Optical Line Tracker For Two Cameras

HG 73830XA

Parallel Interface

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Content

1 Introduction

1.1 Interpreter

This document describes the Optical Line Tracker (interpreting unit) G 73830XA which is part of an Optical Guidance System for Automated Guided Vehicles (AGV) enabling travelling along a contrast line on the ground. The Optical Line Tracker interprets the location of this line within the view of the camera and outputs its position with regards to the center of the produced picture. In addition, it is possible to detect branching from the original course.

The Optical Line Tracker is made for the connection of two (2) PAL standard video cameras with composite video signal, in order to automatically guide a vehicle in two different directions of travel (forwards and backwards). It includes a video multiplex unit. It is possible to connect a video monitor in order to control the detected track/line.

The detected track is indicated on the display. In addition, an LED line indicates the location of the guidance line.

The Optical Line Tracker is located inside a robust metal casing. The suitable camera HW DEV00035 in a spherical housing is available from Götting KG. The interpreter is available in two variants:

- **G 73830ZA** - Here the data output is realized using a CAN bus. A CANopen® protocol (DS 401) is implemented.
- **G 73830XA** - An analog interface is used for the output of a deviation signal (up to ±10 V) and a parallel interface for the rest of the control. Offset and amplitude of the analog voltage are adjustable.

The parameters of the Optical Line Tracker are either set via a serial interface (RS232) using a commonly available terminal program (e.g. Hyperterm). The power supply for the cameras is realized over an integrated DC chopper converter. The output voltage is adjustable in a range of 5...15 V. This manual refers to the hardware version 73830-A3 and to software version 73830A12.00 (and higher).

1.2 Track Detection

The video signal is imported with a resolution of 1000 pixel per line. It is possible to select interpretation lines between the lines 30 and 255, as only these lines offer a useful picture content. Up to 15 consecutive lines can be combined. The update rate for each half-picture is 40 ms.

For the detection of the track, a statistic procedure that compares the relevant selected lines of the camera picture with a model track of predefinded width, is used. The degree of compliance is important. The higher the degree of compliance with regards to the width and contrast of the line, the higher the so-called covariance value. If the covariance value exceeds a threshold determined during the commissioning of the system, the track becomes valid and the location of the covariance maximum is converted into a deviation value.

In case there are two maxima the location of the stronger maximum is used for the calculation of the track deviation. If there are two or more maxima and branching is planned, the locations of the two biggest maxima are used. For the calculation of the deviation, depending on the indicated branching mode, the right or left maxima are used accordingly.

Two different sets of parameters can be used for each of the two connectable cameras.

2 Commissioning

2.1 Presettings

The interpreter is preset to a track width of 150 mm (light track on dark background) and 700 mm reading height for the camera HW DEV 000035. The thresholds for signalization of deviations are set to ±50 mm resp. ±100 mm.

The presettings can be changed using the terminal (see chapter 4 from page 17).

2.2 Track Detection

In order to assure a reliable track detection, it is essential that the contrast of the line on the ground compared to its environment is significant. Due to the signal processing respectively the integrated filter, the system is able to bridge a short-time drop out of the track, depending on duration of the drop out and the velocity. Shadows and light beams may have significant influence on the performance of the system as the track recognition may be impaired. It is, for example, possible that a combination of shadows and light beams simulates a virtual guidance that may be followed by the vehicle. Therefore it is recommended to ensure that the guidance line is protected from external light using an appropriate cover (not included in this scope of supply).

Futhermore it is important that there are no futher contrast in the sight window or slewing range of the camera. If a dark track is located on a light ground, this crossing may be detected as a track by mistake.

In order to avoid reflections from reflective or sealed surfaces, the cameras should be mounted with an inclination of 15 to 20° in direction of travel.

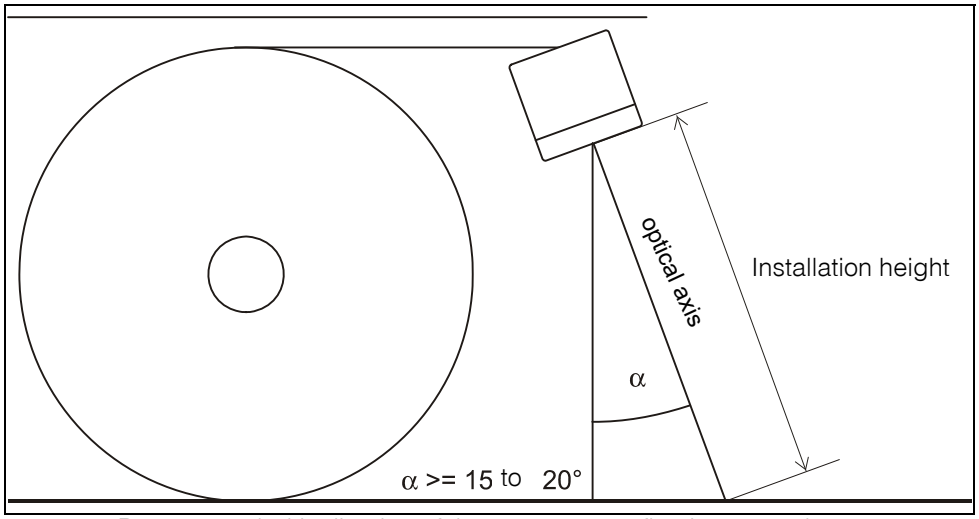


Figure 1 Recommended inclination of the camera on reflective grounds

The max. width of the guidance line depends on the used camera lens as well as on the height above the guidance line at which the camera is installed. The width of the guidance line is ideal once its width on the control display is between 1/6 and 1/3 of the overall width of the display. There are two options for the guidance line: dark on light surface or light on dark surface.

2.3 Leaving the Main Course

In case a vehicle has to leave the main course, the ancillary track has to start as shown in Figure 2. In addition to the main course, only one ancillary track may be within the view of the camera. It is therefore essential to locate the branch-offs on the right and left side with an offset at places where two courses cross.

The instruction to leave the main course in order to get to one of the ancillary tracks is given either by the track selection input. This instruction is to be set just before the branch-off gets in sight - and to reset just after the branch-off has disappeared from sight.

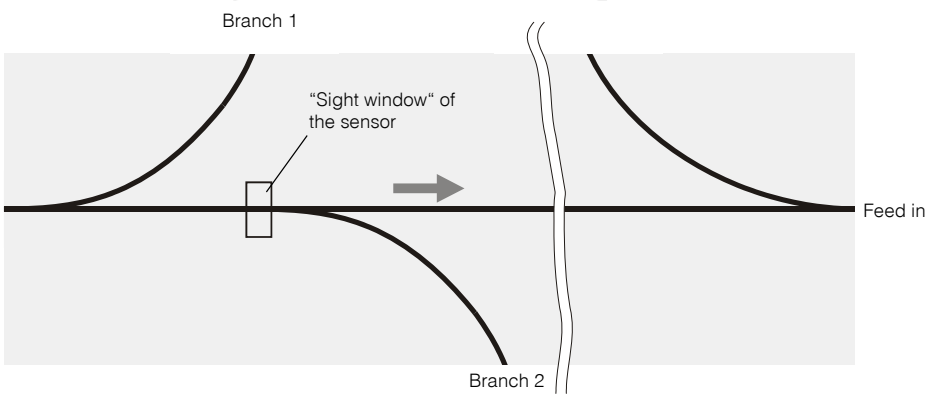


Figure 2 Structure of branch-offs and crossing tracks

2.4 Additional Commissioning Steps

Use the built-in parameter menu for setting the parameters (refer to chapter 4 on page 17). Offset and deviation of the analog output voltage are adjustable in steps of 20 mV using the menu `(O)utput-Input Settings`. For the exact setting, it is necessary to check the output voltage with a voltameter.

Place the camera at the final installation height above a section of the guidance line with bad quality and set straight forward travel.

- Enter the reading height and track width in millimeters in the menu Image Settings. In case the camera HW DEV 00035 is used, the calibration factor is already factory-set. For other cameras, it is necessary to re-determine the calibration factor within the submenu `Adjust width of track` (refer to Figure 12 on page 23).
- Also select the track structure in this menu: black on white or white on black.
- If different sets of parameters are to be used, those sets have to be entered here. For each set of parameters different inputs are possible when using the following variables:

- in the menu `Image Settings` (see 4.3 on page 22) the sub menus `Startline / Inverse Track / Width of Track / Height of Camera / Peak Threshold / Warning Threshold / Calib-Factor`
- in the menu `Output-Input Settings` (see 4.4 on page 24) the points `X-Threshold for Output 1,2 / X-Threshold for Output 3,4`

For the ideal setting of the scan lines, a control monitor or a PC with framegrabber card should be connected.

- Move the marker on the display (parameter `Startline` within menu `Image Settings`, refer to section 4.3 on page 22) to a section of the picture without reflections caused by the lighting of the camera or change the inclination of the camera (refer to Figure 1 on page 6).

Read the peak value for the covariance function from the status line. As the chosen sections is of very poor quality choose an input of approx. 90 % of this value for `Peak Threshold` (refer to section 4.3 on page 22). Select the threshold for the guidance line quality warning according to your requirements.

Now, go to the `Luminance Histogram` (refer to section 4.5 on page 25). The displayed picture should be similar to the one shown in the corresponding chapter. This feature enables inspection of the brightness contrast of the picture. The further away the narrow and high bars are located, the better the contrast. In case the bars become thick and low, leaving no space in between them, the quality of the guidance line is not sufficient. It is necessary to repair the guidance line.

If necessary, adjust the interruption filter within the sub-menu `Output-Input Settings` (refer to section 4.4 on page 24). The value of the interruption filter indicates for how many pictures the track may disappear before the output OUT8 (track recognized) is deactivated. This value multiplied by 20 ms indicates the duration of the tolerable interruption.

Furthermore, this menu enables activation of a jump filter with reaction time. In case the recognized track jumps more than the width of the track, this jump is ignored if the value set under `Bridge a track Jump` is not equal 0. This number, multiplied by 20 ms is the duration of the reaction time. After this reaction time period, the analog output gets closer to the existing value. The velocity of the approximation is set under `Jump Increment`. The value 100 means the fastest jump (40 ms) to the new value, while the value 1 means that 6000 ms are required.

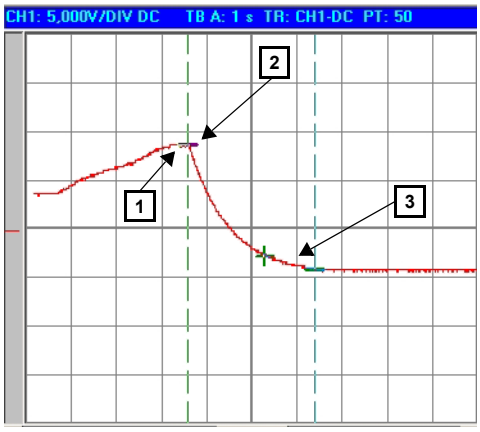


Figure 3 Function of the jump filter

A jump of more than one track width is detected at position 1. 400 ms later, at position 2, the reaction time is over and the output signal approaches the new value until, after approx. 2,8 sec, the new output value is reached at position 3. The filter settings for this example are: `Bridge a track Jump` = 20 and `Jump Increment` = 50. These two filters are only available for the analog output signal in PLC mode (refer to `Menu Output-Input Settings` in section 4.4 on page 24).

Once all settings have been entered, it is necessary to save the new parameters (refer to 4 from page 17).

2.5 Improving the Resolution

If the values for track width and camera height (see 4.3 on page 22) are adjusted correctly the resolution of the system is 1mm. The resolution can be improved by applying the following trick:

Example: installation height: 100 mm, track width: 25 mm

- Enter 200 mm as installation height and 50 mm for the track width, then the resolution will be 0.5 mm
- when entering 400 mm as installation height and 100mm as the track width, the resolution increases to 0.25 mm

Therefore the thresholds for the deviation warning have to be altered correspondingly (see 4.4 on page 24).

3 Hardware

3.1 Casing

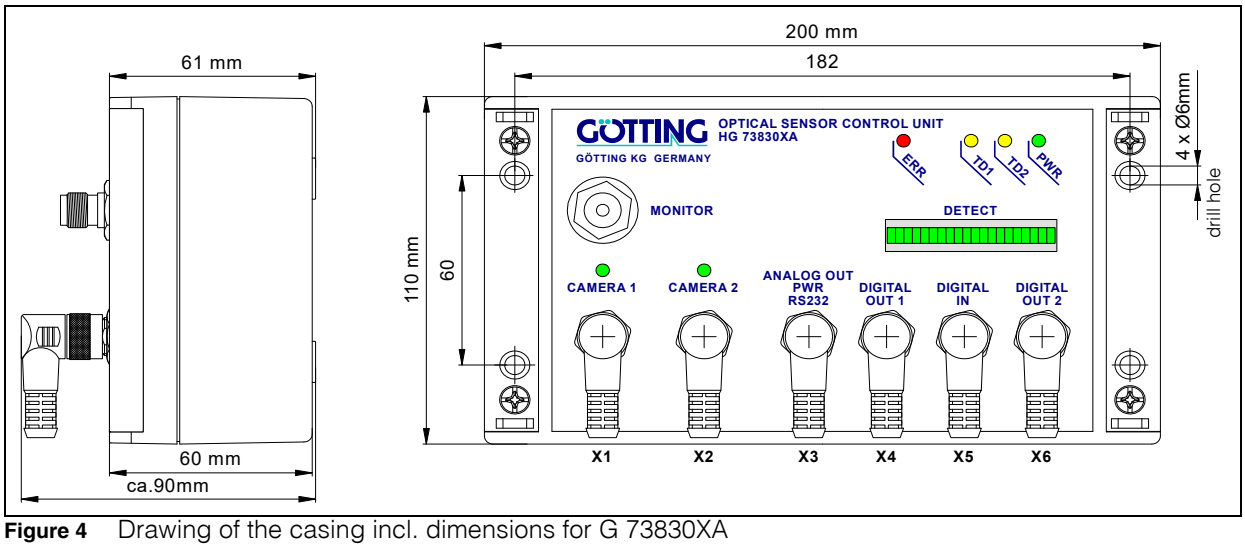


Figure 4 Drawing of the casing incl. dimensions for G 73830XA

3.2 Block Diagram

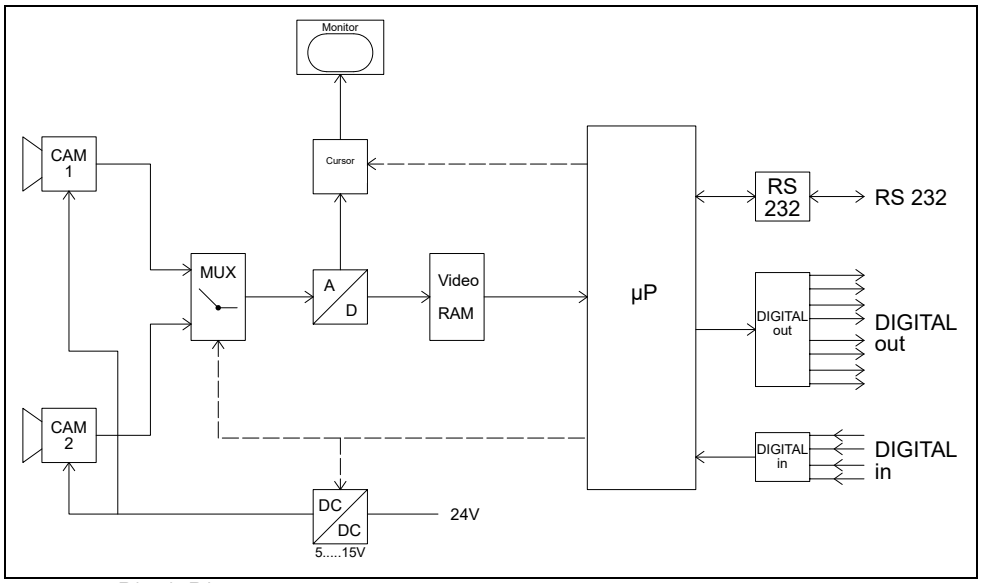


Figure 5 Block Diagram

3.3 Diagrams

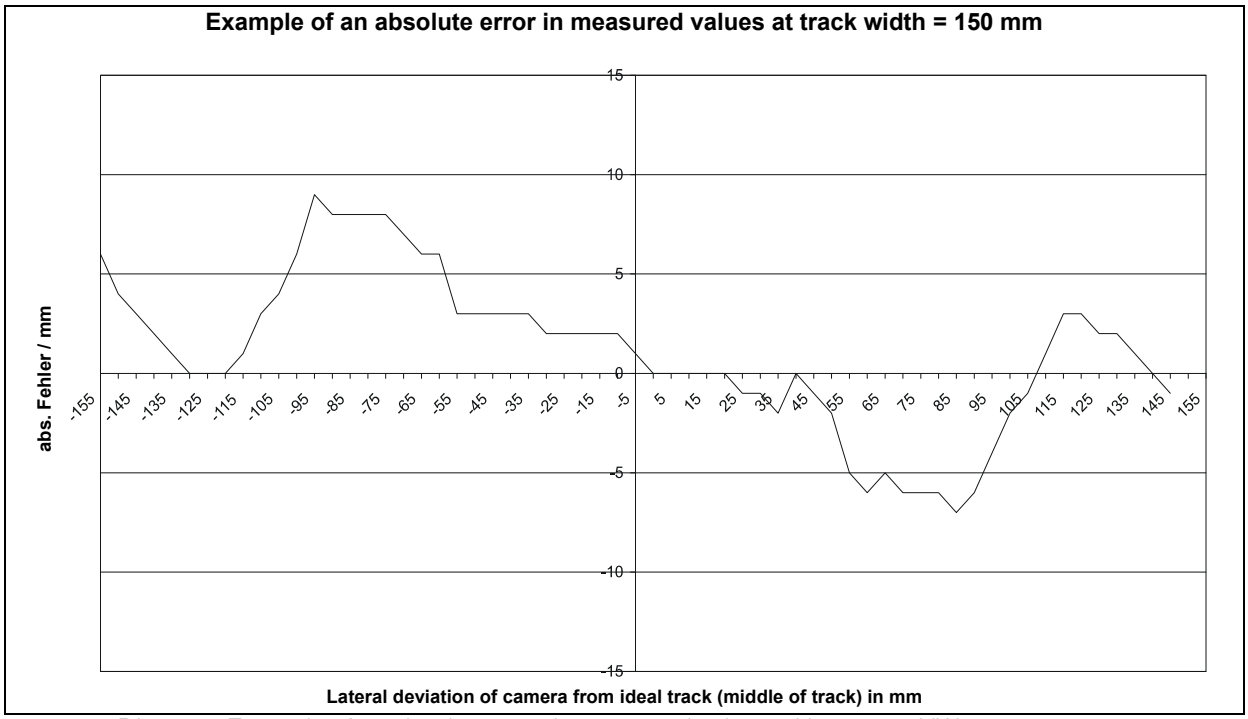


Figure 6 Diagram: Example of an absolute error in measured values with camera HW DEV00035

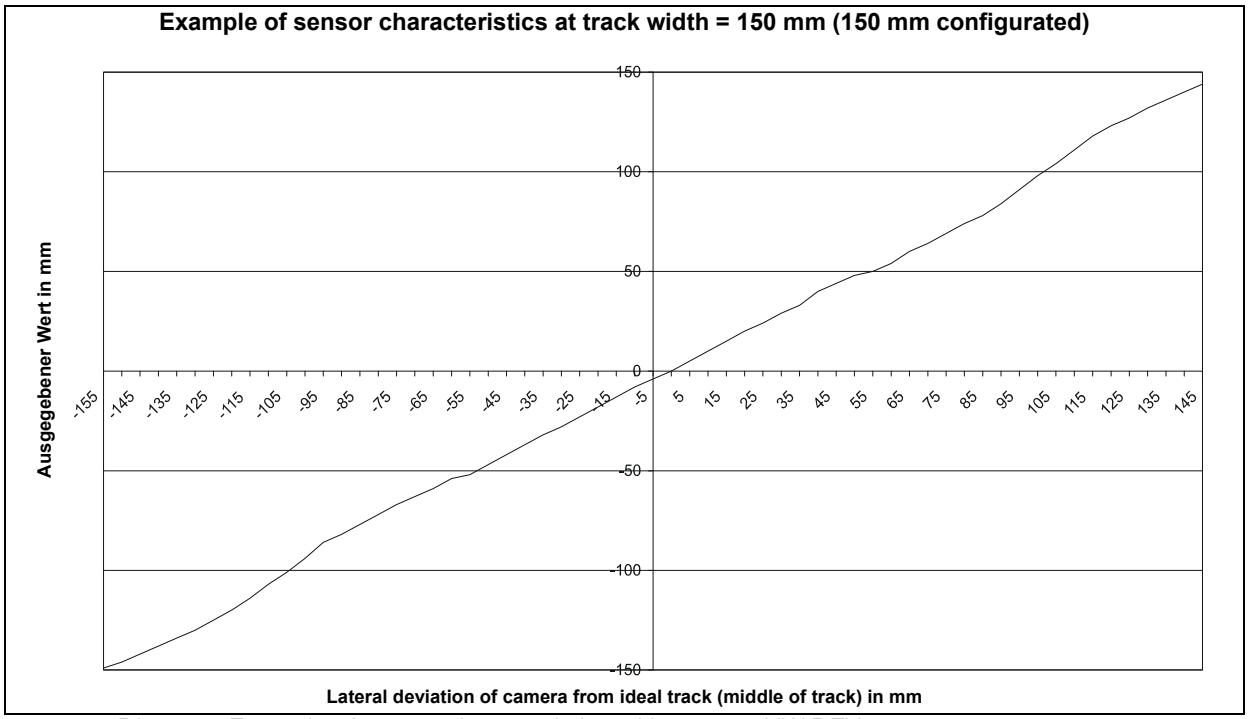


Figure 7 Diagram: Example of sensor characteristics with camera HW DEV00035

3.4 Pin Allocation

All interfaces are to be connected using A-coded M12 connecters on the front. Furthermore, there is a TNC female for connecting the control monitor or Frame Grabbers.

The parallel inputs are active for an input voltage between 15 V and 30 V or smaller than 9 V. Inputs which are not allocated are directed internally to ground. A variable debounce time can be set for the inputs (see `Output-Input Settings` in section 4.4 on page 24).

The short-circuit proof drivers for the parallel outputs switch 24 V on the clamps. In case of a short-circuit the red LED ERR is lit.

Also the analog output is short-circuit proof. Regarding offset and deviation other values besides 0 V and ±10 V can be parametrized. Therefore, the output voltage is scaled, so that the chosen voltage range corresponds to the whole picture range.

3.4.1 Camera

4-pin M12 panel jack (two on front panel)

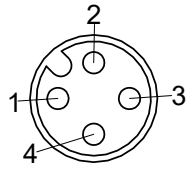
X1, X2	Pin	Signal
	1	Video
	2	Ground
	3	Supply voltage 5..15 V
	4	Ground (supply)

Table 1 Interface X1 and X2

3.4.2 Voltage Supply and Serial Interface

5-pin panel jack

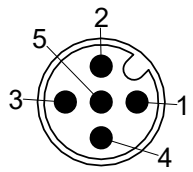
X3	Pin	Signal	Annotation
	1	+Ub (24 V)	
	2	Analog Out	max. deviation of track +-10 V
	3	TxD	RS232 data output
	4	RxD	RS232 data output
	5	GND	Ground (supply)

Table 2 Interface X3

3.4.3 Digital Output

5-pin panel jack

- If no track is detected all 4 outputs are inactive.

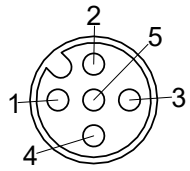
X4	Pin	Signal	Annotation
	1	+Ub (24 V)	
	2	OUT1	24 V: Deviation > +Threshold1 (Default: +100 mm)
	3	OUT2	24 V: Deviation > +Threshold2 (Default: +150 mm)
	4	OUT3	24 V: Deviation < -Threshold1 (Default: -100 mm)
	5	OUT4	24 V: Deviation < -Threshold2 (Default: -150 mm)

Table 3 Interface X4

3.4.4 Digital Input

5-pin panel jack

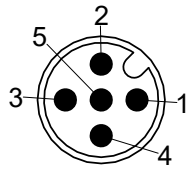
X5	Pin	Signal	Bemerkung
	1	IN1	Choice of track 1 (Leave main course - Approval according to Table 6)
	2	IN2	Choice of track 2 (Leave main course - Approval according to Table 6)
	3	IN3	Choice of camera (0: camera 1 active, 1: camera 2 aktiv)
	4	IN4	Choose set of parameter
	5	GND	Ground (supply)

Table 4 Interface X5

3.4.5 Digital Output

5-pin panel jack

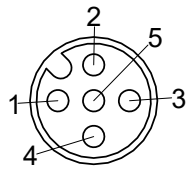
X6	Pin	Signal	Annotation
	1	+Ub (24 V)	
	2	OUT5	free
	3	OUT6	No error noticed when active
	4	OUT7	Track quality poor when active
	5	OUT8	Track detected when active

Table 5 Interface X6

3.4.6 Monitor

TNC female, Standard Composite Video Signal 1 V_{pp} at 75 Ohm

3.4.7 Coding Of Inputs For Direction Choice

In the following table the coding of inputs for direction choice.

IN1	IN2	Bedeutung
0	0	Disabled analog output
1	0	Follow right track
0	1	Follow left track
1	1	Follow track with the highest coariance value (only one track should be visible)

Table 6 Choice of track (1 is active, 0 ist inactive)

3.5 Control LED

On the front panel are three groups of LED:

- the red LED (PWR) shows the operating voltage of the device
- the yellow LED (TD_1, TD_2) show the track detection on the corresponding camera
- the red LED (ERR) is lit if there is a system error (see Table 9 on page 20).
- one LED to display the active camera input
- a 20-digit LED bar to show the location of the detected track

3.6 Operating The Interpreter

In order to operate the Optical Line Tracker using this interface unit, the following connections have to be made:

- In case an operation without turn off is planned, it is necessary to parallel the inputs `IN1` and `IN2`. The analog output for the track deviation is deactivated whenever `IN1` and `IN2` are either not connected or inactive.
- Whenever only one camera is used, the input `IN3` (camera selection) may either remain blank or may be connected to ground. In this case, the camera must be connected to `IN1`.
- Output OUT8 is activated as soon as the covariance maximum exceeds the set threshold (refer to menu `Image Settings` in section 4.3 on page 22 in chapter `Setting Parameters`). The value of the voltage at the analog output indicates the location of the guidance track within view (the lateral deviation from the center of the field of vision).
- In case the track quality (value of the covariance maximum) decreases below a set threshold, output `OUT7` is activated. In such a case, the vehicle could, for example, drive slower in order to securely get through an area of bad tracking quality.
- For higher security reasons, output `OUT6` has been created: once the device has been switched on it becomes inactive if it is detected that the EEProm's set of parameters is faulty. In addition, it becomes inactive in case an activated output (`OUT1` - `OUT8`) is short-circuited. In the latter case, a check is carried out every 500 ms, investigating whether the short-circuit is still there. If not, the corresponding output will be re-activated. During this examination, which takes 20 ms, `OUT6` is activated.
- Furthermore, 2 independent symmetrical deviation threshold can be put out:
  In case the deviation from the track is greater than the value set for threshold 1, `OUT1` activated. If the deviation from the track is less than the negative value of threshold 1, `OUT3` is activated.
  In case the deviation from the track is greater then the value set for threshold 2, `OUT2` is activated. If the deviation from the track is less than the negative value of threshold 2, `OUT4` is activated.
  The values for thresholds 1 and 2 may be changed in menu `Output-Input Settings`. These outputs may also be used for controlling the velocity of the vehicle.
- It is possible to set certain parameters related to the behavior of the analog output in case the track ends or cannot be read anymore:
  Either value 0 V (or the voltage value corresponding to the offset value) is put out or the old value is maintained.
- The four sets of parameters are assigned to the digital inputs as follows:

Input		
IN3 (camera)	**IN4 (set of parameters)**	**Set of parameters no.**
0 (camera 1 active)	0	1
0 (camera 1 active)	1	2
1 (camera 2 active)	0	3
1 (camera 2 active)	1	4

Table 7 Allocation of the sets of parameters

4 Software / Parameter Settings

The system can be configurated using a software running in the interpreter. In order to connect to the software, you have to connect the serial interface of yourm PC to the RS232 interface of the interpreter. Then run the terminal program on your PC.

4.1 Terminal Program

In the following we refer to the programm **HyperTerminal®** (`Hypertrm.exe`), which is part of the scope of supply of Microsoft® Windows®, respectively it can be installed for free.

But every other terminal program can be used as well, as long as it is capable of VT52 emulation. If you use another program than HyperTerminal refer to its documentation and set the values shown in chapter 4.1.2. Therefore, go to page 18.

4.1.1 Add HyperTerminal to your System

4.1.1.1 Windows 2000 or less

First make sure that HyperTerminal is installed on your system. If only the standard version is available, you can easily add Hyper Terminal subsequently using your Windows installation CD.

1. Open `System Control`.

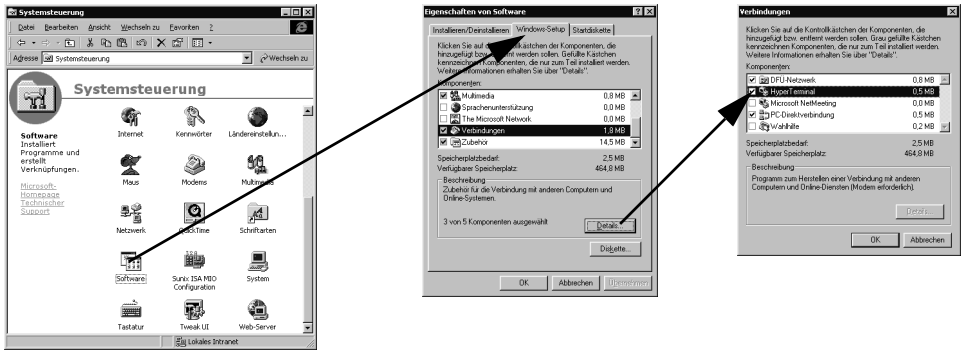


Figure 8 Add HyperTerminal to your system

2. Click on icon `Software.` Select the card index tab `Windows-Setup` in the window `Properties of Software` `Windows-Setup.` Then choose the point `connections` from the `components.` Click `OK`.
3. Now check in the window `connections` if there is a marker in front of `Hyper-Terminal`. If yes, the program is installed on your system. Then click on `Cancel` (twice) and switch to the next section. If not, set the marker with the mouse / keyboard and close both windows with `OK` .
4. Subsequently you will be asked to insert your setup CD into your CD ROM drive. Install the CD and click on icon `OK` .Confirm all installation messages. Hyper Terminal will be installed and will be ready for use then.

4.1.1.2 Windows XP or higher

From Windows XP on Hyperterm is always installed. It can be found under Programs -> Accessories -> Communication.

4.1.2 Parameter Settings

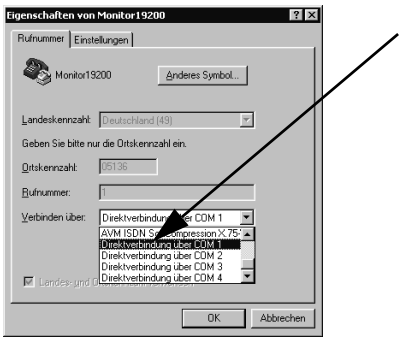
The following parameters are necessary. If you use HyperTerminal you do not have to enter them manually. You can pass this chapter and go to chapter 4.2 on page 18.

Terminalsettings configuration program (see chapter 4.2)	
Baud rate	38400 Baud
Terminalemulation	VT52
Parity	even
Data bits	8
Stop bits	1
Handshake	none
PC interface (Port)	COM1 may vary on some PC (see below)

Table 8 Terminal settings for the configuration program

If you use another port than `COM1` but want to use HyperTerminal you have to switch the port as follows:

1. In the menu `Data` choose the submenu `Properties` (or click on the icon). The following window pops up:



2. Choose in the submenu `Connections` the corresponding port and confirm with `OK`. Save the altered parameters when receiving the corresponding message while closing the program.

4.2 Using the configuration program

The terminal (PC with Hyperterm program) is to be connected to the interpreter via the corresponding socket. The interface parameters are: 38400,8,e,1 and VT52 terminal emulation.

The monitor starts up immediately and cannot be left. The following menu appears:

```
Peak 11056 @ 510   X/mm:    -6   S: 6000




    (I)mage Settings
    (O)utput-Input Settings


    Luminance (H)istogram
    (V)ideo Line Values
    (K)ovariance Values
    Print (C)SV Values

    Status (B)its
    (R)eticle
    (P)assword
    (W)rite EEProm Values
    (L)oad Values to EEProm
    (S)ervicmenu
    (F)irmware Update

    Software Version  73830A1108 / 13.OCT.2008    Serial Number: 49
```

Figure 9 Screenshot: main menu

The upper line shows the calculated values:

Peak:	Maximum of the covariance function.
@:	Location of the maximum in pixels.
X/mm:	The lateral deviation value in millimeters within the range of max. -500 to +500 mm.
Status:	Hexadecimal output of system status, refer to Table 9 on page 20. Entering (B) enables viewing the set status bits as plaintext messages (refer to Figure 10 on page 20).
B:	reveals the set status bits in plain text

The upper line just below the status outputs shows the plaintext message with the lowest rating, refer to Figure 10 on page 20.

```
Peak 18709 @ 158   X/mm:    16   S: 4350            ← Statusausgabe

    -
    -
    -
    -
    TURN_RI                                        ← Wertigkeit 0x0010
    -
    CAM_2                                  +       ← Wertigkeit 0x0040
    -
    THR_2_RI                               +       ← Wertigkeit 0x0100
    THR_1_RI                               +       ← Wertigkeit 0x0200
    -
    -
    -
    -
    DETECT                                 +       ← Wertigkeit 0x4000
    -

                                           =       0x4350 (Status)
```

Figure 10 Screenshot: Status bits as plaintext

Rating	Function when deleted	Function when set
0x8000		
0x4000	No track detected	Track detected
0x2000	Track quality good	Track quality bad
0x1000		
0x0800	Deviation signal > -Threshold 2 left	Deviation signal < -Threshold 2 left
0x0400	Deviation signal > -Threshold 1 left	Deviation signal < -Threshold 1 left
0x0200	Deviation signal < Threshold 1 right	Deviation signal > Threshold 1 right
0x0100	Deviation signal < Threshold 2 right	Deviation signal > Threshold 2 right
0x0080	Set of parameter 1 or 3 active	Set of parameter 2 or 4 active
0x0040	Camera 1 active	Camera 2 active
0x0020	Status of the parallel inputs IN1 and IN2 for turning and release of the analog output according to Table 10 on page 21	
0x0010		
0x0008	Normal track utilization	Crosslines masked into control picture for camera adjustment, no track utilization
0x0004	./.	./.
0x0002	parallel outputs ok	parallel outputs short-circuit
0x0001	EEProm Parameter accurate	Error within EEProm parameters

Table 9 Meaning of the status bits

Whenever Threshold 2 is exceeded, the corresponding bit of threshold 1 remains set. Each time no track is detected, all 4 threshold bits are deleted.

IN2	IN1	Status Rating	Description
0	0	0x..0.	No release of analog output
0	1	0x..1.	Turn right
1	0	0x..2.	Turn left
1	1	0x..3.	Straight ahead

Table 10 Coding of the inputs IN1 and IN2

Choosing a menu:

- I initiates a submenu for input of values for image processing (refer section 4.3 on page 22).You will be asked for the number of the set of parameter (1 to 4, see Table 7 on page 16), to which the output of the menu has to refer to.
- O enables setting the parallel in/outputs and the voltage output (refer to section 4.4 on page 24).You will be asked for the number of the set of parameter (1 to 4, see Table 7 on page 16), to which the output of the menu has to refer to.
- H generates a diagram indicating the brightness distribution along the line. For each brightness value between 0 (black) and 255 (white) its frequency of occurance is inicated. This enables evaluating the quality of the track: 2 perpendicular lines at maximum distance are ideal (refer to section 4.5 on page 25).
- V generates the brightness values of a line relative to the location (refer to section 4.6 on page 26).
- K initiates the display of the calculated covariance function (refer to section 4.7 on page 26).
- C initiates the output of the following parameters. The values are separated by commas and can be used for recording (refer to section 4.8 on page 27).
  - status,
  - covariance maximum,
  - pixel index of the left, respectively maximum covariance maximum,
  - pixel index of a possible right covariance maximum,
  - calculated deviation of the used track in millimeters.
- B enables displaying the set status bits as plaintext messages (refer to Figure 10 on page 20).
- R adds crosslines to the control picture for camera adjustment. The track evaluation is hence interrupted.
- W enables recording the set parameters for documenting (refer to section 4.9 on page 27).

- Changed parameters can be stored inside the EEProm by entering L. Prior to doing so it is necessary to enter P and the password 815 (refer to section 4.10 on page 27).
- The Service menu does not include any relevant settable functions for the operator of the system.
- The submenu Firmware Update enables programming new firmware (refer to section 4.11 on page 27).

4.3 Image Settings

In the second line, the set of parameters for which the menu was activated is displayed.

```
Peak 13583 @ 528   X/mm:    11   S: 4080

   Parameterset:               1       (CAM 1, IN_4 = 0)

   (S)tartline                         [30.255]:    80
   (B)lock Cursor on-off                             1
   (I)nverse Track                     Black on White

   (W)idth of track                    [mm]:       150
   (H)eight of Camera                  [mm]:       700
   (P)eak threshold                    [>1000]:  10000
   Warning (T)hreshold                           12000

   (V)oltage                           [5..15V]:  12.0
   (O)n-Off                                         1


   Calib-(f)actor                  [(H*pix)/S]:  1447
   (A)djust width of track with image cursor

   Width of Reference Track [pix] = 280

   (Q)uit
```

Figure 11 Screenshot: Menü Image Settings

- S enables defining the line within the picture in which the evaluation is to be started. The defined line is marked on the video control monitor by a cursor. The line should be defined to be within the area of the visible picture, while possible reflections from the camera lighting should be outside this line.
- B switches the track labelling within the control monitor on and off again.
- I enables selecting the track variant: white track on dark ground or black track on light ground.
- W enables setting the width of the track in millimeters. It should not be more than 1/3 of the width of the display on the monitor.
- The installed height of the camera in millimeters is entered via H.
- P enables setting the detection threshold for the track recognition. The maximum of the covariance function (refer to Peak of the status line in Figure 10 on page 20) must exceed this threshold in order to enable track recognition. If the track widths

are significantly larger or smaller than the set track width parameter, or the track contrast is very poor, the maximum of the covariance function will fall below the threshold value.

- T enables setting a Warning threshold. If the maximum of the covariance function falls below this threshold value, output **OUT7** is activated.
- With V the supply voltage for both cameras can be adjusted between 5 and 15 V or turned on/of with O
- With F a known calibration factor for the camera can be entered. Otherwise, the factor can be figured out using the following menu
- In order to enable the conversion of camera pixels into track width in millimeters, it is necessary to determine the relation between track width in pixels, track width in millimeters and installation height of a given camera. This can be achieved by pressing A and the corresponding sub menu **(A)djust width of track with image cursor** (also refer to description below). Optical Line Tracker G 73830XA is factory set for camera HW DEV 00035.
- Q returns to the main menu.

The sub menu **(A)djust width of track with image cursor** is structured as follows:

```
Peak 11321 @ 358   X/mm:    19   S: 4300

   (S)et Start of Cursor               [0.. 500 pixel]:   90
   (W)idth of Cursor                   [0.. 166 pixel]:  150
   (H)eight of Camera                  [10..1000 mm]:    700
   (G)auge of Reference Track          [0..500 mm]:      150

   Calib-factor [mm*H/pix] =  1493




   (Q)uit
```

Figure 12 Screenshot: Determination of the calibration factor in submenu (A)djust width of track with image cursor

This menu enables calibrating the Optical Line Tracker for a certain camera:

Position the camera above the guidance track. The track width in millimeters and the installation height of the camera in millimeters are to be input correctly via G and H. Then set the start of the track width now displayed on the screen onto the left hand side of the track using S. Afterwards use W to set the width of the marked area and make sure the marked area covers the track exactly. The calibration factor is then displayed. The quit the submenu by pressing Q.

The set parameters now have to be permanently saved within the main menu by pressing L. The calibration value determined for a certain type of camera can be directly transferred to other Optical Line Trackers if the same type of camera is used.

4.4 Output-Input Settings

In the second line, the set of parameters for which the menu was activated is displayed.

```
Peak 13638 @ 527   X/mm:    11   S: 4080

    Parameterset:               1       (CAM 1, IN_4 = 0)

    (1)X-Threshold for Output 1,2       [1..500 mm]:        50
    (2)X-Threshold for Output 3,4       [1..500 mm]:       100

    (S)pan                              [-10..10V]:      10.00
    (O)ffset                            [-5V..0..5V]:     0.00
    (H)old analogue value                                    0


    (D)ebounce time                     [0..100ms]:         50

    (B)ridge a track gap (n*20 ms)      [0..25]:            20

    Bridge a track (J)ump (n*20 ms)     [0..25]:             0
    Jump (I)ncrement                    [1..100 %]:        100

    (Q)uit
```

Figure 13 Screenshot: Menu (O)utput-Input Settings - output of threshold

- 1 and 2 enable setting the values of the two possible monitoring thresholds in millimeters. For example, if the track deviation exceeds the value +100 mm or falls below -100 mm, the corresponding status bit is set and the digital output switched to + 24 V (see Table 3 on page 13 and Table 9 on page 20).
- S enables setting the absolute value of the height and with O the offset of the analog output voltage is set. Thus, the settings shown in Figure 13 on page 24: Span (Amplitude)= 10 and Offset = 0, generate an output voltage within the range of ±10 V. The voltage is adjustable in steps of approx. 20 mV.

Example In order to obtain an output voltage from 0 to 5 V set the offset and voltage (amplitude) to 2.5.

- In case the guidance track cannot be recognized, the behaviour of the analog output can be adjusted via H: Either the value 0 V (or the voltage value corresponding to the offset value) is output or the last value is maintained.
- D enables setting a debounce time during which the input values have to be stable in order to be valid.
- Futhermore, B enables setting an interruption filter. The set value is a picture counter which indicates for how many pictures the guidance track may cease to be recognized before output OUT8 (track recognized) becomes inactive. This value multiplied by 20 ms is the duration of a possible tolerated interruption.
- J and I enable the configuration of the jump filter. The exact function is described in Figure 3 on page 9 in chapter Commissioning.
- Q exits the submenu and returns to the main menu

4.5 Luminance Histogram

In order to determine the suitability of the guidance track for secure detection, the are Luminance histograms available::

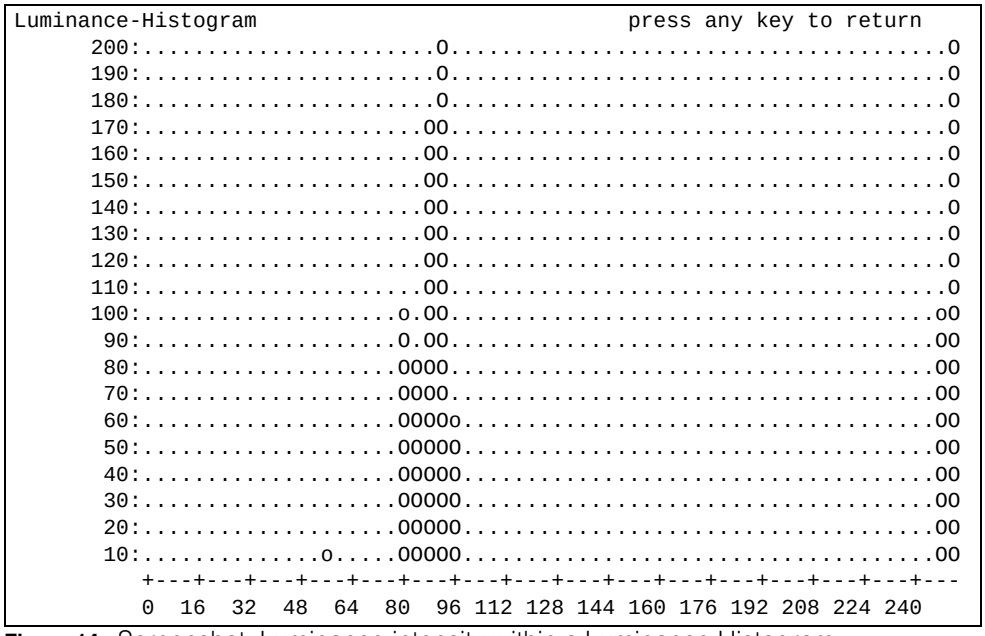


Figure 14 Screenshot: Luminance intensity within a Luminance Histogram

The horizontal axis shows the possible luminance values between 0 and 255. Due to limited space 4 luminance values are always generalized to one value. The vertical axis shows the respective frequencies. The above given example shows a certain accumulation at maximum luminance and a second accummulation at less luminance. This enables perfect guidance track recognition. However, a black-and-white check pattern will give the same luminance picture, but at the same time be completely useless for track recognition. Therefore two addtional diagrams are available.

4.6 Video Line Values

This diagram shows the Luminance values over the location (in pixels). The following diagram shows the guidance track displayed in above given luminance histogram over a display line. The guidance track is clearly detected without doubt.

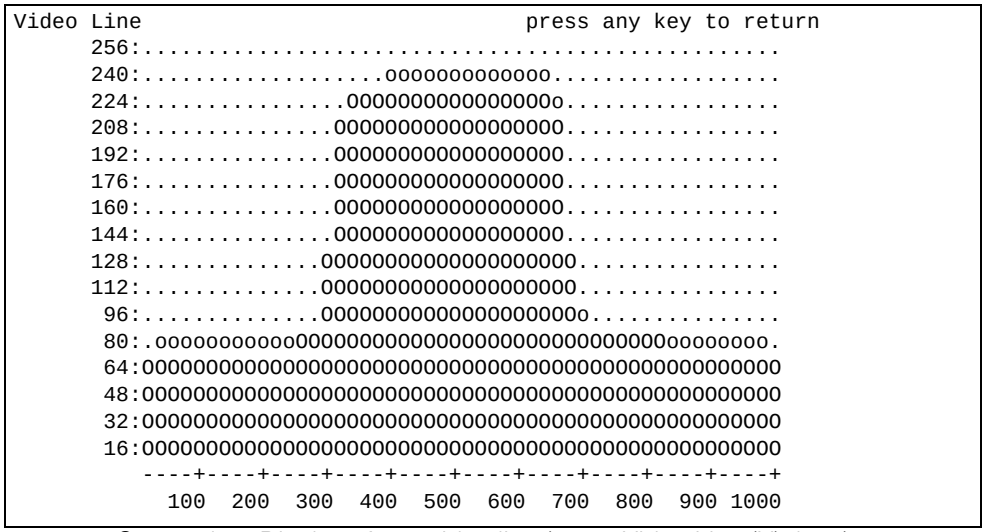


Figure 15 Screenshot: Display of one video line (menu Video Line (V)alues)

The result of the interpretation algorithm is shown in the following diagram.

4.7 Covariance Values

This diagram shows the results of the Covariance function over the location (in pixels):

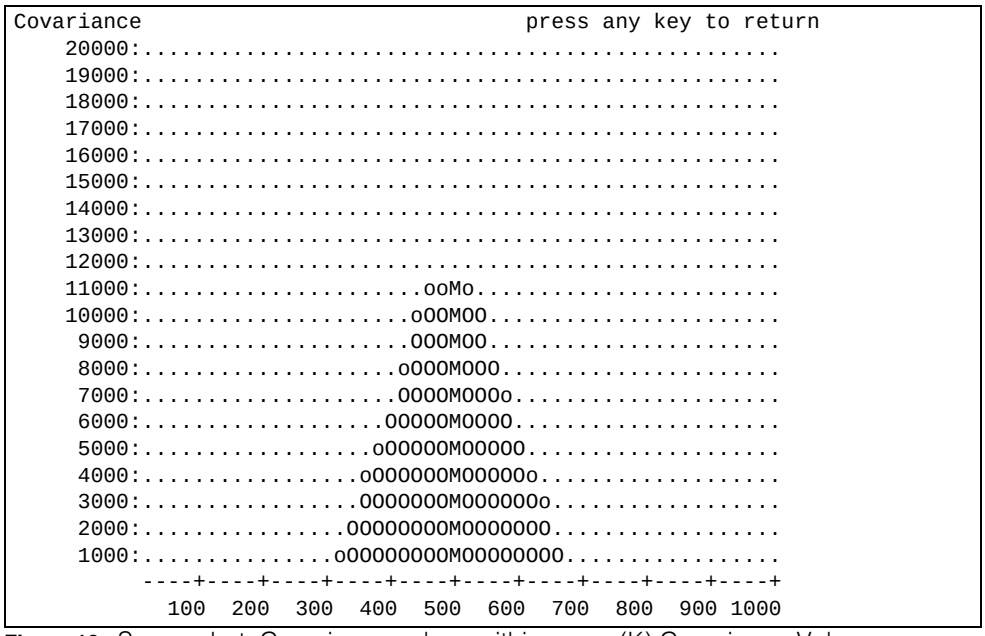


Figure 16 Screenshot: Covariance values within menu (K) Covariance Values

Where the result of the function reaches a maximum, an `M` is displayed. This diagram is an aid for the determination of the best value of `Peak threshold` within menu `Image Settings` in section 4.3 on page 22.

4.8 Print CSV Values

The submenu was created to enable printing the most important values online. The values for `Status`, `Maximum of the Covariance function`, `Location (in Pixels)` of this maximum, `location of a possible 2nd Maximum` and the output `Deviation in Millimeters` are printed. If two maxima are available, the one used for guidance is always set at first position. The values are separated by comma and e. g. may be recorded using Hyperterm and then stored into a file for analysis.

```
4330,17300, 370, 134,   20
4330,17273, 370, 134,   20
4330,17273, 370, 134,   20
4330,17282, 371, 134,   21
4330,17282, 371, 134,   21
4330,17251, 370, 134,   20
4330,17281, 370, 134,   20
4330,17281, 370, 134,   20
4330,17280, 371, 134,   21
4330,17280, 371, 134,   21
4330,17301, 371, 134,   21
4330,17301, 371, 134,   21
```

Figure 17 Screenshot: CSV output within menu Print (C)SV Values

4.9 Write EEProm Values

This submenu is used for recording parameter settings. The following message appears:

- Activate File recording, press any key to continue

Activate the function <Transmission><record text> in Hyperterm and press any key. All parameters are output with their names, a ',' and their value.

Now deactivate this submenu in Hyperterminal via <Transmission> <record text> and <quit>. The values are now stored in the selected file.

4.10 Load Values to EEprom

This submenu is used for permanently storing changed parameters. To do so it is essential to input the password `815` via P.

4.11 Firmwareupdate

It is possible to program the firmware into the used processor via the available serial interface. To do so, it is necessary to set up the serial connection to the PC. Afterwards you can, as described below, program the processor with a new firmware by using the software tools `FLASH269.EXE`

4.11.1 Installation des Flash-Programms

No formal installation is needed. Simply follow the following steps to run the program on your PC.

1. Create a directory for the executalbe file `FLASH269.EXE` (it will then create the programm surface)

2. Copy the file `FLASH269.EXE` into this directory.

2. Copy the file `FLASH269.DLL` in the Windows system directory:

- Windows 95/98: C:\WINDOWS\SYSTEM
- Windows NT/2000 or higher: C:\WINNT\SYSTEM

4.11.2 Using the flash program

Start the programm `FLASH269.EXE` in the directory created in. The following mask appears:

Figure 18 Screenshot Flash ST10F269

Select the corresponding Firmware-Hex file and den relevant COM port. Then enter the password `815` via [P] and start the updating process with ([B])oot Load. It is important, that the Hyperterm connection is interrupted afterwards (e. g. via submenu <connect> <interrupt> or the corresponding Icon).

Now select <Program Target Device> within program <Flash ST10F269> and confirm the appearing question. Once the programming has been successful, it is essential to switch off the device and then switch it on again. The main menu (refer to Figure 9 on page 19) now displays the corresponding program version.

5 Technical Data

cameras		2 camera systems are alternatively available, Composite Video, Signal 1 V_{PP} at 75 ohm
preliminary adjustment of the interpreter		for camera HW DEV00035 (opening 42°) 700 mm reading height, track width 150 mm, light track on dark ground
Interfaces		
	digital inputs	not electrically insulated inactive for U_{in} < 9 V, active for U_{in} > 15 V, Ri > 3300 Ohm Max. range: 30 V < U_{in} < +30 V
	digital outputs	not electrically insulated Ri ~ 0,4 Ohm Ua ~ Ub for active Ua < 1,5 V for inactive Ia < 0,7 A per channel, short-circuit proof
	analog output	not electrically insulated, ±10 V max. ±1 mA
	serial configuration	38400 baud, 8 data bits, even parity, 1 stop bit, not electrically insulated
Update rate		40 ms
Accuracy		refer to diagrams in 3.3 on page 11
Operating voltage		24 VDC -25 %, +50 %
Current consumption		approx. 180 mA at 24 V (without camera)
Output voltage for camera		adjustable from +5 V.. +15 V to 1 A
Dimensions		see Figure 4 on page 10
Temperature range		-20° C to +60° C
Protection class		IP65 with bolted plug caps
Weight		1,100 g

Table 11 Technical data

6 Handbook Conventions

In documentations of Götting KG the following symbols were used at the time of printing this manual:

- **Safety notes** have the following symbols, depending on the emphasis and the degree of exposure:

WARNING!

CAUTION!

ATTENTION!

NOTE!

- Continuative information and tips are identified as follows:

Tip!

- Program texts and variables are highlighted by using the `font 'Courier'`.
- Whenever input of key combinations is required for the operation of programs, the corresponding Keys are Highlighted (in Götting KG programs it is usually possible to use small and capitalized characters equally).
- Sections, figures and tables are automatically numbered consecutively throughout the entire document. In addition, each document has an index listed behind the front page, including pages and - whenever the document has more than 10 pages - following the actual system description a figure and table index in the back. In certain cases (for long and/or complicated documents) a subject index is added.
- Each document provides a table block with metainformation on the front page, indicating the system designer, author and translator , revision and date of issue. In addition, the information regarding revision and date of issue are included within the footer of each page, enabling the exact allocation of the information with a date and a certain system revision.

- The online version (PDF) and the printed manual are generated from the same source. Due to the consistent use of Adobe FrameMaker for our documentations, all directory entries (including page numbers and subject index) and cross references in the PDF file can be clicked on with the mouse and will lead to the corresponding linked contents.

7 List Of Pictures

8 List Of Tables

9 Copyright and Terms of Liability

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Any information given is to be understood as system description only, but is not to be taken as guaranteed features. Any values are reference values. The product characteristics are only valid if the systems are used according to the description.

This instruction manual has been drawn up to the best of our knowledge. Installation, setup and operation of the device will be on the customer's own risk. Liability for consequential defects is excluded. We reserve the right for changes encouraging technical improvements. We also reserve the right to change the contents of this manual without having to give notice to any third party.

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