Optical Line Tracker For Two Cameras

HG 73830ZA

-CANopen®-

English, Revision 02	Developed by: W.M.
Date: 23.11.2015	Author(s): RAD / L.S.
Götting KG, Celler Str. 5, D-31275 Lehrte - Röddensen (Germany), Tel.: +49 (0) 51 36 / 80 96 -0, Fax: +49 (0) 51 36 / 80 96 -80, eMail: techdoc@goetting.de, Internet: www.goetting.de	

Content

1 Introduction

1.1 Interpreter

This document describes the Optical Line Tracker (interpreting unit) G 73830ZA 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 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 is realized over an integrated DC chopper converter. The output voltage is adjustable in range between 5 and 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 CAN baud rate is set to 125Kbaud, the Node ID is preset to 1. The interpreter is preset to a track width of 150 mm (light track on dark background) and 100 mm reading distance for the camera HW DEV 000035. The thresholds for signaling deviation are set to ±50 mm and ±100 mm. The parallel interface is deactivated.

The presettings can be altered using either a terminal program (e. g. Hyperterm on your PC) or via the various SDOs of the CANopen® protocol (also refer to section Table 5 on page 18 and section 5 on page 28).

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).

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.

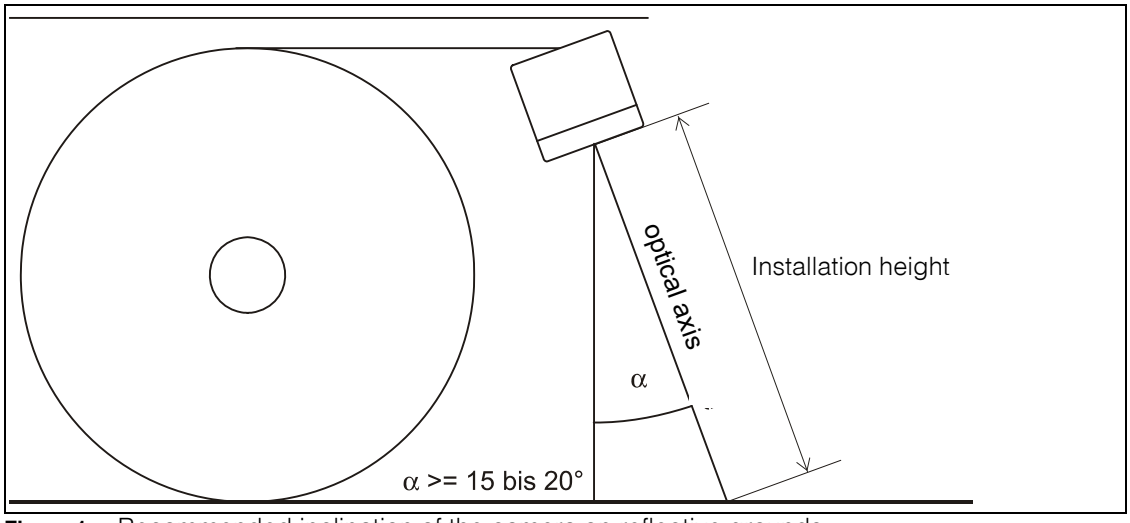


Figure 1 Recommended inclination of the camera on reflective grounds

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.

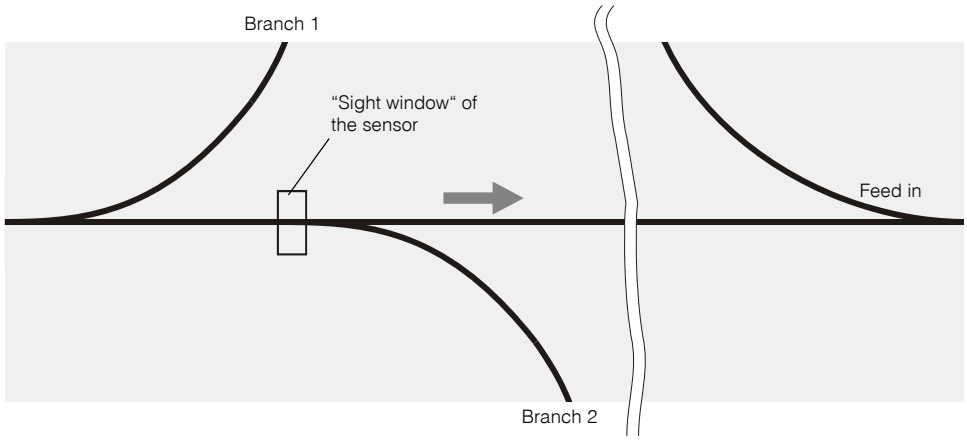


Figure 2 Structure of branch-offs and crossing tracks

2.4 Additional Commissioning Steps

Use the built-in parameter menu for setting the parameters (refer to chapter Table 5 on page 18). 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 DEV000035 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 22).
- 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 or in the corresponding SDOs of the CANopen® protocol. For each set of parameters different inputs are possible when using the following variables:

- in the menu `Image Settings` (see 4.3 on page 20) 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 22) the points `X-Threshold for Output 1,2 / X-Threshold for Output 3,4`

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

- Move the marker on the display (parameter `Startline` within menu `Image Settings`, refer to section 4.3 on page 20) 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 7).

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 20). Select the threshold for the guidance line quality warning according to your requirements.

Now, go to the `Luminance Histogram` (refer to section 4.6 on page 24). 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.

Once all settings have been entered, it is necessary to save the new parameters (refer to section Table 5 on page 18).

2.5 Improving the Resolution

If the values for track width and camera height (see 4.3 on page 20) are adjusted correctly the resolution of the system is 1 mm. The resolution can be improved by applying the following trick:

Example: installtation 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 100 mm 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 22).

3 Hardware

3.1 Casing

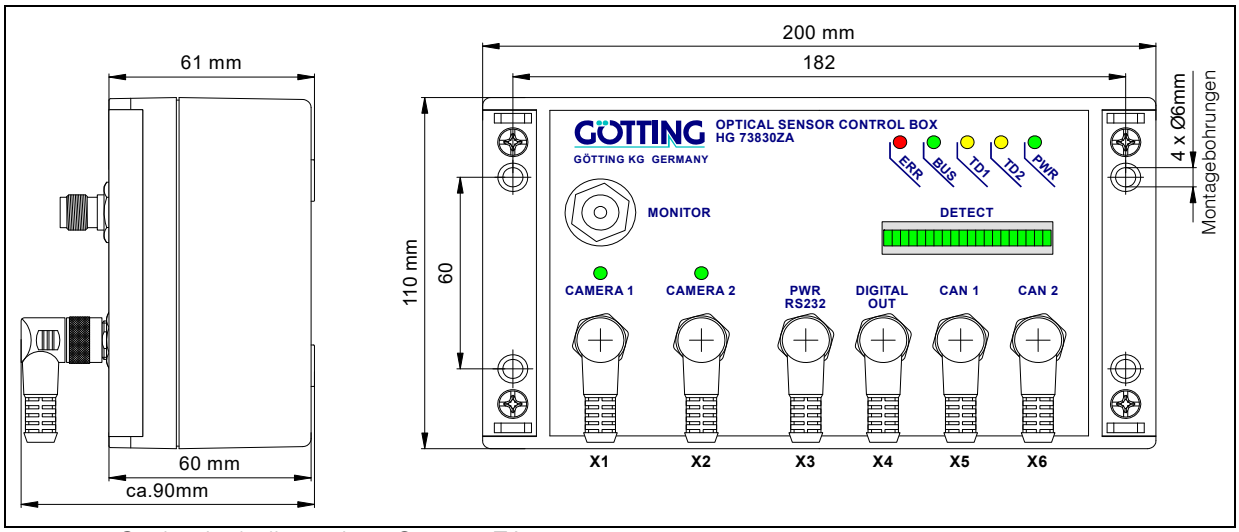


Figure 3 Casing incl. dimensions G 73830ZA

3.2 Block Diagram

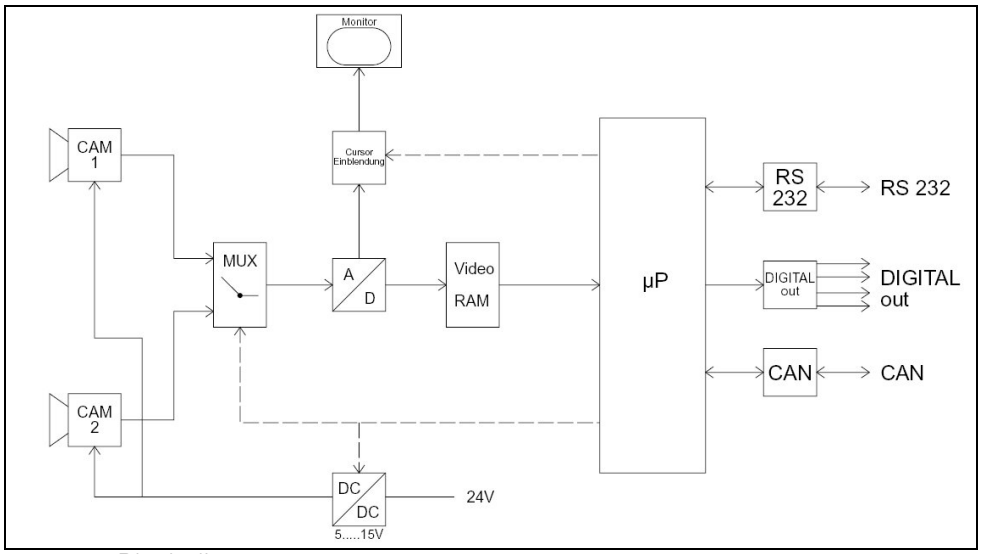


Figure 4 Block diagram

3.3 Diagrams

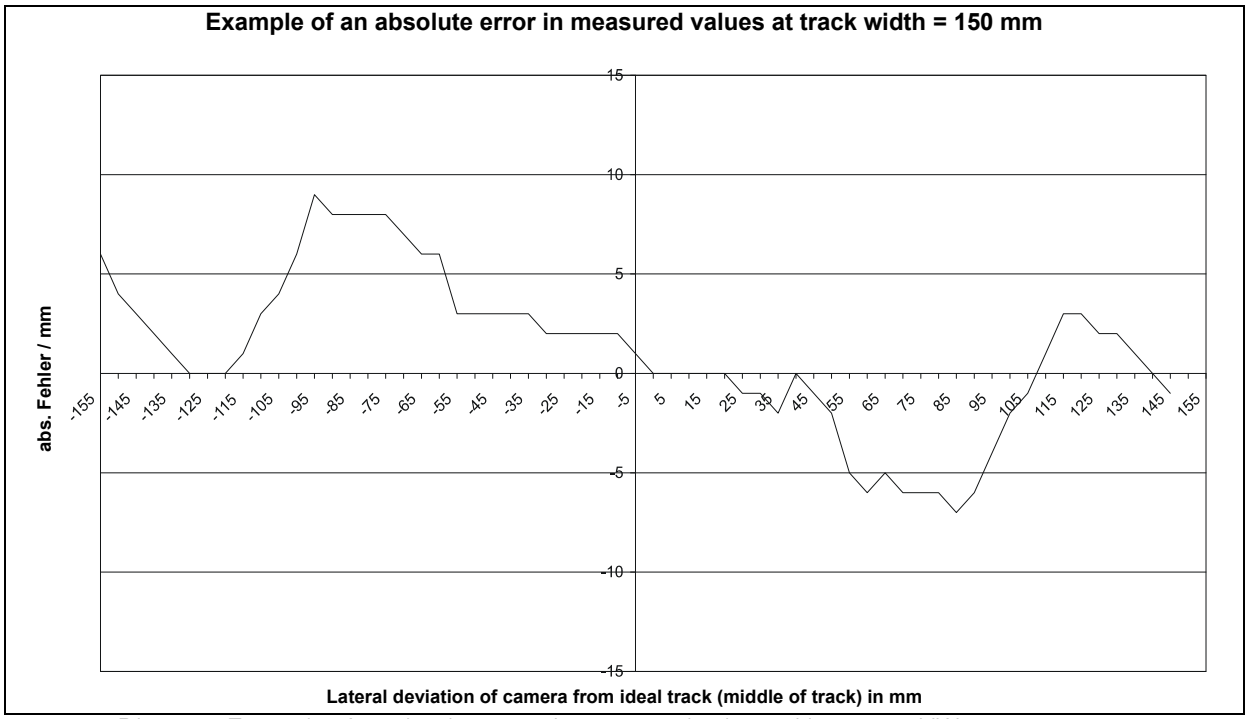


Figure 5 Diagram: Example of an absolute error in measured values with camera HW DEV00035

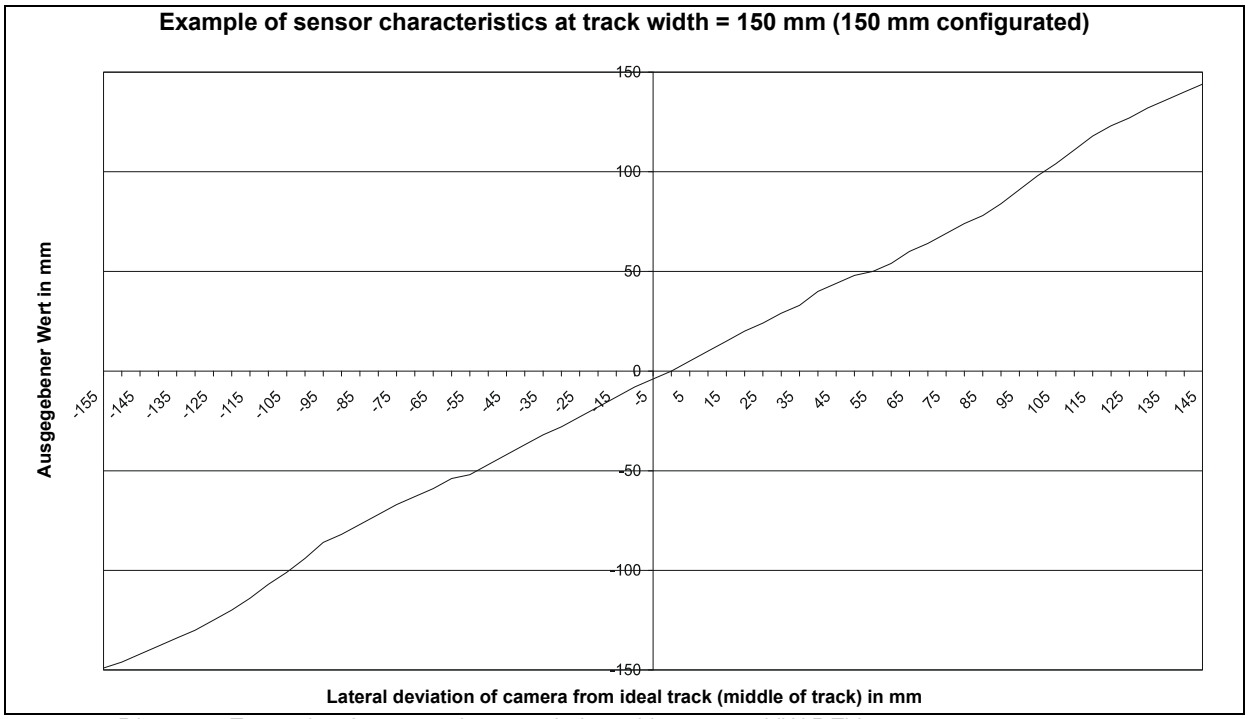


Figure 6 Diagram: Example of sensor characteristics with camera HW DEV00035

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 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)

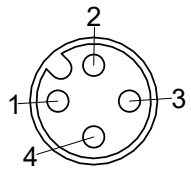
X1, X2	Pin	Signal
	1	Video
	2	Ground
	3	Supply voltage 5..15 V
	4	Ground (supply)

Table 1 Interface X1 and X2

3.4.2 Voltage Supply and Serial Interface

5-pin panel jack

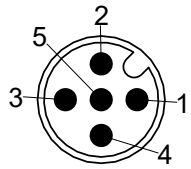
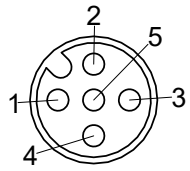
X3	Pin	Signal	Annotation
	1	+Ub (24 V)	
	2	Analog Out	max. deviation of track +-10 V
	3	TxD	RS232 data output
	4	RxD	RS232 data output
	5	GND	Ground (supply)

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)

3.4.4 CAN Bus

Each a 5-pin M12 panel plug with jack, A-coded

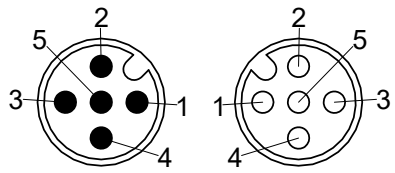
X5 / X6	Pin	Signal
	1	Chassis
	2	+Ub (24 V)
	3	Ground supply
	4	CAN_H
	5	CAN_L

Table 3 Pin allocations X5 and X6

3.4.5 Monitor

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

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 5 on page 18)
- 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

The input information (direction, set of parameters, camera) are transmitted using a SDO (service data object) with the address 0x02000,03 (see Table 26 on page 36). There are four outputs, OUT_1 to OUT_4 (X4) (see Table 3 on page 13). Two symmetric thresholds for deviation can be entered:

- If the track deviation is higher than threshold 1, `OUT1` is set. If it is smaller than the negative threshold 1, `OUT1` is set
- If the track deviation is higher than threshold 2, `OUT2` is set. If it is smaller than the negative threshold 2, `OUT4` is set

The tresholds 1 and 2 can be changed in the menu . The ouputs can be used to affect 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.

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 your 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 16.

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 HyperTerminal subsequently using your Windows installation CD.

1. Open `System Control`.

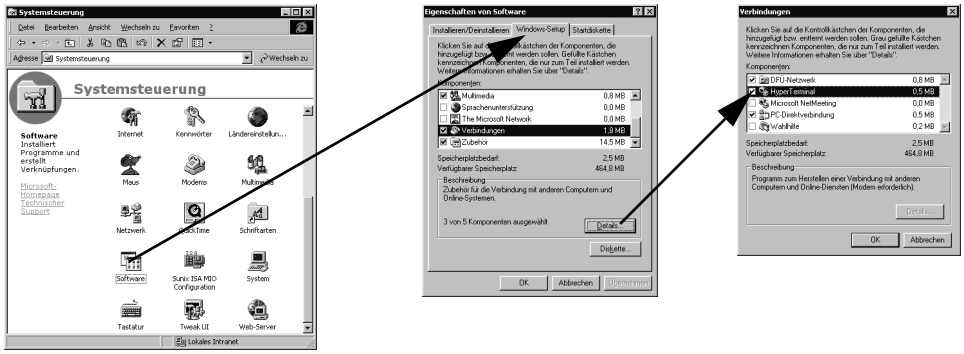


Figure 7 Add HyperTerminal to your system

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

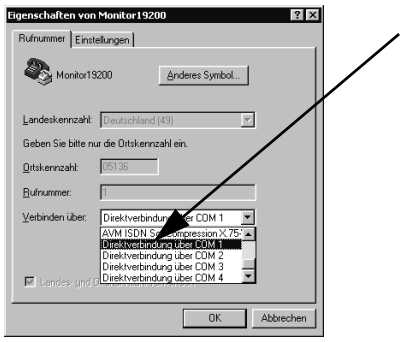
The following parameters are necessary. If you use HyperTerminal you do not have to enter them manually. You can pass this chapter and go to chapter 4.2 on page 16

Terminal settings configuration program (see section 4.2)	
Baudrate	38400 baud
Terminalemulation	VT52
Parität	even
Datenbits	8
Stoppbits	1
Handshake	none
PC-Schnittstelle (Port)	COM1 may vary on some PCs (see below)

Table 4 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 HyperTerminal 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     0 @ 135   X/mm:     0   S: 3030 Code:  10  SCmin:  83 %

    (I)mage Settings
    (O)utput-Input Settings
    C(A)N Menu
    Bar Cod(e)

    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

    (Q)uit
    Software Version  73840A12.00 / 04.May.2009    Serial Number: 7384933
```

Figure 8 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, similar to the output PDO_1 for CANopen, refer to Table 5 on page 18. Entering (B) enables viewing the set status bits as plaintext messages (refer to Figure 9 on page 18).
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 9 on page 18.

```
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 9 Screenshot: Status bits as plain text

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 configuration bits TURN_RIGHT (0x0010) and TURN_LEFT (0+0020) for leaving main course and activation of the analog output according to table 6 on page 19	
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 5 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.

TURN_LEFT	TURN_RIGHT	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.	Follow track with highest covariance value (only one track should be located in the sight window)

Table 6 Coding of the bits TURN_LEFT and TURN_RIGHT in status

Menu Selection:

- I initiates a submenu for input of values for image processing (refer section 4.3 on page 20).
- O enables setting the parallel in/outputs and the voltage output (refer to section 4.4 on page 22).
- With A the CAN menu can be openend.
- 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 4.6 on page 24).
- V generates the brightness values of a line relative to the location (refer to section 4.7 on page 25).
- K initiates the display of the calculated covariance function (refer to section 4.8 on page 25).
- C initiates the output of the following parameters. The values are separated by commas and can be used for recording (refer to section 4.9 on page 26).
  - 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 9 on page 18).
- 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 4.10 on page 26).
- 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 4.11 on page 26).
- 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 4.12 on page 26).

4.3 (I)mage Settings

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

```
Peak 13152 @ 444   X/mm:   -29   S: 4000

    Parameterset:               1       (CAM 1, PARA_SET = 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
    (C)AMSEL                                  Camera1

    Calib-(f)actor                  [(H*pix)/S]:  1307
    (A)djust width of track with image cursor

    Width of Reference Track [pix] = 280

    (Q)uit
```

Figure 10 Screenshot: Menu 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 9 on page 18) 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
- Using C, you are able to switch between camera 1 and 2
- 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 73830ZA is factory set for camera HW DEV 00035.
- Q returns to the main menu.

The submenu `(A)djust width of track with image cursor` is made up 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 11 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 (O)utput-Input Settings

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

```
Peak 13347 @ 458   X/mm:   -24   S: 4000

    Parameterset:               1       (CAM 1, PARA_SET = 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                                    1




    (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 12 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 2 on page 12 and Table 5 on page 18).
- 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 12 on page 22: 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 V.

- 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.

- 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 40 ms is the duration of a possible tolerated interruption.
- J and I enable the configuration of the jump filter.

- Q exits the submenu and returns to the main menu

4.5 C(A)N Menu

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

Bus online     Operational         Last Err: 0000

         (N)ode ID                          [1..127]:     1
         CAN-(B)audrate[20,50,125,250,500,1000 kB]:   125
         (C) TPDO_1 mode              [1..240,255]:   255
         (D) TPDO_1 inhibit time  [0,40..10000 ms]:     0
         (E) TPDO_1 event time    [0,40..10000 ms]:    40

         (I) Heartbeat time      [0,100..65535 ms]:     0

         (A)utostart                                    1
         (H)i Byte first                                1

         (Q)uit
```

Figure 13 Screenshot: CAN Menu

In addition to the above described status line, the CAN bus status is displayed: Bus online switches to Bus offline in case e. g. the CAN bus connector is removed or the CAN bus controller switches to BUSOFF status due to missing terminal resistor. Next to this message, the CANopen® node status: stopped, preoperational or operational is displayed.

Within this menu it is possible to

- select the node address within the range of 1 through 127 via N,
- select the listed baud rates via B, the function autobaud is not implemented,
- select the PDO_1 operational mode via C. With the values 1 through 240 it is possible to choose between synchronous, cyclic and, with 255, asynchronous operational mode. The following two menu functions only exist for the asynchronous operational mode:
  - input the Inhibit time of the PDO_1 via D. In PDO_1 the system status and the calculated distances are transmitted. The Inhibit time is the shortest possible time period between two subsequential transmissions,
  - select the cycle time of the PDO_1 transmission via E. In case both values are 0, PDO_1 is not transmitted.
- change the so-called heartbeat time via I. A control message is transmitted with this cycle time. If the heartbeat time is 0, this function is suppressed. If a value is set for the heartbeat time, the toggle bit of the knot status is no longer changed by remote telegrams (Node Guarding Function).
- activate / deactivate the autostart function via A.
  - If autostart is deactivated, only the heartbeat message is transmitted following the start-up (if activated); the device is then in status `preoperational`.

  - If autostart is activated, immediately upon start-up, `PDO_1` and heartbeat message (if activated) are transmitted; the device is then in status `operational`.

- set the byte sequence of the 16 Bit values within `TxPDO` via H.

4.6 Luminance Histogram

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

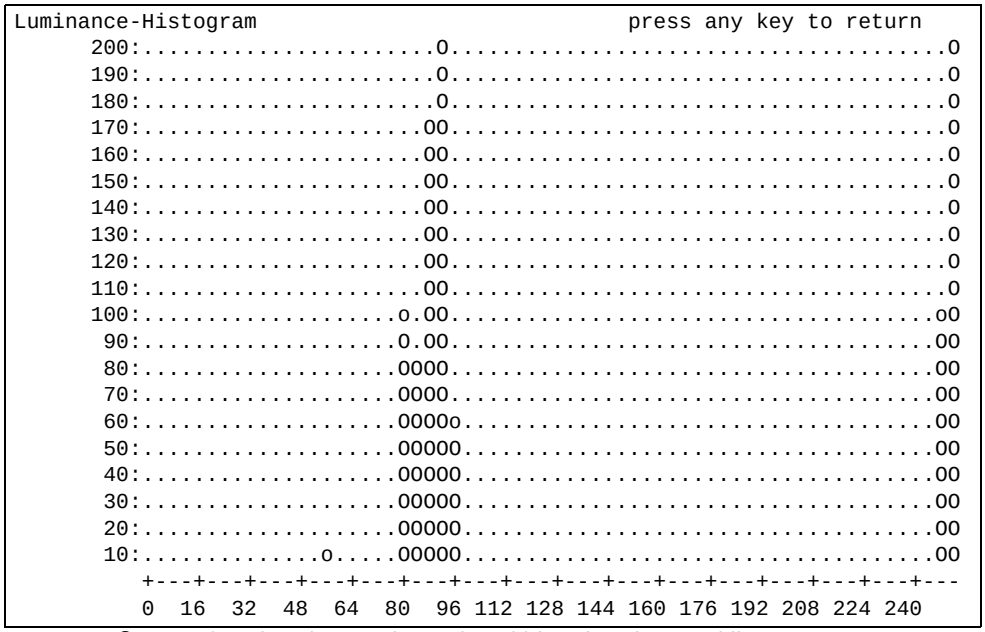


Figure 14 Screenshot: Luminance intensity within a Luminance Histogram

The horizontal axis shows the possible luminance values between 0 and 255. Due to limited space, four 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.

4.7 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 with no doubt.

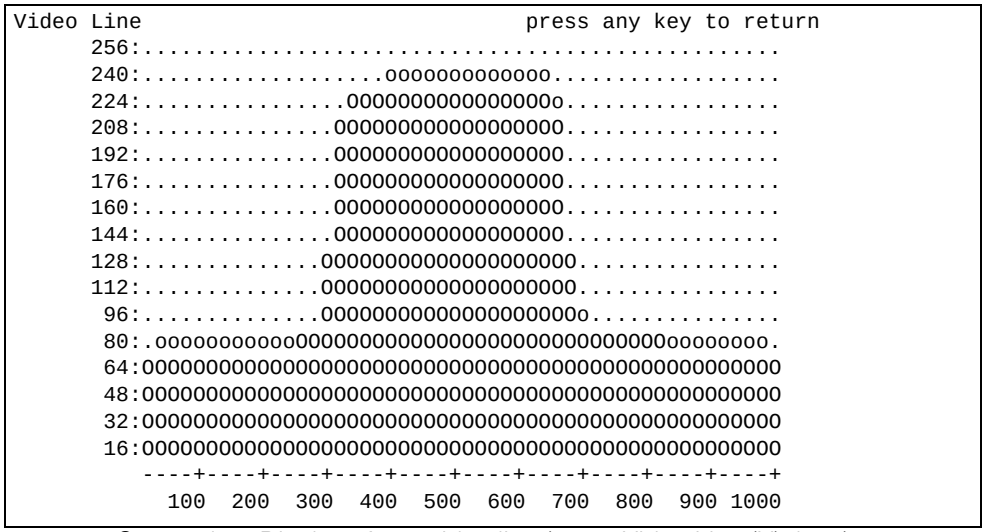


Figure 15 Screenshot: Display of one video line (menu Video Line (V)alues)

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

4.8 Covariance Values

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

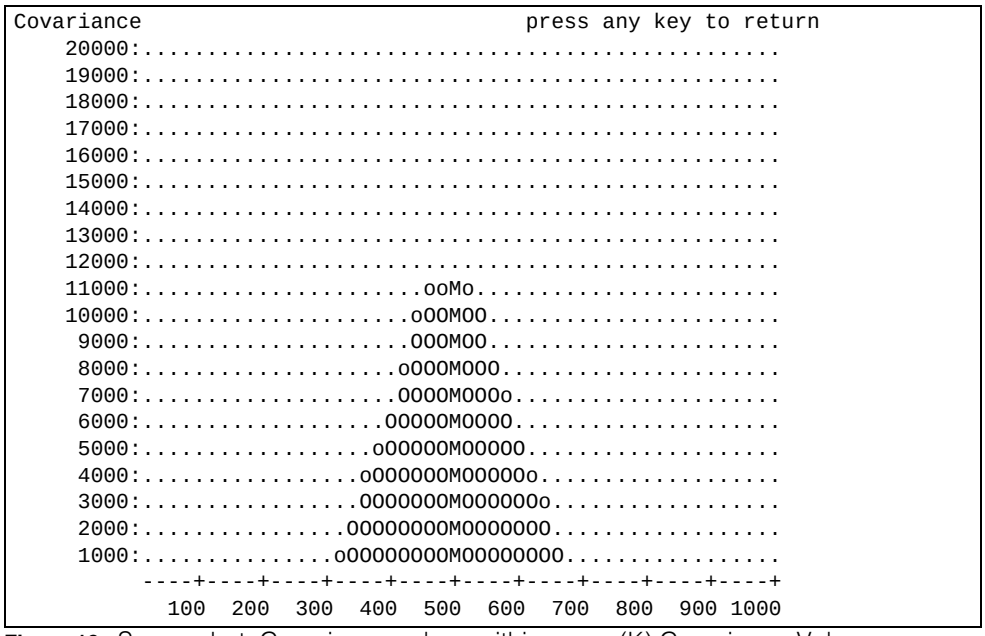


Figure 16 Screenshot: Covariance values within menu (K) Covariance Values

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 20.

4.9 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

4.10 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.

4.11 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.

4.12 Updating the Firmware

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 tool `FLASH269.EXE`

4.12.1 Installation of the Flash Program

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

1. Create a directory for the executable file `FLASH269.EXE` (it will then create the program 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

4.12.2 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 hex file of the firmware and the relevant COM port. Then enter the password `815` via [P] and start the update 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 pop-ups. 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 8 on page 17) now displays the corresponding program version.

5 Data Interface CANopen ®

The node ID and the transmission rate have to be selected either according to the above described serial monitor or the corresponding SDOs. The measured values of the system are transmitted via a so-called TxPDO. SDOs are used for parameter setting. The CAN identifier are determined from the node address (1..127).

5.1 Description of the Process Data Object (PDO)

Fixed places are allocated for the measured values. Dynamical mapping is not possible. It is possible to operate the PDO mode either cyclic, synchronous or asynchronous. In order to avoid excessive bus usage due to continuous exchanges during non-cyclic transmission (Event-Time = 0), it is possible to set the so-called `Inhibit time` within the CAN menu of the serial monitor. It is, however, possible to transmit a PDO cyclically. In this case, it is necessary to select the Event Time accordingly and also set the Inhibit Time = 0.

It is possible to permanently deactivate a TxPDO by selecting the asynchronous mode (255) with Inhibt-Time = 0, Event_time = 0 and storing the parameters. In addition, it is possible to temporarily deactivate/activate the TxPDO by setting/deleting the highest ranking bit within the corresponding PDO COB Identifier.

PDO_1 is transmitted together with identifier 0x180 + node address. It contains 7 bytes, which include, amongst others, the status indicated in serial monitor. The transmission sequence is status, X, peak value, digital inputs and barcode. If no code has been decoded up to now, the value 255 is put out.

Value	Variable	Value range	Comment
Status	unsigned 16	0..0xffff	Status bits according to the following table
X1	signed 16	-32768…..+32767	Track deviation within the range of max. -250 [mm] to +250 [mm]
PEAK	unsigned 16	0....65535	Peak value of the covariance function

Table 7 Variables of PDO_1

The meaning of the status bits is described in Table 5 on page 18.

The synchronous identifier is 0x80. It is possible to read out this parameter under index [1005,00], but it is not possible to change it.

5.2 Heartbeat

The optical line tracker supports the heartbeat mode. Whenever a heartbeat time > 0 is set in the CAN menu, the device status is transmitted under identifier (0x700 + node address) once the heartbeat timer has expired. The guard time is then set to 0.

Node status	Code
stopped	0x04
preoperational	0x7f
operational	0x05

Table 8 Coding of the Node status

5.3 Node Guarding

Whenever the Heartbeat time is set to 0, the device replies to a Remote Transmission Request of the Identifier (0x700 + Node address) with the device status (refer to Table 8 above), while the highest bit changes. The device does not monitor the timely reception of RTR Frames.

5.4 Description of the Service Data Objects (SDOs)

The service data opject is used to access to the object index. An SDO is always transmitted with a confirmation, i. e. each reception of the message is acknowledged. The identifiers for read and write access are:

Read access: 0x600 + node address,

Write access: 0x580 + node address.

The SDO telegrams are described in the CiA standard DS-301. The error codes in case of faulty communication are listed in the following table:

Name	Number	Description
SDO_ABORT_UNSUPPORTED	0x06010000	non-supported access to an object
SDO_ABORT_READONLY	0x06010001	write access to a read-only object
SDO_ABORT_NOT_EXISTS	0x06020000	object not implemented
SDO_ABORT_TRANSFER	0x08000020	The signature 'load' or 'save' was not used for loading or saving parameters.
SDO_ABORT_PARA_VALUE	0x06090030	Parameter value range exceeded
SDO_ABORT_PARA_TO_HIGH	0x06090031	Parameter value too high

Table 9 Error codes

5.5 Object Index

All objects relevant for the device are included in the CANopen Object Index. Each entry is indicated by a 16 bit index. Sub-components are indicated by a 8 bits subindex. RO indicates only readable entries.

- Communication parameters are indicated by C in the corresponding tables.

- Manufacture parameters are indicated by M in the corresponding tables.

The object index is subdivided into the following areas:

5.5.1 Communication specific Entries within the Range of 0x1000 to 0x1FFF

Index	Subindex	Access	Content	EEProm
0x1000	0	RO	Device Type	
0x1001	0	RO	Error Register	
0x1005	0	RO	COB ID Sync Message	
0x1008	0	RO	Device Name	
0x1009	0	RO	Hardware Version	
0x100A	0	RO	Software Version	
0x1010	0	RO	Number of entries of Save Parameter	
	1	RW	Save all	
0x1011	0	RO	Number of entries of Restore Default Parameter	
	1	RW	Restore Default all	
	2	RW	Restore Default Communication Parameter	
	3	RW	Restore Default Manufacture Parameter	
0x1017	0	RW	Producer Heartbeat Time	C
0x1018	0	RO	Number of entries of Identity Object	
	1	RO	Vendor ID	
	2	RO	Product Code	
	3	RO	Revision	
	4	RO	Serial Number	
0x1800	0	RO	Number of entries of Transmit PDO_1	
	1	RW*	COB-ID	
	2	RW	Transmission Type	C
	3	RW	Inhibit Time	C
	5	RW	Event Time	C

Table 10 Overview object index I (part 1 of 2)

Index	Subindex	Access	Content	EEProm
0x1A00	0	RO	Number of Objects mapped to Transmit PDO_1	
	1	RO	Specification of appl. object 1	
	2	RO	Specification of appl. object 2	
	3	RO	Specification of appl. object 3	
*) Only the highest bit may be altered, in order to (de)activate the PDO temporarily.				

Table 10 Overview object index I (part 2 of 2)

5.5.2 Manufacturer specific Entries starting at 0x2000

Index	Subindex	Access	Content	EEProm
0x2000	0	RO	Number of parameters	
	1	RW	Startline	M
	2	RW	U_Camera	M
	3	RW	Config	M
	4	RW	Threshold_1	M
	5	RW	Threshold_2	M
	6	RW	Track_mm	M
	7	RW	Height_mm	M
	8	RW	Peak_Level	M
	9	RW	Warn_Level	M
	10	RW	Calib_factor	M
0x2001	0	RO	Number of Parameter	
	1	RW	Node Baudrate	C
	2	RW	Node ID	C

Table 11 Overview object index II

5.5.3 Standardized Device Profile higher than 0x6000

0x6100	0	RO	Number of 8 Bit Digital Inputs
	1	RW	System Status/ delete port error (W)
	2	RO	Barcode

Table 12 Overview object index III

0x6404	0	RO	Number of 16 Bit analog Inputs
	1	RO	X [mm]
	2	RO	Peaklevel of Covariance

Table 12 Overview object index III

5.6 CANopen® Directory

5.6.1 Device Type

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1000	00	Device Type	Unsigned 32	RO	No	0x00050191	Digital/analog Inputs - DS 401

Table 13 CANopen® Directory: Device Type

5.6.2 Error Register

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1001	00	Error Register	Unsigned 8	RO	No	0x00	Error Register

Table 14 CANopen® Directory: Error Register

Always 0 (no error)

5.6.3 COB-ID SYNC message

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1005	00	COB-ID SYNC	Unsigned 32	RO	No	0x80000080	Sync Consumer, Sync ID = 0x80

Table 15 CANopen® Directory: COB-ID SYNC message

5.6.4 Device Name

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1008	00	Device Name	Visible string	RO	No	„7384“	Device name: „G73840ZA“

Table 16 CANopen® Directory: Device Name

5.6.5 Hardware Version

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1009	00	Hardware Version	Visible_String	R0	No	„0ZA2“	Version number

Table 17 CANopen® Directory: Hardware Version

5.6.6 Software Version

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x100A	00	Software Version	Visible_String	R0	No	„2.00“	Version number

Table 18 CANopen® Directory: Software Version

5.6.7 Save Parameter

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1010	00	Save Parameter	Unsigned 8	RO	No	0x01	number of sub indexes
	01	Save All	Unsigned 32	RW	No	0x00000001	Save All is possible

Table 19 CANopen® Directory: Save Parameter

By writing the signature 'save' in ASCII Code (hex-Code: 0x65766173) onto subindex 1, the currently set parameters are permanently saved. A successful recording procedure is acknowledged by a TxSDO (1. Byte = 0x60) after approx. 400 ms. During the saving process it is not possible to transmit or receive CAN telegrams.

5.6.8 Restore Default Parameter

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1011	00	Restore Parameter	Unsigned 8	RO	No	0x03	Number of subindexes
	01	Restore All	Unsigned 32	RW	No	0x00000001	Restore All is enabled
	02	Restore Communication	Unsigned 32	RW	No	0x00000001	Restore Communication is possible
	03	Restore Manufacture	Unsigned 32	RW	No	0x00000001	Restore Manufacture is possible

Table 20 CANopen® Directory: Restore Default Parameter

By writing the signature 'load' in ASCII Code (hex-Code: 0x64616F6C) onto subindex 1, 2 or 3, the corresponding default parameters are loaded. A reset should be carried out.

- Communication parameters are indicated by C in the corresponding table.
- Manufacture parameters are indicated by M in the corresponding table.

In case or 'Restore All', the Node ID is also set to 1 and the baud rate to 125 Kbaud.

5.6.9 Producer Heartbeat Time

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1017	00	Producer Heartbeat Time	Unsigned 16	RW	No	1000	Heartbeat time in ms (approx.)

Table 21 CANopen® Directory: Producer Heartbeat Time

In case 0 is set, this function is deactivated.

5.6.10 Identity Object

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1018	00	Identity Object	Unsigned 8	RO	No	0x04	Number of subindexes
	01	Vendor ID	Unsigned 32	RO	No	0x00000202	Manufacturer number given by CiA
	02	Product Code	Unsigned 32	RO	No	0x00073840	HG Number 7384(0)
	03	Revision	Unsigned 32	RO	No	0x00000100	Version 1.00
	04	Serial Number	Unsigned 32	RO	No	9999999	Serial number

Table 22 CANopen® Directory: Identity Object

5.6.11 Transmit PDO_1 Parameter

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x1800	00	TxPDO_1 Parameter	Unsigned 8	RO	No	0x05	Number of subindexes
	01	COB ID	Unsigned 32	RW	No	0x40000180 + Node-ID	PDO_1 valid, ID = 0x180 + Node ID
	02	Transmis-sion Type	Unsigned 8	RW	No	255	Asynchronous event-driven
	03	Inhibit Time	Unsigned 16	RW	No	100	shortest time between trans-missions [µs]
	05	Event Time	Unsigned 16	RW	No	10	Cycle time [ms]

Table 23 CANopen® Directory: Transmit PDO_1 Parameter

5.6.12 Mapping TPDO_1

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
1A00	00	Number of mapped objects	Unsigned 8	RO	No	0x05	Number of subindexes
	01	1st mapped object	Unsigned 16	RO	No	0x61000110	mapped on index 0x6100,01 with 16 bit length (status)
	02	2nd mapped object	Unsigned 16	RO	No	0x64040110	mapped on index 0x6404,01 with 16 bit length (X)
	03	3rd mapped object	Unsigned 16	RO	No	0x64040210	mapped on index 0x6404,02 with 16 bit length (Peak)

Table 24 CANopen® Directory: Mapping TPDO_1

5.6.13 Manufacture Parameter

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x2000	00	number of parameter	Unsigned 8	RO	No	0x0A	number of subindexes
	01	Startline	Unsigned 8	RW	No	100	start of picture interpretation in lines
	02	U_camera	Unsigned 16	RW	No	120	voltage of camera in 100 mV steps
	03	Config	Unsigned 16	RW	No	0x0003	configuration accord. to Table 26 on page 36
	04	Threshold_1	Unsigned 16	RW	No	100	threshold deviation signaling 1
	05	Threshold_2	Unsigned 16	RW	No	150	threshold deviation signaling 2
	06	Track_mm	Unsigned 16	RW	No	150	track width in mm
	07	Height_mm	Unsigned 16	RW	No	700	installation height of camera in mm
	08	Peak_Level	Unsigned 16	RW	No	8000	threshold value for covariance evaluation
	09	Warn_Level	Unsigned 16	RW	No	10000	threshold for track warning
	10	Calib_factor	Unsigned 16	RW	No		calibration for camera

Table 25 CANopen® Directory: Manufacture Parameter

5.6.14 Codes for System Configuration

Bit Value	Name	Description
0x0001	AUTOSTART *)	CAN status after start-up is operational if set *)
0x0002	CAMSEL**)	camera input 2 is active if set
0x0004	./.	./.
0x0008	INVTRACK_1)	When set values from set of parameters 1: evaluation dark track on light ground if set *)
0x0010	HOLD_ANA_OUT	refer to menu (O)utput-Input Settings in section 4.4 on page 22 –> (H)old analogue value

Table 26 CANopen® Directory: Codes for System Configuration (part 1 of 2)

Bit Value	Name	Description
0x0020	./.	./.
0x0040	TURN_RIGHT **)	refer to Table 6 on page 19
0x0080	TURN_LEFT *)	refer to Table 6 on page 19
0x0100	CUR_ON	switching the track markings to control monitor *)
0x0200	HILO	byte sequence for 16 bit variable in TxPDO1: "High Byte first" if set
0x0400	EDGE	When set, a track is interpreted as long as the covariance maximum does not exceed the set threshold, even if it crosses the left or right border. The bits TURN_RIGHT and TURN_LEFT have to be the same.
0x0800	./.	./.
0x1000	PARASET	Choice of set of parameters for each camera (see Table 27 on page 37)
0x2000	INVTRACK_2	From set of parameters no. 2: Interpretation dark track on light ground when set
0x4000	INVTRACK_3	From set of parameters no.3: Interpretation dark track on light ground when set
0x8000	INVTRACK_4	From set of parameters no. 4: Interpretation dark track on light ground when set
*) Once any of these parameters have been changed, they have to be saved via the function <save all> and afterwards a Node Reset has to be carried out. In this case camera selection and turning information are also permanently saved. However, these values can also be dynamically altered. **) influences the system only if parallel inputs are disabled		

Table 26 CANopen® Directory: Codes for System Configuration (part 2 of 2)

5.6.15 Set of Parameters

CAMSEL (value 0x0002)	PARASET (value 0x1000)	Set of parameters
0	0	1
0	1	2
1	0	3
1	1	4

Table 27 Set of parameters and configuration bits

5.6.16 Manufacture Parameter - Node Parameter

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x2001	00	number of parameter	Unsigned 8	RO	No	0x02	number of subindexes
	01	Node Bau-drate	Unsigned 8	RW	No	0x02	125 kbaud according Table 29 bottom *)
	02	Node ID	Unsigned 8	RW	No	0x01	Node address 1 *)

Table 28 CANopen® Directory: Set of Parameters

AFTER CHANGING THESE VALUES, THEY HAVE TO BE SAVED WITH <SAVE ALL> AND A NODE RESET HASB TO BE PROCEEDED

input / output value	Baud rate / kBaud
7	20
6	50
4 (Default)	125
3	250
2	500
0	1000

Table 29 Set of Parameters: Coding of baud rates

5.6.17 16 Bit Status (transmission in TxPDO 1)

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x6100	00	number of 16 bit inputs	Unsigned 8	RO	No	0x01	number of sub inde-xes
	01	16 bit digital input	Unsigned 16	RW	Yes	./.	System status / TxP-DO_1 accord. to Table 5 on page 18 / delete port errors

Table 30 CANopen® Directory: 16 Bit Status (transmission in TxPDO 1)

5.6.18 16 Bit Analog Inputs (transm. in TxPDO 1)

Index	Sub Index	Name	Type	Attr.	Map	Default	Description
0x6404	00	number of 16 bit analog inputs	Unsigned 8	RO	No	0x02	number of the analog 16 bit inputs
	01	X mm	Signed 16	RO	Yes	./.	X / TxPDO_1
	02	Peak	Unsigned 16	RO	Yes	./.	Peak / TxPDO_1

Table 31 CANopen® Directory: 16 Bit Analog Inputs (transm. in TxPDO 1)

5.7 EDS Configuration File

Electronic Data Sheet: The so-called EDS-File is available via the internet via the site http://www.goetting.de/en/download/start.html. The file name is `73830A1.EDS`

6 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		
	CAN bus	electrically insulated CANopen® , Device Profile DS 401, node ID and transmission rate configurable using serial interface or SDO. Terminating resistor ist not integrated.
	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 3 on page 10
Temperature range		-20° C to +60° C
Protection class		IP65 with bolted plug caps
Weight		1,100 g

Table 32 Technical Data

7 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. 

8 List Of Pictures

9 List Of Tables

10 Copyright and Terms of Liability

10.1 Copyright

This manual is protected by copyright. All rights reserved. Violations are subject to penal legislation of the Copyright.

10.2 Exclusion of Liability

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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