

CiA Draft Standard Proposal 410

CANopen

Device Profile for Inclinator

This a draft standard proposal and not suitable to be implemented

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1 Scope

This document represents the CANopen device profile for one- and two-axis. The used communication techniques conform to those described in the CANopen communication profile (CiA Draft Standard DS-301). In addition, programmable devices may use communication techniques, which conform to those described in the framework for programmable CANopen Devices (CiA Draft Standard Proposal DSP-302). These specifications should be consulted in parallel to this device profile specification.

2 Normative references

- /1/: CiA DS-301 V4.01, CANopen application layer and communication profile, June 2000.
- /2/ CiA DRP-303-2 V1.0, Representation of SI Units and Prefixes, July 1999.
- /3/ CiA DSP-302 V3.0, Framework for programmable CANopen devices, July 2000

3 Definitions, acronyms and abbreviations

CAN

Controller Area Network. Data link layer protocol for serial communication as specified in ISO 11898-1 (2000).

CiA

CAN in Automation international users and manufacturers group e. V. Non-profit association promoting Controller Area Network (CAN).

COB

Communication Object, which is made of one or more CAN frames. Any information transmitted via CANopen has to be mapped into COBs.

COB-ID

COB-Identifier. Identifies a COB uniquely in a CAN network. The identifier determines the priority of that COB in the data link layer, too.

SDO

Service Data Object. Peer-to-peer communication with access to the Object Dictionary of a CANopen device.

TPDO

Transmit Process Data Object. Communication object of a device, which contains input data.

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 Transmit-PDOs by default, which are transmitted synchronously. The inclinometer device may support optionally Sync 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 shall 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 1029h is implemented, the device can 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:

- (1) Bus-off conditions of the CAN interface
- (2) Life guarding event with the state 'occurred'
- (3) Heartbeat event with state 'occurred'
- (4) Sync error event

Serious device errors also can be caused by device internal failures.

5.3 Additional error code meanings

| Error Code (hex) | Meaning |
|------------------|---------------------------------|
| 5010 | Longitudinal value out of range |
| 5020 | Lateral value out of range |
| FF01 | Longitudinal sensor |
| FF02 | Lateral sensor |

6 Predefinitions

6.1 Introduction

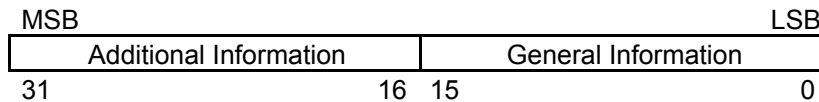
The inclinometer shall support the default TPDO. However, the module can support additional manufacturer-specific PDOs. Additional TPDOs with transmission type 255 shall be transmitted when entering the Operational State.

6.2 Pre-defined communication objects

Modules compliant with this device profile shall come with default values for some communication objects (1000h to 1FFFh), which are not specified in all details in /1/.

6.2.1 Object 1000h: Device Type

The object at index 1000h describes the type of device and its functionality. For multiple device modules the additional information field shall contain FFFFh. In this case, the object 67FFh shall be implemented.



General Information:

Device Profile Number: 410d

Additional Information:

- 0h = reserved
- 1h = one axis with resolution max. 16-bit
- 2h = two axis with resolution max. 16-bit
- 3h = one axis with resolution max. 32-bit
- 4h = two axis with resolution max. 32-bit
- 5h ... 0FFFh = reserved
- 1000h ... FFFEh = manufacturer-specific

6.2.2 Object 1001h: Error Register

The device specific bit in the Error register indicates the occurrence of out-of-range errors for slope values or of defect sensors.

6.2.3 Object 1029h: Error Behaviour

This object specifies to which state the gateway device shall be set, when a communication error or an in-vehicle network error is detected. Besides the specification given in /1/ the following sub-indexes may be implemented optionally. If the object is not implemented the device shall behave as the default values define.

- 0 = pre-operational (only if current state is operational)
- 1 = no state change
- 2 = stopped

Entry Description

| | |
|----------------|------------|
| Sub-Index | 2h |
| Description | Sync_Error |
| Access | rw |
| Entry Category | Optional |
| PDO Mapping | No |
| Value Range | 0h to 2h |
| Default Value | 0h |

| | |
|----------------|-----------------------|
| Sub-Index | 3h |
| Description | Internal Device Error |
| Access | rw |
| Entry Category | Optional |
| PDO Mapping | No |
| Value Range | 0h to 2h |
| Default Value | 0h |

6.2.4 1st TPDO mapping

This TPDO shall transmit object 6010h (Slope_Long16) and optionally object 6020h (Slope_Lateral16). The default transmission type shall be 1. The event-timer and the inhibit-timer shall be set by default to 0.

| Index | Sub-Index | Comment | Default Value |
|-------|-----------|-------------------------------------|---------------|
| 1A00h | 0h | number of mapped objects | (1) |
| | 1h | 1 st object to be mapped | 6010 00 10h |
| | 2h | 2 nd object to be mapped | 6020 00 10h |

(1) Sub-index 2h is optional depending on the device functionality as indicated in object 1000h.

6.2.5 Optional TPDO mapping

Inclinometers supporting 32-bit slope values shall use the following default Transmit-PDO mapping. The TPDO is invalid by default but have valid pre-defined COB-IDs. The default transmission shall be 1. The event-timer and the inhibit-timer shall be set by default to 0.

Default Mapping for 2nd TPDO

| Index | Sub-Index | Comment | Default Value |
|-------|-----------|-------------------------------------|---------------|
| 1A01h | 0h | number of mapped objects | (1) |
| | 1h | 1 st object to be mapped | 6110 00 20h |
| | 2h | 2 nd object to be mapped | 6120 00 20h |

(1) Sub-index 2h is optional depending on the device functionality as indicated in object 1000h.

7 Object description

7.1 Introduction

Each inclinometer compliant with this device profile shall share the CANopen Object Dictionary entries from 6000h to 67FFh. These entries are common to all inclinometers. However, each module only implements those objects relevant to its functionality. Object Description and Entry Description are specified in /1/.

Inclinometers support by default 16-bit slope values. Optionally they may support 32-bit slope values as well. The following table lists all mandatory and optional application objects.

| Index | Name | Object Code | Data Type | Category |
|-------|-------------------------------------|-------------|------------|----------|
| 6000h | Resolution | Variable | Unsigned16 | M |
| 6010h | Slope_Long16 | Variable | Signed16 | M |
| 6011h | Slope_Long16_Operating_Parameter | Variable | Unsigned8 | M |
| 6012h | Slope_Long16_Preset_Value | Variable | Signed16 | O |
| 6013h | Slope_Long16_Offset | Variable | Signed16 | C |
| 6014h | Differential_Slope_Long16_Offset | Variable | Signed16 | C |
| 6020h | Slope_Lateral16 | Variable | Signed16 | O |
| 6021h | Slope_Lateral16_Operating_Parameter | Variable | Unsigned8 | C |
| 6022h | Slope_Lateral16_Preset_Value | Variable | Signed16 | O |
| 6023h | Slope_Lateral16_Offset | Variable | Signed16 | C |
| 6024h | Differential_Slope_Lateral16_Offset | Variable | Signed16 | C |
| 6110h | Slope_Long32 | Variable | Signed32 | O |
| 6111h | Slope_Long32_Operating_Parameter | Variable | Unsigned8 | C |
| 6112h | Slope_Long32_Preset_Value | Variable | Signed32 | O |
| 6113h | Slope_Long32_Offset | Variable | Signed32 | C |
| 6114h | Differential_Slope_Long32_Offset | Variable | Signed32 | C |
| 6120h | Slope_Lateral32 | Variable | Signed32 | O |
| 6121h | Slope_Lateral32_Operating_Parameter | Variable | Unsigned8 | C |
| 6122h | Slope_Lateral32_Preset_Value | Variable | Signed32 | O |
| 6123h | Slope_Lateral32_Offset | Variable | Signed32 | C |
| 6124h | Differential_Slope_Lateral32_Offset | Variable | Signed32 | C |

7.2 Application objects

7.2.1 Object 6000h: Resolution

This object defines the resolution of Slope_Long16 (6010h) and Slope_Lateral16 (6020h) objects based on 0.001° . This resolution is also valid for the 32-bit value objects (6110h and 6120h).

For example:

1 = 0.001°

10 = 0.01°

100 = 0.1°

1000 = 1.0°

If the resolution is fixed and can not be changed, the access is read only.

Object Description

| | |
|-------------|------------|
| INDEX | 6000h |
| Name | Resolution |
| Object Code | Variable |
| Data Type | Unsigned16 |
| Category | Mandatory |

Entry Description

| | |
|---------------|------------|
| Sub-Index | 0h |
| Access | rw (ro) |
| PDO Mapping | Optional |
| Value Range | Unsigned16 |
| Default Value | 1 |

7.2.2 Object 6010h: Slope_Long16

This object gives the 16-bit slope value of the longitudinal axis.

Object Description

| | |
|-------------|--------------|
| INDEX | 6010h |
| Name | Slope_Long16 |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Mandatory |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | Default |
| Value Range | Signed16 |
| Default Value | No |

7.2.3 Object 6011h: Slope_Long16_Operating_Parameter

This object determines the interpretation of the Slope_Long16 value:

| Function | Bit | 0 | 1 |
|-----------------------|--------|----------|---------|
| Inversion | 0 | disabled | enabled |
| Scaling | 1 | disabled | enabled |
| reserved | 2 .. 4 | - | - |
| Manufacturer-specific | 5 .. 7 | - | - |

If scaling is enabled, the Slope_Long16 value is 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 is equal to the physical measured angle.

Object Description

| | |
|-------------|----------------------------------|
| INDEX | 6011h |
| Name | Slope_Long16_Operating_Parameter |
| Object Code | Variable |
| Data Type | Unsigned8 |
| Category | Mandatory |

Entry Description

| | |
|---------------|-----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Unsigned8 |
| Default Value | 0 |

7.2.4 Object 6012h: Slope_Long16_Preset_Value

Accessing this object by means of SDO sets 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 (see 6013h). The Slope_Long16_Offset is calculated with respect to object 6014h.

Object Description

| | |
|-------------|---------------------------|
| INDEX | 6012h |
| Name | Slope_Long16_Preset_Value |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed16 |
| Default Value | No |

7.2.5 Object 6013h: Slope_Long16_Offset

This object includes the application-offset of the longitudinal axis. The value is based on the resolution given in object 6000h. 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 6012h

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6013h |
| Name | Slope_Long16_Offset |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Conditional: if 6012h is implemented |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | No |
| Value Range | Signed16 |
| Default Value | 0h |

7.2.6 Object 6014h: Differential_Slope_Long16_Offset

This object shifts the Slope_Long16 value (object 6010h) independent of Slope_Long16_Preset_Value (object 6012h and Slope_Long16_Offset (object 6013h).

Object Description

| | |
|-------------|----------------------------------|
| INDEX | 6013h |
| Name | Differential_Slope_Long16_Offset |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed16 |
| Default Value | 0h |

7.2.7 Object 6020h: Slope_Lateral16

This object gives the 16-bit slope value of the lateral axis.

Object Description

| | |
|-------------|-----------------|
| INDEX | 6020h |
| Name | Slope_Lateral16 |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | Default |
| Value Range | Signed16 |
| Default Value | No |

7.2.8 Object 6021h: Slope_Lateral16_Operating_Parameter

This object determines the interpretation of the Slope_Lateral16 value:

| Function | Bit | 0 | 1 |
|-----------------------|--------|----------|---------|
| Inversion | 0 | disabled | enabled |
| Scaling | 1 | disabled | enabled |
| reserved | 2 ..4 | - | - |
| Manufacturer-specific | 5 .. 7 | - | - |

If scaling is enabled, the Slope_Lateral16 value is 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 is equal to the physical measured angle.

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6021h |
| Name | Slope_Lateral16_Operating_Parameter |
| Object Code | Variable |
| Data Type | Unsigned8 |
| Category | Conditional: if 6020h is implemented |

Entry Description

| | |
|---------------|-----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Unsigned8 |
| Default Value | 0 |

7.2.9 Object 6022h: Slope_Lateral16_Preset_Value

Accessing this object by means of SDO sets 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 (see 6023h). The Slope_Lateral16_Offset is calculated with respect to object 6024h.

Object Description

| | |
|-------------|------------------------------|
| INDEX | 6022h |
| Name | Slope_Lateral16_Preset_Value |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed16 |
| Default Value | No |

7.2.10 Object 6023h: Slope_Lateral16_Offset

This object includes the application-offset of the lateral axis. The value is based on the resolution given in object 6000h. The following equation shall be applied:

$$\text{Slope_Lateral16_Offset} = \text{Slope_Lateral16_Preset_Value at } t_{\text{acc}} - \text{slope physical measured at } t_{\text{acc}} - \text{Differential_Slope_Lateral16_Offset}$$

t_{acc} = time when accessing object 6022h

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6023h |
| Name | Slope_Lateral16_Offset |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Conditional: if 6022h is implemented |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | No |
| Value Range | Signed32 |
| Default Value | 0h |

7.2.11 Object 6024h: Differential_Slope_Lateral16_Offset

This object shifts the Slope_Lateral16 (object 6020h) value independent of Slope_Lateral16_Preset_Value (object 6022h and Slope_Lateral16_Offset (object 6023h).

Object Description

| | |
|-------------|-------------------------------------|
| INDEX | 6013h |
| Name | Differential_Slope_Lateral16_Offset |
| Object Code | Variable |
| Data Type | Signed16 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed16 |
| Default Value | 0h |

7.2.12 Object 6110h: Slope_Long32

This object gives the 32-bit slope value of the longitudinal axis.

Object Description

| | |
|-------------|--------------|
| INDEX | 6110h |
| Name | Slope_Long32 |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | Optional |
| Value Range | Signed32 |
| Default Value | No |

7.2.13 Object 6111h: Slope_Long32_Operating_Parameter

This object determines the interpretation of the Slope_Long32 value:

| Function | Bit | 0 | 1 |
|-----------------------|--------|----------|---------|
| Inversion | 0 | disabled | enabled |
| Scaling | 1 | disabled | enabled |
| reserved | 2 ..4 | - | - |
| Manufacturer-specific | 5 .. 7 | - | - |

If scaling is enabled, the Slope_Long32 value is 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 is equal to the physical measured angle.

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6111h |
| Name | Slope_Long32_Operating_Parameter |
| Object Code | Variable |
| Data Type | Unsigned8 |
| Category | Conditional: if 6110h is implemented |

Entry Description

| | |
|---------------|-----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Unsigned8 |
| Default Value | 0 |

7.2.14 Object 6112h: Slope_Long32_Preset_Value

Accessing this object by means of SDO sets the actual longitudinal slope value to a desired longitudinal value. The calculated application-offset of the longitudinal slope value is given in Slope_Long32_Offset (see 6113h). The Slope_Long32_Offset is calculated with respect to object 6114h.

Object Description

| | |
|-------------|---------------------------|
| INDEX | 6112h |
| Name | Slope_Long32_Preset_Value |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed32 |
| Default Value | No |

7.2.15 Object 6113h: Slope_Long32_Offset

This object includes the application-offset of the longitudinal axis. The value is based on the resolution given in object 6000h. 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 6112h

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6113h |
| Name | Slope_Long32_Offset |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Conditional: if 6112h is implemented |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | No |
| Value Range | Signed32 |
| Default Value | 0h |

7.2.16 Object 6114h: Differential_Slope_Long32_Offset

This object shifts the Slope_Long32 (object 6110h) value independent of Slope_Long32_Preset_Value (object 6112h and Slope_Long32_Offset (object 6113h).

Object Description

| | |
|-------------|----------------------------------|
| INDEX | 6013h |
| Name | Differential_Slope_Long32_Offset |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed32 |
| Default Value | 0h |

7.2.17 Object 6120h: Slope_Lateral32

This object gives the 32-bit slope value of the lateral axis.

Object Description

| | |
|-------------|-----------------|
| INDEX | 6120h |
| Name | Slope_Lateral32 |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | Optional |
| Value Range | Signed32 |
| Default Value | No |

7.2.18 Object 6121h: Slope_Lateral32_Operating_Parameter

This object determines the interpretation of the Slope_Lateral32 value:

| Function | Bit | 0 | 1 |
|-----------------------|--------|----------|---------|
| Inversion | 0 | disabled | enabled |
| Scaling | 1 | disabled | enabled |
| reserved | 2 ..4 | - | - |
| Manufacturer-specific | 5 .. 7 | - | - |

If scaling is enabled, the Slope_Lateral32 value is 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 is equal to the physical measured angle.

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6121h |
| Name | Slope_Lateral32_Operating_Parameter |
| Object Code | Variable |
| Data Type | Unsigned8 |
| Category | Conditional: if 6120h is implemented |

Entry Description

| | |
|---------------|-----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | Optional |
| Value Range | Unsigned8 |
| Default Value | 0 |

7.2.19 Object 6122h: Slope_Lateral32_Preset_Value

Accessing this object by means of SDO sets the actual slop lateral value to a desired lateral value. The calculated application-offset of the slope lateral is given in Slope_Lateral32_Offset (see 6123h). The Slope_Lateral32_Offset is calculated with respect to object 6124h.

Object Description

| | |
|-------------|------------------------------|
| INDEX | 6122h |
| Name | Slope_Lateral32_Preset_Value |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | No |
| Value Range | Signed32 |
| Default Value | No |

7.2.20 Object 6123h: Slope_Lateral32_Offset

This object includes the application-offset of the lateral axis. The value is based on the resolution given in object 6000h. The following equation shall be applied:

$$\text{Slope_Lateral32_Offset} = \text{Slope_Lateral32_Preset_Value at } t_{\text{acc}} - \text{slope physical measured at } t_{\text{acc}} - \text{Differential_Slope_Lateral32_Offset}$$

t_{acc} = time when accessing object 6122h

Object Description

| | |
|-------------|--------------------------------------|
| INDEX | 6123h |
| Name | Slope_Lateral32_Offset |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Conditional: if 6112h is implemented |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | ro |
| PDO Mapping | Optional |
| Value Range | Signed32 |
| Default Value | 0h |

7.2.21 Object 6124h: Differential_Slope_Lateral32_Offset

This object shifts the Slope_Lateral32 (object 6120h) value independent of Slope_Lateral32_Preset_Value (object 6122h) and Slope_Lateral32_Offset (object 6123h).

Object Description

| | |
|-------------|-------------------------------------|
| INDEX | 6124h |
| Name | Differential_Slope_Lateral32_Offset |
| Object Code | Variable |
| Data Type | Signed32 |
| Category | Optional |

Entry Description

| | |
|---------------|----------|
| Sub-Index | 0h |
| Access | rw |
| PDO Mapping | Optional |
| Value Range | Signed32 |
| Default Value | 0h |

7.3 General device profile objects**7.3.1 Object 67FF: Device Type**

This objects shall describe the first virtual device in a multiple device module according to /1/.