Operating Instructions

ZK-USB-CAN-1

Operating Instructions Version: 1.0.0

Contents

1 Introduction

ZK-USB-CAN-1 is a USB-to-CAN adapter with galvanic isolation between the USB and CAN interface. It enables CAN networks to be connected. Its compact plastic housing also makes it ideal for mobile applications.

Power is supplied via the USB 2.0 type-B plug. The CAN interface can be connected to a shielded RJ45 socket or a 4-pin PCB terminal. The adapter supports the USB 2.0 Full-Speed interface and CAN 2.0.

ZK-USB-CAN-1 also has switchable bus termination as well as two status LEDs (USB and CAN).

1.1 Version information

Document version	Date	Changes	Firmware version
1.0.0	03/2021	Edition	v2110

1.2 Copyright, marking and contact

CE

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1.3 Intended use

ZK-USB-CAN-1 is used as a component of drive systems in various industrial applications where a computer needs to be connected to the CAN bus via USB.

Use the product as intended within the limits defined in the technical data (see Electrical properties and technical data) and the approved Environmental conditions.

Under no circumstances may this Nanotec product be integrated as a safety component in a product or system. All products containing a component manufactured by Nanotec must, upon delivery to the end user, be provided with corresponding warning notices and instructions for safe use and safe operation. All warning notices provided by Nanotec must be passed on directly to the end user.

1.4 Warranty and disclaimer

Nanotec assumes no liability for damages and malfunctions resulting from installation errors, failure to observe this manual or improper repairs. The selection and use of Nanotec products is the responsibility of

the plant engineer or end user. Nanotec accepts no responsibility for the integration of the product in the end system.

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NOTE

Changes or modifications to the product are not permitted.

1.5 Target group and qualification

The product and this documentation are directed towards technically trained specialists staff such as:

- Software developers
- Development engineers
- Installers/service personnel
- Application engineers

Only specialists may install and commission the product. Specialist staff are persons who

- have appropriate training and experience in working with fieldbus systems and electrostatically sensitive components,
- are familiar with and understand the content of this technical manual,
- know the applicable regulations.

1.6 EU directives for product safety

The following EU directives were observed:

- RoHS directive (2011/65/EU, 2015/863/EU)
- EMC directive (2014/30/EU)

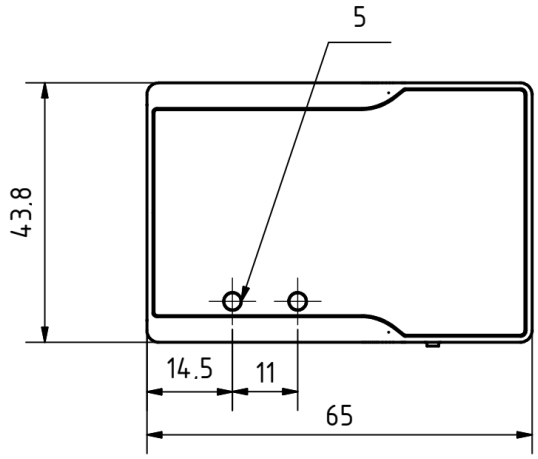
1.7 Numerical values

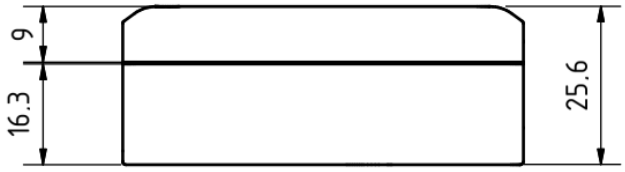
Numerical values are generally specified in decimal (*dec*) notation. If hexadecimal (*hex*) notation is used, it is marked with *0x*.

2 Technical details and pin assignment

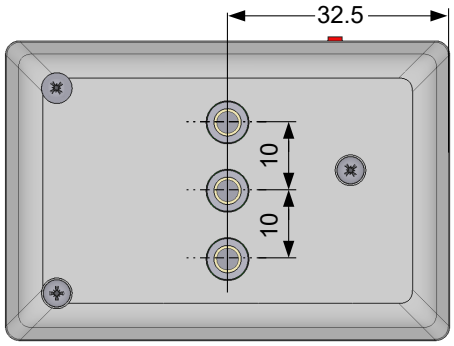
2.1 Dimensioned drawings and installation options

All dimensions are in millimeters.





You can secure the adapter using one to three M4 screws. Three M4x6 threaded holes are provided for this purpose:



Alternatively, you can also screw on a DIN rail clip and install the adapter in a switch cabinet.

2.2 Environmental conditions

Environmental condition	Value	Unit
Ambient temperature (operation)	-10 … 70	°C
Ambient temperature (storage)	-25 … 85	°C
Relative air humidity (non-condensing)	0 … 95	%
Protection class according to EN/IEC 60529	IP 40	

2.3 Electrical properties and technical data

Property	Value	Unit	Note
Power supply	5	V DC	via USB
Insulation voltage	1000 / 500	V DC / V AC	for 1 minute
CAN baud rate	up to 1000	KBaud	

2.4 LED signaling

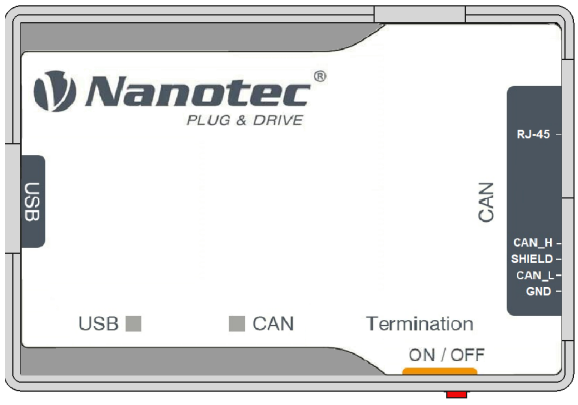
When USB is initialized, the USB status LED lights up green and the device is ready for operation. If communication is taking place, the LED flashes green. If an error occurs, the LED lights up red.

The CAN status LED has similar functions. When the CAN bus is initialized, the LED lights up green. If communication is taking place, the LED flashes green. If an error occurs, the LED lights up red.

LED behavior	USB/CAN status
continuously red	Error
continuously green	initialized
flashing green	communication taking place

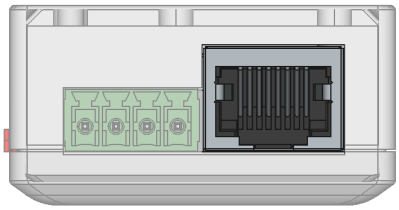
2.5 Pin assignment

Overview



CAN connection 1 — RJ-45

Type: RJ45 socket

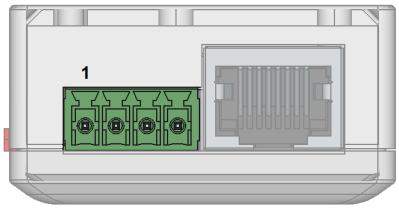


Pin	Function	Note
1	CAN_H	CAN-High
2	CAN_L	CAN-Low
3	CAN_GND	CAN-Ground
4	-	-
5	-	-
6	CAN_SHLD	connected to housing
7	-	-
8	-	-
Housing	Shield	connected with pin 6

CAN connection 2 — PCB terminal

- Type: Phoenix Contact MCV 1.5/ 4-G-3.5
- Mating connector (included in scope of delivery): Phoenix Contact FMC 1.5/ 4-ST-3.5 (or equivalent)

Pin 1 is marked with a 1.

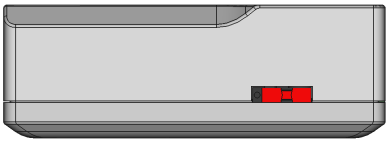


Pin	Function	Note
1	CAN_GND	CAN-Ground
2	CAN_L	CAN-Low
3	CAN_SHLD	Connection for the shielding, connected to the housing of RJ45
4	CAN_H	CAN-High

Termination resistor

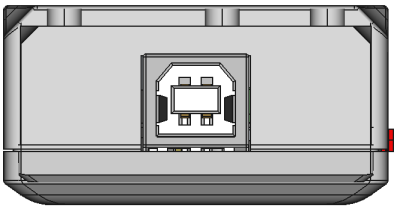
Type: Slide switch

This slide switch switches the termination of 120 Ω between CAN_H and CAN_L of the CAN bus on or off. The "left" switch position switches termination on.



USB connection

Type: USB 2.0, type-B connector. A suitable USB cable is included in scope of delivery.



3 Installing driver and adapter

This chapter explains how to connect the adapter to a PC with Windows 10.

1. Connect the adapter to the PC via USB. The driver is installed automatically and the device bus is detected as a COM port.
2. To find the number of the assigned COM port:
   a. Click the search icon in the task bar.
   b. Search for "Device Manager" and select it.
   c. Go to "Ports (COM & LPT)".
   A USB serial device with the assigned COM number (COM "X") appears.

4 Protocol description

This chapter lists all commands supported by the adapter protocol. You can send the commands via the COM port (e.g. using a terminal program).

The protocol is based on the specification *CiA 309: Access from other networks - Part 3: ASCII mapping*.

All commands are confirmed. You may start each command with a sequence number (UNSIGNED32), which is then included in the response.

Example

```
// Request: Get name info, sequence=[1234]
[1234] info name
// Response: product name
[1234] name: ZK-USB-CAN-1
```

The token [net] is allowed to follow the [sequence] due to compatibility reasons, but it is ignored by the adapter.

4.1 Configuration and initialization

4.1.1 Get Device Information: version, state, ticks, name

You use this command to read out the product information and e.g. carry out initial testing of the connection.

1. Version info
   Syntax: **`"info version"`**
   You use this command to request the version of the CANopen gateway server.

   Example

   ```
   // Request: Get version info
   info version
   // Response:
   620 690 2110.0 352977019 0 00.00 00.00
   ```

   - 620: *Vendor ID*
   - 690: *Product Code*
   - 2110.0: Firmware Version, Year 2021, Week 10
   - 352977019: Serial Number
2. State info
   Request state of the CAN bus state.
   Syntax: **`"info state"`**
   You use this command to query the state of the CAN bus.

   Example

   ```
   // Request: Get baudrate state info
   info state
   // Response: -1 if not initialized, >=0 -> baudrate; 0 = 1000kB
   state:0
   ```
3. Ticks info
   Syntax: **`"info tick"`**

Returns the number of ticks (milliseconds since power on).

Example

```
// Response: Get tick info
info tick
// Response: tick = 6940278
tick:6940278
```

4. Name info
   Syntax: **"info name"**
   Returns the product name.

Example

```
// Request: Get name info
info name
// Response: product name
name: ZK-USB-CAN-1
```

4.1.2 Read Hardware Version

Syntax:**0 r 0x1009 0 vs**

Example

```
// Read adapter hardware version: NodeId=0; Index=0x1009;
 Subindex=0:
// Data Type= visual string
0 r 0x1009 0 vs
// SDO Read Response: hardware version= W003
"W003"
```

4.1.3 Read Firmware Version

Syntax:**0 r 0x100A 0 vs**

Example

```
// Read adapter firmware version: NodeId=0; Index=0x100A;
 Subindex=0:
// Data Type= visual string
0 r 0x100A 0 vs
// SDO Read Response: firmware version= ZKUSBCAN1-FIB-v2110-
B123456
"ZKUSBCAN1-FIB-v2110-B123456"
```

4.1.4 Read Serial Number

Syntax:**0 r 0x4040 0 vs**

Example

```
// Read adapter serial number: NodeId=0; Index=0x4040; Subindex=0:
// Data Type= visual string
0 r 0x4040 0 vs
// SDO Read Response: serial number= B123456 21/10-0123
"B123456 21/10-0123"
```

4.1.5 Initializing gateway

Syntax: **"[sequence] init <baudrate>"**

Determines the baud rate at which the CAN gateway server operates. The baud rate can be specified as a value or as a table index of the standard CANopen table.

Index	Baud rate
-1	Stop Bus
0	1000
1	800
2	500
3	250
4	125
5	100
6	50
7	20
8	10

NOTE

Autobaud is not supported.

Example

```
// Request: Initialize CAN-Baudrate 1000 Kbits
init 0
// Response: "OK"
OK
```

4.1.6 Command set: node ID, network, timeout

You use these commands to set the node ID, network and SDO timeout:

1. Syntax: **"[sequence] [net] set node <value>"**
   Sets the default node ID to be sent with each command, if no other node ID is included in the command.

Example

```
// Request:  Set CAN-NodeId = 127
set node 127
// Response: "OK"
```

```
OK
```

2. Syntax: **"[sequence] [net] set network <value>"**
   You set the default network here (used just for compatibility reasons).

Example

```
// Request: Set CAN-Network = 2
set network 2
// Response: "OK"
OK
```

3. SDO timeout
   Syntax: **"[[sequence] [net] node] set sdo_timeout <ms>"**
   You use this command to set the SDO timeout.

Example

```
// Request: Set timeout = 1ms
set sdo_timeout 1
// Response: "OK"
OK
```

4.1.7 Start node (NMT)

Syntax: **"[[sequence] [net] node] start"**

You use this command to switch the CAN network to the "Operational" state in which PDO transfer takes place.

Example

```
// Request: Send Start operational command to NodeId = 1
1 start
// Response: "OK"
OK
```

```
// Incoming CAN-Message with CobId = 0x701; Data Length = 1;
// Data = 0x5
:>701 1 5
```

```
// Incoming CAN-Message with CobId = 0x281; Data Length = 4;
// Data = 0 0 0 0
:>281 4 0 0 0 0
```

```
// Incoming CAN-Message with CobId = 0x381; Data Length =  1;
// Data = 0 0
:>381 2 0 0
```

```
// Incoming CAN-Message with CobId = 0x481; Data Length = 4;
// Data = 0 0 0 0
:>481 4 0 0 0 0
```

4.1.8 Stop node (NMT)

Syntax: **"[[sequence] [net] node] stop"**

You use this command to switch the CAN network to the "Stop" state.

Example

```
// Request: Send stop command to NodeId = 1
1 stop
// Response: “OK”
OK
```

```
// Incoming CAN-Message with CobId = 0x701; Data Length = 1;
// Data = 4
:>701 1 4
```

4.1.9 Set node Pre-Operational (NMT)

Syntax: **"[[sequence] [net] node] preop[erational]"**

You use this command to switch the CAN network to the "Pre-Operational" state in which you can change the PDO mapping.

Example

```
// Request: Set NodeId = 1 to pre-operational
1 preop
// Response: “OK”
OK
```

```
// Incoming CAN-Message with CobId=0x701; Data Length=0x1;
 Data=0x7F
:>701 1 7F
```

4.1.10 Reset node (NMT)

Syntax: **"[[sequence] [net] node] reset node"**

You use this command to reset the CAN node.

Example

```
// Request: Send Reset Node to NodeId = 1
1 reset node
// Response: “OK”
OK
```

```
// Incoming CAN-Message with CobId=0x701; Data Length=0x1;
 Data=0x0
:>701 1 0
```

4.1.11 Reset communication (NMT)

Syntax: **"[[sequence] [net] node] reset comm"**

Example

```
// Request: Send Reset communication to NodeId = 1
1 reset comm
// Response: "OK"
OK
```

4.1.12 Command for message format

Syntax: **set msg_format [n]**

Where [n] is 0 (default format) or 1:

```
Format (0)
// All return strings are hex values!
:>601 8 40 63 20 0 0 0 0 0
:>581 8 43 63 20 0 1 0 0 0
```

```
Format (1)
// All return strings are hex values!
:>0x00000601 8 0x40 0x63 0x20 0x00 0x00 0x00 0x00 0x00
:>0x00000581 8 0x43 0x63 0x20 0x00 0x01 0x00 0x00 0x00
```

Example

```
// Request: Set the format of message to 0
set msg_format 0
// Response: "OK"
OK
```

4.1.13 Command for CAN mode

Syntax: **set can_mode [m]**

Where [m] is 0 to 3:

- 0 - (Default) normal CAN mode
- 1 - Loopback mode
- 2 - Silent mode
- 3 - Loopback with silent mode

New mode settings become effective after reinitialization of the CAN bus (command init).

Example

```
// Request: Set CAN mode = 1 (Loopback mode)
set can_mode 1
// Response: "OK"
OK
```

4.1.14 Command for: Filters, Filter ID, Filter Mask

You can use filters to filter the incoming CAN messages.

1. Command for setting Filter
   Syntax: **`set filterX [S]`**
   Where:
   - X – 0 to 7: filter number
   - S – 0 or 1: 0 = deactivate filter; 1 = activate filter

   Example

   ```
   // Request: Enable filter 0
   set filter0 1
   // Response: "OK"
   OK
   ```

2. Command for setting Filter ID
   Syntax: **`set filter idX [id]`**
   Where:
   - X – 0 to 7: filter number
   - [id] – value for ID comparison

   The bits of the filter ID are directly compared with the bits of the ID of the incoming message.

   Example

   ```
   // Request:
   set filter_id0 0x581
   // Response: "OK"
   OK
   ```

3. Command for setting Filter Mask
   Syntax: **`filter_maskX [id_mask]`**
   Where:
   - X – 0 to 7: filter number
   - [id_mask] – bit mask for ID comparison

   The bit mask defines which bits of the ID are taken into consideration.

   Example

   ```
   // Request: Set filter MaskId = 0xFFF
   set filter_mask0 0xFFF
   // Response: "OK"
   OK
   ```

Example

```
set filter_id0 0x07D
set filter_mask0 0x0FF
set filter0 1
```

Only those messages are shown whose least significant bits correspond to the ID 0x7D.

After activation of the filter, the following messages would be shown, e.g.:

```
:>17D 8 0 0 0 0 0 0 0 0
:>47D 4 0 1 1 0
```

4.1.15 Command Notification

Syntax: **`set notification [n]`**

Where [n] is 0 to 3:

- 0 - Received RAW CAN messages are not displayed.
- 1 (default) - Only received RAW CAN messages that do not relate to the current SDO transfer are displayed.
- 2 - All received RAW CAN messages are displayed.
- 3 - All received and sent RAW CAN messages are displayed.

Example

```
// Request: Set notification = 0
set notification 0
// Response: "OK"
OK
```

4.1.16 Command for CAN Error list

Syntax: **`info CAN_ERR`**

Returns a message in the CAN_ERR format: [REC] [TEC] [LEC] [BOFF] [EPVF] [EWGF]

Where:

- [REC] - Error counter (receive error)
- [TEC] - Least significant byte of the error counter (transmit error)
- [LEC] - Last error code:
  - 0: No error
  - 1: Stuff Error
  - 2: Form Error
  - 3: Acknowledgment Error
  - 4: Bit recessive Error
  - 5: Bit dominant Error
  - 6: CRC Error
  - 7: Reserved
- [BOFF] - CAN bus OFF flag (0 or 1)
- [EPVF] - CAN bus error passive flag (0 or 1)
- [EWGF] - CAN bus error warning flag (0 or 1)

Example

```
// Request: Get info for a CAN error
info CAN_ERR
//Response CAN_ERR: [REC] [TEC] [LEC] [BOFF] [EPVF] [EWGF]
CAN_ERR: 0 0 0 0 0 0
```

4.2 Commands for reading and writing

The following table shows all supported data types and the format used in the commands.

Data Type	Format
SIGNED8	i8
SIGNED16	i16
SIGNED32	i32
UNSIGNED8	u8
UNSIGNED16	u16
UNSIGNED32	u32
Octet String (base64 encoded data)	os
Domain (base64 encoded data)	d
Visual String (see following section)	vs

Visual Strings

You can use visual strings inside quotes:

`"vs"`

Escape sequences are also supported inside:

Escape Sequence	Format
Backslash	\\ - character \
Single Quotation Mark	\' - character '
Double Quotation Mark	\" - character "
Question Mark	\? - character ?

You can also use one of the following special control characters:

Control Character	Format
Bell	\a
Backspace	\b
Form Feed	\f
Line Feed	\n
Carriage Return	\r
Horizontal Tab	\t
Vertical Tab	\v
Octal Number of ASCII Character	\xNNN, where NNN the octal number of the ASCII character you want to place inside the escape sequence

4.2.1 Command "r" (SDO Read Request)

Syntax: **`[[sequence] [net] node] r <multiplexer> <datatype>`**

Example

```
// SDO Read Request: NodeId=1; Index=0x1000; Subindex=0:
// Data Type=UInt32
1 r 0x1000 0 u32
// SDO Read Response: Value = 393618 = 0x00060192
393618
```

4.2.2 Command "w" (SDO Write Request)

Syntax: **`[[sequence] [net] node] w <index> <subindex> <datatype> <value>`**

Example

```
// SDO Write Request: NodeId=1; Index=0x1016; Subindex=0:
// Data Type=UInt32, Value = 100
1 w 0x60FE 1 u32 100
// Response: "OK"
OK
```

4.2.3 Command "wl" (Initiate download SDO command for large data)

Syntax: **`"[sequence] [net] [node] wl <multiplexer> <command-specifier> <datatype> <overall_size> <value>"`**

This command is used for writing large quantities of data and is directly linked to the "wlseg" command (for further details, see *CiA 309:Access from other networks - Part 3: ASCII mapping*).

4.2.4 Command "rl" (Initiate upload SDO command for large data)

Syntax: **`"[sequence] [net] [node] rl <multiplexer>"`**

This command is used for reading large quantities of data and is directly linked to the "NEXT" command (for further details, see *CiA 309:Access from other networks - Part 3: ASCII mapping*).

4.2.5 Command "wlb" (Initiate download SDO command for large data)

Syntax: **`"[sequence] [net] [node] wlb <multiplexer> <command-specifier> <datatype> <overall_size> <value>"`**

This command functions in the same way as "wl", but with SDO block transfer.

4.2.6 Command "rlb" (Initiate upload SDO command for large data)

Syntax: **`"[sequence] [net] [node] rlb <multiplexer>"`**

This command functions in the same way as "rl", but with SDO block transfer.

4.2.7 Command for SDO abort

Syntax: **`[sequence] [net] sdo_abort [force]`**

Aborts the SDO tranfer with the commands "wl(b)" and "rl(b)" with the SDO abort code 0x05000000. With `[force]`, an SDO abort request is sent, even if there is no ongoing SDO transfer.

Example

```
// Request: SDO abort
sdo_abort
// Response: “OK”
OK
```

4.2.8 Command "rm" (remote request)

Syntax: **`[sequence] [net] rm <cobid>`**

Example

```
// Request: Send remote request
rm 0x181
// Response: “OK”
OK
```

4.2.9 Command "wm" (write CAN message)

Syntax: **`[sequence] [net] wm <cobid> <dataLength> <value1>[..<value8>]`**

Example

```
// Request: CobId=0x00;
wm 0 2 2 0
// Response: “OK”
OK
```

```
// Incoming CAN-Message with CobId=0x701; Data Length=1; Data=0x4
:>701 1 4
```

4.2.10 Command ":<" (send CAN message)

Syntax: **`[sequence] [net] :< <cobid> <dataLength> <value1>[..<value8>]`**

All values are in hexadecimal notation, without the prefix *0x*.

Example

```
// Request: CobId=0x1F4;
:< 1F4 5 21 5A 3 1 CA
// Response: “OK”
OK
```

5 Error messages

If an error occurs, the adapter returns an error code. The error can be an internal error (syntax, incorrect parameter input) or an error during SDO transfer.

The format of the error message depends on the type of error:

Synchronous Error

Error returned in responce to a command.

Format: `ERROR: XXX`, where XXX the error code.

Asynchronous Error

Error that can occur anytime.

Format: `ERROR XXX`, where XXX the error code. Only error codes 300 and 301 are returned in this format

Example

```
// Request: Send wrong command!!!
wrong command
// Response: "ERROR" with error code = 101
ERROR: 101
```

Internal errors

Error code (dec)	Error message
100	Request not supported
101	Syntax error
102	Request not processed due to internal state
103	Timeout (where applicable)
300	Error passive
301	Bus off
303	CAN buffer overflow
304	CAN init
305	CAN active (at init or start-up)

SDO error messages

NOTE

Depending on your CAN controller, further SDO error messages can appear.

Error code (hex)	Description
0500 0000	General SDO protocol error detected
0503 0000	Toggle bit not alternated
0504 0000	SDO protocol timed out

Error code (hex)	Description
0504 0001	Client/server command specifier not valid or unknown
0504 0002	Invalid block size (block mode only)
0504 0003	Invalid sequence number (block mode only)
0504 0004	CRC error (block mode only)
0504 0005	Out of memory.
0601 0000	Unsupported access to an object
0601 0001	Attempt to read a write only object
0601 0002	Attempt to write a read only object
0602 0000	Object does not exist in the object dictionary
0604 0041	Object cannot be mapped to the PDO
0604 0042	The number and length of the objects to be mapped would exceed PDO length
0604 0043	General parameter incompatibility reason
0604 0047	General internal incompatibility in the device