, NULL);

CInterfaceLLT::FreeEvent(event);

// Callback funktion (copies received data to buffer and sets an event)
void NewProfile (const void *pucData, size_t uiSize, gpointer user_data)
{
   if (uiSize == ProfileBuffer.size())
   {
      memcpy(&ProfileBuffer[0], pucData, uiSize);
   }
   CInterfaceLLT::SetEvent(event);
}
```

See API: RegisterCallback(), TransferProfiles(), ConvertProfiles2Values(), Event handling

5.5 Set profile filter

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

```
// Set average filter to 7 taps
unsigned int ProfileFilter = FILTER_AVG_7;
// Set median filter to 5 taps
ProfileFilter |= FILTER_MEDIAN_5;
// Set resampling (inter/extrapolation of invalid points; alle Info; huge)
ProfileFilter |= FILTER_RESAMPLE_EXTRAPOLATE_POINTS |
                 FILTER_RESAMPLE_ALL_INFO | FILTER_RESAMPLE_HUGE;

// Set configured filters
pLLT->SetFeature(FEATURE_FUNCTION_PROFILE_FILTER, ProfileFilter);
```

See API: SetFeature(), FEATURE_FUNCTION_PROFILE_FILTER
See Operation Manual Part B: *OpManPartB.html#profilefilter*

5.6 Encoder

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

```
unsigned int Encoder = 0;

// Set trigger input to encoder
unsigned int Trigger = TRIG_MODE_ENCODER;
// Set digital inputs as trigger input and activate ext. triggering
Trigger |= TRIG_INPUT_DIGIN | TRIG_EXT_ACTIVE;
// Set trigger settings
pLLT->SetFeature(FEATURE_FUNCTION_TRIGGER, Trigger);

// Set multi-function port to bidirectional 24V encoder mode
unsigned int MultiPort = MULTI_DIGIN_ENC_INDEX | MULTI_LEVEL_24V
                                                | MULTI_ENCODER_BIDIRECT;
pLLT->SetFeature(FEATURE_FUNCTION_RS422_INTERFACE_FUNCTION, MultiPort);

// Read maintenance register and activate encoder
pLLT->GetFeature(FEATURE_FUNCTION_MAINTENANCEFUNCTIONS, &Encoder);
Encoder |= MAINTENANCE_ENCODER_ACTIVE;
pLLT->SetFeature(FEATURE_FUNCTION_MAINTENANCEFUNCTIONS, Encoder);
```

See API: SetFeature(), FEATURE_FUNCTION_TRIGGER, FEATURE_FUNCTION_MAINTENANCEFUNCTIONS
See Operation Manual Part B: *OpManPartB.html#trigger, OpManPartB.html#maintenance*

5.7 External triggering

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

```
// Set trigger input to pos. pulse mode
unsigned int Trigger = TRIG_MODE_PULSE | TRIG_POLARITY_HIGH;
// Set digital input as trigger input and activate ext. triggering
Trigger |= TRIG_INPUT_DIGIN | TRIG_EXT_ACTIVE;
// Set trigger settings
pLLT->SetFeature(FEATURE_FUNCTION_TRIGGER, Trigger);

// Set multi-function port to 5V digital input triggering
unsigned int MultiPort = MULTI_DIGIN_TRIG_ONLY | MULTI_LEVEL_5V;
pLLT->SetFeature(FEATURE_FUNCTION_RS422_INTERFACE_FUNCTION, MultiPort);
```

See API: SetFeature(), FEATURE_FUNCTION_TRIGGER
See Operation Manual Part B: *OpManPartB.html#trigger*

5.8 Software trigger

This example shows how to activate external triggering via software trigger.

```
// Activate ext. triggering
pLLT->SetFeature(FEATURE_FUNCTION_TRIGGER, TRIG_EXT_ACTIVE);

// Software triggering; triggers one profile
pLLT->TriggerProfile();
```

See API: SetFeature(), FEATURE_FUNCTION_TRIGGER
See Operation Manual Part B: *OpManPartB.html#trigger*

5.9 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. Since scanCONTROL firmware version v43 the peak filter can be set/read via SetFeature, e.g. SetFeature(FEATURE_FUNCTION_PEAKFILTER_WIDTH, (max_width << 16) + min_width). To activate a 0 must be written to FEATURE_FUNCTION_SHARPNESS.

```
// Set desired peak filter values
unsigned short min_width       = 2;   // values <2 increase noise significantly
unsigned short max_width       = 1023;
unsigned short min_intensity   = 0;
unsigned short max_intensity   = 1023;

pLLT->SetPeakFilter(min_width, max_width, min_intensity, max_intensity);
```

See API: SetPeakFilter

5.10 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 also be set via sequential register. Since scanCONTROL firmware version v43 the free measuring field can be set/read via SetFeature, e.g. SetFeature(FEATURE_FUNCTION_FREE_MEASURINGFIELD_X, (size_z << 16) + start_z). To activate a 0 must be written to FEATURE_FUNCTION_SHARPNESS.

```
// Activate free measuring field
pLLT->SetFeature(FEATURE_FUNCTION_MEASURINGFIELD, MEASFIELD_ACTIVATE_FREE);

// Set measuring field size
unsigned short start_z = 20000;
unsigned short size_z = 25000;
unsigned short start_x = 20000;
unsigned short size_x = 25000;

pLLT->SetFreeMeasuringField(start_x, size_x, start_z, size_z);
```

See API: SetFeature(), FEATURE_FUNCTION_MEASURINGFIELD, SetFreeMeasuringField
See Operation Manual Part B: *OpManPartB.html#measuringfield*

The *start* and *size* values are to be seen in reference to 65535. Example: *start_z* = 20000 → 20000/65535 * 100 % = 30.52 %; *start_z* is therefore at 30.52 % of the sensor matrix height. For a scanCONTROL 2900 (height: 1024 pixel) this means approx. at pixel 313. The matrix rotation of the specific sensor type has to be considered!

5.11 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.

```
// Rotational centrum and angle
double center_x = -9; // mm
double center_z = 86.7; // mm
double angle = -45; // °

// Shift rotational centrum
double shift_x = 0; // mm
double shift_z = 0; // mm

// Set calibration
pLLT->SetCustomCalibration(center_x, center_z, angle, shift_x, shift_z);

// Reset calibration
pLLT->ResetCustomCalibration();
```

See API: SetCustomCalibration(), ResetCustomCalibration()

5.12 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.

```
#include <math.h>

[…]

unsigned int ProfileCount = 500;// Number of profiles in one image/container

// Calculate flag for current resolution
unsigned int Res = (unsigned int)floor((log((double)Resolution)*1.0/log(2.0))+0.5);
unsigned int Rearrangement = CONTAINER_DATA_Z | CONTAINER_STRIPE_1 |
                                            CONTAINER_DATA_LSBF | Res << 12);

 // Set rearrangement parameters for z data extraction
pLLT->SetFeature(FEATURE_FUNCTION_REARRANGEMENT_PROFILE, Rearrangement);

// Set container size
pLLT->SetProfileContainerSize(Resolution, uiProfileCount);

// Allocate buffer (z value has 2 bytes)
ProfilerBuffer.resize(Resolution * 2 * ProfileCount);

// Start profile transmission
pLLT->TransferProfiles(NORMAL_CONTAINER_MODE, true);

[…] // Callback

// Stop profile transmission
pLLT->TransferProfiles(NORMAL_CONTAINER_MODE, false);

// Extract/convert complete raw data to mm
CInterfaceLLT::ConvertRearrangedContainer2Values(&ContainerBuf[0],
  ContainerBuf.size(), Rearrangement, ProfileCount, LLTType, 0, NULL, NULL, NULL,
                                                           &ValueX[0], &ValueZ[0]);
```

See API: SetFeature(), SetProfileContainerSize(), TransferProfiles(), FEATURE_FUNCTION_REARRANGEMENT_PROFILE, ConvertRearrangedContainer2Values()

See Operational Manual Part B: *OpManPartB.html#rearrangementprofile*

5.13 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.

```
// Struct defining the partial profile
TPartialProfile PartialProfile;

[…] // Init

// Set partial profile size
PartialProfile.nStartPoint = 20; // Offset 20 -> start point = point 21
PartialProfile.nStartPointData = 4; // Data offset 4 bytes -> start x data
PartialProfile.nPointCount = m_uiResolution / 2; // Half the resolution
PartialProfile.nPointDataWidth = 4; // 4 bytes -> x and z (2 bytes each)

// Allocate profile buffer
ProfileBuffer.resize(PartialProfile.nPointCount * PartialProfile.nPointDataWidth);

// Set partial profile
pLLT->SetPartialProfile(&PartialProfile);

[…] // Callback

// Convert buffer content to real measured values
CInterfaceLLT::ConvertPartProfile2Values(&ProfileBuffer[0], ProfileBuffer.size(),
&PartialProfile, LLTType, 0, NULL, NULL, NULL, &ValueX[0], &ValueZ[0], NULL, NULL);
```

See API: SetPartialProfile(), TransferProfiles(),ConvertPartProfile2Values()

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.

5.14 Use several sensors in one application

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

```
// Create handle for each sensor
CInterfaceLLT pLLT  = new CInterfaceLLT();
CInterfaceLLT pLLT2 = new CInterfaceLLT();

// Search interfaces
CInterfaceLLT::GetDeviceInterfaces(Interfaces, Interfaces.GetLength(0));

// Set interfaces
pLLT->SetDeviceInterface(Interfaces[0]);
pLLT2->SetDeviceInterface(Interfaces[1]);

// Connect to sensors
pLLT->Connect();
pLLT2->Connect();

[…]

int userData1 = 1;
int userData2 = 2;
```

```
// Register callback sensor 1
pLLT->RegisterBufferCallback((gpointer)&NewProfile, &userData1);

// Register callback sensor 1
pLLT2->RegisterBufferCallback((gpointer)&NewProfile, &userData2);

[…] // Start of transmission equivalent

// Callback with differentiation of sensor data
void NewProfile(const void *pucData, size_t uiSize, gpointer userData)
{
   if (*(int *)userData == 1
   {
      // Data sensor 1
   }

   if (*(int *)userData == 2)
   {
      // Data sensor 2
   }
}
```

See API: CreateLLTDevice(), GetDeviceInterfaces(), SetDeviceInterface(), Connect(), RegisterBufferCallback()

5.15 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.

```
// Register Callback
pLLT->RegisterControlLostCallback((gpointer)&ControlLostCallback, NULL)

void ControlLostCallback(ArvGvDevice *mydevice)
{
   if (mydevice)
   {
      /* Example behavior after lost connection */
      cout << “Control lost!” << endl;
      exit(0);
   }
}
```

See API: RegisterControlLostCallback()

5.16 Read temperature

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

```
unsigned int Temperature = 0;

// Before reading temperature TEMP_PREPARE_VALUE has to be written to register
pLLT->SetFeature(FEATURE_FUNCTION_TEMPERATURE, TEMP_PREPARE_VALUE);

// Read temperature
pLLT->GetFeature(FEATURE_FUNCTION_TEMPERATURE, &Temperature);
```

See API: SetFeature(), FEATURE_FUNCTION_TEMPERATURE
Siehe Operational Manual Part B: *OpManPartB.html#temperature*

5.17 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:

$$PD_{min} = (Number\ of\ sensors - 1) * \frac{Packet\ size}{Network\ bandwidth}$$

The maximum delay is calculated like this:

$$PD_{max} = \left(1000 * \frac{\frac{1000}{Profile\ frequency}}{\frac{KByte\ per\ profile * 1024}{Packet\ size} + 1} - \frac{Packet\ size}{Network\ bandwidth}\right) * 0{,}8$$

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):

```
unsigned int PacketDelay = 50;

// Set packet delays in us
pLLT->SetFeature(FEATURE_FUNCTION_PACKET_DELAY, PacketDelay);
```

See API: SetFeature(), FEATURE_FUNCTION_PACKET_DELAY

6 API

This chapter lists the complete API (Application Program Interface). Every function is illustrated with its parameters and return values. This chapter focuses on the C++ API (CInterfaceLLT class). For a pure C implementation the corresponding C functions follow the naming scheme: llt_handle->*CppInterfaceFunc([args]*); → *c_api_func(llt_handle, [args]); e.g. hllt->SetFeature(([args]); → set_feature(hllt, ([args]);*. In C the llt_handle can be created with *create_llt_device()* (see comment in code chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**) and deleted with *del_device()*.

6.1 Interface and initialization functions

- **GetDeviceInterfaces ()**

```
static int
CInterfaceLLT::GetDeviceInterfaces(char *interfaces[], unsigned int size);
```

Query the available scanCONTROL device interfaces at the PCs interface cards. The returned device interfaces is an Ethernet IP address.

Parameter

interfaces	Array for available interfaces (unique identifiers)
size	Size of array

Return value

Number of device interfaces found
General error codes
Specific return values:

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

- **InitDevice ()**

```
static int
CInterfaceLLT::InitDevice(const char *camName, MEDeviceData *devData,
                                             const char *pathDevProp);
```

Initialization of scanner - is called automatically while executing Connect() .

Parameter

camName	Identificator of sensor
devData	Device data of sensor
pathDevProp	Path to device_properties.dat

Return value

General error codes
Specific return values*:*

ERROR_DEVPROP_NOT_FOUND	-1300	device_properties.dat (file) not found
ERROR_DEVPROP_DECODE	-1301	Decoding of file failed

ERROR_DEVPROP_DEPRECATED	-1302	Dataversion of file obsolete
ERROR_DEVPROP_READ_FAILURE	-1303	Reading the file failed

- **SetPathtoDeviceProperties ()**

```
int
CInterfaceLLT::SetPathtoDeviceProperties(const char *pathDevProp);
```

Set path to the device_properties.dat. Optionally; must be called before Connect. If set more information about the sensors is available in MEDeviceData.

Parameter

pathDevProp	Path to device_properties.dat

Return value

General error codes

Specific return values*:*

ERROR_DEV_PROP_NOT_FOUND	-1300	device_properties.dat (file) not found

- **SetDeviceInterface ()**

```
int
CInterfaceLLT::SetDeviceInterface(unsigned int interface);
```

Assign a scanCONTROL device interface to a sensor instance in the library. The interface is described by a unique identifier. This identifier consists of the device name and the serial number used.

Parameter

interface	Interface of scanCONTROL to be connected

Return value

General return values

Specific return value:

ERROR_GETDEVINTERFACES _CONNECTED	-252	The scanCONTROL is connected, call *Disconnect()*

6.2 Connection functions

- **Connect ()**

```
int
CInterfaceLLT::Connect();
```

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

Return value

General return values

Return values of InitDevice()

Specific return values:

`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_DEVPROP_NOT_AVAILABLE`	-999	device_properties.dat not found

- **Disconnect ()**

```
int
CInterfaceLLT::Disconnect();
```

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

Return value

General return values

6.3 Identification functions

- **GetDeviceName ()**

```
int
CInterfaceLLT::GetDeviceName(const char **devName, const char **venName);
```

Query device name and vendor name of scanCONTROL sensor.

Parameter

devName	Pointer device name
venName	Pointer vendor name

Return value

General return values

- **GetLLTVersion ()**

```
int
CInterfaceLLT::GetLLTVersion(const char **devVersion);
```

Query the device Firmware version.

Parameter

devVersion	Pointer Firmware

Return value

General return values

- **GetLLTType ()**

```
int
CInterfaceLLT::GetLLTType(TScannerType *scannerType);
```

Query measuring range and type of scanCONTROL sensor.

Parameter

scannerType	Scanner type

Return value

General return values

- **GetLLTTypeByName ()**

```
static int
CInterfaceLLT::GetLLTTypeByName (const char *modelName,
                                         TScannerType *scannerType);
```

Query measuring and scanner type of LLT via device name.

Parameter

modelName	Name of sensor (*devName)*
scannerType	Scanner type

Return value

General return values

- **TScannerType**

TScannerType	Wert	scanCONTROL Type	Messbereich
`StandardType`	-1	-	-
`scanCONTROL27xx_25`	1000	27xx	25 mm
`scanCONTROL27xx_100`	1001	27xx	100 mm
`scanCONTROL27xx_50`	1002	27xx	50 mm
`scanCONTROL27xx_xxx`	1999	27xx	-
`scanCONTROL26xx_25`	2000	26xx	25 mm
`scanCONTROL26xx_50`	2002	26xx	50 mm

`scanCONTROL26xx_100`	2001	26xx	100 mm
`scanCONTROL26xx_xxx`	2999	26xx	-
`scanCONTROL29xx_25`	3000	29xx	25 mm
`scanCONTROL29xx_50`	3002	29xx	50 mm
`scanCONTROL29xx_100`	3001	29xx	100 mm
`scanCONTROL29xx_10`	3003	29xx	10 mm
`scanCONTROL29xx_xxx`	3999	29xx	-

- **GetLLTScalingAndOffset ()**

```
int
CInterfaceLLT::GetLLTScalingAndOffset(double *scaling, double *offset);
```

Query scaling and offset factors of connected LLT.

Parameter

scaling	Scaling factor
offset	Offset factor

Return value

General return values

- **GetLLTScalingAndOffsetByType ()**

```
static int
CInterfaceLLT::GetLLTScalingAndOffsetByType (TScannerType scannerType,
                                              double *scaling, double *offset);
```

Query scaling and offset factors of a certain sensor type.

Parameter

scannerType	Scanner type
scaling	Scaling factor
offset	Offset factor

Return value

General return values

6.4 Feature functions

5.4.1 Set-/get functions

- **GetFeature ()**

```
int
CInterfaceLLT::GetFeature(unsigned int register, unsigned int *value);
```

Query currently set parameter value / Check availability of a feature according to the table in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Parameter

register	Register address of function (FEATURE or INQUIRY)
value	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 ()**

```
int
CInterfaceLLT::SetFeature(unsigned int register, unsigned int value);
```

Set feature parameter.

Parameter

register	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

5.4.2 Features / Parameter

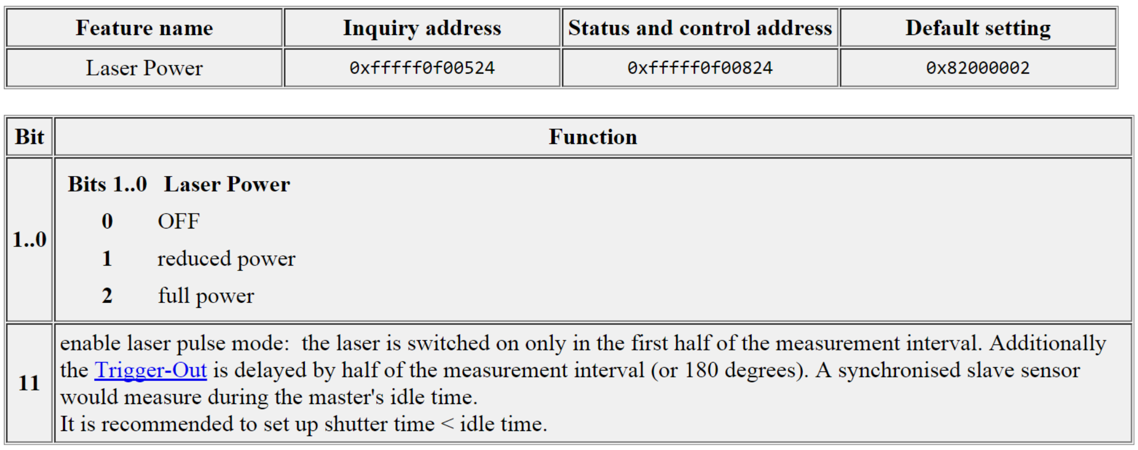
The following paragraph illustrates how to use the FEATURE and INQUIRY registers. INQUIRY registers are used for confirmation of function availability and feature classification. FEATURE registers are used for querying and setting parameter values. The LSB is Bit 0.

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 power



Feature name	Inquiry address	Status and control address	Default setting
Laser Power	0xffffff0f00524	0xffffff0f00824	0x82000002

Bit	Function
1..0	**Bits 1..0 Laser Power** **0** OFF **1** reduced power **2** full power
11	enable laser pulse mode: the laser is switched on only in the first half of the measurement interval. Additionally the Trigger-Out is delayed by half of the measurement interval (or 180 degrees). A synchronised slave sensor would measure during the master's idle time. It is recommended to set up shutter time < idle time.

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 0 $|_{dec}$ corresponds with laser off, 1 $|_{dec}$ with reduced and 2 $|_{dec}$ with full laser power. Bit 11 activates the laser pulse mode.

- **SERIAL**

CLLTI.FEATURE_FUNCTION_SERIAL	0xf0000410

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

- **LASERPOWER**

CLLTI.FEATURE_FUNCTION_LASERPOWER	0xf0f00824
CLLTI.INQUIRY_FUNCTION_LASERPOWER	0xf0f00524

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#laserpower* for the specific type of sensor.

- **MEASURINGFIELD**

`CLLTI.FEATURE_FUNCTION_MEASURINGFIELD`	0xf0f00880
`CLLTI.INQUIRY_FUNCTION_MEASURINGFIELD`	0xf0f00580

Querying or setting of a predefined measuring field or activation of the advanced measuring field configuration. The profile transmitted directly after setting the measuring field might be corrupted. See *OpManPartB.html#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.

- **TRIGGER**

`CLLTI.FEATURE_FUNCTION_TRIGGER`	0xf0f00830
`CLLTI.INQUIRY_FUNCTION_TRIGGER`	0xf0f00530

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 RS422_INTERFACE_FUNCTION). Changing the trigger settings resets the profile counter. See *OpManPartB.html#trigger* for the specific type of sensor.

- **SHUTTERTIME**

`CLLTI.FEATURE_FUNCTION_SHUTTERTIME`	0xf0f0081c
`CLLTI.INQUIRY_FUNCTION_SHUTTERTIME`	0xf0f0051c

Query and control of the shutter 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#shutter* for the specific type of sensor.

- **IDLETIME**

`CLLTI.FEATURE_FUNCTION_IDLETIME`	0xf0f00800
`CLLTI.INQUIRY_FUNCTION_IDLETIME`	0xf0f00500

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 (OpManPartB.html#idletime).

- **PROCESSING_PROFILEDATA**

CLLTI.FEATURE_FUNCTION_PROCESSING_PROFILEDATA	0xf0f00804
CLLTI.INQUIRY_FUNCTION_PROCESSING_PROFILEDATA	0xf0f00504

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#processingprofile for the *specific type of* sensor.

- **THRESHOLD**

CLLTI.FEATURE_FUNCTION_THRESHOLD	0xf0f00810
CLLTI.INQUIRY_FUNCTION_THRESHOLD	0xf0f00510

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.

- **MAINTENANCEFUNCTIONS**

CLLTI.FEATURE_FUNCTION_MAINTENANCEFUNCTIONS	0xf0f0088c
CLLTI.INQUIRY_FUNCTION_ MAINTENANCEFUNCTIONS	0xf0f0058c

Query and control of internal maintenance settings (e.g. encoder counter). See OpManPartB.html#maintenance for the specific type of sensor.

- **ANALOGFREQUENCY**

CLLTI.FEATURE_FUNCTION_ANALOGFREQUENCY	0xf0f00828
CLLTI.INQUIRY_FUNCTION_ANALOGFREQUENCY	0xf0f00528

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. See *OpManPartB.html#focus* for the scanCONTROL 28xx sensor.

- **ANALOGOUTPUTMODES**

CLLTI.FEATURE_FUNCTION_ANALOGOUTPUTMODES	0xf0f00820

CLLTI.INQUIRY_FUNCTION_ANALOGOUTPUTMODES	0xf0f00520

Setting of the analogue output modes (only scanCONTROL 28xx). E.g. the voltage range and the polarity of the analogue outputs may be shifted. See OpManPartB.html#gain for the scanCONTROL 28xx *sensor.*

- **CMMTRIGGER**

CLLTI.FEATURE_FUNCTION_CMMTRIGGER	0xf0f00888
CLLTI.INQUIRY_FUNCTION_CMMTRIGGER	0xf0f00588

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

- **REARRANGEMENT_PROFILE**

CLLTI.FEATURE_FUNCTION_REARRANGEMENT_PROFILE	0xf0f0080c
CLLTI.INQUIRY_FUNCTION_REARRANGEMENT_PROFILE	0xf0f0050c

Parametrization of profile information to be transmitted in the transposed Container Mode. See OpManPartB.html#rearrangementprofile for the specific type of sensor.

- **PROFILE_FILTER**

CLLTI.FEATURE_FUNCTION_PROFILE_FILTER	0xf0f00818
CLLTI.INQUIRY_FUNCTION_PROFILE_FILTER	0xf0f00518

Applying Resampling, Median-Filter and/or Average-Filter. See OpManPartB.html#profilefilter for the specific type of sensor.

- **RS422_INTERFACE _FUNCTION**

CLLTI.FEATURE_FUNCTION_RS422_INTERFACE_FUNCTION	0xf0f008c0
CLLTI.INQUIRY_FUNCTION_RS422_INTERFACE_FUNCTION	0xf0f005c0

Parameter to configure the RS422 interface or digital inputs. See OpManPartB.html#ioconfig or. OpManPartB.html#capturesize for the specific type of sensor.

- **PACKET_DELAY**

CLLTI.FEATURE_FUNCTION_PACKET_DELAY	0x00000d08

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**

CLLTI.FEATURE_FUNCTION_TEMPERATURE	0xf0f0082c
CLLTI.INQUIRY_FUNCTION_TEMPERATURE	0xf0f0052c

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. (OpManPartB.html#temperature)

- **SHARPNESS**

CLLTI.FEATURE_FUNCTION_SHARPNESS	0xf0f00808
CLLTI.INQUIRY_FUNCTION_SHARPNESS	0xf0f00508

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* for the specific type of sensor.

- **FEATURE_FUNCTION_FREE_MEASURINGFIELD**

CLLTI.FEATURE_FUNCTION_FREE_MEASURINGFIELD_X	0xf0b0200c
CLLTI.FEATURE_FUNCTION_FREE_MEASURINGFIELD_Z	0xf0b02008

Set the start point and size of the X and Z axis of the measuring field. 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_SHARPNESS.

- **FEATURE_FUNCTION_PEAKFILTER**

CLLTI.FEATURE_FUNCTION_PEAKFILTER_WIDTH	0xf0b02000
CLLTI.FEATURE_FUNCTION_PEAKFILTER_HEIGHT	0xf0b02004

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

- **FEATURE_FUNCTION_DYNAMIC_TRACK**

CLLTI.FEATURE_FUNCTION_DYNAMIC_TRACK_DIVISOR	0xf0b02010
CLLTI.FEATURE_FUNCTION_DYNAMIC_TRACK_FACTOR	0xf0b02014

Set the encoder-controlled measuring field tracking function.

- **FEATURE_FUNCTION_CALIBRATION**

CLLTI.FEATURE_FUNCTION_CALIBRATION_0 - 7	0xf0b02020 - 0xf0b0203c

Set the calibration offset and angle.

6.5 Special feature functions

5.5.1 Software Trigger

- **TriggerProfile ()**

```
int
CInterfaceLLT::TriggerProfile();
```

Execute a software trigger signal.

Return value
General return values

5.5.2 Profile configuration

- **GetProfileConfig ()**

```
int
CInterfaceLLT::GetProfileConfig(TProfileConfig *profileConf);
```

Query the current profile configuration.

Parameter

profileConf	Profile configuration read from sensor

Return value
General return values

- **SetProfileConfig ()**

```
int
CInterfaceLLT::SetProfileConfig(TProfileConfig profileConf);
```

Profile configuration to be set.

Parameter

profileConf	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
PARTIAL_PROFILE	5	Partial profile as set by SetPartialProfile
CONTAINER	6	Container data
VIDEO_IMAGE	7	Matrix video image

5.5.3 Profile resolution / Points per profile

- **GetResolution ()**

```
int
CInterfaceLLT::GetResolution(unsigned int *value);
```

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

Parameter

value	Profile resolution queried

Return value

General return values

- **SetResolution ()**

```
int
CInterfaceLLT::SetResolution(unsigned int value);
```

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

value	Profile resolution queried

Return value

General return values

Specific return value:

ERROR_ SETGETFUNCTIONS_NOT _SUPPORTED_RESOLUTION	-153	The requested resolution is not supported

- **GetResolutions ()**

```
int
CInterfaceLLT::GetResolutions(unsigned int *value, unsigned int size);
```

Query available profile resolutions.

Parameter

value	Array with available profile resolutions
size	Size of array

Return value

Number of available resolutions

Specific return value:

ERROR_ SETGETFUNCTIONS_NOT _SUPPORTED_RESOLUTION	-156	The size of the passed field is too small

5.5.4 Container size

- **GetProfileContainerSize ()**

```
int
CInterfaceLLT::GetProfileContainerSize(unsigned int *width,
                                        unsigned int *height);
```

Query of currently set container size.

Parameter

width	Container width read from sensor
height	Container height read from sensor

Return value

General return values

- **SetProfileContainerSize ()**

```
int
CInterfaceLLT::SetProfileContainerSize(unsigned int width, unsigned int height);
```

Set container size. The container width is set automatically if *SetFeature(FEATURE_FUNCTION_REARRANGEMENT_PROFILE)* 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#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.

Parameter

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 ()**

```
int
CInterfaceLLT::GetMaxProfileContainerSize(unsigned int *maxWidth,
                                          unsigned int *maxHeight);
```

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

Parameter

maxWidth	Maximum container width
maxHeight	Maximum container height

Return value

General return values

5.5.5 Allocated buffer for profile polling

- **GetHoldBuffersForPolling ()**

```
int
CInterfaceLLT::GetHoldBuffersForPolling(unsigned int *holdBuffersForPolling);
```

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

Parameter

holdBuffersForPolling	Buffer count queried

Return value

General return values

- **SetHoldBuffersForPolling ()**

```
int
CInterfaceLLT::SetHoldBuffersForPolling(unsigned int holdBuffersForPolling);
```

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

holdBuffersForPolling	Buffer count set

Return value

General return values

Specific return value:

ERROR_SETGETFUNCTIONS_WRONG _BUFFER_COUNT	-150	Buffer count is not in the range of >=2 and <= 200

5.5.6 Buffer count

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 ()**

```
int
CInterfaceLLT::GetBufferCount(unsigned int *value);
```

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

Parameter

value	Buffer count

Return value

General return values

- **SetBufferCount ()**

```
int
CInterfaceLLT::SetBufferCount(unsigned int value);
```

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

Parameter

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

5.5.7 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 ()**

```
int
CInterfaceLLT::GetPacketSize(unsigned int *value);
```

Query the active packet size of the Ethernet streaming packets.

Parameter

value Packet size queried

Return value

General return values

- **SetPacketSize ()**

```
int
CInterfaceLLT::SetPacketSize(unsigned int value);
```

Set the active packet size for the size of the Ethernet streaming packets.

Parameter

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 ()**

```
int
CInterfaceLLT::GetMinMaxPacketSize(unsigned int *minPacketSize,
                                   unsigned int *maxPacketSize);
```

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

Parameter

minPacketSize	Minimal packet size
maxPacketSize	Maximal packet size

Return value

General return values

5.5.8 Timeout for communication supervision to the sensor

Setting and reading the heartbeat timeout in milliseconds to monitor the connection between linllt 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 ()**

```
int
CInterfaceLLT::GetEthernetHeartbeatTimeout(unsigned int *timeout);
```

Query the set heartbeat timeout.

Parameter

CInterfaceLLT	LLT class
timeout	Heartbeat timeout queried

Return value

General return values

- **SetEthernetHeartbeatTimeout ()**

```
int
CInterfaceLLT::SetEthernetHeartbeatTimeout(unsigned int timeout);
```

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

Parameter

CInterfaceLLT	LLT class

Value	Heartbeat timeout to be set

Return value

General return values

Specific return value:

ERROR_SETGETFUNCTIONS_HEARTBEAT_TOO_HIGH	-162	Parameter value too large

5.5.9 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 ()**

```
int
CInterfaceLLT::GetActualUserMode(unsigned int *actualUserMode,
                                 unsigned int *userModeCount);
```

Query the last loaded user mode / parameter queue. The scanCONTROL sensors of type 26xx/27xx/29xx support 16 user modes.

Parameter

actualUserMode	Currently loaded user mode
userModeCount	Available user modes

Return value

General return values

- **ReadWriteUserModes ()**

```
int
CInterfaceLLT::ReadWriteUserModes(gboolean write, unsigned int userMode);
```

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

Parameter

write	Loading (0) or saving (other than 0) of an user mode
userMode	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)

6.6 Register functions

5.6.1 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 userData 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 linLLT 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.

- **RegisterBufferCallback ()**

```
int
 CInterfaceLLT::RegisterBufferCallback(gpointer *bufferCb, gpointer userData);
```

Registrieren callback for profile reception

Parameter

bufferCb	Pointer to callback function
userData	User defined data, available in callback

Return value

General return values

5.6.2 Register error message for error handling

- **RegisterControlLostCallback ()**

```
int
CInterfaceLLT::RegisterControlLostCallback(gpointer *controlLostCb,
                                                      gpointer userData);
```

Register callback for the case the connection to a sensor is lost.
Parameter

controlLostCb	Pointer to ControlLost function
userData	User defined data, available in callback

Return value

General return values

6.7 Profile transmission function

5.7.1 Start/stop profiles transmission

- **TransferProfiles ()**

```
int
CInterfaceLLT::TransferProfiles(TTransferProfileType transferProfileType,
                                                        gboolean enable);
```

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. If a transfer is terminated, the function waits automatically till the driver has returned all buffers.

<u>Parameter</u>

transferProfileType	Profile transfer type
enable	Start (true) or stop (false) transmission

<u>Return value</u>

General return values

- **TTransferProfileType**

Available TTransferProfileTypes:

Constant return value	Value	Description
NORMAL_TRANSFER	0	Activation of a continuous transfer of profiles
NORMAL_CONTAINER_MODE	2	Activation of a continuous transfer in the container mode

- **SetStreamNiceValue ()**

```
int
CInterfaceLLT::SetStreamNiceValue(unsigned int niceValue);
```

Sets nice value of stream thread (19 to -20). Smaller values set higher priorities, but may need advanced user privileges. (=arv_make_thread_high_priority)

<u>Parameter</u>

niceValue	nice value

<u>Return value</u>

General return values

- **GetStreamNiceValue ()**

```
int
CInterfaceLLT::GetStreamNiceValue(unsigned int *niceValue);
```

Reads the currently set nice value.

Parameter

niceValue	nice value

Return value

General return values

- **SetStreamPriority ()**

```
int
CInterfaceLLT::SetStreamPriority (unsigned int priority);
```

Sets the (realtime-)priority of the stream thread (0 to 99). Higher values set higher priorities, but may need advanced user privileges. (=arv_make_thread_realtime)

Parameter

priority	Priority

Return value

General return values

- **GetStreamPriority ()**

```
int
CInterfaceLLT::SetStreamPriority(unsigned int *priority);
```

Reads the currently set priority value.

Parameter

priority	Priority

Return value

General return values

- **GetStreamPriorityState ()**

```
int
CInterfaceLLT::GetStreamPriorityState (TStreamPriorityState *prioState);
```

Reads the current priority state of the stream thread.

Parameter

prioState	Priority state

Return value

General return values

- **TStreamPriorityState**

Available TStreamPriorityStates:

Name	Wert	Beschreibung
`PRIO_NOT_SET`	0	No priority set. Uses system default.
`PRIO_SET_SUCCESS`	1	Priority set successfully
`PRIO_SET_RT_FAILED`	2	Priority value could not be set. Check user privileges. (arv_make_thread_realtime)
`PRIO_SET_NICE_FAILED`	3	nice value could not be set. Check user privileges. (arv_make_thread_high_priority)
`PRIO_SET_FAILED`	4	Priority values could not be set. Check user privileges.

- **GetStreamStatistics ()**

```
int
GetLLTOffsetAndScaling (unsigned long *completedBuffer,
                        unsigned long *failures, unsigned long underruns);
```

Queries the current transmission statistics. A transmission must be active during function call.

Parameter

completedBuffer	Successfully completed buffers
failures	Buffer failures
underruns	Buffer underruns

Return value

General return values

5.7.2 Fetch current profile / container / video image

- **GetActualProfile ()**

```
int
CInterfaceLLT::GetActualProfile(unsigned char *buffer, int bufferSize,
                 TProfileConfig profileConfig, unsigned int lostProfiles);
```

Fetching the active profile/container/video image from holding buffer.

Parameter

buffer	Transmission buffer
buffersize	Size of transmission buffer
profileConfig	Profile configuration of transmission
lostProfiles	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

5.7.3 Convert profile data

- **ConvertProfile2Values ()**

```
static int
CInterfaceLLT::ConvertProfile2Values(const unsigned char *buffer,
unsigned int bufferSize, unsigned int resolution, TProfileConfig profileConfig,
 TScannerType scannerType, unsigned int reflection, unsigned short *width,
   unsigned short *intensity, unsigned short *threshold, double *x, double *z,
      unsigned int *m0, unsigned int *m1);
```

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

Parameter

buffer	Profile buffer
bufferSize	Size of profile buffer
resolution	Points per profile
profileConfig	Profile Config (must be PROFILE)
scannerType	Sensor type
reflection	Profile stripe to be evaluated
width	Array for reflection width
maximum	Array for maximum intensity
threshold	Array for threshold setting
x	Array for position values
z	Array for distance values
m0	Array for moment 0
m1	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 ()**

```
static int
CInterfaceLLT::ConvertPartProfile2Values(const unsigned char buffer,
   unsigned int bufferSize, TPartialProfile partialProfile,
      TScannerType scannerType, unsigned int reflection,
         unsigned short *width, unsigned short *intensity,
               unsigned short *threshold, double *x, double *z,
                                 unsigned int *m0, unsigned int *m1);
```

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.

<u>Parameter</u>

buffer	Profile buffer
bufferSize	Size of profile buffer
partialProfile	Partial profile
scannerType	Sensor type
reflection	Profile stripe to be evaluated
width	Array for reflection width
maximum	Array for maximum intensity
threshold	Array for threshold setting
x	Array for position values
z	Array for distance values
m0	Array for moment 0
m1	Array for moment 1

<u>Return value</u>

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

- **ConvertRearrangendContainer2Values ()**

```
static int
CInterfaceLLT::ConvertRearrangendContainer2Values (const unsigned char *buffer,
unsigned int bufferSize, unsigned int rearrangement,
 unsigned int numberProfiles,  TScannerType scannerType,
  unsigned int reflection, unsigned short *width,
   unsigned short *intensity, unsigned short *threshold, double *x, double *z);
```

Extracts and converts rearranged container raw data to coordinates and advanced profile information. The whole container is converted, thus more than one profile. This means the arrays for X, Z, … must have a size of resolution*number of profiles.

Parameter

buffer	Profile buffer
bufferSize	Size of profile buffer
rearrangement	Value of rearrangement parameter
numberProfiles	Number of profiles in container
scannerType	Sensor type
reflection	Profile stripe to be evaluated
width	Array for reflection width
maximum	Array for maximum intensity
threshold	Array for threshold setting
x	Array for position values
z	Array for distance values

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

6.8 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 ()**

```
int
CInterfaceLLT::GetPartialProfile(TPartialProfile *partialProfile);
```

Query the current partial profile setting set on the scanCONTROL.

Parameter

partialProfile Reference to partial profile structure

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);

- **SetPartialProfile ()**

```
int
CInterfaceLLT::SetPartialProfile(TPartialProfile *partialProfile);
```

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 unit size of the function *GetPartialProfileUnitSize()*.

Parameter

partialProfile Reference to partial profile structure

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	-355	nStartPointData or nPointDataWidth

_UNITSIZE_DATA	are not a multiple of nUnitSizePointData

- **GetPartialProfileUnitSize ()**

```
int
CInterfaceLLT::GetPartialProfileUnitSize(unsigned int *unitSizePoint,
                                          unsigned int *unitSizePointData);
```

This function returns the increments for adjusting the partial profile.

<u>Parameter</u>

unitSizePoint	Unit size of point increments
unitSizePointData	Unit size of data increments

<u>Return value</u>

General return values

6.9 Timestamp extraction functions

- **Timestamp2TimeAndCount ()**

```
static int
CInterfaceLLT::Timestamp2TimeAndCount(unsigned char *buffer,
 double *shutterOpen, double *shutterClose, unsigned int *profileCount,
                                       unsigned short encTimes2OrDigIn);
```

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.

<u>Parameter</u>

buffer	Reference to timestamp bytes of profile buffer
shutterOpen	Timestamp shutter open
shutterClosed	Timestamp shutter closed
profileCount	Profile count
encTimes2OrDigIn	2x value encoder counter or state digital inputs (binary)

<u>Return value</u>

General return values

6.10 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.

- **ReadPostProcessingParameter ()**

```
int
CInterfaceLLT::ReadPostProcessingParameter(unsigned int *parameter,
                                           unsigned int size);
```

Read post processing parameters.

Parameter

CInterfaceLLT	LLT class
parameter	Post processing parameter array
size	Size of post processing parameter (max. 1024 DWORDs)

Return value

General return values

- **WritePostProcessingParameter ()**

```
int
CInterfaceLLT::WritePostProcessingParameter(unsigned int *parameter,
                                            unsigned int size);
```

Write post processing parameters.

Parameter

CInterfaceLLT	LLT class
parameter	Post processing parameter array
size	Size of post processing parameter (max. 1024 DWORDs)

Return value

General return values

6.11 Calibration

- **SetCustomCalibration ()**

```
int
CInterfaceLLT::SetCustomCalibration(double cX, double cZ, double angle,
                                    double sX, double sZ);
```

Calibration of sensor mounting position through rotation and shift of a profile. For permanent saving of the calibration the user mode has to be saved. The calibration is valid for every user mode.

Parameter

cX	Rotational centrum x in mm
cZ	Rotational centrum z in mm
angle	Rotation angle in degree
sX	Shift of rotational centrum x in mm
sZ	Shift of rotational centrum z in mm

Return value

General return values

ERROR_SETGETFUNCTIONS_WRONG _FEATURE_ADRESS	-155	The address of the selected property is wrong

- **ResetCustomCalibration ()**

```
int
CInterfaceLLT::ResetCustomCalibration();
```

Reset calibration of sensor mounting position. For permanent saving of the calibration the user mode has to be saved. The calibration is valid for every user mode.

Return value

General return values

ERROR_SETGETFUNCTIONS_WRONG _FEATURE_ADRESS	-155	The address of the selected property is wrong

6.12 MISC

- **SetPeakFilter ()**

```
int
CInterfaceLLT::SetPeakFilter(unsigned short minWidth, unsigned short maxWidth,
                             unsigned short minIntensity, unsigned short maxIntensity);
```

Sets the peak filter, which allows limiting the characteristics for valid points.

Parameter

minWidth	Min. valid reflection width
maxWidth	Max. valid reflection width
minIntensity	Min. valid intensity
maxIntensity	Max. valid intensity

Return value

General return values

Like SetFeature()

- **SetFreeMeasuringField ()**

```
int
CInterfaceLLT::SetFreeMeasuringField(unsigned short startX, unsigned short sizeX,
                                     unsigned short startZ, unsigned short sizeZ);
```

Sets a custom measuring field with specific size. The *start* and *size* values are to be seen in reference to 65535. Example: *start_z* = 20000 → 20000/65535 * 100 % = 30.52 %; *start_z* is therefore at 30.52 % of the sensor matrix height. For a scanCONTROL 2900 (height: 1024 pixel) this means approx. at pixel 312. For correct results the matrix rotation of the current sensor type has to be considered (check with DeveloperDemo).

Parameter

startX	Start value X
sizeX	Size of X
startZ	Start value Z
sizeZ	Size of Z

Return value

General return values
Like SetFeature()

- **SetDynamicMeasuringFieldTracking ()**

```
int
CInterfaceLLT::SetDynamicMeasuringFieldTracking (unsigned short divX,
               unsigned short divZ, unsigned short shiftX, unsigned short shiftZ);
```

Sets the dynamic, Encoder-controlled measuring field.

Parameter

divX	Steps in X
divZ	Steps in Z
shiftX	Shift in X
shiftZ	Shift Z

Return value

General return values
Like SetFeature()

6.13 Event handling (for Win compatibility)

- **CreateEvent ()**

```
static EHANDLE*
CInterfaceLLT::CreateEvent();
```

Creates event handle.

Return value

Event handle or error

- **FreeEvent ()**

```
static void
CInterfaceLLT::FreeEvent(EHANDLE *eventHandle);
```

Frees resources of event.

Parameter

eventHandle	Event handle

- **SetEvent ()**

```
static void
CInterfaceLLT::CreateEvent(EHANDLE *eventHandle);
```

Sets event.

Parameter

eventHandle	Event handle

- **ResetEvent ()**

```
static void
CInterfaceLLT::ResetEvent(EHANDLE *eventHandle);
```

Resets event.

Parameter

eventHandle	Event handle

- **WaitForSingleObject ()**

```
static int
CInterfaceLLT::WaitForSingleObject(EHANDLE *eventHandle, unsigned int timeout);
```

Blocks until event is set or timeout is expired.

Parameter

eventHandle	Event handle
timeout	Timeout in ms

Return value

0 if successful

6.14 Save/Export configuration

- **ExportLLTConfig ()**

```
int
CInterfaceLLT::ExportLLTConfig(const char *fileName);
```

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

CInterfaceLLT	LLT class
fileName	Name of file to be exported

Return value

General return values
Specific return value:
Return values of GetFeature()

ERROR_READWRITECONFIG_CANT_CREATE_FILE	-500	The specified file cannot be created

- **ExportLLTConfigString ()**

```
int
CInterfaceLLT::ExportLLTConfigString(const char *configData, int size);
```

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 files created thus can be transmitted to the scanCONTROL without changes via the serial port using a terminal program or via ImportLLTConfigString.

Parameter

CInterfaceLLT	LLT class
configData	char array for config data
size	char array size

Return value

General return values
Specific return value:
Return values of GetFeature()

ERROR_READWRITECONFIG_QUEUE_TO_SMALL	-502	Data array to small

- **ImportLLTConfig ()**

```
int
CInterfaceLLT::ImportLLTConfig(const char *fileName, bool ignoreCalibration);
```

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

CInterfaceLLT	LLT class

fileName	Path/name of file to be imported
ignoreCalibration	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 ()**

```
int
CInterfaceLLT::ImportLLTConfigString(const char *configData, int size,
                                     bool ignoreCalibration);
```

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

CInterfaceLLT	LLT class
configData	char array with config data
size	char array size
ignoreCalibration	if true, do not import calibration data from string

Return value

General return values

Specific return value:

Return values of SetFeature()

ERROR_READWRITE_UNKNOWN_FILE	-504	The imported data has not the expected format

- **SaveGlobalParameter ()**

```
int
CInterfaceLLT::SaveGlobalParameter();
```

Save IP configuration and calibration independent of user mode.

Parameter

CInterfaceLLT	LLT class

Return value

General return values

7 Appendix

7.1 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.

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_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_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_SECOND_CONNECTION_TO_LLT`	-1008	A second instance is connected to this scanCONTROL Ethernet port. Please close the second instance

7.2 SDK example 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
`GetProfilesCallback`	Transfer of profiles to the linLLT and pick up of profiles with a callback
`GetProfilesPoll`	Transfer of profiles to the linLLT and pick up of profiles via polling mode
`VideoMode`	Transfer and save matrix image

`PartialProfile`	Transfer of partial profiles
`ContainerMode`	Transfer and save profile containers respectively grey scale maps
`PartialProfiles_MultiLLT`	Usage of more than one scanCONTROL in one program with partial profile configuration
`LLTPeakFilter`	Set peak filter, free measuring field and dynamic, encoder defined measuring field
`Calibration`	Set sensor calibration (angle, offset)

7.3 Limitations

Scanner functionality not available in the linLLT in comparison to the Win SDK (LLT.dll):

- SHOT transfer
- Load and Save profiles
- CMM triggering

On certain embedded boards (e.g. Raspberry Pi) only the partial profile mode can be used, due to interface limitations.

7.4 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; Revision: c76c4eff608a ; Date: 2016/06/29 09:55:05

[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; Revision: 1.50; Date: 2015/10/05 10:10:20

[3] 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; Revision: c76c4eff608a ; Date: 2016/06/29 09:55:05

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