

**CiA<sup>®</sup> 410**



*Device profile for inclinometer*

**Version: 1.3.0**  
**23 February 2010**

**© CAN in Automation (CiA) e. V.**

## HISTORY

| Date       | Changes   |
|------------|---|
| 2000-09-01 | <i>Publication of Version 1.0</i> as draft standard proposal  |
| 2005-01-01 | <i>Publication of Version 1.1</i> as draft standard   |
| 2005-05-24 | <i>Publication of Corrigendum 1</i>   |
| 2006-08-02 | <i>Publication of Version 1.2</i> as draft standard   |
| 2010-02-23 | <i>Publication of Version 1.3</i> as draft standard (now publicly available) <ul style="list-style-type: none"><li>- Editorial changes</li><li>- Error code FF00<sub>h</sub> was changed to FF01<sub>h</sub></li><li>- SYNC start value was added to PDO parameters</li></ul> |

NOTE: This document has been converted into "docx format". The conversion caused minor layout differences to the predecessor document in "doc format". The technical content word-by-word is the very same.

## General information on licensing and patents

CAN in AUTOMATION (CiA) calls attention to the possibility that some of the elements of this CiA specification may be subject of patent rights. CiA shall not be responsible for identifying any or all such patent rights.

Because this specification is licensed free of charge, there is no warranty for this specification, to the extent permitted by applicable law. Except when otherwise stated in writing the copyright holder and/or other parties provide this specification "as is" without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The entire risk as to the correctness and completeness of the specification is with you. Should this specification prove failures, you assume the cost of all necessary servicing, repair or correction.

## Trademarks

CANopen and CiA are registered community trademarks of CAN in Automation. The use is restricted for CiA members or owners of CANopen® vendor ID. More detailed terms for the use are available from CiA.

## © CiA 2010

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from CiA at the address below.

CAN in Automation e. V.  
Kontumazgarten 3  
DE - 90429 Nuremberg, Germany  
Tel.: +49-911-928819-0  
Fax: +49-911-928819-79  
Url: [www.can-cia.org](http://www.can-cia.org)  
Email: [headquarters@can-cia.org](mailto:headquarters@can-cia.org)

## CONTENTS

|        |  |    |
|--------|--|----|
| 1      | Scope .....  | 4  |
| 2      | Normative references .....   | 4  |
| 3      | Abbreviations and definitions .....                                  | 4  |
| 3.1    | Abbreviations .....  | 4  |
| 3.2    | Definitions .....  | 4  |
| 4      | Operating principle .....  | 4  |
| 4.1    | Introduction .....   | 4  |
| 4.2    | Offset and differential offset.....                                  | 4  |
| 5      | Error handling .....   | 4  |
| 5.1    | Principle.....   | 4  |
| 5.2    | Error behaviour .....  | 4  |
| 5.3    | Additional error code meanings.....                                  | 4  |
| 6      | Predefinitions .....   | 6  |
| 6.1    | General.....   | 6  |
| 6.2    | Pre-defined communication objects.....                               | 6  |
| 6.2.1  | Object 1000 <sub>h</sub> : Device type .....                         | 6  |
| 6.2.2  | Object 1001 <sub>h</sub> : Error register.....                       | 6  |
| 6.2.3  | Object 1029 <sub>h</sub> : Error behaviour .....                     | 6  |
| 6.2.4  | PDO definition .....   | 7  |
| 7      | Object dictionary .....  | 13 |
| 7.1    | Introduction .....   | 13 |
| 7.2    | Application objects .....  | 13 |
| 7.2.1  | Object 6000 <sub>h</sub> : Resolution.....                           | 13 |
| 7.2.2  | Object 6010 <sub>h</sub> : Slope long16.....                         | 13 |
| 7.2.3  | Object 6011 <sub>h</sub> : Slope long16 operating parameter .....    | 14 |
| 7.2.4  | Object 6012 <sub>h</sub> : Slope long16 preset value .....           | 15 |
| 7.2.5  | Object 6013 <sub>h</sub> : Slope long16 offset.....                  | 15 |
| 7.2.6  | Object 6014 <sub>h</sub> : Differential slope long16 offset.....     | 16 |
| 7.2.7  | Object 6020 <sub>h</sub> : Slope lateral16.....                      | 16 |
| 7.2.8  | Object 6021 <sub>h</sub> : Slope lateral16 operating parameter ..... | 17 |
| 7.2.9  | Object 6022 <sub>h</sub> : Slope lateral16 preset value .....        | 18 |
| 7.2.10 | Object 6023 <sub>h</sub> : Slope lateral16 offset.....               | 18 |
| 7.2.11 | Object 6024 <sub>h</sub> : Differential slope lateral16 offset.....  | 19 |
| 7.2.12 | Object 6110 <sub>h</sub> : Slope long32.....                         | 19 |
| 7.2.13 | Object 6111 <sub>h</sub> : Slope long32 operating parameter .....    | 20 |
| 7.2.14 | Object 6112 <sub>h</sub> : Slope long32 preset value .....           | 21 |
| 7.2.15 | Object 6113 <sub>h</sub> : Slope long32 offset.....                  | 21 |
| 7.2.16 | Object 6114 <sub>h</sub> : Differential slope long32 offset.....     | 22 |
| 7.2.17 | Object 6120 <sub>h</sub> : Slope lateral32.....                      | 22 |
| 7.2.18 | Object 6121 <sub>h</sub> : Slope lateral32 operating parameter ..... | 23 |
| 7.2.19 | Object 6122 <sub>h</sub> : Slope lateral32 preset value .....        | 24 |
| 7.2.20 | Object 6123 <sub>h</sub> : Slope lateral32 offset.....               | 24 |
| 7.2.21 | Object 6124 <sub>h</sub> : Differential slope lateral32 offset.....  | 25 |
| 7.3    | General device profile objects .....                                 | 25 |
| 7.3.1  | Object 67FF <sub>h</sub> : Device type.....                          | 25 |
|        | Annex A (informative) .....  | 26 |

## 1 Scope

This specification represents the CANopen device profile for one- and two-axis inclinometers.

## 2 Normative references

/CiA301/      CiA 301, CANopen application layer and communication profile

## 3 Abbreviations and definitions

### 3.1 Abbreviations

The abbreviations given in /CiA301/ apply for this document as well.

### 3.2 Definitions

The definitions given in /CiA301/ apply to this specification as well.

## 4 Operating principle

### 4.1 Introduction

One-axis inclinometers provide only longitudinal slope axis value. Two-axis inclinometers provide additionally lateral slope axis value. These values are mapped into PDOs by default, which are transmitted synchronously. The inclinometer device may support optionally synchronisation producer, time-stamp producer/consumer, emergency producer/consumer functionality, and additional PDOs. For new designs, it is highly recommended to support heartbeat functionality.

### 4.2 Offset and differential offset

The slope value (displayed value) is the sum of the physical measurement (true value), differential offset and offset.

## 5 Error handling

### 5.1 Principle

Emergency messages are triggered by internal errors in the device and they are assigned the highest possible priority to ensure that they get access to the bus without latency. By default, the emergency messages contain the error field with pre-defined error numbers and additional information.

### 5.2 Error behaviour

If a serious device failure is detected the module shall enter by default autonomously the pre-operational state. If object 1029<sub>h</sub> is implemented, the device may be configured to enter alternatively the stopped state or remain in the current state in case of device failure. Device failures shall include the following communication errors:

- Bus-off conditions of the CAN interface
- Life guarding event with the state 'occurred'
- Heartbeat event with state 'occurred'
- Sync error event

Serious device errors are caused by device internal failures, too.

### 5.3 Additional error code meanings

Table 1 specifies the additional error code meanings.

**Table 1 – Additional error code meanings**

| Error code        | Meaning                         |
|-------------------|---------------------------------|
| 5010 <sub>h</sub> | Longitudinal value out of range |
| 5020 <sub>h</sub> | Lateral value out of range      |
| FF01 <sub>h</sub> | Longitudinal sensor is defect   |
| FF02 <sub>h</sub> | Lateral sensor is defect        |

## 6 Predefinitions

### 6.1 General

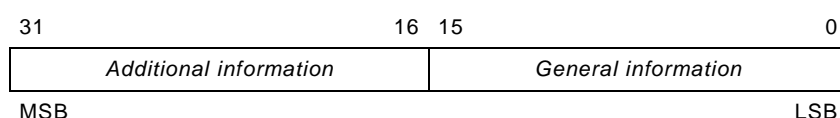
This clause provides additional specifications with regard to the communication objects, which are already pre-defined in /CiA301/.

### 6.2 Pre-defined communication objects

#### 6.2.1 Object 1000<sub>h</sub>: Device type

The object at index 1000<sub>h</sub> provides the type of device and its functionality. For multiple device modules the additional information field contains FFFF<sub>h</sub> (see /CiA 301/). In this case, the object 67FF<sub>h</sub> shall be implemented. For the object and entry description see /CiA301/.

Figure 1 specifies the object structure and Table 2 specifies the value definition.



**Figure 1 – Object structure**

**Table 2 – Value definition**

| Field                         | Value  | Definition   |
|-------------------------------|--|--|
| <i>General Information</i>    | 410 <sub>d</sub>   | Device profile number  |
| <i>Additional information</i> | 0000 <sub>h</sub><br>0001 <sub>h</sub><br>0002 <sub>h</sub><br>0003 <sub>h</sub><br>0004 <sub>h</sub><br>0005 <sub>h</sub> to FFFE <sub>h</sub><br>FFFF <sub>h</sub> | see /CiA 301/<br>One axis with resolution max. 16-bit<br>Two axis with resolution max. 16-bit<br>One axis with resolution max. 32-bit<br>Two axis with resolution max. 32-bit<br>reserved<br>see /CiA 301/ |

#### 6.2.2 Object 1001<sub>h</sub>: Error register

The device-profile specific bit in the error register shall indicate the occurrence of out-of-range errors for slope values or of defect sensors. Table 3 provides the value definition.

**Table 3 - Value definition for Bit 5: Device profile specific error**

| Bit value  | Description  |
|--|--|
| 0  | No device-profile specific error is currently active |
| 1  | Device-profile specific error is currently active    |
| NOTE Bit 1 to 7 provide just additional error information. In any error conditions, the generic error (bit 0) is set to 1 (for details see /CiA301/) |  |

#### 6.2.3 Object 1029<sub>h</sub>: Error behaviour

This object specifies to which state the CANopen device shall be set, when a communication error is detected. Besides the specification given in /CiA301/ the following sub-indexes may be implemented additionally. If the object is not implemented the device shall behave as the default values define.

For the value definition and object description see /CiA301/. Table 4 specifies the entry description.

**Table 4 – Entry description**

| Attribute      | Value                              |
|----------------|------------------------------------|
| Sub-index      | 02 <sub>h</sub>                    |
| Description    | Sync error                         |
| Entry category | Optional                           |
| Access         | rw                                 |
| PDO mapping    | No                                 |
| Value range    | 00 <sub>h</sub> to 02 <sub>h</sub> |
| Default value  | 00 <sub>h</sub>                    |
|                |                                    |
| Sub-index      | 03 <sub>h</sub>                    |
| Description    | Internal device error              |
| Entry category | Optional                           |
| Access         | rw                                 |
| PDO mapping    | No                                 |
| Value range    | 00 <sub>h</sub> to 02 <sub>h</sub> |
| Default value  | 00 <sub>h</sub>                    |
|                |                                    |

## 6.2.4 PDO definition

### 6.2.4.1 General

The inclinometer shall support the default TPDOs. It may support additional manufacturer-specific PDOs. Additional event-driven TPDOs shall be transmitted when entering the NMT operational state, and may be transmitted when a mapped process data is changing.

### 6.2.4.2 TPDO 1

The TPDO 1 is defined by the following parameter sets.

Table 5 specifies the object description of the PDO communication parameter and Table 6 specifies the associated entry description. The values are defined in /CiA301/. The sub-index 04<sub>h</sub> is reserved for compatibility reasons and shall not be implemented.

**Table 5 – Object description**

| Attribute   | Value                         |
|-------------|-------------------------------|
| Index       | 1800 <sub>h</sub>             |
| Name        | TPDO1 communication parameter |
| Object code | RECORD                        |
| Data type   | PDO_COMMUNICATION_PARAMETER   |
| Category    | Mandatory                     |

**Table 6 – Entry description**

| Attribute      | Value   |
|----------------|---|
| Sub-index      | 00 <sub>h</sub>   |
| Description    | Highest sub-index supported                                   |
| Entry category | Mandatory   |
| Access         | const   |
| PDO mapping    | No  |
| Value range    | 02 <sub>h</sub> to 06 <sub>h</sub>                            |
| Default value  | Manufacturer-specific   |
|                |   |
| Sub-index      | 01 <sub>h</sub>   |
| Description    | COB-ID  |
| Entry category | Mandatory   |
| Access         | rw or const   |
| PDO mapping    | No  |
| Value range    | See /CiA301/  |
| Default value  | {0000 0180 <sub>h</sub> or 4000 0180 <sub>h</sub> } + node-ID |
|                |   |
| Sub-index      | 02 <sub>h</sub>   |
| Description    | Transmission type   |
| Entry category | Mandatory   |
| Access         | rw or const   |
| PDO mapping    | No  |
| Value range    | See /CiA301/  |
| Default value  | 01 <sub>h</sub>   |
|                |   |
| Sub-index      | 03 <sub>h</sub>   |
| Description    | Inhibit time  |
| Entry category | Optional  |
| Access         | rw  |
| PDO mapping    | No  |
| Value range    | See /CiA301/  |
| Default value  | 0000 <sub>h</sub>   |
|                |   |
| Sub-index      | 05 <sub>h</sub>   |
| Description    | Event timer   |
| Entry category | Optional  |
| Access         | rw  |
| PDO mapping    | No  |
| Value range    | See /CiA301/  |
| Default value  | 0000 <sub>h</sub>   |
|                |   |



| Attribute      | Value                 |
|----------------|-----------------------|
| Sub-index      | 06 <sub>h</sub>       |
| Description    | SYNC start value      |
| Entry category | Optional              |
| Access         | rw or const           |
| PDO mapping    | No                    |
| Value range    | See /CiA301/          |
| Default value  | Manufacturer-specific |
|                |                       |

Table 7 specifies the object description of the PDO mapping parameter and Table 8 specifies the associated entry description. The values are defined in /CiA301/.

**Table 7 – Object description**

| Attribute   | Value                   |
|-------------|-------------------------|
| Index       | 1A00 <sub>h</sub>       |
| Name        | TPDO1 mapping parameter |
| Object code | RECORD                  |
| Data type   | PDO_MAPPING             |
| Category    | Mandatory               |

**Table 8 – Entry description**

| Attribute      | Value  |
|----------------|--|
| Sub-index      | 00 <sub>h</sub>                                |
| Description    | Highest sub-index supported                    |
| Entry category | Mandatory                                      |
| Access         | const or rw (if variable mapping is supported) |
| PDO mapping    | No   |
| Value range    | See /CiA301/                                   |
| Default value  | 01 <sub>h</sub> or 02 <sub>h</sub>             |
|                |  |
| Sub-index      | 01 <sub>h</sub>                                |
| Description    | 1 <sup>st</sup> application object             |
| Entry category | Mandatory                                      |
| Access         | const or rw                                    |
| PDO mapping    | No   |
| Value range    | See /CiA301/                                   |
| Default value  | 6010 00 10 <sub>h</sub>                        |
|                |  |
| Sub-index      | 02 <sub>h</sub>                                |
| Description    | 2 <sup>nd</sup> application object             |
| Entry category | Optional (see NOTE)                            |
| Access         | const or rw                                    |
| PDO mapping    | No   |
| Value range    | See /CiA301/                                   |
| Default value  | 6020 00 10 <sub>h</sub>                        |

|  |
|--|
| NOTE: Sub-index 02 <sub>h</sub> is optional depending on the device functionality as indicated in object 1000 <sub>h</sub> . |
|--|

### 6.2.4.3 TPDO 2

The TPDO 2 is defined by the following parameter sets.

Table 9 specifies the object description of the PDO communication parameter and Table 10 specifies the associated entry description. The values are defined in /CiA301/. The sub-index 04<sub>h</sub> is reserved for compatibility reasons and shall not be implemented.

**Table 9 – Object description**

| Attribute   | Value                          |
|-------------|--------------------------------|
| Index       | 1801 <sub>h</sub>              |
| Name        | TPDO 2 communication parameter |
| Object code | RECORD                         |
| Data type   | PDO_COMMUNICATION_PARAMETER    |
| Category    | Mandatory                      |

**Table 10 – Entry description**

| Attribute      | Value   |
|----------------|---|
| Sub-index      | 00 <sub>h</sub>   |
| Description    | Highest sub-index supported                                   |
| Entry category | Mandatory   |
| Access         | const   |
| PDO mapping    | No  |
| Value range    | 02 <sub>h</sub> to 06 <sub>h</sub>                            |
| Default value  | Manufacturer-specific   |
|                |   |
| Sub-index      | 01 <sub>h</sub>   |
| Description    | COB-ID  |
| Entry category | Mandatory   |
| Access         | rw or const   |
| PDO mapping    | No  |
| Value range    | See /CiA301/  |
| Default value  | {0000 0280 <sub>h</sub> or 0400 0280 <sub>h</sub> } + node-ID |
|                |   |
| Sub-index      | 02 <sub>h</sub>   |
| Description    | Transmission type   |
| Entry category | Mandatory   |
| Access         | rw or const   |
| PDO mapping    | No  |
| Value range    | See /CiA301/  |
| Default value  | 01 <sub>h</sub>   |
|                |   |

| Attribute      | Value                 |
|----------------|-----------------------|
| Sub-index      | 03 <sub>h</sub>       |
| Description    | Inhibit time          |
| Entry category | Optional              |
| Access         | rw                    |
| PDO mapping    | No                    |
| Value range    | See /CiA301/          |
| Default value  | 0000 <sub>h</sub>     |
|                |                       |
| Sub-index      | 05 <sub>h</sub>       |
| Description    | Event timer           |
| Entry category | Optional              |
| Access         | rw                    |
| PDO mapping    | No                    |
| Value range    | See /CiA301/          |
| Default value  | 0000 <sub>h</sub>     |
|                |                       |
| Sub-index      | 06 <sub>h</sub>       |
| Description    | SYNC start value      |
| Entry category | Optional              |
| Access         | rw or const           |
| PDO mapping    | No                    |
| Value range    | See /CiA301/          |
| Default value  | Manufacturer-specific |
|                |                       |

Table 11 specifies the object description of the PDO mapping parameter and Table 12 specifies the associated entry description. The values are defined in /CiA301/.

**Table 11 – Object description**

| Attribute   | Value                    |
|-------------|--------------------------|
| Index       | 1A01 <sub>h</sub>        |
| Name        | TPDO 2 mapping parameter |
| Object code | RECORD                   |
| Data type   | PDO_MAPPING              |
| Category    | Mandatory                |

**Table 12 – Entry description**

| Attribute      | Value  |
|----------------|--|
| Sub-index      | 00 <sub>h</sub>                                |
| Description    | Highest sub-index supported                    |
| Entry category | Mandatory                                      |
| Access         | const or rw (if variable mapping is supported) |
| PDO mapping    | No   |
| Value range    | See /CiA301/                                   |
| Default value  | 01 <sub>h</sub> or 02 <sub>h</sub>             |

| Attribute  | Value                              |
|--|------------------------------------|
|  |                                    |
| Sub-index  | 01 <sub>h</sub>                    |
| Description  | 1 <sup>st</sup> application object |
| Entry category   | Mandatory                          |
| Access   | const or rw                        |
| PDO mapping  | No                                 |
| Value range  | See /CiA301/                       |
| Default value  | 6110 00 20 <sub>h</sub>            |
|  |                                    |
| Sub-index  | 02 <sub>h</sub>                    |
| Description  | 2 <sup>nd</sup> application object |
| Entry category   | Optional (see NOTE)                |
| Access   | const or rw                        |
| PDO mapping  | No                                 |
| Value range  | See /CiA301/                       |
| Default value  | 6120 00 20 <sub>h</sub>            |
|  |                                    |
| NOTE: Sub-index 02 <sub>h</sub> is optional depending on the device functionality as indicated in object 1000 <sub>h</sub> . |                                    |

## 7 Object dictionary

### 7.1 Introduction

Each inclinometer compliant with this device profile shall share the CANopen object dictionary entries from 6000<sub>h</sub> to 67FF<sub>h</sub>. These entries are common to all inclinometers. However, each device only implements those objects relevant to its functionality. Object description and entry description are specified in /CiA301/.

Inclinometers support by default 16-bit slope values. Optionally they may support 32-bit slope values as well.

### 7.2 Application objects

#### 7.2.1 Object 6000<sub>h</sub>: Resolution

This object shall indicate the resolution of *Slope long16* (object 6010<sub>h</sub>) and *Slope lateral16* (object 6020<sub>h</sub>) objects based on 0,001°. This resolution is also valid for the 32-bit value objects (6110<sub>h</sub> and 6120<sub>h</sub>).

Table 13 specifies the value definition. If the resolution is fixed and may not be changed, the access is read only.

**Table 13 – Value definition**

| Value             | Definition |
|-------------------|------------|
| 1 <sub>d</sub>    | 0,001°     |
| 10 <sub>d</sub>   | 0,01°      |
| 100 <sub>d</sub>  | 0,1°       |
| 1000 <sub>d</sub> | 1,0°       |
| Other             | reserved   |

Table 14 specifies the object description and Table 15 specifies the entry description.

**Table 14 – Object description**

| Attribute   | Value             |
|-------------|-------------------|
| Index       | 6000 <sub>h</sub> |
| Name        | Resolution        |
| Object code | VAR               |
| Data type   | UNSIGNED16        |
| Category    | Mandatory         |

**Table 15 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | rw              |
| PDO mapping   | Optional        |
| Value range   | See Table 13    |
| Default value | 1 <sub>d</sub>  |

#### 7.2.2 Object 6010<sub>h</sub>: Slope long16

This object shall provide the 16-bit slope value of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 16 specifies the object description and Table 17 specifies the entry description.

**Table 16 – Object description**

| Attribute   | Value             |
|-------------|-------------------|
| Index       | 6010 <sub>h</sub> |
| Name        | Slope long16      |
| Object code | VAR               |
| Data type   | INTEGER16         |
| Category    | Mandatory         |

**Table 17 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | ro              |
| PDO mapping   | Default         |
| Value range   | INTEGER16       |
| Default value | No              |

### 7.2.3 Object 6011<sub>h</sub>: Slope long16 operating parameter

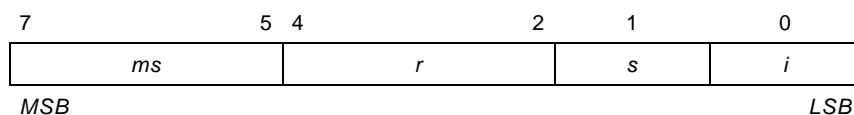
This object shall indicate the interpretation of the *Slope long16* value.

If scaling is enabled, the *Slope long16* value shall be calculated accordingly to the following equation:

$$\text{Slope long16} = \text{physically measured angle} + \text{Differential slope long16 offset} + \text{Slope long16 offset}$$

If scaling is disabled, the *Slope long16* value shall be equal to the physical measured angle.

Figure 2 specifies the object structure and Table 18 specifies the value definition.

**Figure 2 – Object structure****Table 18 – Value definition**

| Field                | Value                            | Definition                                 |
|----------------------|----------------------------------|--|
| <i>ms</i>            |                                  | Manufacturer-specific                      |
| <i>r</i>             | 0 <sub>b</sub>                   | reserved                                   |
| <i>s</i> (scaling)   | 0 <sub>b</sub><br>1 <sub>b</sub> | Scaling not enabled<br>Scaling enabled     |
| <i>i</i> (inversion) | 0 <sub>b</sub><br>1 <sub>b</sub> | Inversion not enabled<br>Inversion enabled |

Table 19 specifies the object description and Table 20 specifies the entry description.

**Table 19 – Object description**

| Attribute   | Value                            |
|-------------|----------------------------------|
| Index       | 6011 <sub>h</sub>                |
| Name        | Slope long16 operating parameter |
| Object code | VAR                              |
| Data type   | UNSIGNED8                        |
| Category    | Mandatory                        |

**Table 20 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | rw              |
| PDO mapping   | No              |
| Value range   | UNSIGNED8       |
| Default value | 00 <sub>h</sub> |

#### 7.2.4 Object 6012<sub>h</sub>: Slope long16 preset value

Accessing this object by means of SDO shall set directly the actual longitudinal slope value to a desired longitudinal slope value. The calculated application-offset of the longitudinal slope value is given in *Slope long16 offset* (object 6013<sub>h</sub>). The *Slope long16 offset* is calculated with respect to object 6014<sub>h</sub>. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 21 specifies the object description and Table 22 specifies the entry description.

**Table 21 – Object description**

| Attribute   | Value                     |
|-------------|---------------------------|
| Index       | 6012 <sub>h</sub>         |
| Name        | Slope long16 preset value |
| Object code | VAR                       |
| Data type   | INTEGER16                 |
| Category    | Optional                  |

**Table 22 – Entry description**

| Attribute     | Value                 |
|---------------|-----------------------|
| Sub-index     | 00 <sub>h</sub>       |
| Access        | rw                    |
| PDO mapping   | No                    |
| Value range   | INTEGER16             |
| Default value | Manufacturer-specific |

#### 7.2.5 Object 6013<sub>h</sub>: Slope long16 offset

This object shall indicate the application-offset of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. The following equation shall be applied:

$$\text{Slope long16 offset} = \text{Slope long16 preset value at } t_{acc} - \text{slope physical measured at } t_{acc} - \text{Differential slope long16 offset}$$

$t_{acc}$  = time when accessing object 6012<sub>h</sub>

Table 23 specifies the object description and Table 24 specifies the entry description.

**Table 23 – Object description**

| Attribute   | Value  |
|-------------|--|
| Index       | 6013 <sub>h</sub>  |
| Name        | Slope long16 offset  |
| Object code | VAR  |
| Data type   | INTEGER16  |
| Category    | Conditional; mandatory if 6012 <sub>h</sub> is implemented |

**Table 24 – Entry description**

| Attribute     | Value             |
|---------------|-------------------|
| Sub-index     | 00 <sub>h</sub>   |
| Access        | rw                |
| PDO mapping   | No                |
| Value range   | INTEGER16         |
| Default value | 0000 <sub>h</sub> |

**7.2.6 Object 6014<sub>h</sub>: Differential slope long16 offset**

This object shall shift the *Slope long16* value (object 6010<sub>h</sub>) independent of *Slope long16 preset value* (object 6012<sub>h</sub>) and *Slope long16 offset* (object 6013<sub>h</sub>). The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 25 specifies the object description and Table 26 specifies the entry description.

**Table 25 – Object description**

| Attribute   | Value                            |
|-------------|----------------------------------|
| Index       | 6014 <sub>h</sub>                |
| Name        | Differential slope long16 offset |
| Object code | VAR                              |
| Data type   | INTEGER16                        |
| Category    | Optional                         |

**Table 26 – Entry description**

| Attribute     | Value             |
|---------------|-------------------|
| Sub-index     | 00 <sub>h</sub>   |
| Access        | rw                |
| PDO mapping   | No                |
| Value range   | INTEGER16         |
| Default value | 0000 <sub>h</sub> |

**7.2.7 Object 6020<sub>h</sub>: Slope lateral16**

This object shall provide the 16-bit slope value of the lateral axis. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 27 specifies the object description and Table 28 specifies the entry description.



**Table 27 – Object description**

| Attribute   | Value             |
|-------------|-------------------|
| Index       | 6020 <sub>h</sub> |
| Name        | Slope lateral16   |
| Object code | VAR               |
| Data type   | INTEGER16         |
| Category    | Optional          |

**Table 28 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | ro              |
| PDO mapping   | Default         |
| Value range   | INTEGER16       |
| Default value | No              |

### 7.2.8 Object 6021<sub>h</sub>: Slope lateral16 operating parameter

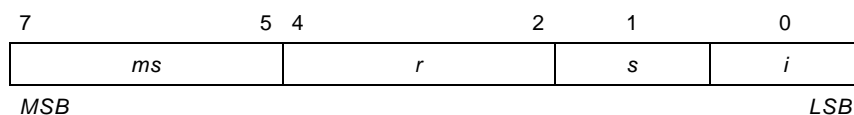
This object shall indicate the interpretation of the *Slope lateral16* value.

If scaling is enabled, the *Slope lateral16* value shall be calculated accordingly to the following equation:

$$\text{Slope lateral16} = \text{physically measured angle} + \text{Differential slope lateral16 offset} + \text{Slope lateral16 offset}$$

If scaling is disabled, the *Slope lateral16* value shall be equal to the physical measured angle.

Figure 3 specifies the object structure and Table 29 specifies the value definition.

**Figure 3 – Object structure****Table 29 – Value definition**

| Field                | Value                            | Definition                                 |
|----------------------|----------------------------------|--|
| <i>ms</i>            |                                  | Manufacturer-specific                      |
| <i>r</i>             | 0 <sub>b</sub>                   | reserved                                   |
| <i>s</i> (scaling)   | 0 <sub>b</sub><br>1 <sub>b</sub> | Scaling not enabled<br>Scaling enabled     |
| <i>i</i> (inversion) | 0 <sub>b</sub><br>1 <sub>b</sub> | Inversion not enabled<br>Inversion enabled |

Table 30 specifies the object description and Table 31 specifies the entry description.

**Table 30 – Object description**

| Attribute   | Value  |
|-------------|--|
| Index       | 6021 <sub>h</sub>  |
| Name        | Slope lateral16 operating parameter                        |
| Object code | VAR  |
| Data type   | UNSIGNED8  |
| Category    | Conditional; mandatory if 6020 <sub>h</sub> is implemented |

**Table 31 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | rw              |
| PDO mapping   | No              |
| Value range   | UNSIGNED8       |
| Default value | 00 <sub>h</sub> |

**7.2.9 Object 6022<sub>h</sub>: Slope lateral16 preset value**

Accessing this object by means of SDO shall set the actual lateral slop value to a desired lateral slope value. The calculated application-offset of the lateral slope value is given in *Slope lateral16 offset* (object 6023<sub>h</sub>). The *Slope lateral16 offset* is calculated with respect to object 6024<sub>h</sub>. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 32 specifies the object description and Table 33 specifies the entry description.

**Table 32 – Object description**

| Attribute   | Value                        |
|-------------|------------------------------|
| Index       | 6022 <sub>h</sub>            |
| Name        | Slope lateral16 preset value |
| Object code | VAR                          |
| Data type   | INTEGER16                    |
| Category    | Optional                     |

**Table 33 – Entry description**

| Attribute     | Value                 |
|---------------|-----------------------|
| Sub-index     | 00 <sub>h</sub>       |
| Access        | rw                    |
| PDO mapping   | No                    |
| Value range   | INTEGER16             |
| Default value | Manufacturer-specific |

**7.2.10 Object 6023<sub>h</sub>: Slope lateral16 offset**

This object shall provide the application-offset of the lateral axis. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. The following equation shall be applied:

$$\text{Slope lateral16 offset} = \text{Slope lateral16 preset value at } t_{acc} - \text{slope physical measured at } t_{acc} - \text{Differential slope lateral16 offset}$$

$t_{acc}$  = time when accessing object 6022<sub>h</sub>

Table 34 specifies the object description and Table 35 specifies the entry description.

**Table 34 – Object description**

| Attribute   | Value   |
|-------------|---|
| Index       | 6023 <sub>h</sub>                                       |
| Name        | Slope lateral16 offset                                  |
| Object code | VAR   |
| Data type   | INTEGER16   |
| Category    | Conditional; mandatory 6022 <sub>h</sub> is implemented |

**Table 35 – Entry description**

| Attribute     | Value             |
|---------------|-------------------|
| Sub-index     | 00 <sub>h</sub>   |
| Access        | rw                |
| PDO mapping   | No                |
| Value range   | INTEGER16         |
| Default value | 0000 <sub>h</sub> |

**7.2.11 Object 6024<sub>h</sub>: Differential slope lateral16 offset**

This object shall shift the *Slope lateral16* (object 6020<sub>h</sub>) value independent of *Slope lateral16 preset value* (object 6022<sub>h</sub>) and *Slope lateral16 offset* (object 6023<sub>h</sub>).

The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>.

Table 36 specifies the object description and Table 37 specifies the entry description.

**Table 36 – Object description**

| Attribute   | Value                               |
|-------------|-------------------------------------|
| Index       | 6024 <sub>h</sub>                   |
| Name        | Differential slope lateral16 offset |
| Object code | VAR                                 |
| Data type   | INTEGER16                           |
| Category    | Optional                            |

**Table 37 – Entry description**

| Attribute     | Value             |
|---------------|-------------------|
| Sub-index     | 00 <sub>h</sub>   |
| Access        | rw                |
| PDO mapping   | No                |
| Value range   | INTEGER16         |
| Default value | 0000 <sub>h</sub> |

**7.2.12 Object 6110<sub>h</sub>: Slope long32**

This object shall provide the 32-bit slope value of the longitudinal axis. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 38 specifies the object description and Table 39 specifies the entry description.

**Table 38 – Object description**

| Attribute   | Value             |
|-------------|-------------------|
| Index       | 6110 <sub>h</sub> |
| Name        | Slope long32      |
| Object code | VAR               |
| Data type   | INTEGER32         |
| Category    | Optional          |

**Table 39 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | ro              |
| PDO mapping   | Optional        |
| Value range   | INTEGER32       |
| Default value | No              |

**7.2.13 Object 6111<sub>h</sub>: Slope long32 operating parameter**

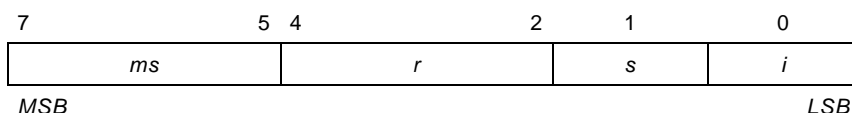
This object shall indicate the interpretation of the *Slope long32* value:

If scaling is enabled, the *Slope long32* value shall be calculated accordingly to the following equation:

$$\text{Slope long32} = \text{physically measured angle} + \text{Differential slope long32 offset} + \text{Slope long32 offset}$$

If scaling is disabled, the *Slope long32* value shall be equal to the physical measured angle.

Figure 4 specifies the object structure and Table 40 specifies the value definition.

**Figure 4 – Object structure****Table 40 – Value definition**

| Field                | Value                            | Definition                                 |
|----------------------|----------------------------------|--|
| <i>ms</i>            |                                  | Manufacturer-specific                      |
| <i>r</i>             | 0 <sub>b</sub>                   | reserved                                   |
| <i>s</i> (scaling)   | 0 <sub>b</sub><br>1 <sub>b</sub> | Scaling not enabled<br>Scaling enabled     |
| <i>i</i> (inversion) | 0 <sub>b</sub><br>1 <sub>b</sub> | Inversion not enabled<br>Inversion enabled |

Table 41 specifies the object description and Table 42 specifies the entry description.

**Table 41 – Object description**

| Attribute   | Value   |
|-------------|---|
| Index       | 6111 <sub>h</sub>                                       |
| Name        | Slope long32 operating parameter                        |
| Object code | VAR   |
| Data type   | UNSIGNED8   |
| Category    | Conditional; mandatory 6110 <sub>h</sub> is implemented |

**Table 42 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | rw              |
| PDO mapping   | No              |
| Value range   | UNSIGNED8       |
| Default value | 00 <sub>h</sub> |

**7.2.14 Object 6112<sub>h</sub>: Slope long32 preset value**

Accessing this object by means of SDO shall set the actual longitudinal slope value to a desired longitudinal value. The calculated application-offset of the longitudinal slope value shall be given in *Slope long32 offset* (object 6113<sub>h</sub>). The *Slope long32 offset* shall be calculated with respect to object 6114<sub>h</sub>. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 43 specifies the object description and Table 44 specifies the entry description.

**Table 43 – Object description**

| Attribute   | Value                     |
|-------------|---------------------------|
| Index       | 6112 <sub>h</sub>         |
| Name        | Slope long32 preset value |
| Object code | VAR                       |
| Data type   | INTEGER32                 |
| Category    | Optional                  |

**Table 44 – Entry description**

| Attribute     | Value                 |
|---------------|-----------------------|
| Sub-index     | 00 <sub>h</sub>       |
| Access        | rw                    |
| PDO mapping   | No                    |
| Value range   | INTEGER32             |
| Default value | Manufacturer-specific |

**7.2.15 Object 6113<sub>h</sub>: Slope long32 offset**

This object shall provide the application-offset of the longitudinal axis. The value shall be based on the resolution given in object 6000<sub>h</sub>. The following equation shall be applied:

$$\text{Slope long32 offset} = \text{Slope long32 preset value at } t_{acc} - \text{slope physical measured at } t_{acc} - \text{Differential slope long32 offset}$$

$t_{acc}$  = time when accessing object 6112<sub>h</sub>

The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>.

Table 45 specifies the object description and Table 46 specifies the entry description.

**Table 45 – Object description**

| Attribute   | Value   |
|-------------|---|
| Index       | 6113 <sub>h</sub>                                       |
| Name        | Slope long32 offset                                     |
| Object code | VAR   |
| Data type   | INTEGER32   |
| Category    | Conditional; mandatory 6112 <sub>h</sub> is implemented |

**Table 46 – Entry description**

| Attribute     | Value                  |
|---------------|------------------------|
| Sub-index     | 00 <sub>h</sub>        |
| Access        | rw                     |
| PDO mapping   | No                     |
| Value range   | INTEGER32              |
| Default value | 0000 0000 <sub>h</sub> |

**7.2.16 Object 6114<sub>h</sub>: Differential slope long32 offset**

This object shall shift the *Slope long32* (object 6110<sub>h</sub>) value independent of *Slope long32 preset value* (object 6112<sub>h</sub>) and *Slope long32 offset* (object 6113<sub>h</sub>). The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 47 specifies the object description and Table 48 specifies the entry description.

**Table 47 – Object description**

| Attribute   | Value                            |
|-------------|----------------------------------|
| Index       | 6114 <sub>h</sub>                |
| Name        | Differential slope long32 offset |
| Object code | VAR                              |
| Data type   | INTEGER32                        |
| Category    | Optional                         |

**Table 48 – Entry description**

| Attribute     | Value                  |
|---------------|------------------------|
| Sub-index     | 00 <sub>h</sub>        |
| Access        | rw                     |
| PDO mapping   | No                     |
| Value range   | INTEGER32              |
| Default value | 0000 0000 <sub>h</sub> |

**7.2.17 Object 6120<sub>h</sub>: Slope lateral32**

This object shall provide the 32-bit slope value of the lateral axis. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 49 specifies the object description and Table 50 specifies the entry description.

**Table 49 – Object description**

| Attribute   | Value             |
|-------------|-------------------|
| Index       | 6120 <sub>h</sub> |
| Name        | Slope lateral32   |
| Object code | VAR               |
| Data type   | INTEGER32         |
| Category    | Optional          |

**Table 50 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | ro              |
| PDO mapping   | Optional        |
| Value range   | INTEGER32       |
| Default value | No              |

**7.2.18 Object 6121<sub>h</sub>: Slope lateral32 operating parameter**

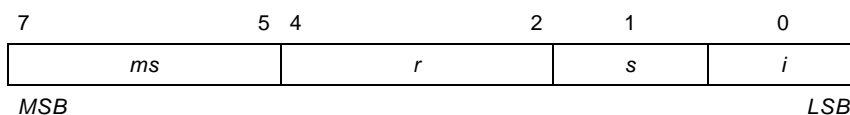
This object shall indicate the interpretation of the *Slope lateral32* value.

If scaling is enabled, the *Slope lateral32* value shall be calculated accordingly to the following equation:

$$\text{Slope lateral32} = \text{physically measured angle} + \text{Differential slope lateral32 offset} + \text{Slope lateral32 offset}$$

If scaling is disabled, the *Slope lateral32* value shall be equal to the physical measured angle.

Figure 5 specifies the object structure and Table 51 specifies the value definition. Table 52 specifies the object description and Table 53 specifies the entry description.

**Figure 5 – Object structure****Table 51 – Value definition**

| Field         | Value                            | Definition                                 |
|---------------|----------------------------------|--|
| ms            |                                  | Manufacturer-specific                      |
| r             | 0 <sub>b</sub>                   | reserved                                   |
| s (scaling)   | 0 <sub>b</sub><br>1 <sub>b</sub> | Scaling not enabled<br>Scaling enabled     |
| i (inversion) | 0 <sub>b</sub><br>1 <sub>b</sub> | Inversion not enabled<br>Inversion enabled |

**Table 52 – Object description**

| Attribute   | Value  |
|-------------|--|
| Index       | 6121 <sub>h</sub>                                |
| Name        | Slope lateral32 operating parameter              |
| Object code | VAR  |
| Data type   | UNSIGNED8  |
| Category    | Conditional: if 6120 <sub>h</sub> is implemented |

**Table 53 – Entry description**

| Attribute     | Value           |
|---------------|-----------------|
| Sub-index     | 00 <sub>h</sub> |
| Access        | rw              |
| PDO mapping   | Optional        |
| Value range   | UNSIGNED8       |
| Default value | 00 <sub>h</sub> |

**7.2.19 Object 6122<sub>h</sub>: Slope lateral32 preset value**

Accessing this object by means of SDO shall set the actual slop lateral value to a desired lateral value. The calculated application-offset of the slope lateral shall be given in *Slope lateral32 offset* (object 6123<sub>h</sub>). The *Slope lateral32 offset* shall be calculated with respect to object 6124<sub>h</sub>. The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 54 specifies the object description and Table 55 specifies the entry description.

**Table 54 – Object description**

| Attribute   | Value                        |
|-------------|------------------------------|
| Index       | 6122 <sub>h</sub>            |
| Name        | Slope lateral32 preset value |
| Object code | VAR                          |
| Data type   | INTEGER32                    |
| Category    | Optional                     |

**Table 55 – Entry description**

| Attribute     | Value                 |
|---------------|-----------------------|
| Sub-index     | 00 <sub>h</sub>       |
| Access        | rw                    |
| PDO mapping   | No                    |
| Value range   | INTEGER32             |
| Default value | Manufacturer-specific |

**7.2.20 Object 6123<sub>h</sub>: Slope lateral32 offset**

This object shall provide the application-offset of the lateral axis. The value shall be based on the resolution given in object 6000<sub>h</sub>. The following equation shall be applied:

$$\text{Slope lateral32 offset} = \text{Slope lateral32 preset value at } t_{acc} - \text{slope physical measured at } t_{acc} - \text{Differential slope lateral32 offset}$$

$t_{acc}$  = time when accessing object 6122<sub>h</sub>

The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>.

Table 56 specifies the object description and Table 57 specifies the entry description.



**Table 56 – Object description**

| Attribute   | Value  |
|-------------|--|
| Index       | 6123 <sub>h</sub>  |
| Name        | Slope lateral32 offset                                     |
| Object code | VAR  |
| Data type   | INTEGER32  |
| Category    | Conditional; mandatory if 6112 <sub>h</sub> is implemented |

**Table 57 – Entry description**

| Attribute     | Value                  |
|---------------|------------------------|
| Sub-index     | 00 <sub>h</sub>        |
| Access        | rw                     |
| PDO mapping   | Optional               |
| Value range   | INTEGER32              |
| Default value | 0000 0000 <sub>h</sub> |

**7.2.21 Object 6124<sub>h</sub>: Differential slope lateral32 offset**

This object shall shift the *Slope lateral32* (object 6120<sub>h</sub>) value independent of *Slope lateral32 preset value* (object 6122<sub>h</sub>) and *Slope lateral32 offset* (object 6123<sub>h</sub>). The value shall be given in degree (angle) with the resolution given in object 6000<sub>h</sub>. Table 58 specifies the object description and Table 59 specifies the entry description.

**Table 58 – Object description**

| Attribute   | Value                               |
|-------------|-------------------------------------|
| Index       | 6124 <sub>h</sub>                   |
| Name        | Differential slope lateral32 offset |
| Object code | VAR                                 |
| Data type   | INTEGER32                           |
| Category    | Optional                            |

**Table 59 – Entry description**

| Attribute     | Value                  |
|---------------|------------------------|
| Sub-index     | 00 <sub>h</sub>        |
| Access        | rw                     |
| PDO mapping   | Optional               |
| Value range   | INTEGER32              |
| Default value | 0000 0000 <sub>h</sub> |

**7.3 General device profile objects****7.3.1 Object 67FF<sub>h</sub>: Device type**

This objects shall describe the first virtual device in a multiple device module according to /CiA301/.

## Annex A (informative)

The Table 60 gives an overview on the application objects used by inclinometers compliant to this profile.

**Table 60 – Overview on communication parameter and process data**

| Index  | Name                                | Category |
|--|-------------------------------------|----------|
| 6000 <sub>h</sub>                            | Resolution                          | M        |
| 6010 <sub>h</sub>                            | Slope long16                        | M        |
| 6011 <sub>h</sub>                            | Slope long16 operating parameter    | M        |
| 6012 <sub>h</sub>                            | Slope long16 preset value           | O        |
| 6013 <sub>h</sub>                            | Slope long16 offset                 | C        |
| 6014 <sub>h</sub>                            | Differential slope long16 offset    | O        |
| 6020 <sub>h</sub>                            | Slope lateral16                     | O        |
| 6021 <sub>h</sub>                            | Slope lateral16 operating parameter | C        |
| 6022 <sub>h</sub>                            | Slope lateral16 preset value        | O        |
| 6023 <sub>h</sub>                            | Slope lateral16 offset              | C        |
| 6024 <sub>h</sub>                            | Differential slope lateral16 offset | O        |
| 6110 <sub>h</sub>                            | Slope long32                        | O        |
| 6111 <sub>h</sub>                            | Slope long32 operating parameter    | C        |
| 6112 <sub>h</sub>                            | Slope long32 preset value           | O        |
| 6113 <sub>h</sub>                            | Slope long32 offset                 | C        |
| 6114 <sub>h</sub>                            | Differential slope long32 offset    | O        |
| 6120 <sub>h</sub>                            | Slope lateral32                     | O        |
| 6121 <sub>h</sub>                            | Slope lateral32 operating parameter | C        |
| 6122 <sub>h</sub>                            | Slope lateral32 preset value        | O        |
| 6123 <sub>h</sub>                            | Slope lateral32 offset              | C        |
| 6124 <sub>h</sub>                            | Differential slope lateral32 offset | O        |
| NOTE: M=Mandatory, O=Optional, C=Conditional |                                     |          |