

# Track Guidance Controller

## Module Segments – Functional Description

### HG 73650-A

|  |                       |
|--|-----------------------|
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## 1 Introduction

This component / module provides the required Can-Bus communication with the steering controller, also called "BR, Track Controller, Guidance Controller or Track Guidance Controller", connected. The information received is stored in a variable attached.

In order to drive automatically a segment sequence is entered into the component in addition to the clearances required. Once a segment has been driven through, the existing segments are moved forward in the component by one position in the list (like in a FIFO - Buffer) and the segment already covered is overwritten.

The segment currently driven on is on top of the buffer. Procedure according to established operation of the steering controller. Information regarding segment handling is described in the document HG 73650 *Basics, Setup and Software*.

In order to identify the required starting segment that matches the current position, a segment search is triggered in the component. A list showing driveable segments from this position is produced as a result.

If the vehicle is moving, this list is no longer up to date and can no longer be used. That means, that the vehicle must stand still during a segment search.

Passing a segment means, that the steering controller's output issues the target steering angle and the target vehicle velocity via the interface of the component.

The target vehicle velocity is stored in the segment itself. The target steering angle results from the vehicle's position. Various additional information can also be stored and linked with actions via attributes in the segments.

## 2 Control

### 2.1 Program Integration

#### 2.1.1 Specification of Variables

Local variables declaration of that component in which the module *segment* will be called:

```
firstrun : BOOL := TRUE;
```

Global variables declaration:

```
BR: Steering controller interface;          (* Status variables steering controller *)
Segs: Segments;                            (* Segment module for global access *)
BR_CAN: BR_CAN_ifm_CR108x;                 (* BR CAN receive and transmit data,
enter FB to match the used hardware*)
```

#### 2.1.2 Call instruction

(\* Initialisation \*)

```
IF firstrun THEN
  Segs.Peripheral := 2#00000100;(* Periphery at BR: Laser scanner *)
  Segs.SegListLength := 7;
  firstrun := FALSE;
END_IF
```

(\* Module start segments \*)

```
Segs.AutoMode:= BA_Auto;
Segs.EmergencyStopActiv:= emergency stop;
Segs.Acknowledge:= Di_Quit;(*Send error acknowledgement to BR *)

BR_CAN(ReadData := TRUE);(*BR read CAN Data*)
Segs ( );
BR_CAN(ReadData := FALSE);(*BR write CAN Data*)
```

#### 2.1.3 Initialisation

- Adapt variable peripheral to the devices connected. Initial value for operation with transponder antenna and gyro.  
Bit0=TP-Antenna; Bit1=Gyro; Bit2=Laser scanner; Bit3=Servo; Bit4=angle sensor for trailer (0=not available; 1=connected)
- Set *SegListLength* to the maximum number of segments in the segment sequence transferred. This helps to reduce the repetition rate of some for- loops.

#### 2.1.4 Operation

- If the variable *AutomSegSearch* is active, a segment search is initiated at the end of a segment sequence or after tracking. As a result, the current segment and the driveable segments are identified. The specified segment list is shortened internally in *SegList* until the current segment is at zero.

The segment list must be shifted on if the vehicle is tracked between the starting and finishing point and the whole segment sequence cannot be driven through. If AutomSegSearch is deactivated, time can be saved at the end of the segment because the search is not carried out. However, then it must also be possible to drive directly on the segment list subsequently specified because this is not shifted correctly in this position. Because the vehicle is positioned at a defined point, the fact there is no shift is not a disadvantage in this case either. This setting can be changed while the vehicle is driven.

- When calculating the steering angle using PLC, copy this periodically into the *ActSteerAngle* variable.
- Should a malfunction occur, an emergency stop by the track guidance controller must be guaranteed. Regular checks must be carried out to ensure this works. Set the *EmergencyStopTest* variable to TRUE – output at BR I/O 4 is powered down – emergency stop device has triggered an emergency stop – functions properly – return *EmergencyStopTest* variable to FALSE.
- The steering controller gives the current speed and outputs this to the vehicle controller running in the PLC. Status and actual values can be found in this description in section 3.3 „Variables of the structure Steering Controller Interface“ on page 12.

### 2.1.5 Segment search

- With SegSearchRequest the segment search in the steering controller is triggered. During this process (Variable *SegSearchActive* = TRUE) the vehicle must not be moved.  
Once the segment SegSearchRequest has changed to TRUE, the segment search is completed and the result of the SegListController can be used.  
Reset SegSearchRequest to FALSE
- Once the variable *SegSearchErr* had been set no segment search could be carried out.  
In this case it is most likely that the release *Clearance* was manually set to 0 via Hyper Terminal. With the key C in level "Main" the status of *Clearance* can be changed.
- SegSearchNoSeg indicates that no segment is addressable in the environment of the vehicle. Adjust the vehicle's position on the track manually and a new segment search has to be triggered.
- If *AutoMode* is started and the vehicle has been manually moved before, a segment search will be requested automatically (if not already done).

2.2 Flow chart

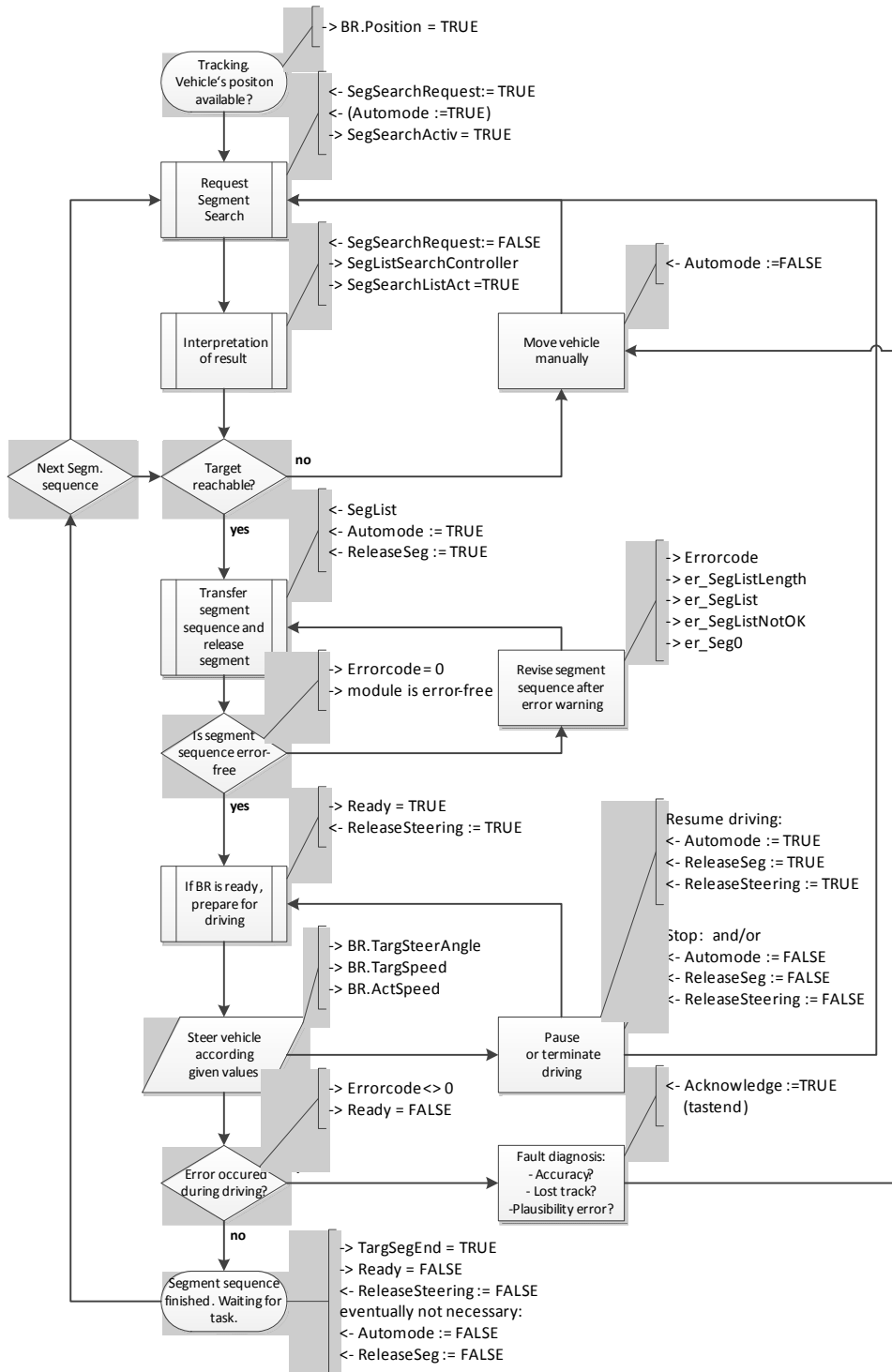


Figure 1 Flow Chart

## 3 Description of Variables

### 3.1 Input Variables

#### 3.1.1 SegList : ARRAY [0..31] OF WORD := 32(16#FFFF)

- Array for the segment sequence transferred to the steering controller as a movement request. 0 functions as the start segment of the sequence.  
If the vehicle is not exactly positioned on a defined point where the driveable segments are already known this segment has to be determined by using the search functionalities.
- Segment numbers from 1 - 65534 must be used.
- Non used entries in the segment list have to be filled up either with 65535 (16#FFFF) or 0.
- The end- and start coordinates of two successive segments have to match and should be free of any angular offset.
- The first line of the X/Y coordinates of segment 0 in the track file is solely reserved for the version number and may not be transferred to the component.

#### 3.1.2 SegListLength: BYTE := 31;

- In order to speed up program processing in the PLC *SegList Length* should be set to the segment number of the longest segment sequence.
- This entry is optional, otherwise the initial value corresponds to the array size. Setting range 7 - 31.

#### 3.1.3 SegSearchRequest: BOOL;

- Triggers the segment search in the controller to obtain the driveable segments for the current position. The search result determines the driveable segment sequences.
- To initiate the segment search a positive edge of the input signal is necessary. This is only possible during standstill.

#### 3.1.4 ReleaseSeg: BOOL;

- A segment release is issued, if the given segment sequence shall be passed.
- A general release may be set without any failure occurring.
- Upon removal of the release signal the steering controller sets the parameters / defaults of TargSpeed and TargSteerAngle to 0.

#### 3.1.5 ReleaseSteer: BOOL;

- Steering controller does not provide TargSteerAngle and TargSpeed before the steering will be released.
- Withdraw steering authorisation if no steering is to occur while stationary (if the servo is directly connected to the guidance controller)



### 3.1.6 **AutoMode: BOOL := FALSE;**

- AutoMode is set if the vehicle is to move by the control unit and not by the driver.
- Can be set directly with "automatic" mode.

### 3.1.7 **Acknowledge: BOOL;**

- Signal for error acknowledgement in steering controller.
- Resetting of message "SegSearchErr"

### 3.1.8 **EmergencyStopActiv: BOOL;**

- Tells the steering controller, that an emergency stop was actuated, e.g. by an emergency stop control unit.

### 3.1.9 **EmergencyStopTest: BOOL;**

- If EmergencyStopTest is requested, the emergency stop relay output on the guidance controller will open.
- The signal must be removed again after an external control system has ensured perfect functioning.

### 3.1.10 **ActSteerAngle: INT;**

- The vehicle's steering angle, calculated by the PLC, is transmitted to the guidance controller in  $0.01^\circ$  steps (if no steering angle sensor is directly connected to the guidance controller).

### 3.1.11 **Optional Input Variables**

#### 3.1.11.1 **AutomSegSearch: BOOL := TRUE;**

- Automatic segment search upon reaching the target (TargSegEnde) and changing to automatic drive.

#### 3.1.11.2 **OperationMode: BOOL := FALSE;**

- Not used

#### 3.1.11.3 **GetPositionMode: BOOL := FALSE;**

- The GetPositionMode is a semi-automatic mode: automatic steering with manual speed. Automatic steering makes tracking the route easier (in large vehicles like trucks).
- The segment must be specified by a segment search so that the vehicle goes on the right track.

#### 3.1.11.4 **SleepTranspAnt: BOOL := FALSE;**

- Message that the transponder antenna has been switched off in order to reduce energy consumption during a longer standstill period.

#### 3.1.11.5 **Loaded: BOOL := FALSE;**

- Vehicle is loaded. Steering controller uses different parameters for the changed wheel perimeter.

### 3.1.11.6 Peripheral: BYTE := 2#00000011;

- Periphery connected to the steering controller for the output of the corresponding status- and error messages.
- Initial value for operation with transponder antenna and gyro.  
Bit0=TP-antenna; Bit1=gyro; Bit2=laser scanner; Bit3=servo; Bit4=angle sensor for trailer (0=not available; 1=connected)

## 3.2 Output variables

SeglistController: ARRAY[0..7] OF WORD := 8(16#FFFF);

Segment list sent from the steering controller

SeglisteSearchController: ARRAY[0..7] OF WORD := 8(16#FFFF);

Result of the latest segment search

SegSearchActive: BOOL;

Segment search active; vehicle must not be moved until the variable changes to false.

SegSearchErr: BOOL;

An error occurred during the search process. The result cannot be applied.

Via HyperTerminal a track was predefined in the steering controller, thus Clearance was set to 0. (With C Clearance can be reset).

SegSearchListAct: BOOL;

Result of the segment search list is up-to-date until the vehicle will be moved

SegSearchNoSeg: BOOL;

Segment search has not found any driveable segment  
Vehicle position on the track has to be changed

SegAct: WORD;

Active segment (SeglistController[0] that is currently driven on or completed.

SegActOk: BOOL;

If SegAct is driveable and no error occurs (e.g. plausibility, leaving the track,...)

TargSeg: WORD;

Target segment of the transport request, last segment of the segment sequence transferred.

TargSegEnd: BOOL;

Current segment is target segment and the segment end was reached.

Movement request has been completed.

SegListPos: BYTE;

Array position of the current segments in the segment list transferred

LastSeg: WORD := 16#FFFF;

The last segment driven on that has been completed.  
Last segment before changing of „Seg.Act“.

SegPoint: WORD; Current position on active segment (Start - Centre - End) not activated!

AutoModeActiv: BOOL;  
Controller is in automode

Ready: BOOL; Steering controller is ready to start and outputs after ReleaseSteering TargSteerAngel and ActSpeed.

### 3.2.1 Error Messages: Module Errors

er\_SegListLength: BOOL;  
Value for maximum length of segment list transferred was parameterised / set incorrectly

er\_SegList: BOOL; Error in segment list

er\_ListNotOK: BOOL;  
Segment list transmitted contains no segment of the current segment search.

er\_Seg0: BOOL; Driveable segment0 detected, not supported by component!!!

### 3.2.2 Error Messages: Control Unit Errors

Errorcode: DWORD;  
Error code upon stop request from controller, as described in documentation "G 73650 D reference manual", chapter 2.2 page 8-9

EmergencyStop: BOOL;  
Emergency Stop

er\_CAN: BOOL; Interferences of CAN communication. Message, even in parameter level.

er\_Para: BOOL; Parameter, segment list or transponder list faulty or not initialised

er\_Servo: BOOL; Error steering servo - even if no steering release is issued.

er\_NoPosExt: BOOL;  
No position from external sensorfusion (Goetting laser scanner with orientation controller)

er\_Gyro: BOOL; Error message from gyro / stop due to angle mean value calculation from gyro

er\_TrailAngle: BOOL;  
Angle error of the trailer

er\_SensAcc: BOOL;  
Accuracy too low, insufficient

er\_Plausi: BOOL; Plausibility error - beyond the segment or current velocity in the wrong direction

er\_DevErr: BOOL; Leaving the track; considerable deviation between target velocity / current velocity

er\_Heading: BOOL;  
Error heading - no reflection mark available or no scanner data.

er\_SegTab: BOOL; Error segment table or error when changing the segment.

er\_RelActSeg: BOOL;  
No segment list received.

er\_SegRel: BOOL;  
No segment release.

er\_VehNotReady: BOOL;  
vehicle not ready for guidance controller automatic mode

er\_Gyro: BOOL; Error message of gyro

Stop\_Gyro: BOOL; stop due to angle calculation from gyro.

inf\_TransponderInit: BOOL;  
Transponder initialised and position calculated.

er\_TransponderAcc: BOOL;  
Insufficient accuracy of transponder position.

er\_Transponderantenna: BOOL;  
Interferences of CAN communication with the transponder antenna.

### 3.3 Variables of the structure Steering Controller Interface

#### 3.3.1 \* Transmitting to the steering controller \*

##### 3.3.1.1 BOX ID 0x194 "SEC:PATH Path Data"

Out\_SEC\_Seg\_Rel: BOOL;  
Segment release

Out\_SEC\_Bearing: BOOL;  
Bearing activation in combination with steering- attribute "bearing"

Out\_SEC\_Toggle: BOOL;  
Transmission-Toggle

Out\_SEC\_SegSearch: BOOL;  
Request for segment search

Out\_SEC\_TargNr: WORD;  
Target segment

Out\_SEC\_SegNr: WORD;  
Segment number in connection with SEC\_Pos

Out\_SEC\_Pos: BYTE;  
Pointer for segment list

Out\_SEC\_Count: BYTE;  
Telegram counter

### 3.3.1.2 BOX ID 0x196 "Steer Angle actual Values"

Out\_SteeringAngle\_front: INT;  
Not used, instead actual steering angle

Out\_SteeringAngle\_back: INT;  
Not used

Out\_SteeringOK: BOOL;  
Steering release so that the steering controller outputs target values

Out\_AutomaticDriving: BOOL;  
BA\_Auto und no segment search

Out\_TrackingMode: BOOL;  
Tracking mode, automatic steering with manual velocity

Out\_ErrorAck: BOOL;  
Signal for error acknowledgement

Out\_EmergencyStopActive: BOOL;  
Test is active

Out\_EmergencyStopTest: BOOL;  
Request for emergency stop test

Out\_SleepTranspAnt: BOOL;  
Switch off Posipulse, Antenna switched off by energy saving mode

Out\_CounterBox2: BYTE;  
Telegram counter

### 3.3.2 Reception from the steering controller \*

#### 3.3.2.1 BOX ID 0x190 "Status vehicle guidance controller"

In\_VehicleNo: BYTE;  
Vehicle number

In\_ReadyState: BYTE;  
Vehicle error, independent from automatic driving

In\_VRdy\_LowAcc : BOOL;  
Accuracy of position not sufficient

In\_VRdy\_OutOfLane : BOOL;  
Upon starting the vehicle is out of track, considerable deviation from target position.

In\_VRdy\_VehErr: BOOL;  
Vehicle is not ready for automatic driving

In\_VRdy\_EmergStop: BOOL;  
Emergency Stop

In\_VRdy\_ParErr: BOOL;  
Parameters, segment list or transponder list faulty or not initialised

In\_StopCondition: DWORD;  
Resolution as in Hyper Terminal

In\_StopCondition1: WORD;  
Error automatic driving, first part from two parts

IN\_VBrk\_SegGo: BOOL;  
Segment release issued

IN\_VBrk\_SegEnd : BOOL;  
Segment end reached

IN\_VBrk\_SensAcc : BOOL;  
Accuracy not sufficient

IN\_VBrk\_EmergStop: BOOL;  
Emergency Stop

In\_VBrk\_er\_Giro: BOOL;  
Error message from gyro / stop due to angle mean value calculation from gyro

IN\_VBrk\_RelAktSeg: BOOL;  
No segment list received

IN\_VBrk\_BearingErr: BOOL;  
Error bearing - no reflection mark available or no scanner data

IN\_VBrk\_NoPosExt : BOOL;  
No position from external sensor fusion (Goetting laser scanner)

IN\_VBrk\_DevErr : BOOL;  
Lost track, deviation too big

IN\_VBrk\_ServoErr: BOOL;  
Error steering servo- even if there is no steering release

IN\_VBrk\_PlausErr : BOOL;  
Plausibility error - beyond the segment or actual velocity in wrong direction

IN\_VBrk\_CANAutErr: BOOL;  
Interferences in CAN communication - message, even if in parameter level

IN\_VBrk\_SegTabErr: BOOL;  
Error segment table or error when changing the segment

In\_StopCondition2: WORD;  
Error automatic driving, second part from two parts

IN\_VBrk\_ErrSegRel: BOOL;  
No segment release

IN\_VBrk\_TrailAngle: BOOL;  
Angle error of the trailer

IN\_HWStatus : BYTE;

In\_CounterBox1 : BYTE;  
Telegram counter Box 190

### 3.3.2.2 BOX ID 0x191 "steering references"

In\_SteerRef\_Status: BYTE;  
"steering references"

In\_SteerRef\_NavSys :BOOL;  
navigation system operation status: 0=operational; 1=non-operational"

In\_SteerRef\_AccFront: BOOL;  
Accuracy front OK

In\_SteerRef\_AccRear: BOOL;  
Accuracy back OK

In\_SteerRef\_DisFront: BOOL;  
Track offset front OK

In\_SteerRef\_DisCentre :BOOL;  
Track offset centre OK

In\_SteerRef\_DisRear :BOOL;  
Track offset back OK

In\_SteerRef\_Seg :BOOL;  
Segment OK

In\_SteerRef\_Dir : BOOL;  
Direction on segment OK

In\_Attribute1:BYTE;  
Attributes according to segment base point, defined by user

In\_Attribute2:BYTE;  
Attribute according to segment base point, defined by user

In\_CounterBox2:BYTE;  
Telegram counter Box 191

### 3.3.2.3 BOX ID 0x192 external sensor fusion with Goetting laser-scanner

NumberOfMarks :BYTE;  
number of identified reflection marks

MarkIdent :BYTE; number of reflection marks identified as listed

LS\_PosFixed: BOOL;  
Scanner has calculated the position

LS\_Error: BOOL; Error occurred

### 3.3.2.4 BOX ID 0x192 with Transponder antenna

Ant\_Status: BYTE; Status antenna 1 and 2

Noise\_Ant1: BOOL;  
Noise at antenna 1

Noise\_Ant2: BOOL;  
Noise at antenna 2

TPdetect\_Ant1: BOOL;  
Transponder detected Ant 1

TPdetect\_Ant2: BOOL;  
Transponder detected Ant 2

CodeOK\_Ant1: BOOL;  
Code transmission is error free Ant 1

CodeOK\_Ant2: BOOL;  
Code transmission is error free Ant 2

DeviationONS: BOOL;  
Deviation between transponder and Odometrie too high

IncErr: BOOL; Monitoring of rotary encoder triggered

### 3.3.2.5 BOX ID 0x195 "Path Data actual"

In\_Path\_AutoAct :BOOL;  
Automatic Steering active

In\_Path\_VehMov :BOOL;  
Vehicle is moving

In\_Path\_OpMode: BOOL;

In\_Path\_Toggle :BOOL;  
Mirrored Toggle Bit

In\_Path\_SegSearch\_akt: BOOL;  
Segment search active in the component

In\_Path\_SegSearch\_end :BOOL;  
Segment search terminated in the component

In\_Path\_TargNr: WORD;  
Target segment in the component

In\_Path\_SegNr :WORD;  
Segment number of segment list in the steering controller on position of PathPos

In\_Path\_Pos: BYTE;  
Pointer for segment list

In\_Path\_Count :BYTE;  
Telegram Counter

PosX: DINT; X-Position

PosY: DINT; Y-Position

Angle: REAL; Angle of vehicle, orientation, heading

AccuracyPos: DWORD;  
Current accuracy



## Description of Variables

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|                      |   |
|----------------------|---|
| Position: BOOL;      | Specified accuracy achieved so that automatic driving can be started        |
| TargSteerAngle: INT; | Set value from steering controller (BR) (steering-angle-reference)          |
| TargSpeed: INT;      | Set value from steering controller (BR) (speed limit on actualpath segment) |
| ActSteerAngle: INT;  | Actual steering angle transmitted by the PLC                                |
| ActSpeed: INT;       | Actual speed calculated by the steering controller (BR)                     |

**4 List Of Pictures**

Figure 1 Flow Chart..... 7

## 5 Essential Information for Reading this Manual

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

- ◆ Security advices have the following symbols, depending on the emphasis and the degree of exposure:

**NOTE!**



**ATTENTION!**



**CAUTION!**



**WARNING!**



- ◆ 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 programmes, the corresponding **K**ey(s) are **H**ighlighted (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 meta-information on the front page, indicating the system designer, author, 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 certain a system revision.
- ◆ Online-Version (PDF) and printed manual are generated from the same source. Due to the consistent use of Adobe FrameMaker for the generation of documentation, 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.
- ◆



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### 6.1 Copyright

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### 6.2 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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