iPOS CANopen Programming

TECHNOSOFT

User Manual

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P091.063.iPOS.UM.0913

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Read This First

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About This Manual

This book describes how to program Technosoft iPOS family of intelligent drives using **CANopen** protocol. The iPOS drives are confirming to **CiA 301 v4.2** application layer and communication profile, CiA **WD 305 v.2.2.13**[1] Layer Setting Services and to **CiA DSP 402 v3.0** device profile for drives and motion control, now included in IEC 61800-7-1 Annex A, IEC 61800-7-201 and IEC 61800-7-301 standards. The manual presents the object dictionary associated with these three profiles. The manual also explains how to combine the Technosoft Motion Language (**TML**) commands and the CANopen protocol commands in order to distribute the application between the CANopen master and the Technosoft drives. In order to operate the Technosoft iPOS drives, you need to pass through 3 steps:

- **Step 1 Hardware installation**
- **Step 2 Drive setup** using Technosoft **EasySetUp** software for drive commissioning
- **Step 3 Motion programming** using one of the options:
  - A. A **CANopen master**
  - B. The drive **built-in motion controller** executing a Technosoft Motion Language (**TML**) program developed using Technosoft **EasyMotion Studio** software
  - C. A **TML_LIB motion library for PCs** (Windows or Linux)
  - D. A **TML_LIB motion library for PLCs**
  - E. A **distributed control** approach which combines the above options, like for example a host calling motion functions programmed on the drives in TML

Scope of This Manual

This manual applies to the iPOS family of Technosoft intelligent drives.

Notational Conventions

This document uses the following conventions:

[1] Available starting with firmware revision C.

- **TML** – Technosoft Motion Language
- **iPOS** – a Technosoft drive family, the code is usually iPOSxx0x xx-CAN
- **IU** – drive/motor internal units
- **ControlWord.5** – bit 5 of ControlWord data
- **cs** – command specifier
- **Axis ID = CAN ID = COB ID** – the unique number allocated to each drive in a network.

Related Documentation

Help of the EasySetUp software – describes how to use **EasySetUp** to quickly setup any Technosoft drive for your application using only 2 dialogues. The output of EasySetUp is a set of setup data that can be downloaded into the drive EEPROM or saved on a PC file. At power-on, the drive is initialized with the setup data read from its EEPROM. With EasySetUp it is also possible to retrieve the complete setup information from a previously programmed drive. **EasySetUp can be downloaded free of charge from Technosoft web page**

Technical Reference Manual of each iPOS drive version – describes the hardware including the technical data, the connectors, the wiring diagrams needed for installation and detailed setup information.

Motion Programming using EasyMotion Studio (part no. P091.034.ESM.UM.xxxx) – describes how to use the EasyMotion Studio to create motion programs using in Technosoft Motion Language (TML). EasyMotion Studio platform includes **EasySetUp** for the drive/motor setup, and a **Motion Wizard** for the motion programming. The Motion Wizard provides a simple, graphical way of creating motion programs and automatically generates all the TML instructions. *With EasyMotion Studio you can fully benefit from a key advantage of Technosoft drives – their capability to execute complex motions without requiring an external motion controller, thanks to their built-in motion controller.* **A demo version of EasyMotion Studio (with EasySetUp part fully functional) can be downloaded free of charge from Technosoft web page**

TML_LIB v2.0 **(part no. P091.040.v20.UM.xxxx)** – explains how to program in **C, C++, C#, Visual Basic or Delphi Pascal** a motion application for the Technosoft intelligent drives using TML_LIB v2.0 motion control library for PCs. The manual includes over 40 ready-to-run examples that can be executed on **Windows** or **Linux** (x86 and x64)

TML_LIB_LabVIEW v2.0 **(part no. P091.040.LABVIEW.v20.UM.xxxx)** – explains how to program in **LabVIEW** a motion application for the Technosoft intelligent drives using TML_LIB_LabVIEW v2.0 motion control library for PCs. The manual includes over 40 ready-to-run examples.

TML_LIB_S7 **(part no. P091.040.S7.UM.xxxx)** – explains how to program a PLC Siemens series S7-300 or S7-400 with a motion application for the Technosoft intelligent drives using TML_LIB_S7 motion control library. The manual includes over 40 ready-to-run examples. The library is PLCOpen compatible.

TML_LIB_CJ1 **(part no. P091.040.CJ1.UM.xxxx)** – explains how to program a PLC Omron series CJ1 with a motion application for the Technosoft intelligent drives using TML_LIB_CJ1 motion control library for PCs. The manual includes over 40 ready-to-run examples. The library is **PLCOpen** compatible.

TML_LIB_X20 **(part no. P091.040.X20.UM.xxxx)** – explains how to program in a PLC **B&R series X20** a motion application for the Technosoft intelligent drives using TML_LIB_X20 motion control library for PLCs. The TML_LIB_X20 library is **IEC61131-3 compatible**

TechnoCAN **(part no. P091.063.TechnoCAN.UM.xxxx)** – presents TechnoCAN protocol – an extension of the CANopen communication profile used for TML commands

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Receive general information or assistance (see Note)	World Wide Web: http://www.technosoftmotion.com/ Email: contact@technosoftmotion.com
Ask questions about product operation or report suspected problems (see Note)	Fax: (41) 32 732 55 04 Email: hotline@technosoftmotion.com
Make suggestions about, or report errors in documentation (see Note)	Mail: Technosoft SA Avenue des Alpes 20 CH-2000 NEUCHATEL, Switzerland

Contents

1. Getting Started

1.1. Setting up the drive using EasySetUp or EasyMotion Studio

1.1.1. What are EasySetUp and EasyMotion Studio?

EasySetUp is a PC software platform for the setup of the Technosoft drives. Via EasySetUp you can quickly commission any Technosoft drive for your application using only 2 dialogues.

The output of EasySetUp is the *setup data* that can be stored into the drive EEPROM or saved on a PC file. The *setup data* contains all the information needed to configure and parameterize a Technosoft drive. At power-on, the drive is initialized with the *setup data* read from its EEPROM. EasySetUp may also be used to retrieve the *setup data* previously stored in a drive EEPROM.

EasySetUp also includes evaluation tools like: Data Logger, Control Panel and Command Interpreter which help you to quickly measure, check and analyze your drive commissioning.

EasyMotion Studio is an advanced PC software platform that can be used both for the drives setup and for their motion programming. With EasyMotion Studio you can fully benefit from a key advantage of the Technosoft drives – their capability to execute stand-alone complex motion programs thanks to their built-in motion controller.

EasyMotion Studio includes **EasySetUp** for the drive setup, and a **Motion Wizard** for the motion programming. The Motion Wizard provides a simple, graphical way of creating motion programs written in Technosoft Motion Language (TML). It automatically generates all the TML instructions, hence you don't need to learn or write any TML code. Via TML you can:

- Set various motion modes
- Change the motion modes and/or the motion parameters
- Execute homing sequences
- Control the program flow through:
  - Conditional jumps and calls of TML functions
  - Interrupts generated on pre-defined or programmable conditions (protections triggered, transitions of limit switch or capture inputs, etc.)
  - Waits for programmed events to occur
- Handle digital I/O and analogue input signals
- Execute arithmetic and logic operations

The output of EasyMotion Studio is the *application data* that can be loaded into the drive EEPROM or saved on a file. The *application data* includes both the *setup data* and the *TML motion program*.

Using TML, you can really simplify complex applications, by distributing the intelligence between the master and the drives. Thus, instead of trying to command each step of an axis movement from the master, you can program the drives using TML to execute complex tasks, and inform the master when these tasks have been completed.

Important: *You need **EasyMotion Studio full version**, only if you use TML programming. For electronic camming applications, you need the free of charge **EasyMotion Studio demo version** to format the cam data. For all the other cases, you can use the free of charge **EasySetUp***

1.1.2. Installing EasySetUp or EasyMotion Studio

EasySetUp and **EasyMotion Studio demo version** can be downloaded ***free of charge*** from Technosoft web page. Both include an ***Update via Internet*** tool through which you can check if your software version is up-to-date, and when necessary download and install the latest updates.

EasyMotion Studio demo version includes a fully functional version of **EasySetUp**, hence you don't need to install both of them.

You can install the EasyMotion Studio full version in 2 ways:

a) Using the CD provided by Technosoft. In this case, after installation, use the ***Update via Internet*** tool to check for the latest updates;
b) Transforming EasyMotion Studio demo into a full version, by introducing in the application menu command **Help | Registration Info** the serial number provided by Technosoft.

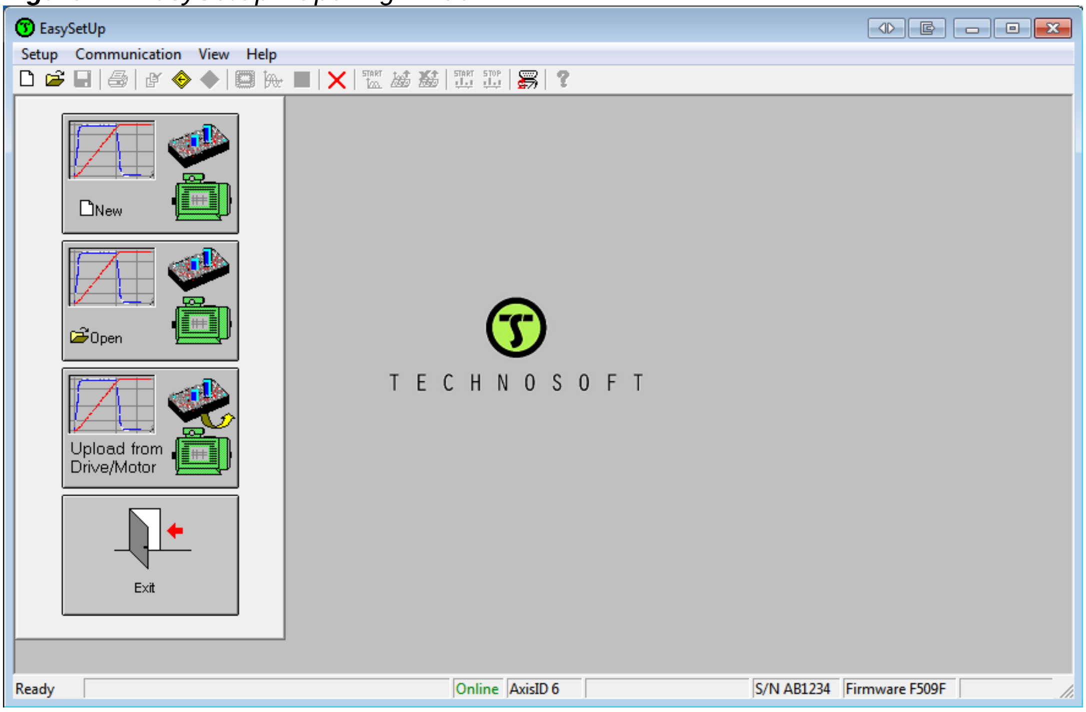
The 2^{nd} option is especially convenient if the EasyMotion Studio demo version is al ready installed.

Remark*: The next paragraphs present only the drive commissioning with EasySetUp. Par. 18.1.1. shows how to perform the same steps with EasyMotion Studio demo or full version.*

1.1.3. Establishing serial communication with the drive

EasySetUp communicates with the drive via an RS-232 serial link or CAN interface. If your PC has no serial port, use an USB to RS232 adapter. For the serial connections refer to the drive Technical Reference manual. If the drive or the Starter Kit board accompanying the drive has a 9-pin serial port, use a standard 9-wire, non-inverting (one to one) serial cable.

***Figure 1.1** EasySetUp - Opening window*



All Technosoft drives with CAN interface have a unique AxisID (address) for serial communication. The AxisID value is by default 255 or it is set by the levels of the AxisID selection inputs, when these exist.

***Remark:** When first started, EasySetUp tries to communicate via RS-232 and COM1 with a drive having axis ID=255 (default communication settings). When it is connected to your PC port COM1 via an RS-232 cable, the communication shall establish automatically.*

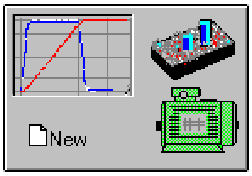
If the communication is established, EasySetUp displays in the status bar (the bottom line) the text "**Online**" plus the axis ID of your drive/motor and its firmware version. Otherwise the text displayed is "**Offline**" and a communication error message tells you the error type. In this case, use menu command **Communication | Setup** to check/change your PC communication settings. Check the following:

- **Channel Type**: RS232 or CAN interface
- **CAN Protocol:** CANopen or TechnoCAN
- **Port:** Select the COM port where you have connected the drive
- **Baud rate:** can be any value for RS232 and it is automatically detected. For best performance, we recommend to use the highest value: 115200. For a CAN interface, choose the default baud rate 500 Kbps.
  ***Remark:** Once the communication is established, you can reopen the **Communication | Setup** dialogue and change the baud rate*
- **Axis ID of drive/motor:** connected to PC **(**autodetected) for RS232 or the CAN Axis ID which is by default 127 in CANopen.

Close the **Communication | Setup** dialogue with OK and check the status bar. If the communication is established, the text "**Online**" shall occur in the status bar. If the communication is still not established, check the serial cable connections and the drive power. Refer to the Technical reference manual of the drive for details.

Remark: *Reopen the* ***Communication | Setup*** *dialogue and press the* ***Help*** *button. Here you can find detailed information about communication setup and troubleshooting.*

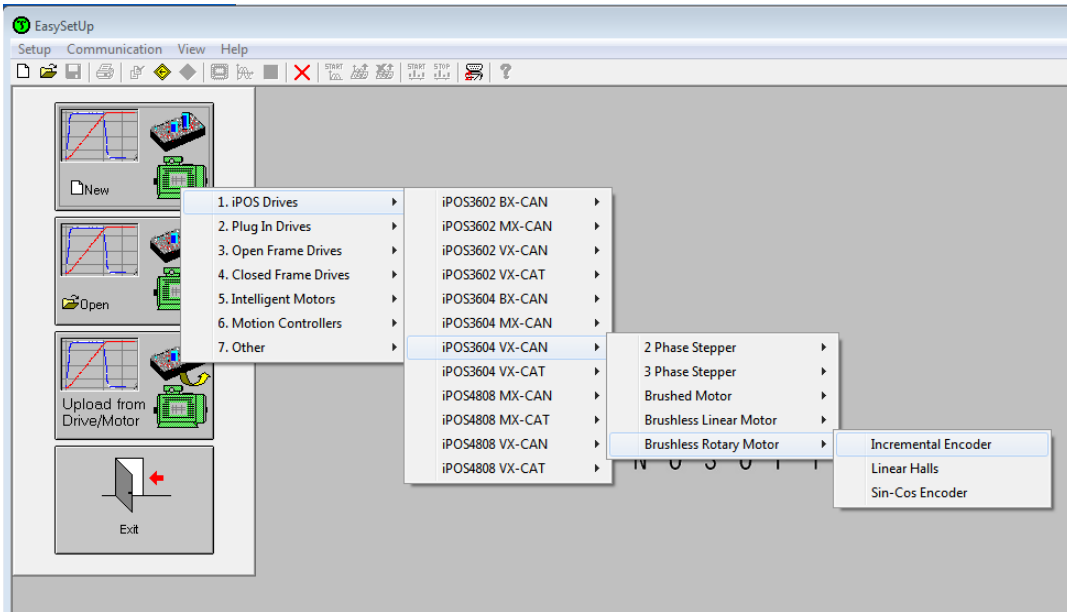
1.1.4. Choosing the drive, motor and feedback configuration

Press **New** button 

and select your drive category: iPOS Drives (all drives from the new iPOS line), Plug In Drives (all plug-in drives, except iPOS line), Open Frame Drives, (all open-frame drives except iPOS line), Closed Frame Drives (all close-frame drives except iPOS line), etc. If you don't know your drive category, you can find it on Technosoft web page.

Continue the selection tree with the motor technology: rotary or linear brushless, brushed, 2 or 3 phase stepper, the control mode in case of steppers (open-loop or closed-loop) and type of feedback device, if any (for example: none or incremental encoder).

Figure 1.2 *EasySetUp – Selecting the drive, motor and feedback*



The selection opens 2 setup dialogues: for **Motor Setup** and for **Drive setup** through which you can introduce your motor data and commission the drive, plus several predefined control panels customized for the drive selected.

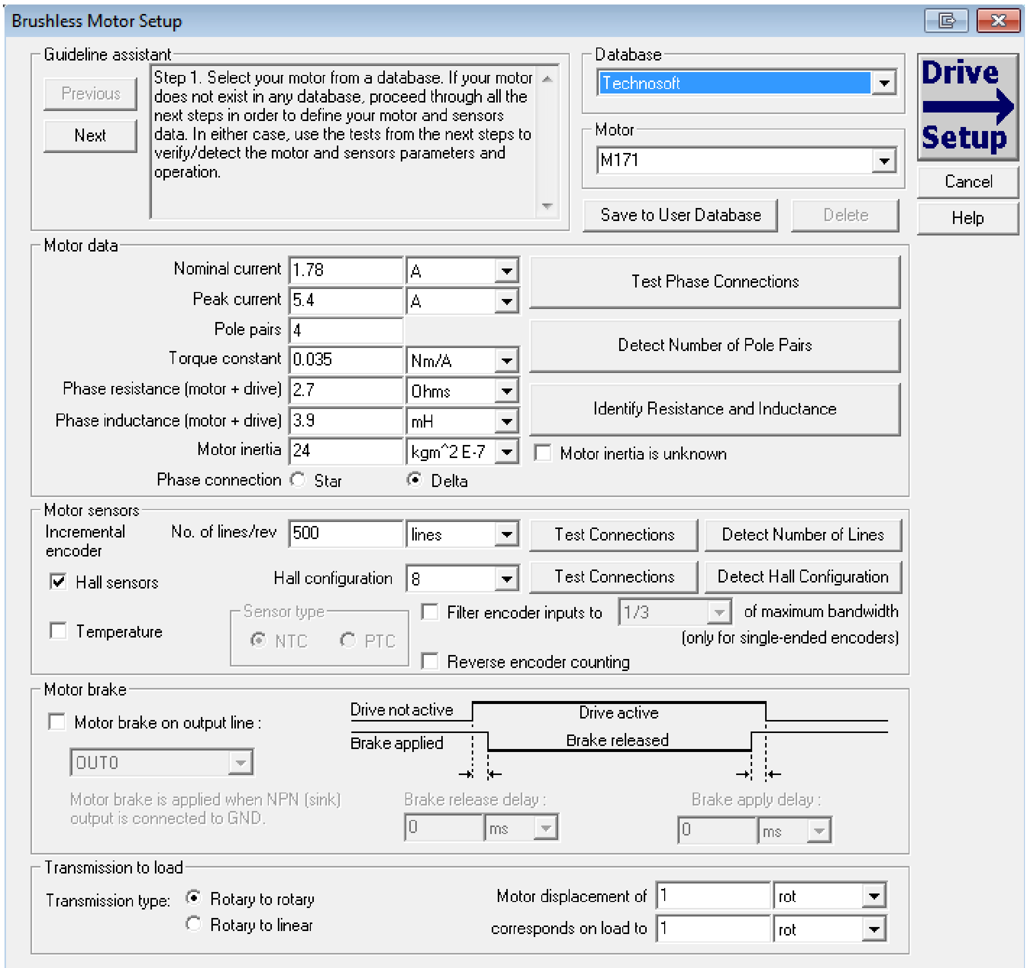
1.1.5. Introducing motor data

Figure 1.3 shows the **Motor setup** dialogue where you can introduce the data of your motor and the associated sensors. Use the **Guideline Assistant**, and follow the steps described. This will guide you through the whole process of introducing and/or checking the motor and sensors data. Use the **Next** button to see the next guideline step and the **Previous** button to return to the previous step. Data introduction is accompanied by a series of tests having as goal to check the connections to the drive and/or to determine or validate a part of the motor and sensors parameters.

When finished, click on **Drive Setup** button to move to the 2nd dialogue.

Remark*: Press the* ***Help*** *button from the Motor setup dialogue for detailed information*

Figure 1.3 *EasySetUp – Introducing motor data*



1.1.6. Commissioning the drive

Figure 1.4 shows the **Drive setup** dialogue where you can configure and parameterize the drive for your application. Use the **Guideline Assistant**, and follow the steps described. This will guide you through the whole process of setting up the drive. Use the **Next** button to see the next guideline step and the **Previous** button to return to the previous step.

Close the Drive setup dialogue with **OK** to preserve all the changes done in both motor and drive setup dialogues.

Remarks:

1) *Press the **Help** button from the Drive setup dialogue for detailed information*
2) *Set the motor **Over current** protection level below the motor **Peak current** value. This shall protect the motor against accidental high currents bypassing ite **Peak current** value*
3) *When motor I2t protection is enabled, set its **Over current** value over the motor **Nominal current***
4) *Set the drive **Current limit** equal or below the motor **Over current** protection level. During a hard stop homing (no. -1 to -4) you can temporary reduce the Current limit via* <u>Object 207Fh: Current limit</u> *to avoid triggering the protection during the homing*

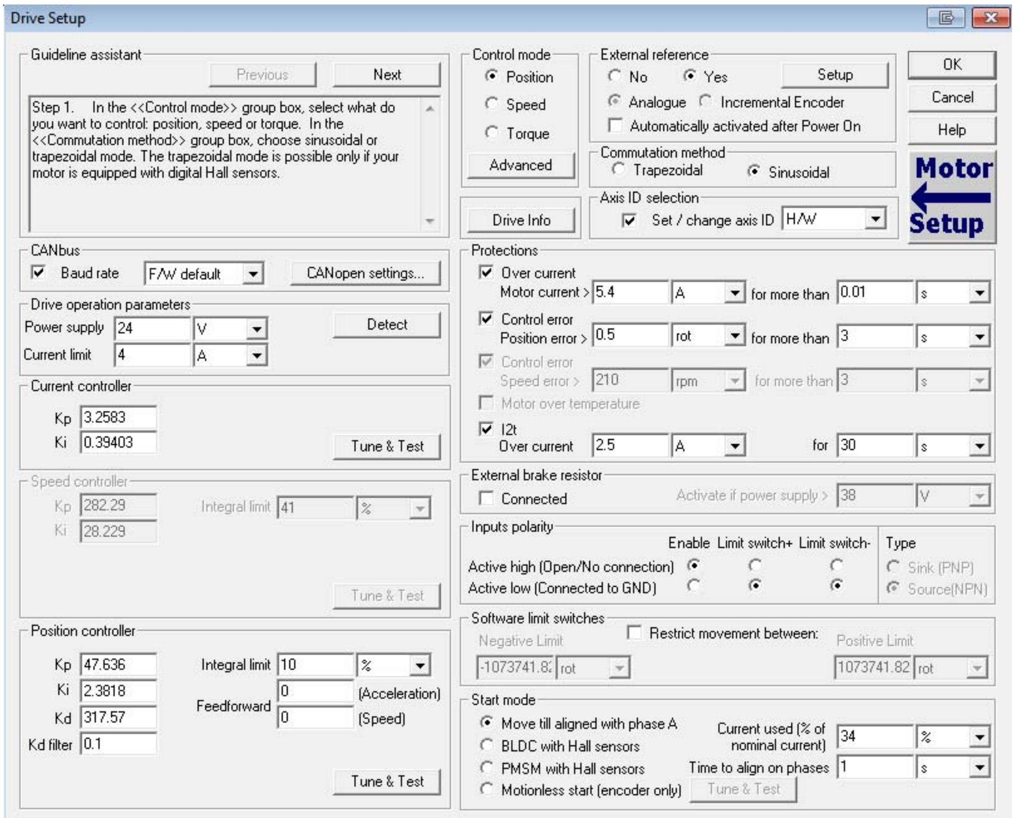


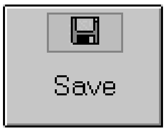
Figure 1.4 *EasySetUp – Commissioning the drive*

1.1.7. Downloading setup data to drive/motor

Closing the Drive setup dialogue with **OK**, keeps the new settings only in the EasySetUp project. In order to store the new settings into the drive you need to press the **Download to Drive/Motor** button 

. This downloads the entire setup data in the drive EEPROM memory. The new settings become effective after the next power-on, when the setup data is copied into the active RAM memory used at runtime.

1.1.8. Saving setup data in a file

It is also possible to **Save** 

the setup data on your PC and use it later.

To summarize, you can define or change the setup data in the following ways:

- create a new setup data by going through the motor and drive dialogues
- use setup data previously saved in the PC
- upload setup data from a drive/motor EEPROM memory

1.1.9. Creating a .sw file with the setup data

Once you have validated your setup, you can create with the menu command **Setup | Create EEPROM Programmer File** a software file (with extension **.sw**) which contains all the setup data to write in the EEPROM of your drive.

A software file is a text file that can be read with any text editor. It contains blocks of data separated by an empty line. Each block of data starts with the *block start address*, followed by the block *data values* ordered in ascending order at consecutive addresses: first *data value* – what to write in drive EEPROM memory at *block start address*, second data – what to write at *block start address + 1*, third data – what to write at *block start address* +2 etc. All data are hexadecimal 16-bit values (maximum 4 hexadecimal digits). Each line contains a single data value. When less then 4 hexadecimal digits are shown, the value must be right justified. For example 92 is 0x0092.

The **.sw** file can be programmed into a drive:

- from a CANopen master, using the communication objects for writing data into the drive EEPROM (see **Chapter 17** for detailed example)
- using the EEPROM Programmer tool, which comes with EasySetUp but may also be installed separately. The EEPROM Programmer was specifically designed for repetitive fast and easy programming of **.sw** files into the Technosoft drives during production

1.1.10. Checking and updating setup data via .sw files with a CANopen master

You can program a CANopen master to automatically check after power on if all the Technosoft drives connected to the CAN network have the right setup data stored in their EEPROM. The comparison shall be done with the reference .sw files of each axis. These need to be loaded into the CANopen master. There fastest way to compare a .sw file with a drive EEPROM contents is by comparing the checksums computed on the .sw file data with those computed by the drive on the same address range. In case of mismatch, the reference .sw file has to be reloaded into the drive by the CANopen master. Par **17.4** and **17.5** present examples how to program a .sw file in a drive and how to check its consistency versus a .sw reference file.

1.1.11. Testing and monitoring the drive behavior

You can use the **Data Logger** or the **Control Panel** evaluation tools to quickly measure and analyze your application behavior. In case of errors like protections triggered, check the Drive Status control panel to find the cause.

1.1.12.TechnoCAN Extension

In order to take full advantage of the powerful Technosoft Motion Language (TML) built into the intelligent drives, Technosoft has developed an extension to CANopen, called TechnoCAN through which TML commands can be exchanged with the drives. Thanks to TechnoCAN you can inspect or reprogram any of the Technosoft drives from a CANopen network using EasySetUp or EasyMotion Studio and an RS-232 link between your PC and any of the drives.

TechnoCAN uses only message identifiers outside of the range used by the CANopen predefined connection set (as defined by CiA DS301 v4.2.0). Thus, TechnoCAN protocol and CANopen protocol can co-exist and communicate simultaneously on the same physical CAN bus, without disturbing each other.

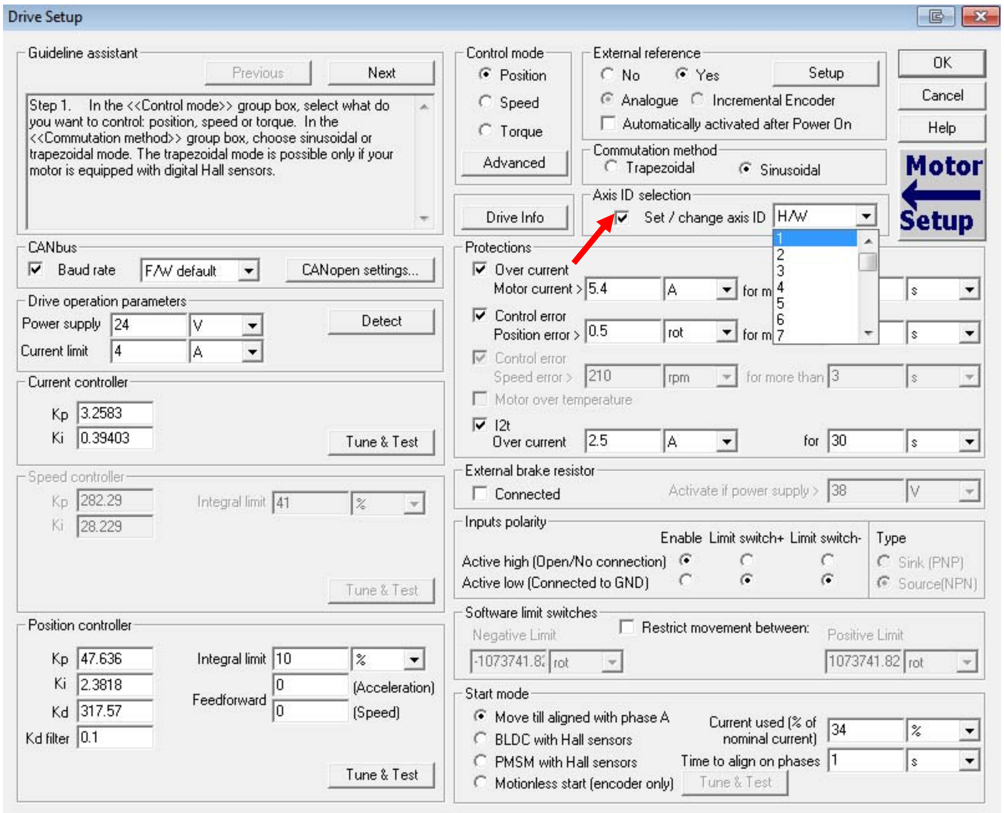
1.2. Changing the drive Axis ID (Node ID)

The axis ID of an iPOS drive can be set in 3 ways:

- Hardware (H/W)
- Software (via Setup)– any value between 1 and 255, stored in the setup table.
- Software (via CANopen master) – using CiA-305 protocol

Remark:

- If the drive is in CANopen mode, a Node ID value above 127 is automatically converted into 255 and the drive is set with CAN communication “non-configured” mode waiting for a CANopen master to configure it using CiA-305 protocol. <u>A “non-configured” drive answers only to CiA-305 commands. All other CANopen commands are ignored and transmission of all other CANopen messages (including boot-up) is disabled. The Ready (green) LED will flash at 1 second time intervals while in this mode.</u>
- In absence of a CANopen master, you can get out a drive from “non-configured” mode, by setting another axis ID between 1 and 127, either by Hardware or by Software (via Setup).



The axis ID is initialized at power on, using the following algorithm:

a) If a valid setup table exists, and this setup table was created with the *Axis ID Selection* checkbox checked in the Drive Setup dialogue (see above) – with the value read from the setup table. This value can be an axis number 1 to 255 or can indicate that axis ID will be set according with the AxisID inputs levels. If the drive is set in CANopen mode and the Axis ID is over 127 it is converted into 255 and the drive enters in CAN communication "non-configured" mode. The Ready (green) LED will flash at 1 second time intervals while in this mode.

b) If a valid the setup table exists, and this was created with the *Axis ID Selection* checkbox unchecked in the Drive Setup dialogue (see above) – with the last value set either from a valid setup table or by a CANopen master via CiA-305 protocol. This value can be an axis number 1 to 255 for TMLCAN, 1 to 127 for CANopen, or can indicate that axis ID will be set according with the AxisID inputs levels

c) If the setup table is invalid, with the last value set either from a valid setup table or by a CANopen master via CiA-305 protocol. This value can be an axis number 1 to 255 for TMLCAN, 1 to 127 for CANopen, or can indicate that axis ID will be set according with the AxisID inputs levels

d) If the setup table is invalid, there is no previous axis ID set from a valid setup table or by a CANopen master, according with the AxisID inputs levels

Remark: *If you don't know the axis ID set in a drive, you can find it in the following way:*

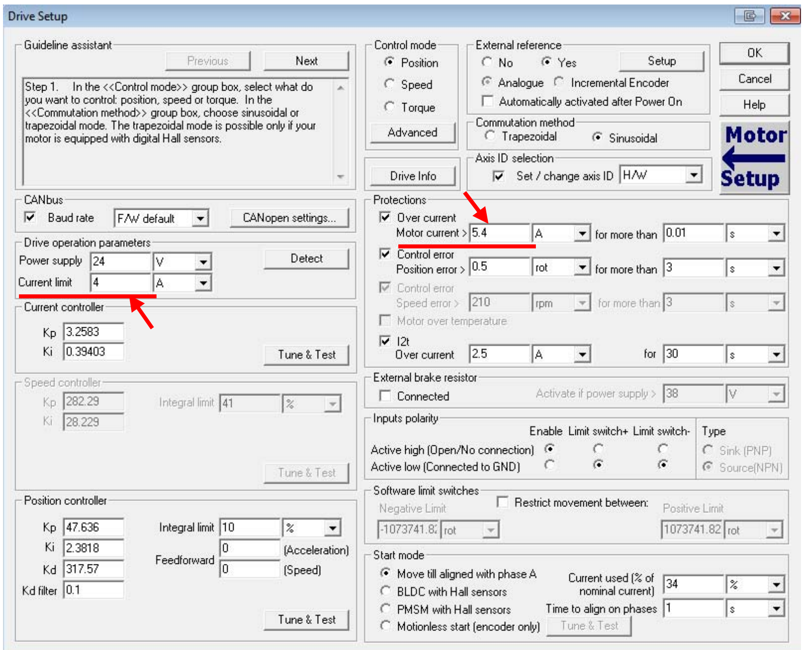
a) *Connect the drive via a serial RS232 link to a PC where EasySetUp or EasyMotion Studio are installed*

b) *With the drive powered, open EasySetUp or EasyMotion Studio and check the status bar. If communication with the drive is established, the status bar displays **Online** in green and nearby the drive's Axis ID. If the status bar displays **Offline** in red, execute menu command "Communication|Setup…" and in the dialogue opened select at "Channel Type" **RS232** and at "Axis ID of drive/motor connected to PC" the option **Autodetected**. After closing the dialogue with OK, communication with the drive shall be established and the status bar shall display the drive's Axis ID*

c) *If the access to the drive with the unknown Axis ID is difficult, but this drive is connected via CANbus with other Technosoft drives having an easier access, connect your PC serially to one of the other drives. Use EasySetUp or EasyMotion Studio menu command **Communication | Scan Network** to find the axis IDs of all the Technosoft drives present in the network.*

1.3. Setting the current limit

In Easy Setup if a feedback device is used, the user can choose a current limit. It is advised to use a lower value than the one set in current protection.



The current limit can also be set using Object 207Fh: Current limit[1].

1.4. Setting the CANbus rate

The iPOS drives accept the following CAN rates: 125Kbps, 250 Kbps, 500kbps and 1Mbps. Using the Drive Setup dialogue you can choose the initial CAN rate after power on. This information is stored in the setup table The CAN rate is initialized using the following algorithm:

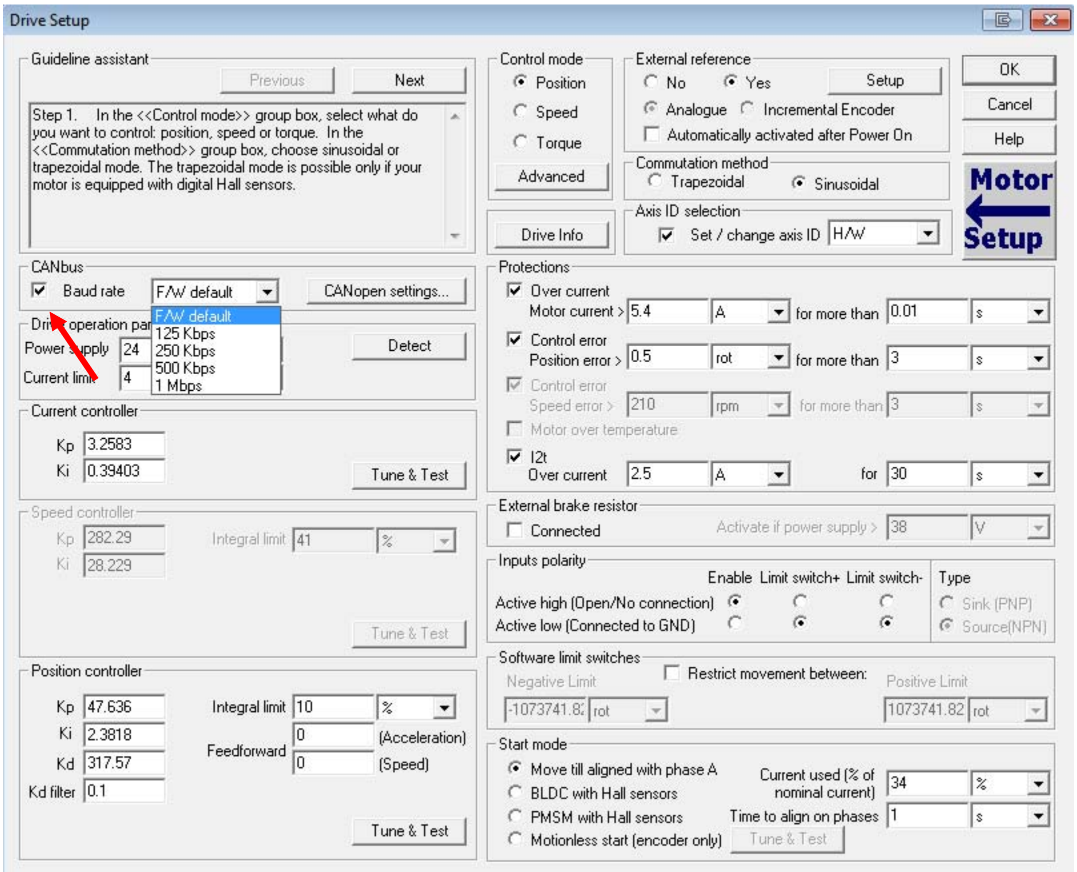
a) If a valid setup table exists, and this setup table was created with the *Set baud rate* checkbox checked in the Drive Setup dialogue (see above) – with the value read from the setup table. This value can be one of the above 4 values or the firmware default (F/W default) which is 500kbs

b) If a valid setup table exists, and this setup table was created with the *Set baud rate* checkbox unchecked in the Drive Setup dialogue (see above) – with the last value set either from a valid setup table or by a CANopen master via CiA-305 protocol

c) If the setup table is invalid, with the last value set either from a valid setup table or by a CANopen master via CiA-305 protocol.

d) If the setup table is invalid, there is no previous CAN rate set from a valid setup table or by a CANopen master, with f/w default value which is 500kbs

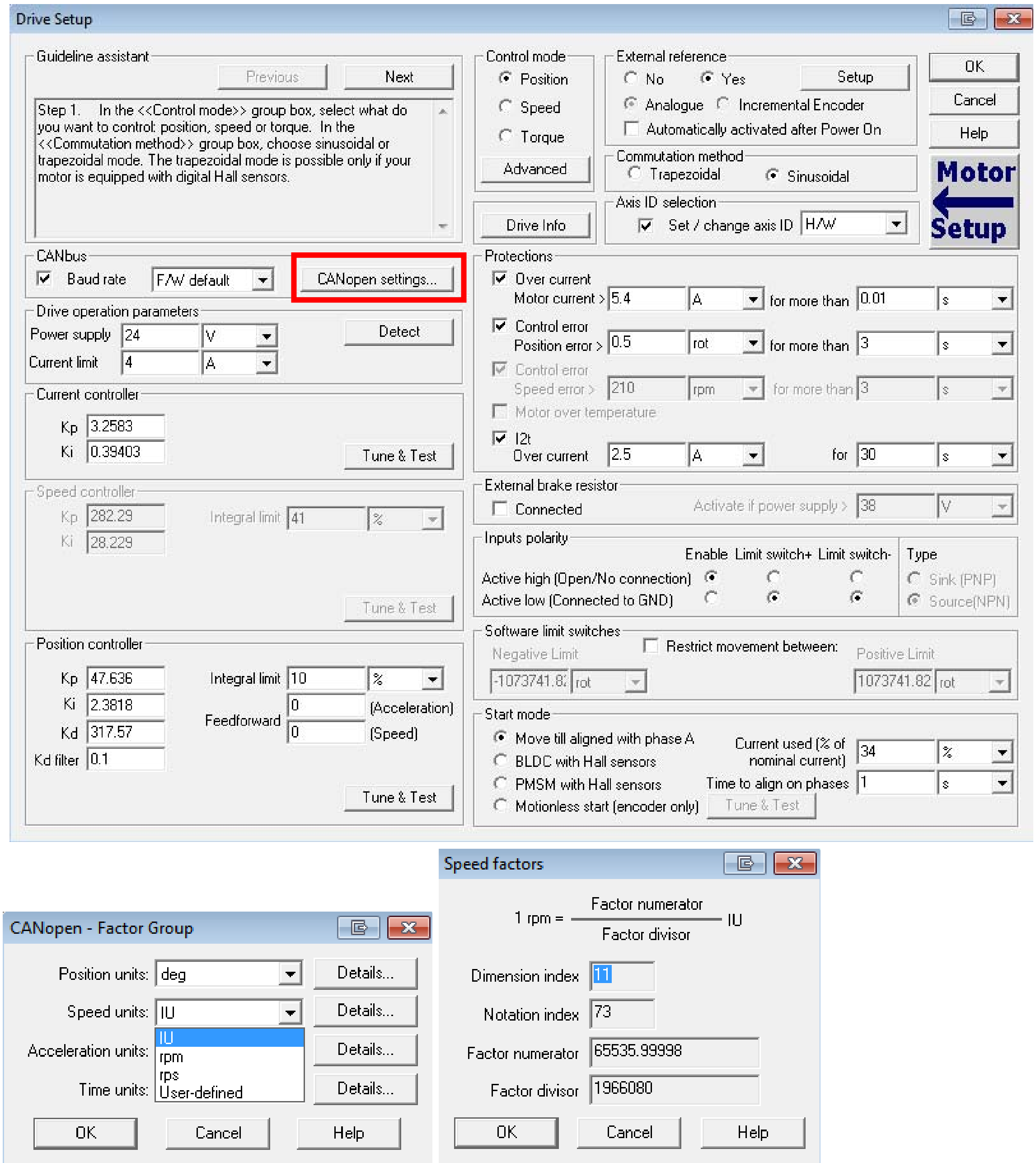
[1] Available starting with firmware revision D.



1.5. CANopen factor group setting[1]

By pressing the CANopen Settings button, you can choose the initial values after power on for the CANopen factor group settings. The factor group settings describe the scaling factors for position, speed, acceleration and time objects. In the factor group dialogue you can select the units to use when writing to these objects or reading them. You can either choose one of the standard units defined in the CANopen standard CiA402 or define your own unit.

[1] Note: this option does not work if TMLCAN mode is set



In the last case, it is your responsibility to set the factor numerator and divisor as well as its dimension and notation index. The factor group settings are stored in the setup table. By default the drive uses its internal units. The correspondence between the drive internal units and the SI units is presented in the drives' user manual.

1.6. Using the built-in Motion Controller and TML

One of the key advantages of the Technosoft drives is their capability to execute complex motions without requiring an external motion controller. This is possible because Technosoft drives offer in a single compact package both a state of art digital drive and a powerful motion controller.

1.6.1. Technosoft Motion Language Overview

Programming motion directly on a Technosoft drive requires to create and download a TML (Technosoft Motion Language) program into the drive memory. The TML allows you to:

- Set various motion modes (profiles, PVT, PT, electronic gearing or camming, etc.)
- Change the motion modes and/or the motion parameters
- Execute homing sequences
- Control the program flow through:
  - Conditional jumps and calls of TML functions
  - Interrupts generated on pre-defined or programmable conditions (protections triggered, transitions of limit switch or capture inputs, etc.)
  - Waits for programmed events to occur
- Handle digital I/O and analogue input signals
- Execute arithmetic and logic operations
- Perform data transfers between axes
- Control motion of an axis from another one via motion commands sent between axes
- Send commands to a group of axes (multicast). This includes the possibility to start simultaneously motion sequences on all the axes from the group
- Synchronize all the axes from a network

In order to program a motion using TML you need EasyMotion Studio software platform.

Chapter 18 describes in detail how the TML features can be combined with the CANopen programming.

2. Layer Setting Services (LSS protocol)

By using layer setting services, the CANopen node-ID and/or the bit timing settings of a LSS slave device may be configured via the CAN network without using any hardware components such as jumpers or DIP-switches. The CANopen device that can configure other devices via CANopen network is called a LSS Master. There must be only one (active) LSS master in a network. The CANopen device that will be configured by the LSS Master via CANopen network is called a LSS Slave.

An LSS Slave can be identified by its unique LSS address. The LSS address consists of the sub objects **Vendor ID**, **Product Code**, **Revision Number** and **Serial Number** of the CANopen “Identity Object” with index 1018_h. In the network, there must not be other LSS Slaves possessing the same LSS address.

With this unique LSS address an individual CANopen device can be allocated within the network. The Node ID is valid if it is in the range of 0x01…0x7F. The value 0xFF indicates not configured CANopen devices.

Communication between LSS Master and LSS Slaves is accomplished by LSS protocols which use only two COB-IDs:

- LSS master messages from LSS Master to LSS Slaves (COB-ID 0x7E5)
- LSS slave messages from the LSS Slaves to LSS Master (COB-ID 0x7E4).

2.1. Overview

The table below provides an overview on the LSS commands, including details on whether they may be used in states “Waiting” and “Configuration”. To change the LSS state, the LSS services **Switch State Global** or **Switch State Selective** may be used.

Table 2.1 Drive State Transitions

Command Specifier	**Services**		**LSS waiting state**	**LSS configuration state**
0x04	**Switch State Global**		yes	yes
0x40	**Switch state selective procedure**	Vendor ID	yes	no
0x41		Product Code	yes	no
0x42		Revision Number	yes	no
0x43		Serial Number	yes	no
0x11	**Configure node-ID**		no	yes
0x13	**Configure bit timing parameters**		no	yes
0x15	**Activate bit timing parameters**		no	yes
0x17	**Store configuration**		no	yes
0x5A	Inquire LSS address protocol	**Identity Vendor ID**	no	yes
0x5B		**Identity Product Code**	no	yes
0x5C		**Identity Revision Number**	no	yes
0x5D		**Identity Serial Number**	no	yes
0x5E	**Inquire node-ID protocol**		no	yes
0x46	**Identify remote slave procedure**	Vendor ID	yes	yes
0x47		Product Code	yes	yes
0x48		Revision Number Low	yes	yes
0x49		Revision Number High	yes	yes
0x4A		Serial Number Low	yes	yes
0x4B		Serial Number High	yes	yes
0x4C	**Identify non-configured Remote Slave**		yes	yes

2.2. Configuration services

The LSS configuration services are used to configure the node-ID or bit rate.

2.2.1. Switch State Global

Switches all LSS slave devices in the network into LSS “Waiting” state or LSS “Configuration” state.

The service is unconfirmed.

cs	0x04	Command Specifier for Switch State Global command
mode	0	Switch to LSS state waiting
	1	Switch to LSS state configuration

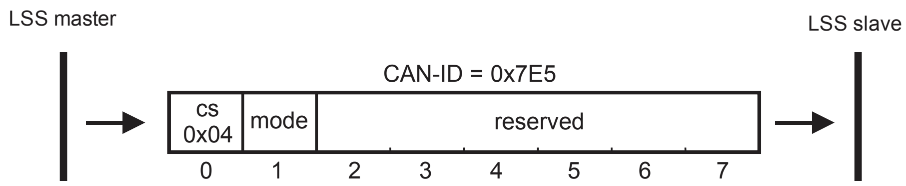


Figure 2.1 **LSS – Switch State Global**

2.2.2. Switch State Selective

Changed state of one LSS Slave from "Waiting" to "Configuration".

LSS command specifier can be:
- 0x40 to submit the Vendor ID,
- 0x41 to submit the Product Code,
- 0x42 to submit the Revision Number,
- 0x43 to submit the Serial Number

To selectively switch a target LSS slave to "Configuration" state, all the Switch State Selective commands must be sent and must contain the same data as found in the "**Identity Object**", **index** $\mathbf{1018_h}$, of the target drive.

The service is confirmed. The LSS slave sends the command specifier 0x44 meaning it has entered "Configuration" state.

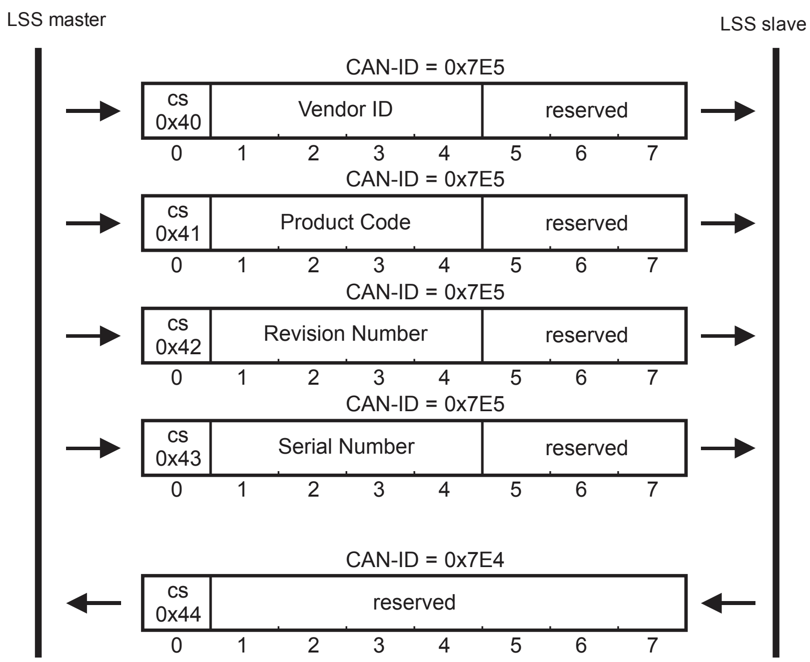


Figure 2.2 **LSS – Switch State Selective**

2.2.3. Configure Node ID

Configures the Node ID (of value 1…127 or 255).

The LSS Master can set the LSS Slave's Node ID only in LSS configuration state. The LSS Master is responsible to switch **a single** LSS Slave into LSS state "Configuration" (with Switch State Selective) before requesting this service. With this service, the LSS Salve's Node ID can take only values between 1 and 127 (valid Node ID) or 255 (set slave to not-configured).

If the Node ID is set to 255 (0xFF), the LSS slave remains in NMT Initialization sub-state "reset communication" and waits in LSS waiting state for further commands. During this waiting state, the LSS slave is not allowed to send messages, except when LSS replies are needed.

To activate the new node ID, the LSS master has to send the NMT command "Reset communication". To store the new node ID in the non-volatile memory, the LSS master has to use LSS Store Configuration protocol before resetting the communication or the node.

cs	0x11	Command specifier for configure node-ID protocol
mode	0	Protocol successfully completed
	1	Node ID out of range value
specific error	always 0	

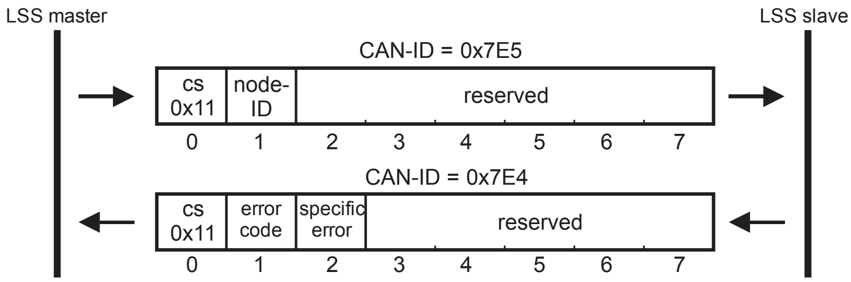


Figure 2.3 **LSS – Configure Node ID**

2.2.4. Configure Bit Timing Parameters

By means of the service configure bit timing parameters, the LSS Master can configure new bit timing on a single or multiple LSS Slaves. The new bit timing will be active only after LSS Activate Bit Timing Parameters command or LSS Store Configuration Protocol followed by node reset commands.

cs	0x13	Command specifier for configure bit timing parameters protocol
table selector	always 0	
table index	CAN bit rate codes	
error code	0	Protocol successfully completed
	1	Node ID out of range value
specific error	always 0	

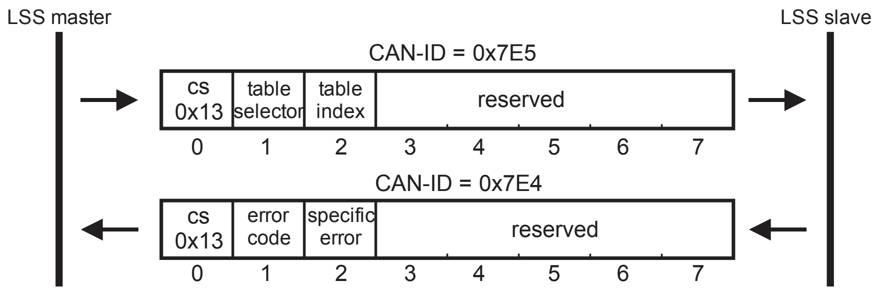


Figure 2.4 **LSS – Configure Bit Timing Parameters**

Table 2.2 Supported CAN bitrates

Value	Bit Rate
0	1 Mbit/s
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s

2.2.5. Activate Bit Timing Parameters

Activates bit timing parameters selected with Configure Bit Timing Parameters service.

Switch delay = specifies the duration [in ms] of the two delay periods of equal length. The first period is until the bit timing parameters switch is done. The second period is the time before sending any new CAN message. They are necessary to avoid operating the network with different bit rates.

After receiving an activate bit timing command, the LSS slave stops communication. After the first switch delay, communication is switched to the new bit rate. After the second delay, the LSS slave is allowed to transmit messages with the new bit rate active.

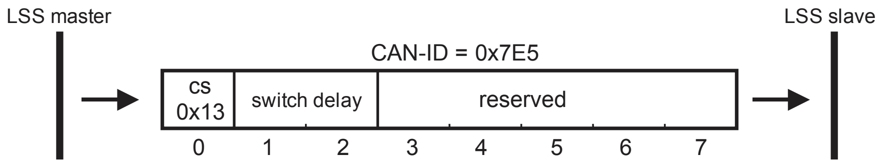


Figure 2.5 **LSS – Activate Bit Timing Parameters**

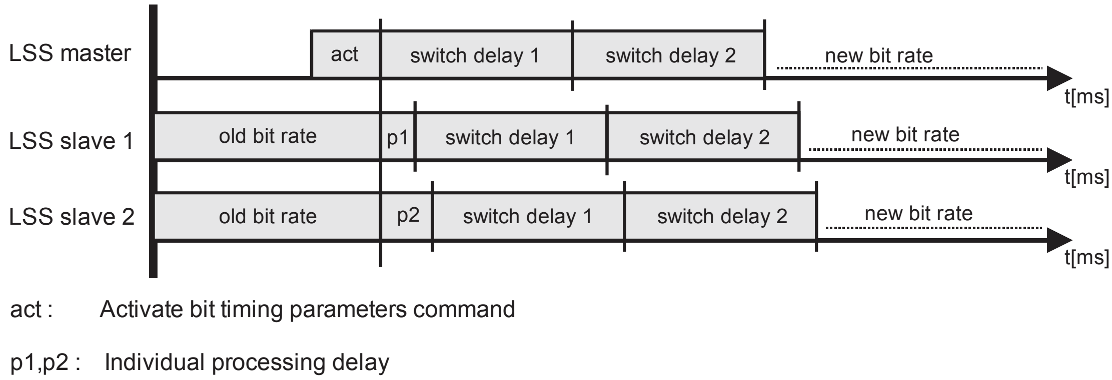


Figure 2.6 **LSS – LSS master and LSS slave timing**

2.2.6. Store Configuration Protocol

The pending node-ID and bit rate are copied to the persistent node-ID and bit rate in the non-volatile memory. The result is confirmed by the LSS slave with success or failure message.

cs	0x17	Store Configuration
error code	always 0	
specific error	always 0	

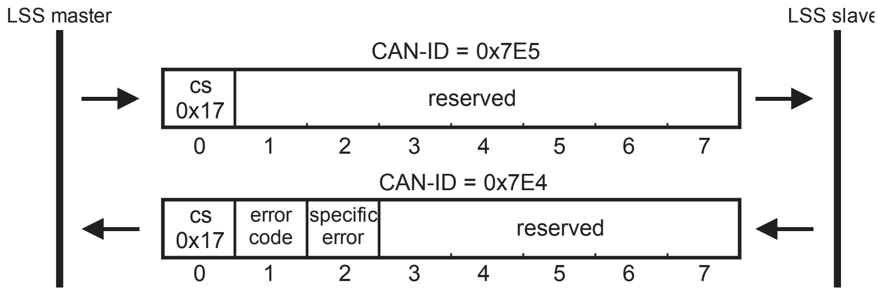


Figure 2.7 **LSS – Store Configuration**

2.2.7. Inquire Identity Vendor ID

Reads Vendor ID of LSS slave. The same value can be found in Identity Object, index 1018_h, Subindex 01 of target slave.

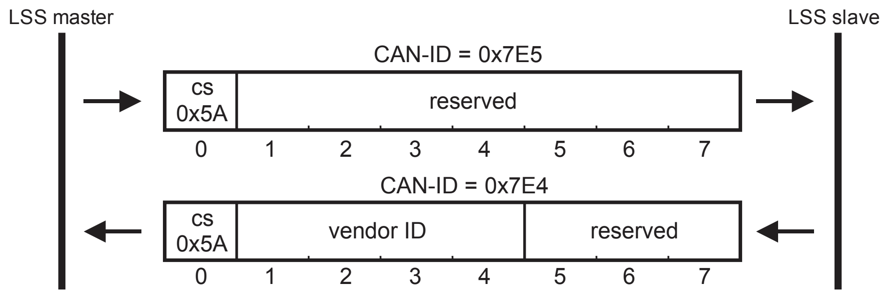


Figure 2.8 **LSS – Inquire Identity Vendor ID**

2.2.8. Inquire Identity Product Code

Reads Product Code of LSS slave. The same value can be found in Identity Object, index 1018_h, Subindex 02 of target slave.

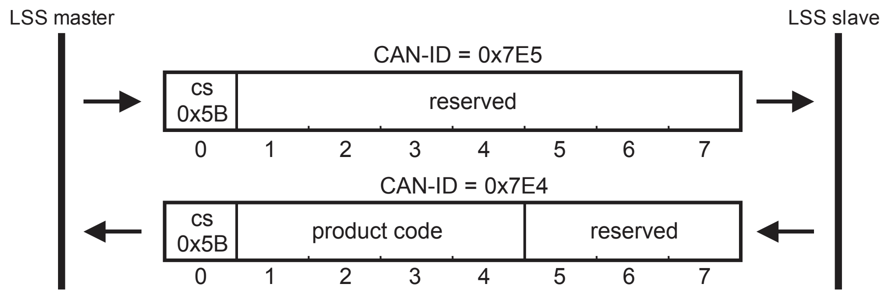


Figure 2.9 **LSS – Inquire Identity Product Code**

2.2.9. Inquire Identity Revision Number

Reads Revision Number of LSS slave. The same value can be found in Identity Object, index 1018_h, Subindex 03 of target slave.

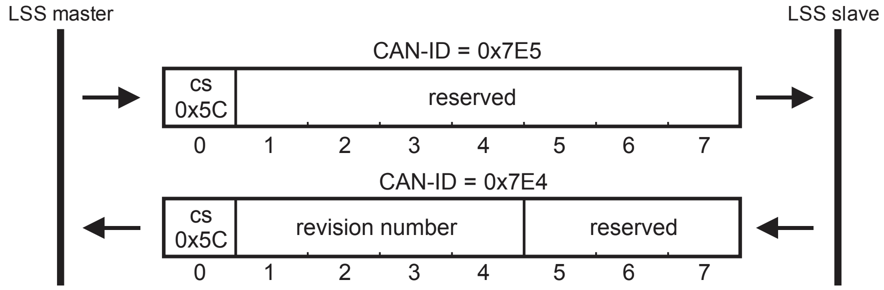


Figure 2.10 **LSS – Inquire Identity Revision Number**

2.2.10.Inquire Identity Serial Number

Reads Serial Number of LSS slave. The same value can be found in Identity Object, index 1018_h, Subindex 04 of target slave.

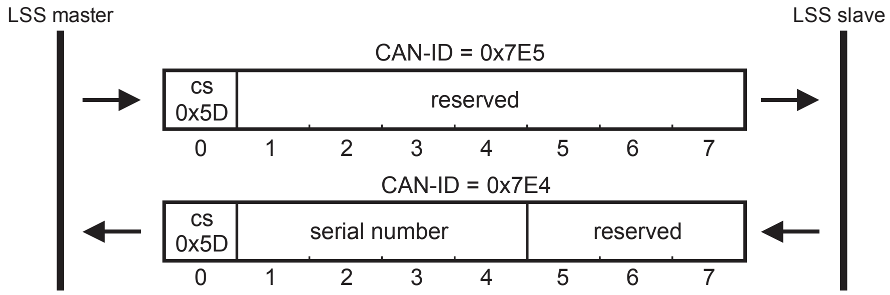


Figure 2.11 **LSS – Inquire Identity Serial Number**

2.2.11.Inquire Identity Node ID

Reads active Node ID of LSS slave.

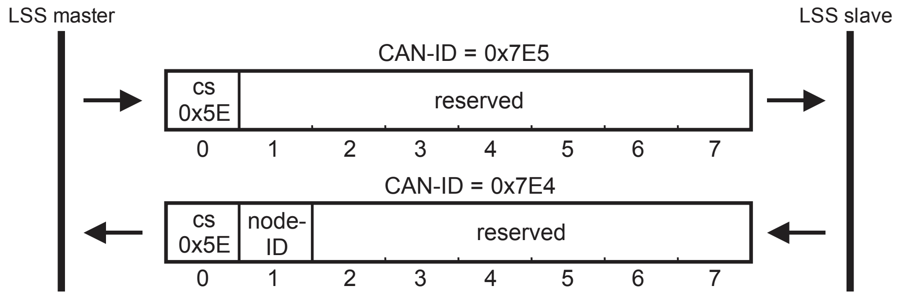


Figure 2.12 **LSS – Inquire Identity Node ID**

2.2.12.Identify Remote Slave

Identifies LSS Salves in the CAN network. The LSS master sends identify remote slave commands containing a single Vendor ID, a single Product Code, and a range of Revision Numbers and Serial Numbers. All LSS Slaves that are within these values (including the boundaries) answer with an Identify Remote Slave response (cs=0x4F). An LSS Slave answers, only after all Identify commands are sent and it is within the correct parameters.

With this protocol, a network search can be implemented on the LSS master. With this method, the LSS address range is set to maximum values, and identifies the number of remote slaves in the network. This range will be split in two sub-areas and identify the slaves again. This process will be repeated until all LSS Slaves have been identified.

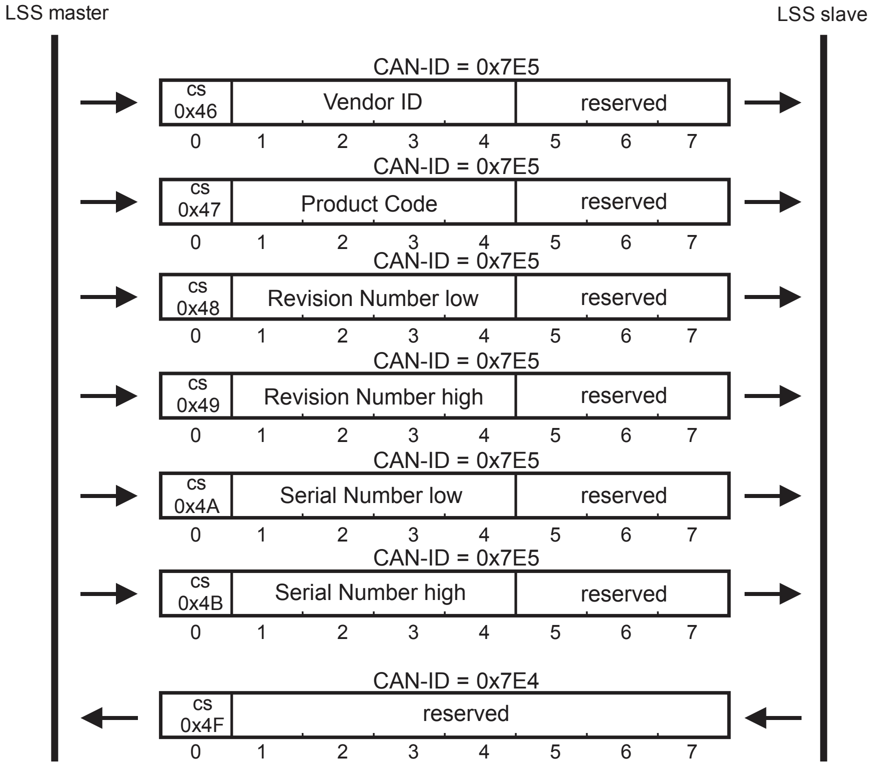


Figure 2.13 **LSS – Identify Remote Slave**

2.2.13. Identify non-configured Remote Slave

Allows the LSS master to detect non-configured slave devices in the network. All LSS Slaves without a configured Node ID (0xFF) will answer with a 0x50 command specifier response.

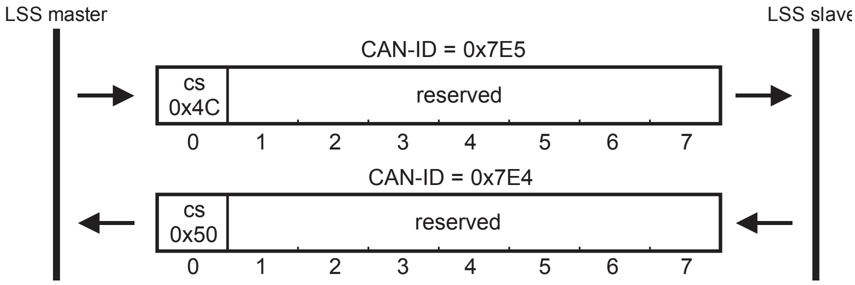


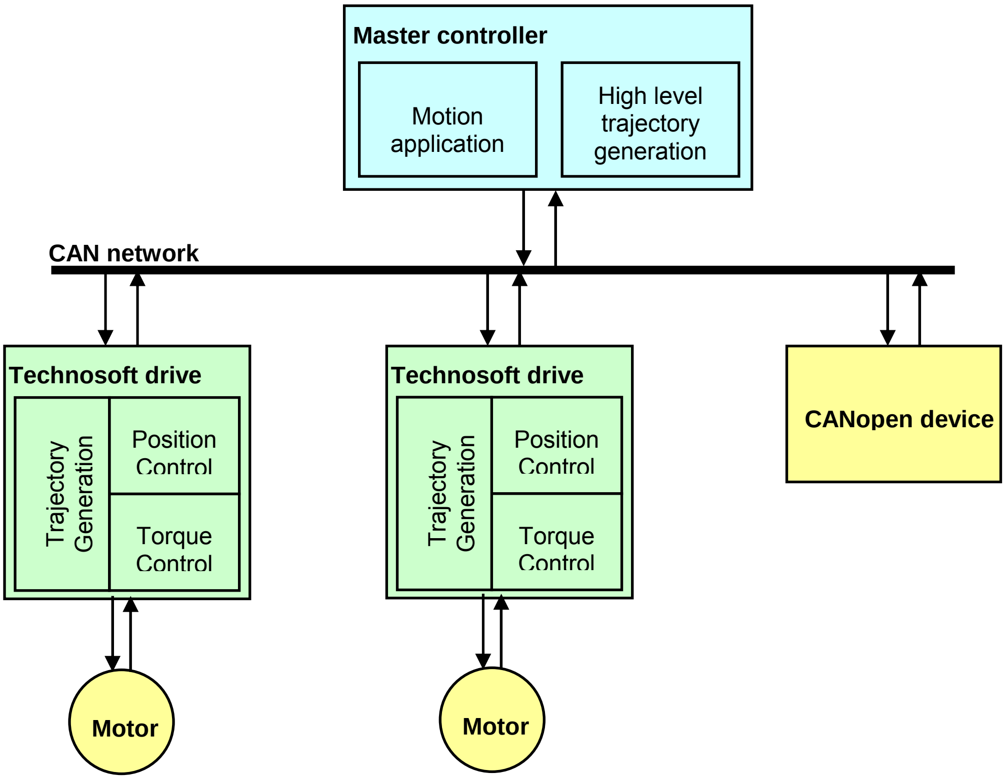
Figure 2.14 **LSS – Identify non-configured Remote Slave**

3. CAN and the CANopen protocol

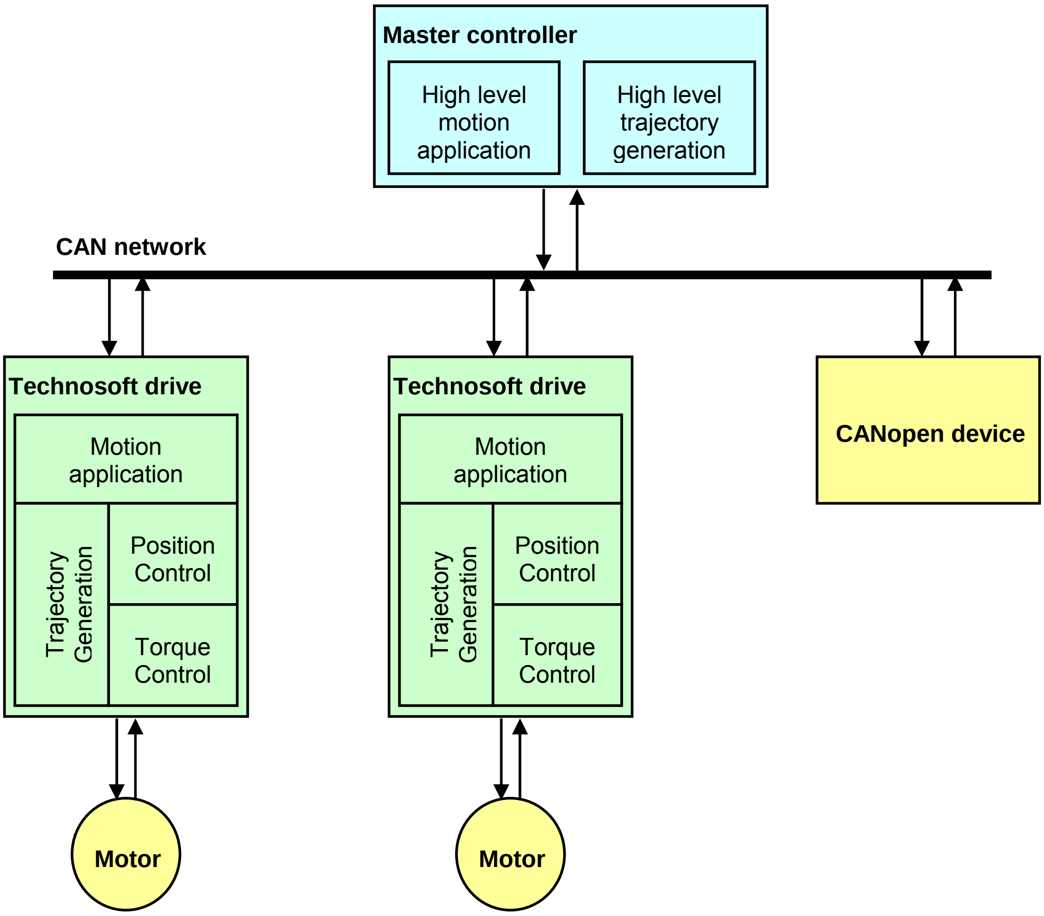
CAN (Controller Area Network) is a serial bus system used in a broad range of automation control systems. The CAN specifies the data link and the physical connection over which lays the CANopen, a high level protocol specifying how various types of devices can use the CAN network.

3.1. CAN Architecture

CAN provides distributed control of the motion application, the control loops are closed locally not on the master controller. The master controller coordinates multiple devices through the commands it sends and receives information about the status of the devices.



Technosoft extended the concept of distributed motion application allowing splitting the motion application between the Technosoft drives and the CANopen master. Using TML the user can build complex motion applications locally, on each drive, leaving on the CANopen master only a high level motion application and thus reducing the CAN master complexity. The master has the vision of the motion application, specific tasks being executed on the Technosoft drives.



3.2. Accessing CANopen devices

A CANopen device is controlled through read/write operations to/from objects performed by a CANopen master (PC or PLC).

3.2.1. Object dictionary

The Object Dictionary is a group of objects that describe the complete functionality of a device by way of communication objects and is the link between the communication interface and the application. All communication objects of a device (application data and configuration parameters) are described in the Object Dictionary in a standardized way.

3.2.2. Object access using index and sub-index

The objects defined for a device are accessed using a 16-bit index and an 8-bit sub-index. In case of arrays and records there is an additional sub-index for each element of the array or record.

3.2.3. Service Data Objects (SDO)

Service Data Objects are used by CANopen master to access any object from the drive's Object Dictionary. Both expedited and segmented SDO transfers are supported (see DS301 v4.2.0 for details). The SDOs are typically used for drive configuration after power-on, for PDO mapping and for infrequent low priority communication.

SDO transfers are confirmed services. In case of an error, an Abort SDO message is transmitted with one of the codes listed in **Table 3.1**.

Table 3.1 *SDO Abort Codes*

Abort code	Description
0503 0000h	Toggle bit not alternated
0504 0001h	Client/server command specifier not valid or unknown
0601 0000h	Unsupported access to an object
0602 0000h	Object does not exist in the object dictionary
0604 0041h	Object cannot be mapped to the PDO
0604 0042h	The number and length of the objects to be mapped would exceed PDO length
0604 0043h	General parameter incompatibility reason
0604 0047h	General internal incompatibility error in the device
0607 0010h	Data type does not match, length of service parameter does not match
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0011h	Sub-index does not exist
0609 0030h	Value range of parameter exceeded (only for write access)
0609 0031h	Value of parameter written too high
0609 0032h	Value of parameter written too low
0800 0000h	General error
0800 0020h	Data cannot be transferred or stored to the application
0800 0021h	Data cannot be transferred or stored to the application because of local control
0800 0022h	Data cannot be transferred or stored to the application because of the present device state

3.2.4. Process Data Objects (PDO)

Process Data Objects are used for high priority, real-time data transfers between CANopen master and the drives. The PDOs are unconfirmed services and are performed with no protocol overhead. Transmit PDOs are used to send data from the drive, and receive PDOs are used to receive data. The Technosoft drives accept 4 transmit PDOs and 4 receive PDOs. The contents of the PDOs can be set according with the application needs through the dynamic PDO-mapping. This operation can be done during the drive configuration phase using SDOs.

A PDO is defined by two objects: the communication object and the mapping object. The communication object defines the COB-ID of the PDO, the transmission type and the event triggering the transmission. The mapping object contains the descriptions of the objects mapped into the PDO, i.e. the index, sub-index and size of the mapped objects.

3.3. Objects that define SDOs and PDOs

3.3.1. Object 1200h: Server SDO Parameter

The object contains the COB-IDs of the messages used for the SDO protocol. The COBID of the SDO packages received by the drive, stored in sub-index 01, is computed as 600h + drive Node ID. The COB ID of the SDO packages sent by the drive, stored in sub-index 02, is computed as 580h + drive Node ID.

Object description:

Index	1200_h
Name	Server SDO Parameter
Object code	RECORD
Data type	SDO Parameter

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	2
Default value	2

Sub-index	01_h
Description	SDO receive COB-ID
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	600_h + Node-ID

Sub-index	02_h
Description	SDO transmit COB-ID
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	580_h + Node-ID

3.3.2. Object 1400h: Receive PDO1 Communication Parameters

The object contains the communication parameters of the receive PDO1. Sub-index 1_h contains the COB ID of the PDO. The transmission type (sub-index 2_h) defines the reception character of the PDO.

Object description:

Index	1400_h
Name	RPDO1 Communication Parameter
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	2

Sub-index	01_h
Description	COB-ID RPDO1
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	200_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW

PDO mapping	No
Value range	UNSIGNED8
Default value	255

Table 3.2 PDO COB-ID entry description

Bit	Value	Meaning
31	0	PDO exists / is valid / is enabled
	1	PDO does not exist / is not valid / is disabled
30	0	RTR allowed on this PDO
	1	No RTR allowed on this PDO
29	0	11 bit ID
	1	29 bit ID
28…11	0	If bit 29=0
	X	If bit 29=1: Bit 11...28 of 29-bit PDO COB-ID
10...0	X	Bit 0...10 of PDO COB-ID

It is not allowed to change bits 0-29 while the PDO exists (bit 31=0).

3.3.3. Object 1401h: Receive PDO2 Communication parameters

The object contains the communication parameters of the receive PDO2. Sub-index 1_h contains the COB ID of the PDO. The transmission type (sub-index 2_h) defines the reception character of the PDO. The receive PDO2 COB-ID entry description is identical with the one of the receive PDO1 (see **Table 3.2**).

Object description:

Index	1401_h
Name	RPDO2 Communication Parameter
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	2

Sub-index	01_h
Description	COB-ID RPDO2
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	300_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8
Default value	255

3.3.4. Object 1402h: Receive PDO3 Communication parameters

The object contains the communication parameters of the receive PDO3. Sub-index 1_h contains the COB ID of the PDO. The transmission type (sub-index 2_h) defines the reception character of the PDO. The receive PDO3 COB-ID entry description is identical with the one of the receive PDO1 (see **Table 3.2**).

Object description:

Index	1402_h
Name	RPDO3 Communication Parameter
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	2

Sub-index	01_h
Description	COB-ID RPDO3
Access	RW

PDO mapping	No
Value range	UNSIGNED32
Default value	400_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8
Default value	255

3.3.5. Object 1403h: Receive PDO4 Communication parameters

The object contains the communication parameters of the receive PDO4. Sub-index 1_h contains the COB ID of the PDO. The transmission type (sub-index 2_h) defines the reception character of the PDO. The receive PDO4 COB-ID entry description is identical with the one of the receive PDO1 (see **Table 3.2**).

Object description:

Index	1403_h
Name	RPDO4 Communication Parameter
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	2

Sub-index	01_h
Description	COB-ID RPDO2
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	500_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8
Default value	255

3.3.6. Object 1600h: Receive PDO1 Mapping Parameters

This object contains the mapping parameters of the receive PDO1. The sub-index 00_h contains the number of valid entries within the mapping record. This number of entries is also the number of the objects that shall be transmitted/received with the corresponding PDO. The sub-indices from 01_h to the number of entries contain the information about the mapped objects. These entries describe the PDO contents by their index, sub-index and length. The length entry contains the length of the mapped object in bits and is used to verify the overall mapping length.

The structure of the entries from sub-index 01_h to the number of entries is as follows:

MSB **LSB**

Index (16 bits)	Sub-index (8 bits)	Object length (8 bits)

In order to change the PDO mapping, first the PDO has to be disabled - the object $160x_h$ sub-index 00_h has to be set to 0. Now the objects can be remapped. If a wrong mapping parameter is introduced (object does not exist, the object can not be mapped or wrong mapping length is detected) the SDO transfer will be aborted with an appropriate error code (0602 0000_h or 0604 0041_h). After all objects are mapped, sub-index 00_h has to be set to the valid number of mapped objects thus enabling the PDO.

If data types (index 01_h - 07_h) are mapped, they serve as “dummy entries”. The corresponding data is not evaluated by the drive. This feature can be used to transmit data to several drives using only one PDO, each drive using only a part of the PDO. This feature is only valid for receive PDOs.

Object description:

Index	1600_h
Name	RPDO1 Mapping Parameters
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of mapped objects
Access	RW

PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	1

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60400010_h – control word

3.3.7. Object 1601h: Receive PDO2 Mapping Parameters

This object contains the mapping parameters of the receive PDO2. The sub-index 00_h contains the number of valid entries within the mapping record. This number of entries is also the number of the objects that shall be transmitted/received with the corresponding PDO.

Object description:

Index	1601_h
Name	RPDO2 Mapping Parameter
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of mapped objects
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	2

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60400010_h – control word

Sub-index	02_h
Description	2nd mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60600008_h – modes of operation

3.3.8. Object 1602h: Receive PDO3 Mapping Parameters

This object contains the mapping parameters of the receive PDO3. The sub-index 00_h contains the number of valid entries within the mapping record. This number of entries is also the number of the objects that shall be transmitted/received with the corresponding PDO.

Object description:

Index	1602_h
Name	RPDO3 Mapping Parameter
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of mapped objects
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	2

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60400010_h – control word

Sub-index	02_h
Description	2nd mapped object
Access	RW

PDO mapping	No
Value range	UNSIGNED32
Default value	$607A0020_h$ – target position

3.3.9. Object 1603h: Receive PDO4 Mapping Parameters

This object contains the mapping parameters of the receive PDO4. The sub-index 00_h contains the number of valid entries within the mapping record. This number of entries is also the number of the objects that shall be transmitted/received with the corresponding PDO.

Object description:

Index	1603_h
Name	RPDO4 Mapping Parameters
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of mapped objects
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	2

Sub-index	01_h
Description	1^{st} mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60400010_h – control word

Sub-index	02_h
Description	2^{nd} mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	$60FF0020_h$ – target velocity

3.3.10.Object 1800h: Transmit PDO1 Communication parameters

This object contains the communication parameters of the transmit PDO1. For detailed description see object 1400_h (Receive PDO1 communication parameters, COB-ID entry description, described in **Table 3.2**). The inhibit time is defined as multiples of 100 µs.

Object description:

Index	1800_h
Name	TPDO1 Communication Parameters
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	5

Sub-index	01_h
Description	COB-ID TPDO1
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	180_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8
Default value	255

Sub-index	03_h
Description	Inhibit time
Access	RW
PDO mapping	No

Value range	UNSIGNED16
Default value	300 (30 ms)

Sub-index	04_h
Description	Reserved

Sub-index	05_h
Description	Event timer
Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	0

3.3.11. Object 1801h: Transmit PDO2 Communication parameters

This object contains the communication parameters of the transmit PDO2. For detailed description see object 1400_h (Receive PDO1 communication parameters, COB-ID entry description, described in **Table 3.2**). The inhibit time is defined as multiples of 100 µs.

Object description:

Index	1801_h
Name	TPDO2 Communication Parameters
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	5

Sub-index	01_h
Description	COB-ID TPDO2
Access	RW
PDO mapping	No
Value range	UNSIGNED32

Default value	280_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8
Default value	255

Sub-index	03_h
Description	Inhibit time
Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	300 (30 ms)

Sub-index	04_h
Description	Reserved

Sub-index	05_h
Description	Event timer
Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	0

3.3.12.Object 1802h: Transmit PDO3 Communication parameters

This object contains the communication parameters of the transmit PDO3. By default, this TxPDO is disabled by setting Bit31 to 1_b in Sub-index 01_h. For detailed description see object 1400_h (Receive PDO1 communication parameters, COB-ID entry description, described in **Table 3.2**). The inhibit time is defined as multiples of 100 µs.

Object description:

Index	1802_h
Name	TPDO3 Communication Parameters
Object code	RECORD

Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	5

Sub-index	01_h
Description	COB-ID TPDO3
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	80000380_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8
Default value	255

Sub-index	03_h
Description	Inhibit time
Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	300 (30 ms)

Sub-index	04_h
Description	Reserved

Sub-index	05_h
Description	Event timer

Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	0

3.3.13.Object 1803h: Transmit PDO4 Communication parameters

This object contains the communication parameters of the transmit PDO4. By default, this TxPDO is disabled by setting Bit31 to 1_b in Sub-index 01_h. For detailed description see object 1400_h (Receive PDO1 communication parameters, COB-ID entry description, described in **Table 3.2**) . The inhibit time is defined as multiples of 100 μs.

Object description:

Index	1803_h
Name	TPDO4 Communication Parameter
Object code	RECORD
Data type	PDO CommPar

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	-
Default value	5

Sub-index	01_h
Description	COB-ID TPDO4
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	80000480_h + Node-ID

Sub-index	02_h
Description	Transmission type
Access	RW
PDO mapping	No
Value range	UNSIGNED8

Default value	255

Sub-index	03_h
Description	Inhibit time
Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	300 (30 ms)

Sub-index	04_h
Description	Reserved

Sub-index	05_h
Description	Event timer
Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	0

3.3.14.Object 1A00h: Transmit PDO1 Mapping Parameters

This object contains the mapping parameters of the transmit PDO1. For detailed description see object 1600_h (Receive PDO1 mapping parameters)

Object description:

Index	$1A00_h$
Name	TPDO1 Mapping Parameters
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of mapped objects
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	1

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60410010_h – status word

3.3.15.Object 1A01h: Transmit PDO2 Mapping Parameters

This object contains the mapping parameters of the transmit PDO2. For detailed description see object 1600_h (Receive PDO1 mapping parameters)

Object description:

Index	$1A01_h$
Name	TPDO2 Mapping Parameter
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of mapped objects
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	2

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60410010_h – status word

Sub-index	02_h
Description	2nd mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32

Default value	60610008_h – modes of operation display

3.3.16.Object 1A02h: Transmit PDO3 Mapping Parameters

This object contains the mapping parameters of the transmit PDO3. For detailed description see object 1600_h (Receive PDO1 mapping parameters). By default, this PDO is disabled with object 1802h Sub-index 01 by setting Bit31 to 1.

Object description:

Index	$1A02_h$
Name	TPDO3 Mapping Parameter
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	2

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60410010_h – status word

Sub-index	02_h
Description	2nd mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60640020_h – position actual value

3.3.17. Object 1A03h: Transmit PDO4 Mapping Parameters

This object contains the mapping parameters of the transmit PDO4. For detailed description see object 1600_h (Receive PDO1 mapping parameters). By default, this PDO is disabled with object 1803h Sub-index 01 by setting Bit31 to 1.

Object description:

Index	$1A03_h$
Name	TPDO4 Mapping Parameter
Object code	RECORD
Data type	PDO Mapping

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RW
PDO mapping	No
Value range	0: Mapping disabled 1 – 64: Sub-index 1 to x is valid
Default value	2

Sub-index	01_h
Description	1st mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	60410010_h – status word

Sub-index	02_h
Description	2nd mapped object
Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	$606C0020_h$ – velocity actual value

3.3.18. Object 207Dh: Dummy

This object may be used to fill a RPDO up to a length matching the CANopen master requirements.

Object description:

Index	$207D_h$
Name	Dummy
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW
PDO mapping	Possible
Value range	0 … 255
Default value	0

3.4. Dynamic mapping of the PDOs

Follow the next steps to change the default mapping of a PDO:

1. **Disable (destroy) the PDO** by setting bit *valid* (Bit31) to 1_b of sub-index 01_h of the according PDO communication parameter object (index 1400_h-1403_h for RxPDOs and 1800_h-1803_h for TxPDOs). The PDO COB-ID entry description is described in **Table 3.2 .**
2. **Disable mapping**. In the PDO's mapping object (index 1600_h-1603_h for RxPDOs and $1A00_h$-$1A03_h$ for TxPDOs) set the first sub-index 00_h (the number of mapped objects) to 00_h.
3. **Map the new objects**. Write in the PDO's mapping object (index 1600_h-1603_h for RxPDOs and $1A00_h$-$1A03_h$ for TxPDOs) sub-indexes (1-8) the description of the objects that will be mapped. You can map up to 8 objects having 1 byte size.
4. **Enable mapping**. In sub-index 0 of the PDO's associated mapping object (index 1600_h-1603_h for RxPDOs and $1A00_h$-$1A03_h$ for TxPDOs) write the number of mapped objects.
5. **Enable (create) the PDO** by setting bit *valid* (Bit31) to 0_b of sub-index 01_h of the according PDO communication parameter object (index 1400_h-1403_h for RxPDOs and 1800_h-1803_h for TxPDOs).

3.5. RxPDOs mapping example

Map the Receive PDO3 of axis number 06 with **ControlWord** (index 6040_h) and **Modes of Operation** (index 6060_h).

1. **Disable the RxPDO**. Set Bit31 to 1_b of sub-index 01_h in object 1402_h, this will disable the RxPDO. The PDO COB-ID entry description is described in **Table 3.2 .**

Bit31 valid	RxPDO 3 COB-ID	Axis Node ID	Resulting data
0_b +	400_h +	06_h =	80000406_h

Send the following message (SDO access to object 1402_h sub-index 1, 32-bit value 80000406_h):

COB-ID	**606**
Data	**23 02 14 01 06 04 00 80**

2. **Change the communication parameters.** For example purposes the communication parameters default values are acceptable.
3. **Disable mapping PDO**. Write zero in object 1602_h sub-index 0, this will the PDO's mapping.

Send the following message (SDO access to object 1602_h sub-index 0, 8-bit value 0):

COB-ID	**606**
Data	**2F 02 16 00 00 00 00 00**

4. **Map the new objects**.
   a. Write in object 1602_h sub-index 1 the description of the Control Word:

Index	Sub-index	Length	Resulting data
6040_h	00_h	10_h	60400010_h

Send the following message (SDO access to object 1602_h sub-index 1, 32-bit value 60400010_h):

COB-ID	**606**
Data	**23 02 16 01 10 00 40 60**

   b. Write in object 1602_h sub-index 2 the description of the Modes of Operation:

Index	Sub-index	Length	Resulting data
6060_h	00_h	08_h	60600008_h

Send the following message (SDO access to object 1602_h sub-index 2, 32-bit value 60600008_h):

COB-ID	**606**
Data	**23 02 16 02 08 00 60 60**

5. **Enable the RxPDO's mapped objects**. Set the object 1602_h sub-index 0 with the value 2 to enable both mapped objects.

Send the following message (SDO access to object 1602_h sub-index 0, 8-bit value 2):

COB-ID	**606**
Data	**2F 02 16 00 02 00 00 00**

6. **Enable the RxPDO**. Set Bit31 to 0_b of sub-index 01_h in object 1402_h, this will enable the RxPDO. Set in object 1402_h sub-index 1 Bit31 to 0. The PDO COB-ID entry description is described in **Table 3.2 .**

Bit31 valid	**RxPDO 3 COB-ID**	**Axis Node ID**	**Resulting data**
0_b +	**400_h +**	**06_h =**	**00000406_h**

Send the following message (SDO access to object 1402_h sub-index 1, 32-bit value 0x00000406):

COB-ID	**606**
Data	**23 02 14 01 06 04 00 00**

3.6. TxPDOs mapping example

Map the Transmit PDO4 of axis number 06 with **Position actual value** (index 6064_h) and **Digital inputs** (index $60FD_h$).

1. **Disable the TxPDO**. Set Bit31 to 1_b of sub-index 01_h in object 1803_h, this will disable the TxPDO. The PDO COB-ID entry description is described in **Table 3.2 .**

Bit31 valid	**TxPDO4 COB-ID**	**Axis Node ID**	**Resulting data**
0_b +	**480_h +**	**06_h =**	**80000486_h**

Send the following message (SDO access to object 1801_h sub-index 1, 32-bit value 80000486h):

COB-ID	**606**
Data	**23 03 18 01 86 04 00 80**

2. **Set the transmission type**. Write 255 in object 1803_h sub-index 2. This will set the transmission type as asynchronous, meaning that the PDO will be sent every time anything changes in its data field.

Send the following message (SDO access to object 1803_h sub-index 2, 8-bit value FF_h):

COB-ID	**606**
Data	**2F 03 18 02 FF 00 00 00**

3. **Set inhibit time**. Write 1000 in object 1803_h sub-index 3. This will set an inhibit time of 100ms. This means that even though the PDO should be sent faster, it will be sent at minimum 100ms intervals.

Send the following message (SDO access to object 1803_h sub-index 3, 16-bit value $03E8_h$):

COB-ID	**606**
Data	**2B 03 18 03 E8 03 00 00**

4. **Set event timer**. Write 1000 in object 1803_h sub-index 5. This will set an event timer of 1000 ms. This means that the PDO will be sent at 1000ms intervals, even if nothing changes in its data field.

Send the following message (SDO access to object 1803_h sub-index 5, 16-bit value $03E8_h$):

COB-ID	**606**
Data	**2B 03 18 05 E8 03 00 00**

5. **Disable the PDO mapping**. Write zero in object $1A03_h$ sub-index 0, this will disable the PDO's mapping.

Send the following message (SDO access to object $1A03_h$ sub-index 0, 8-bit value 0):

COB-ID	**606**
Data	**2F 03 1A 00 00 00 00 00**

6. **Map the new objects**.
   a. Write in object $1A03_h$ sub-index 1 the description of the Position actual value:

Index	**Sub-index**	**Length**	**Resulting data**
6064_h	**00_h**	**20_h**	**60640020_h**

Send the following message (SDO access to object $1A03_h$ sub-index 1, 32-bit value 60640020_h):

COB-ID	**606**
Data	**23 03 1A 01 20 00 64 60**

   b. Write in object $1A03_h$ sub-index 2 the description of the Digital inputs:

Index	**Sub-index**	**Length**	**Resulting**

			data
60FD$_h$	**00$_h$**	**20$_h$**	**60FD0020$_h$**

Send the following message (SDO access to object 1A03$_h$ sub-index 2, 32-bit value 60FD0020$_h$):

COB-ID	**606**
Data	**23 03 1A 02 20 00 FD 60**

7. **Enable the TxPDO's mapped objects**. Set the object 1A03$_h$ sub-index 0 with the value 2 to enable both mapped objects.

Send the following message (SDO access to object 1A03$_h$ sub-index 0, 8-bit value 2):

COB-ID	**606**
Data	**2F 03 1A 00 02 00 00 00**

8. **Enable the TxPDO 4**. Set Bit31 to 0$_b$ of sub-index 01$_h$ in object 1803$_h$, this will enable the TxPDO 4. Set in object 1803$_h$ sub-index 1 Bit31 to 0. The PDO COB-ID entry description is described in **Table 3.2 .**

Bit31 valid	TxPDO4 COB-ID	Axis Node ID	Resulting data
0$_b$ +	**480$_h$ +**	**06$_h$ =**	**00000486$_h$**

Send the following message (SDO access to object 1803$_h$ sub-index 1, 32-bit value 0x00000486):

COB-ID	**606**
Data	**23 03 18 01 86 04 00 00**

9. **Start remote node 6**. Send a NMT message to start the node id 6. This message is to enable the use of the PDOs.

Send the following message:

COB-ID	**0**
Data	**01 06**

After the last message, the drive will start emitting at 1s intervals data with COB-ID 0x486 showing the motor actual position and the Digital input status. If the encoder is rotated, the PDO will be sent every time the position changes, but not faster than 100ms.

4. Network Management

4.1. Overview

The Network Management (NMT) services initialize, start, monitor, reset or stop the CANopen nodes. The NMT requires a node in the network (a PC or a PLC) to be designed as a network manager while the Technosoft intelligent drives are the NMT slaves. The NMT services are fulfilled by the NMT objects described later in this chapter.

4.1.1. Network Management (NMT) State Machine

Figure 4.1.1 shows the NMT state diagram of a CANopen device. After finishing the initialization, the iPOS drive enters the NMT state Pre-operational. During this state, both the communication parameters and drive parameters can be changed using SDO messages. In this state the PDO messages are defined. Once entered in the operational mode, the drive is typically controlled via PDO messages.

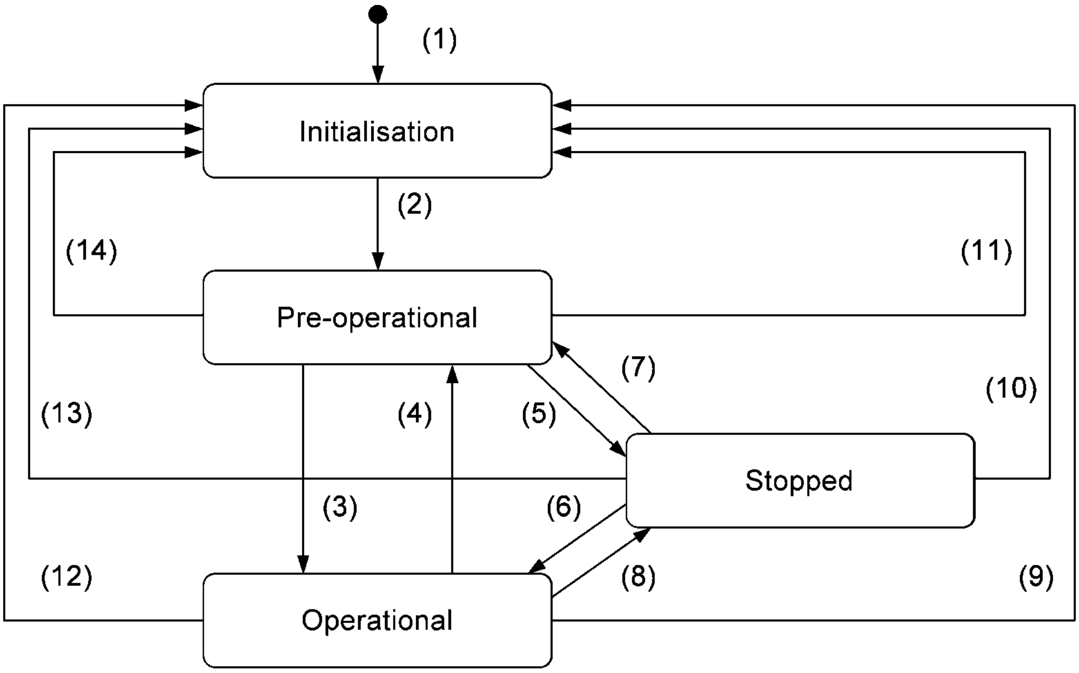


Figure 4.1 *NMT state diagram*

Table 4.1 *NMT state transitions*

(1)	At Power on the NMT state initialization is entered autonomously
(2)	NMT state initialization finished - enter NMT state Pre-operational automatically
(3)	NMT service start remote node indication or by local control
(4),(7)	NMT service enter pre-operational indication
(5),(8)	NMT service stop remote node indication
(6)	NMT service start remote node indication
(9),(10),(11)	NMT service reset node indication
(12),(13),(14)	NMT service reset communication indication

4.1.2. Device control

Through Module Control Services, the NMT master controls the state of the NMT slaves. The following states are implemented on the Technosoft drives:

State	Description
Pre-operational	The drive enters the pre-operational state after finishing its initialization. In this state the communication between the CANopen master and the drive can be done only via SDOs. PDOs are not allowed.
Operational	This is the normal operating state of the drives. The communication through SDO and PDO is allowed
Stopped	In this state the drive stops the communication except the network management messages.

The network manager can change the state of the drives using one of the following services:

Service	Description
Start Remote Node	The NMT master sets the state of the selected NMT slave to operational
Stop Remote Node	The NMT master sets the state of the selected NMT slave to stopped
Enter Pre-Operational	The NMT master sets the state of the selected NMT slave to pre-operational
Reset Node	The NMT master sets the state of the selected NMT slave to the “reset application” sub-state. In this state the drives perform a software reset and enter the pre-operational state.

Reset Communication	The NMT master sets the state of the selected NMT slave to the “reset communication” sub-state. In this state the drives resets their communication and enter the pre-operational state.

All the services are unconfirmed.

4.1.2.1. Enter Pre-Operational

Used to change NMT state of one or all NMT slaves to “Pre-Operational”.

cs	0x80	Command specifier for NMT command Enter Pre-Operational
Node ID	1…127	NMT slave with corresponding Node ID will enter in NMT state Pre-Operational
	0	All NMT Slaves will enter NMT state Pre-Operational

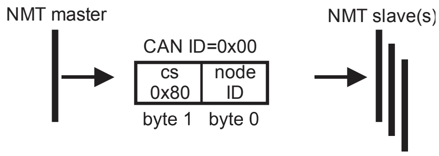


Figure 4.2 *NMT Enter Pre-Operational*

4.1.2.2. Reset communication

Used to reset communication of one or all NMT slaves.

cs	0x82	Command specifier for NMT command Reset Communication
Node ID	1…127	NMT slave with corresponding Node ID will reset communication
	0	All NMT Slaves will reset communication

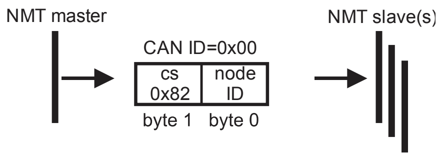


Figure 4.3 *NMT Reset Communication*

4.1.2.3. Reset Node

Used to reset one or all NMT slaves.

cs	0x81	Command specifier for NMT command Reset Node
Node ID	1…127	NMT slave with corresponding Node ID will reset
	0	All NMT Slaves will reset

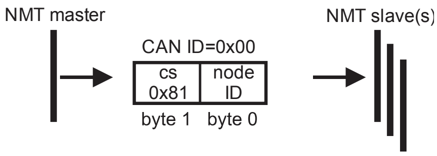


Figure 4.4 *NMT Reset Node*

4.1.2.4. Start Remote Node

Used to change NMT state of one or all NMT slaves to "Operational". PDO communication will be allowed.

cs	0x01	Command specifier for NMT command Start Remote Node
Node ID	1…127	NMT slave with corresponding Node ID will enter "Operational" state
	0	All NMT Slaves will enter "Operational" state

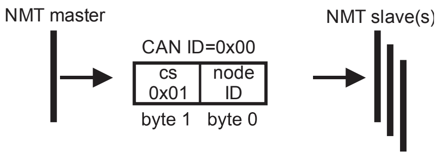


Figure 4.5 *NMT Start Remote Node*

4.1.2.5. Stop Remote Node

Used to change NMT state of one or all NMT slaves to "Stopped".

cs	0x01	Command specifier for NMT command Stop Remote Node
Node ID	1…127	NMT slave with corresponding Node ID will enter "Stopped" state
	0	All NMT Slaves will enter "Stopped" state

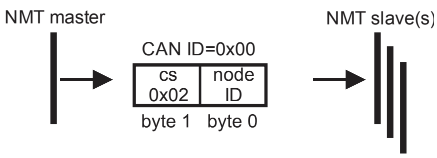


Figure 4.6 NMT Stop Remote Node

4.1.3. Device monitoring

In addition to controlling the drive states the NMT provides services for monitoring the nodes in the network. The monitoring services are achieved mainly through the periodical transmission of messages by the network manager, with answers from the slaves, or messages sent by the slaves without master intervention. Monitoring services can use the Node Guarding protocol (including Life Guarding) or the Heartbeat protocol.

Node guarding protocol

The master polls each NMT slave at regular time intervals. This time interval is called the guard time and may be different for each NMT slave. The slaves answer with a node-guarding message containing their state. This allows both the master and the slave to identify a network error if either the remote request or the guarding messages stop.

The node life time is computed as the product between the guard time (index $100C_h$) and the life time factor (index $100D_h$). If the drive is not accessed within the life time then a Life Time event occurs and an emergency telegram is sent.

Heartbeat protocol

The Heartbeat protocol defines an error control service without the need of remote frames. It implies independent and cyclical transmission of a telegram by the drive (the Heartbeat producer) indicating the drives current state. The time interval between two heartbeat messages is specified through producer heartbeat time (index 1017_h). The master (Heartbeat consumer) guards the reception of the heartbeat messages within the Heartbeat Consumer Time. If the value of this object is 0, the heartbeat transmission is disabled. If the master doesn't receive the heartbeat message this indicates a problem with the drive or with its network connection.

Bootup protocol

This protocol is used by the drive to signal to the network master that it has entered the state pre-operational.

4.1.4. Synchronization between devices

The synchronization message (SYNC) allows synchronizing the devices in the network and triggering the synchronous transmission of PDOs. The SYNC producer broadcasts the synchronization object periodically. This service is unconfirmed. Technosoft intelligent drives can act both as SYNC consumer and producer.

For time critical applications, which require more accurate synchronization, the Technosoft drives can use the optional high-resolution synchronization protocol, which employs a special form of time stamp message. The High Resolution Time Stamp object (index 1013_h) contains a time stamp with a resolution of 1µs. The object can be mapped into a PDO in order to define a high-resolution time stamp message. The PDO should be configured for synchronous transmission. When one of the Technosoft drives is set as synchronization master, the High resolution time stamp is by default sent using the COB ID defined in COB-ID High Resolution Time Stamp object (index 2004_h).

4.1.5. Emergency messages

A drive sends an emergency message (EMCY) when a drive internal error occurs. An emergency message is transmitted only once per 'error event'. As long as no new errors occur, the drive will not transmit further emergency messages.

The emergency error codes supported by the Technosoft drives are listed in **Table 4.2**. Details regarding the conditions that may generate emergency messages are presented at object Motion Error Register index 2000_h.

Table 4.2 *Emergency Error Codes*

Error code (hex)	Description
0000	Error Reset or No Error
1000	Generic Error
2310	Continuous over-current
2340	Short-circuit
3210	DC-link over-voltage
3220	DC-link under-voltage
4280	Over temperature motor
4310	Over temperature drive
5441	Drive disabled due to enable input
5442	Negative limit switch active
5443	Positive limit switch active
6100	Invalid setup data
7500	Communication error
8110	CAN overrun (message lost)
8130	Life guard error or heartbeat error
8331	I2t protection triggered
8580	Position wraparound
8611	Control error / Following error
9000	Command error
FF01	Generic interpolated position mode error (PVT / PT error)
FF02	Change set acknowledge bit wrong value
FF03	Specified homing method not available
FF04	A wrong mode is set in object 6060h, modes_of_operation
FF05	Specified digital I/O line not available
FF06	Positive software position limit triggered
FF07	Negative software position limit triggered

The Emergency message contains of 8 data bytes having the following contents:

0-1	2	3-7
Emergency Error Code	Error Register (Object 1001h)	Manufacturer specific error field

4.2. Network management objects

The section describes the objects related to network management

4.2.1. Object 1001h: Error Register

This object is an error register for the device. The device can map internal errors in this byte. This entry is mandatory for all devices. It is a part of an Emergency object.

Object description:

Index	1001_h
Name	Error register
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RO
PDO mapping	No
Value range	UNSIGNED8
Default value	No

Table 4.3 *Bit description of the object*

Bit	**Description**
0	Generic error
1	Current
2	Voltage
3	Temperature
4	Communication error
5	Device profile specific
6	Reserved (always 0)
7	Manufacturer specific.

Valid bits while an error occurs – bit 0 and bit 4. The other bits will remain 0.

4.2.2. Object 1003h: Pre-defined error field

This object provides the errors that occurred on the iPOS drive and were signaled via the emergency object. If no error was signaled, sub-index 00h reports 0 entries. The object can report up to 5 emergency messages recently transmitted. The last reported error will always be set in sub-index 1.

Object description:

Index	1003_h
Name	Pre-defined error field
Object code	ARRAY
Data type	UNSIGNED32

Entry description:

Sub-index	00_h
Description	Number of errors in history
Access	RO
PDO mapping	No
Value range	1..5
Default value	0

Sub-index	01_h
Description	Standard error field
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	-

Sub-index	02_h to 05_h
Description	Standard error field
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	-

4.2.3. Object 1005h: COB-ID of the SYNC Message

This object defines the COB-ID of the Synchronization Object (SYNC) and whether the drive generates the SYNC or not.

Object description:

Index	1005_h
Name	COB-ID SYNC Message
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	80_h

The structure of the parameter is the following:

Table 4.4 *Bit description of the object*

Bit	Value	Description
31	X	Reserved
30	0	Drive does not generate synchronization messages
	1	Drive is the synchronization master (SYNC producer)
29	0	Use 11 bit identifier
	1	Use 29 bit identifier
28…11	X	Bit 11...28 of 29-bit SYNC COB-ID
10...0	X	Bit 0...10 of SYNC COB-ID

The first transmission of SYNC object starts within 1 sync cycle after setting bit 30 to 1. It is not allowed to change bit 0...29, while the object exists (bit 30 = 1).

4.2.4. Object 1006h: Communication Cycle Period

The object defines the time interval between SYNC messages expressed in µs. A drive sends SYNC messages if it is configured to send SYNC messages through object 1005_h and the object 1006_h is set with a non-zero value.

Object description:

Index	1006_h
Name	Communication cycle period
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	0

4.2.5. Object 1010h: Store parameters

This object controls the saving of certain object parameters in the non-volatile memory. By writing 65766173h ("save" in /ISO8859/ characters) into sub--index 01h, the drive stores the parameters of the following objects:

- 1400h-1403h;
- 1600h-1603h;
- 1800h-1803h;
- 1A00h-1A03h;
- 1005h; 1006h; 100Ch; 100Dh; 1014h; 1017h;
- 207Bh[1]; 207Ch[1];
- 6007h[1]; 605Ah[1]; 605Bh[1]; 605Ch[1]; 605Dh[1]; 605Eh[1]; 6060h; 6065h; 6066h; 6067h; 6068h; 607Ah[1]; 607Ch; 607Dh[1]; 607Eh[1]; 6081h; 6083h; 6085h[1]; 6098h; 6099h; 609Ah[1]; 60FFh.

By reading sub-index 01h of object 1010h, the reply shall be 0x00000001, meaning the device does not save parameters autonomously and it saves them on command.

On reception of the correct signature in 01h sub-index, the drive will confirm the SDO transmission (SDO download response). Because storing of drive parameters lasts more than an SDO write command, always wait for the SDO confirmation message.

After save command is performed, the iPOS, shall always load the parameters of the previously mentioned objects at startup. To restore the default standard values see *Object 1011h: Restore parameters*.

Object description:

Index	1010_h
Name	Store parameters
Object code	ARRAY
Data type	UNSIGNED32

Entry description:

Sub-index	00_h
Description	highest sub-index supported
Access	RO
PDO mapping	No
Value range	1
Default value	1

Sub-index	01_h
Description	Save parameters
Access	RW
PDO mapping	No

[1] Available from firmware revision G.

Value range	UNSIGNED32
Default value	-

To save the parameters of the objects previously mentioned, send the following command:

(SDO access to object 1010_h sub-index 1, 32-bit value 65766173_h)

COB-ID	**60A**
Data	**23 10 10 01 73 61 76 65**

4.2.6. Object 1011h: Restore parameters

This object restores certain object parameters to their default values. By writing 64616F6Ch ("load" in /ISO8859/ characters) into sub--index 01h, the drive restores to their default values the parameters of the following objects :

- 1400h-1403h;
- 1600h-1603h;
- 1800h-1803h;
- 1A00h-1A03h;
- 1005h; 1006h; 100Ch; 100Dh; 1014h; 1017h;
- 6065h; 6066h; 6067h; 6068h; 6060h; 607Ch; 6081h; 6083h; 6098h; 6099h; 60FFh

By reading sub-index 01h of object 1011h, the reply shall be 0x00000001, meaning the device can restore CANopen parameters to their default value.
The default values will be set valid after the iPOS drive is reset.

Object description:

Index	1011_h
Name	Restore default parameters
Object code	ARRAY
Data type	UNSIGNED32

Entry description:

Sub-index	00_h
Description	highest sub-index supported
Access	RO
PDO mapping	No
Value range	1
Default value	1

Sub-index	01_h
Description	Restore all default parameters
Access	RW

PDO mapping	No
Value range	UNSIGNED32
Default value	-

To restore the object parameters to their default values, send the following command:

(SDO access to object 1011_h sub-index 1, 32-bit value 64616F6C $_h$)

COB-ID	**60A**
Data	**23 11 10 01 6C 6F 61 64**

4.2.7. Object 100Ch: Guard Time

The Guard Time object multiplied with Lifetime Factor (index $100D_h$) gives the Lifetime of the drive for the Life Guarding Protocol. The Guard Time is expressed in ms. When the Life Guarding Protocol is not used the object must be set to 0. When the Node Guarding is active, i.e. the network manager sends the Node Guarding messages, the Life Guarding Protocol checks if the master has stopped sending messages or not. The decision of Node Guarding failure is taken if no message from the master is received within the period defined as Lifetime.

Object description:

Index	$100C_h$
Name	Guard time
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	0

4.2.8. Object 100Dh: Life Time Factor

The lifetime factor multiplied with the guard time gives the lifetime for the Life Guarding Protocol. Must be 0 if not used.

Object description:

Index	$100D_h$
Name	Life time factor
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW

PDO mapping	No
Value range	UNSIGNED8
Default value	0

4.2.9. Object 1013h: High Resolution Time Stamp

This object should receive a time stamp with a resolution of 1µs. It can be used in order to synchronize the drives in the CANopen network.

When setting up the synchronization mechanism, the master can map the object 1013_h on a receive PDO whose COB-ID should be identical on all the slave drives that need to be synchronized.

This object has to be written immediately after the SYNC message (the one that has the COB-ID 0x80 and nothing in the data field). Upon the time reception in this object, the drive will adjust its internal clock so that to compensate for the difference between the received value and its internal clock value. When reading the object, the value shown will be the one last written in it.

Object description:

Index	1013_h
Name	High resolution time stamp
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	0

Remark: The high resolution time stamp may also be sent in a message with the COB-ID defined by object 2004h (default value is 0x100).

4.2.10.Object 2004h: COB-ID of the High-resolution time stamp

This object defines the COB-ID used by the high-resolution time stamp message sent by the synchronization master (when the drive is configured as a SYNC producer) in order to achieve synchronization on the network.

When the drive is the SYNC producer, this object defines if the high resolution time stamp is sent or not.

Object description:

Index	2004_h
Name	COB-ID High resolution time

	stamp
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	100_h

The structure of the parameter is the following:

Bit	Value	Meaning
31	0	High resolution time stamp exists / is valid
	1	High resolution time stamp does not exist / is not valid
30	0	Reserved (always 0)
29	0	11 bit ID
	1	29 bit ID
28…11	X	Bit 11...28 of 29-bit High resolution time stamp COB-ID
10...0	X	Bit 0...10 of High resolution time stamp COB-ID

It is not allowed to change bits 0-29 while the object exists (bit 31=0).

This object will be used when a Technosoft drive is required to be the master for the synchronization messages. In this case, the CANopen master does not need to map the 1013_h into a receive PDO.

4.2.11.Configure the drive as a SYNC master Example

The procedure to activate the synchronization is the following:

1. **Set the SYNC interval**. Write the desired SYNC interval into the object 1006_h (Communication Cycle Period). For example – 20 ms.

Send the following message (SDO access to object 1006_h sub-index 0, 32-bit value 0x4E20 = 20000 µs = 20 ms):

COB-ID	**60A**
Data	**23 06 10 00 20 4E 00 00**

2. **Activate the SYNC producer**. Set bit 30 in object 1005_h (COB-ID of SYNC Message).

Send the following message (SDO access to object 1005_h sub-index 0, 32-bit value 40000080_h):

COB-ID	**60A**
Data	**23 05 10 00 80 00 00 40**

The drive will start sending sync messages with COB ID 0x80 Data null. It will also send time stamp messages with COB ID 0x100 Data 0x12 0x34 0x56 0x78 0x00 0x00 where

0x000078563412 is the time stamp data expressed in µs. Also, if in object 2004h the time stamp is disabled, the sync producer will emit only sync messages with COB ID 0x80.

4.2.12.Object 1014h: COB-ID Emergency Object

Index 1014h defines the COB-ID of the Emergency Object (EMCY).

Object description:

Index	1014_h
Name	COB-ID Emergency message
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED32
Default value	80h + Node-ID

***Table 4.5** Structure of the EMCY Identifier*

MSB				LSB
31	30	29	28 - 11	10 - 0
0/1	0	1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11-bit Identifier
0/1	0	1	29 –bit Identifier	

***Table 4.6** Description of EMCY COB-ID entry*

Bit	**Value**	**Description**
31 (MSB)	0	EMCY exists / is valid
	1	EMCY does not exist / is not valid
30	0	Reserved
29	0	Use 11 bit identifier
	1	Use 29 bit identifier
28…11	0 X	If bit 29 = 0 Bit 11...28 of 29-bit SYNC COB-ID
10...0 (LSB)	X	Bit 0...10 of COB-ID

It is not allowed to change Bits 0-29, while the object exists (Bit 31=0).

4.2.13.Object 1017h: Producer Heartbeat Time

This object defines the cycle time of the heartbeat (if not equal to zero). If the heartbeat is not used, this object must have the default value 0. The time has to be a multiple of 1 ms.

Object description:

Index	1017_h
Name	Producer Heartbeat Time
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	0

5. Drive control and status

5.1. Overview

The state machine from **Device Profile Drives and Motion Control** describes the drive status and the possible control sequences of the drive. The drive states can be changed by the **Control Word** and/or according to internal events. The drive current state is reflected in the **Status Word**. The state machine presented in **Figure 5.** describes the state machine of the drive with respect to the control of the power stage as a result of user commands and internal drive faults.

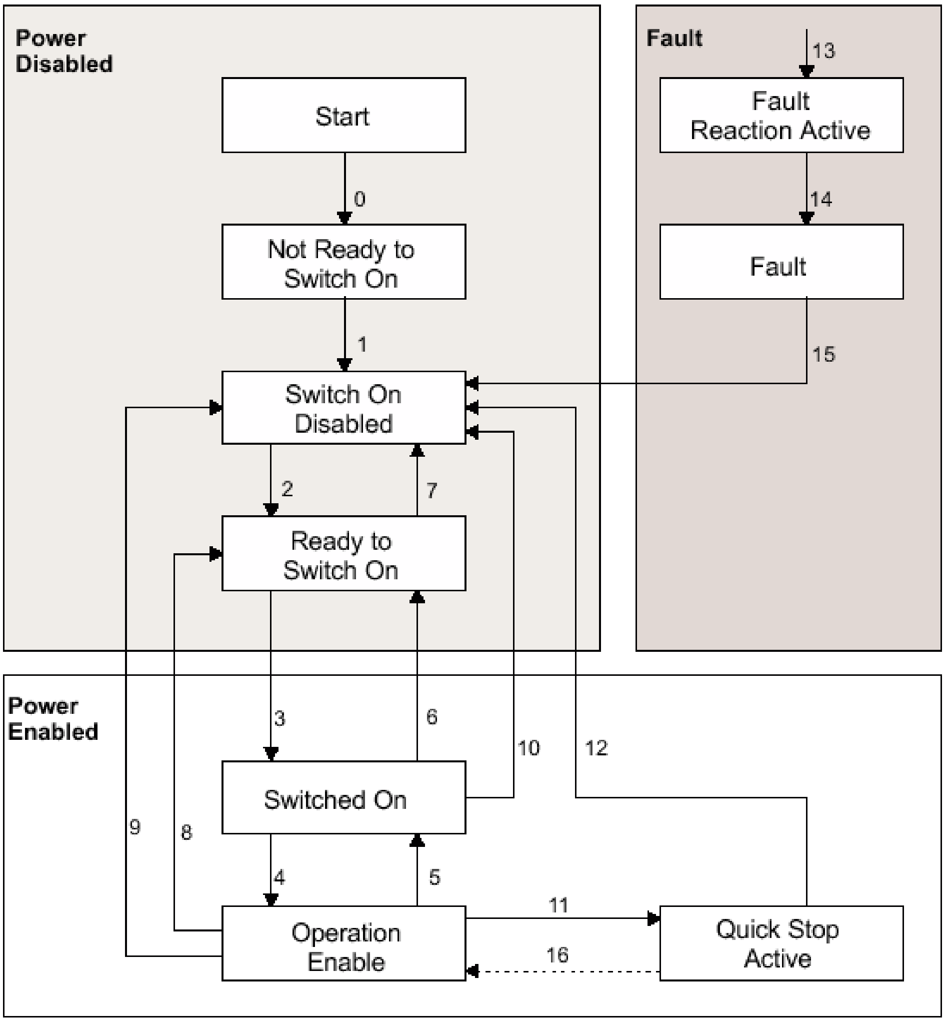


Figure 5.1 *Drive's status machine. States and transitions*

Table 5.1 *Drive State Transitions*

Transition	Event	Action
0	Automatic transition after power-on or reset application	Initialization
1	Initialization completed successfully. Drive is ready to operate.	None
2	Bit 1 *Disable Voltage* and Bit 2 *Quick Stop,* are set in Control Word (*Shutdown* command). Motor voltage may be present.	None
3	Bit 0 is also set in Control Word (*Switch On* command)	Power stage is switched on (enabled), provided that the enable input is on enable status. Drive has torque and depending on the mode of operation set, may held motor at the present position, keep the motor at zero speed or keep the motor at zero torque
4	Bit 3 is also set Control Word (*Enable Operation* command)	Motion function is enabled, depending on the mode that is set
5	Bit 3 is cancelled in Control Word (*Disable Operation* command)	Motion function is inhibited. Drive is stopped, using the acceleration rate set for position or speed profiles. Depending on the mode of operation set before the Disable Operation command, the motor may be held at the present position, kept at zero speed or zero torque
6	Bit 0 is cancelled in Control Word (*Shutdown* command)	Power stage is disabled. Drive has no torque. Motor is free to rotate
7	Bit 1 or 2 is cancelled in Control Word (*Quick Stop* or *Disable Voltage* command)	None
8	Bit 0 is cancelled in Control Word (*Shutdown* command)	Power stage is disabled. Drive has no torque. Motor is free to rotate
9	Bit 1 is cancelled in Control Word (*Disable Voltage* command)	Power stage is disabled. Drive has no torque. Motor is free to rotate
10	Bit 1 or 2 is cancelled in Control Word (*Quick Stop* or *Disable Voltage* command)	Power stage is disabled. Drive has no torque. Motor is free to rotate
11	Bit 2 is cancelled in Control Word (*Quick Stop* command)	Drive is stopped with the quick-stop deceleration rate. The power stage remains enabled. Depending on the mode of operation set before the Quick Stop

		command, the motor may be held at the present position, kept at zero speed or zero torque.
12	*Quick Stop* is completed or bit 1 is cancelled in Control Word (*Disable Voltage* command)	Output stage is disabled. Drive has no torque.
13	Fault signal	Execute specific fault treatment routine
14	The fault treatment is complete	The drive function is disabled
15	Bit 7 is set in Control Word (*Reset Fault* command)	Some of the bits from Motion Error Register are reset. If all the error conditions are reset, the drive returns to Switch On Disabled status. After leaving the state *Fault* the bit *Fault Reset* of the *control_word* has to be cleared by the host.
16	Bit 2 is set in Control Word (*Enable Operation* command). This transition is possible if *Quick-Stop-Option-Code* is 5, 6, 7 or 8	Drive exits from Quick Stop state. Drive function is enabled.

Table 5.2 *Drive States*

State	Description
Not Ready to switch on	The drive performs basic initializations after power-on. The drive function is disabled The transition to this state is automatic.
Switch On Disabled	The drive basic initializations are done and the green led must turn-on if no error is detected. The drive is not Ready to switch on; any drive parameters can be modified, including a complete update of the whole EEPROM data (setup table, TML program, cam files, etc.) The motor supply can be switched on, but the motion functions cannot be carried out yet. The transition to this state is automatic.
Ready to switch on	The motor supply voltage may be switched on, most of the drive parameter settings can still be modified, motion functions cannot be carried out yet.
Switched On (Operation Disabled)	The motor supply voltage must be switched on. The power stage is switched on (enabled). If the operation mode set performs position control, the motor is held in position. If the operation mode set performs speed control, the motor is kept at zero speed. If the operation mode is torque external, the motor is kept with

	zero torque. The motion functions cannot be carried out yet.
Operation Enable	No fault present, power stage is switched on, motion functions are enabled. This corresponds to the normal operation of the drive.
Quick Stop Active	Drive has been stopped with the quick stop deceleration. The power stage is enabled. If the drive was operating in position control when quick stop command was issued, the motor is held in position. If the drive was operating in speed control, the motor is kept at zero speed. If the drive was operating in torque control, the motor is kept at zero torque.
Fault Reaction Active	The drive performs a default reaction to the occurrence of an error condition
Fault	The drive remains in fault condition, until it receives a Reset Fault command. If following this command, all the bits from the Motion Error Register are reset, the drive exits the fault state

5.2. Drive control and status objects

5.2.1. Object 6040h: Control Word

The object controls the status of the drive. It is used to enable/disable the power stage of the drive, start/halt the motions and to clear the fault status. The status machine is controlled through the Control Word.

Object description:

Index	6040_h
Name	Control word
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Yes
Units	-
Value range	0 … 65535
Default value	No

The Control Word has the following bit assignment:

Table 5.3 **Bit Assignment in Control Word**

Bit	Value	Meaning
15	0	Registration mode inactive
	1	Activate registration mode
14	0	When an update is performed, update the demand values for speed and position with the actual values of speed and position
	1	When an update is performed, keep unchanged the demand values for speed and position
13		When it is set it cancels the execution of the TML function called through object 2006h. The bit is automatically reset by the drive when the command is executed.
12	0	No action
	1	If bit 14 = 1 – Force *position demand value* to 0 If bit 14 = 0 – Force *position actual value* to 0 This bit is valid regardless of the status of the drive or other bits in control_word
11		Manufacturer Specific - Operation Mode Specific. The meaning of this bit is detailed further in this manual for each operation mode
10-9		Reserved. Writes have no effect. Read as 0
8	0	No action
	1	Halt command – the motor will slow down on slow down ramp
7	0	No action
	1	Reset Fault. The faults are reset on 0 to 1 transition of this bit. After a Reset Fault command, the master has to reset this bit.
4-6		Operation Mode Specific. The meaning of these bits is detailed further in this manual for each operation mode
3		Enable Operation
2		Quick Stop
1		Enable Voltage
0		Switch On

5.2.2. Object 6041h: Status Word

Object description:

Index	6041_h
Name	Status word
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Yes
Units	-
Value range	0 … 65535
Default value	No

The Status Word has the following bit assignment:

Table 5.4 *Bit Assignment in Status Word*

Bit	Value	Description
15	0	Axis off. Power stage is disabled. Motor control is not performed
	1	Axis on. Power stage is enabled. Motor control is performed
14	0	No event set or the programmed event has not occurred yet
	1	Last event set has occurred
13..12		Operation Mode Specific. The meaning of these bits is detailed further in this manual for each operation mode
11		Internal Limit Active
10		Target reached
9	0	Remote – drive is in local mode and will not execute the command message.
	1	Remote – drive parameters may be modified via CAN and the drive will execute the command message.
8	0	No TML function or homing is executed. The execution of the last called TML function or homing is completed.
	1	A TML function or homing is executed. Until the function or homing execution ends or is aborted, no other TML function / homing may be called

7	0	No Warning
	1	Warning. A TML function / homing was called, while another TML function / homing is still in execution. The last call is ignored.
6		Switch On Disabled.
5		Quick Stop. When this bit is zero, the drive is performing a quick stop
4	0	Motor supply voltage is absent
	1	Motor supply voltage is present
3		Fault. If set, a fault condition is or was present in the drive.
2		Operation Enabled
1		Switched On
0		Ready to switch on

The drive state can be identified when Status Word coding is the following:

Table 5.5 *State coding*

Statusword	Drive state
xxxx xxxx x0xx 0000_b	Not Ready to switch on
xxxx xxxx x1xx 0000_b	Switch on disabled
xxxx xxxx x01x 0001_b	Ready to switch on
xxxx xxxx x01x 0011_b	Switched on
xxxx xxxx x01x 0111_b	Operation enabled
xxxx xxxx x00x 0111_b	Quick stop active
xxxx xxxx x0xx 1111_b	Fault reaction active
xxxx xxxx x0xx 1000_b	Fault

5.2.3. Object 1002h: Manufacturer Status Register

This object is a common status register for manufacturer specific purposes.

Object description:

Index	1002_h
Name	Manufacturer status register
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RO
PDO mapping	Optional
Value range	UNSIGNED32
Default value	No

Table 5.6 *Bit Assignment in Manufacturer Status Register*

Bit	Value	Description
31	1	Drive/motor in fault status
30	1	Reference position in absolute electronic camming mode reached
29	1	Reserved
28	1	Gear ratio in electronic gearing mode reached
27	1	Drive I2t protection warning level reached
26	1	Motor I2t protection warning level reached
25	1	Target command reached
24	1	Capture event/interrupt triggered
23	1	Limit switch negative event / interrupt triggered
22	1	Limit switch positive event / interrupt triggered
21	1	AUTORUN mode enabled
20	1	Position trigger 4 reached
19	1	Position trigger 3 reached
18	1	Position trigger 2 reached
17	1	Position trigger 1 reached
16	1	Drive/motor initialization performed
15…0		Same as Object 6041h, Status Word

5.2.4. Object 6060h: Modes of Operation

The object selects the mode of operation of the drive.

Object description:

Index	6060_h
Name	Modes of Operation
Object code	VAR

Data type	INTEGER8

Entry description:

Access	WO
PDO mapping	Yes
Units	-
Value range	-128 … 127
Default value	No

Data description:

Value	Description
-128…-6	Reserved
-5	Manufacturer specific – External Reference Torque Mode
-4	Manufacturer specific – External Reference Speed Mode
-3	Manufacturer specific – External Reference Position Mode
-2	Manufacturer specific – Electronic Camming Position Mode
-1	Manufacturer specific – Electronic Gearing Position Mode
0	Reserved
1	Profile Position Mode
2	Reserved
3	Profile Velocity Mode
4,5	Reserved
6	Homing Mode
7	Interpolated Position Mode
8…127	Reserved

Remark: *The actual mode is reflected in object 6061h (Modes of Operation Display).*

5.2.5. Object 6061h: Modes of Operation Display

The object reflects the actual mode of operation set with object Modes of Operation (index 6060_h)

Object description:

Index	6061_h
Name	Modes of Operation Display
Object code	VAR
Data type	INTEGER8

Entry description:

Access	RO
PDO mapping	Possible

Units	-
Value range	-128 … 127
Default value	-

Data description: Same as for object 6060h, Modes of Operation.

5.3. Error monitoring

5.3.1. Object 2000h: Motion Error Register

The Motion Error Register displays all the drive possible errors. A bit set to 1 signals that a specific error has occurred. When the error condition disappears or the error is reset using a Fault Reset command, the corresponding bit is reset to 0.

The Motion Error Register is continuously checked for changes of the bits status. When a bit is set (e.g. an error has occurred), if the corresponding bit from Motion Error Register Mask (2001_h) is set to 1, an emergency message with the specific error code is sent. When a bit is reset, if the corresponding bit from Motion Error Register Mask (2001_h) is set to 1, an emergency message for error reset is sent.

Object description:

Index	2000_h
Name	Motion Error Register
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	-
Value range	0 … 65535
Default value	0

Table 5.7 *Bit Assignment in Motion Error Register*

Bit	Description
15	Drive disabled due to enable input. Set when enable input is on disable state. Reset when enable input is on enable state
14	Command error. This bit is set in several situations. They can be distinguished either by the associated emergency code, or in conjunction with other bits: 0xFF03 - Specified homing method not available 0xFF04 - A wrong mode is set in object 6060h, modes_of_operation 0xFF05 - Specified digital I/O line not available A function is called during the execution of another function (+ set bit 7 of object 6041h, status word) Update of operation mode received during a transition This bit acts just as a warning.
13	Under-voltage. Set when protection is triggered. Reset by a Reset Fault command
12	Over-voltage. Set when protection is triggered. Reset by a Reset Fault command
11	Over temperature drive. Set when protection is triggered. Reset by a Reset Fault command.
10	Over temperature motor. Set when protection is triggered. Reset by a Reset Fault command. This protection may be activated if the motor has a PTC or NTC temperature contact.
9	I^2T protection. Set when protection is triggered. Reset by a Reset Fault command
8	Over current. Set when protection is triggered. Reset by a Reset Fault command
7	Negative limit switch active. Set when LSN input is in active state. Reset when LSN input is inactive state
6	Positive limit switch active. Set when LSP input is in active state. Reset when LSP input is inactive state
5	Motor position wraps around. Set when protection is triggered. Reset by a Reset Fault command
4	Communication error. Set when protection is triggered. Reset by a Reset Fault command
3	Control error (position/speed error too big). Set when protection is triggered. Reset by a Reset Fault command
2	Invalid setup data. Set when the EEPROM stored setup data is not valid or not present.
1	Short-circuit. Set when protection is triggered. Reset by a Reset Fault command
0	CAN error. Set when CAN controller is in error mode. Reset by a Reset Fault command

5.3.2. Object 2001h: Motion Error Register Mask

Object description:

Index	2001_h
Name	Motion Error Register Mask
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Units	-
Value range	0 … 65535
Default value	$FFFF_h$

The Motion Error Register Mask offers the possibility to choose which of the errors set or reset in the Motion Error Register to be signaled via emergency messages. The Motion Error Register Mask has the same bit codification as the Motion Error Register (see **Table 5.7**) and the following meaning:

1 – Send an emergency message when the corresponding bit from the Motion Error Register is set

0 – Don't send an emergency message when the corresponding bit from the Motion Error Register is set

5.3.3. Object 2002h: Detailed Error Register[1]

The Detailed Error Register displays detailed information about the errors signaled with command Error bit from Motion Error Register. This register also displays the status of software limit switches. A bit set to 1 signals that a specific error has occurred. When the error condition disappears or the error is reset using a Fault Reset command, the corresponding bit is reset to 0.

Object description:

Index	2002_h
Name	Detailed Error Register
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	-

[1] Available starting with firmware revision D.

Value range	0 … 65535
Default value	0

Table 5.8 *Bit Assignment in Detailed Error Register*

Bit	Description
15	Reserved
14	Reserved
13	Self check error
12	Reserved
11	Motionless start failed
10	Encoder broken wire
9	Update ignored for S-curve
8	S-curve parameters caused and invalid profile. UPD instruction was ignored.
7	Negative software limit switch is active.
6	Positive software limit switch is active.
5	Cancelable call instruction received while another cancelable function was active.
4	UPD instruction received while AXISON was executed. The UPD instruction was ingnored and it must be sent again when AXISON is completed.
3	A call to an inexistent function was received.
2	A call to an inexistent homing routine was received.
1	A RET/RETI instruction was executed while no function/ISR was active.
0	The number of nested function calls exceeded the length of TML stack. Last function call was ignored.

5.3.4. Object 605Ah: Quick stop option code

This object determines what action should be taken if the quick stop function is executed. The slow down ramp is a deceleration value set by the Profile acceleration object, index 6083_h. The quick stop ramp is a deceleration value set by the Quick stop deceleration object, index 6085_h.

Object description:

Index	$605A_h$
Name	Quick stop option code
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	No

Value range	-32768 … 32767
Default value	2

Data description:

Value	Description
-32768…-1	Manufacturer specific
0	Disable drive function
1	Slow down on slow down ramp and transit into Switch On Disabled
2	Slow down on quick stop ramp and transit into Switch On Disabled
3	Reserved
4	Reserved
5	Slow down on slow down ramp and stay in Quick Stop Active
6	Slow down on quick stop ramp and stay in Quick Stop Active
7…32767	Reserved

5.3.5. Object 605Bh: Shutdown option code

This object determines what action is taken if when there is a transition from Operation Enabled state to Ready to Switch On state. The slow down ramp is a deceleration value set by the Profile acceleration object, index 6083_h.

Object description:

Index	$605B_h$
Name	Shutdown option code
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	No
Value range	-32768 … 32767
Default value	0

Data description:

Value	Description
-32768…-1	Manufacturer specific

0	Disable drive function (switch-off the drive power stage)
1	Slow down on slow down ramp and disable the drive function
2…32767	Reserved

5.3.6. Object 605Ch: Disable operation option code

This object determines what action is taken if when there is a transition from Operation Enabled state Switched On state. The slow down ramp is a deceleration value set by the Profile acceleration object, index 6083_h.

Object description:

Index	$605C_h$
Name	Disable operation option code
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	No
Value range	-32768 … 32767
Default value	1

Data description:

Value	**Description**
-32768…-1	Manufacturer specific
0	Disable drive function (switch-off the drive power stage)
1	Slow down on slow down ramp and disable the drive function
2…32767	Reserved

5.3.7. Object 605Dh: Halt option code

This object determines what action is taken if when the halt command is executed. The slow down ramp is a deceleration value set by the Profile acceleration object, index 6083_h. The quick stop ramp is a deceleration value set by the Quick stop deceleration object, index 6085_h.

Object description:

Index	$605D_h$
Name	Halt option code

Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	No
Value range	-32768 … 32767
Default value	1

Data description:

Value	**Description**
-32768…-1	Manufacturer specific
0	Reserved
1	Slow down on slow down ramp and stay in Operation Enabled
2	Slow down on quick stop ramp and stay in Operation Enabled
3…32767	Reserved

5.3.8. Object 605Eh: Fault reaction option code

This object determines what action should be taken if a non-fatal error occurs in the drive. The non-fatal errors are by default the following:

- Under-voltage
- Over-voltage
- I^2t error
- Drive over-temperature
- Motor over-temperature
- Communication error (object 6007_h option 1 is set)

Object description:

Index	$605E_h$
Name	Fault reaction option code
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	No
Value range	-32768 … 32767

Default value	2

Data description:

Value	Description
-32768…-2	Manufacturer specific
-1	No action
0	Disable drive, motor is free to rotate
1	Reserved
2	Slow down with quick stop ramp
3…32767	Reserved

5.3.9. Object 6007h: Abort connection option code

The object sets the action performed by the drive when one of the following events occurs: bus-off, heartbeat and life guarding.

Object description:

Index	6007_h
Name	Abort connection option code
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	Yes
Value range	-32768…32767
Default value	0

Table 5.9 *Abort connection option codes values:*

Option code	Description
-32768…-1	Manufacturer specific (reserved)
0	No action
+1	Fault signal - Execute specific fault routine set in Object 605Eh: Fault reaction option code
+2	Disable voltage command
+3	Quick stop command
+4…+32767	Reserved

5.4. Digital I/O control and status objects

5.4.1. Object 60FDh: Digital inputs

The object contains the actual value of the digital inputs available on the drive. Each bit from the object corresponds to a digital input (manufacturer specific or device profile defined). If a bit is SET, then the status of the corresponding input is logical '1' (high). If the bit is RESET, then the corresponding drive input status is logical '0' (low).

Remarks:

The device profile defined inputs (limit switches, home input and interlock) are mapped also on the manufacturer specific inputs. Hence, when one of these inputs changes the status, then both bits change, from the manufacturer specific list and from the device profile list.

The number of available digital inputs is product dependent. Check the drive user manual for the available digital inputs.

Object description:

Index	$60FD_h$
Name	Digital inputs
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RO
PDO mapping	Possible
Value range	UNSIGNED32
Default value	0

	Bit	**Description**
Manufacturer specific	31	IN15 status
	30	IN14 status
	29	IN13 status
	28	IN12 status
	27	IN11 status
	26	IN10 status
	25	IN9 status
	24	IN8 status
	23	IN7 status
	22	IN6 status
	21	IN5 status
	20	IN4 status

	19	IN3 status
	18	IN2 status
	17	IN1 status
	16	IN0 status
Device profile defined	15..4	Reserved
	3	Interlock (Drive enable)
	2	Home switch status
	1	Positive limit switch status
	0	Negative limit switch status

5.4.2. Object 60FEh: Digital outputs

The object defines the digital outputs of the drive that are controlled. The first sub-index defines the outputs that will be controlled by the mask set in the second sub-index. The second sub-index describes a mask that specifies how the selected outputs will be commanded. If any of the bits is **SET**, then the corresponding drive output will be switched to logical '1' (high). If the bit is **RESET**, then the corresponding drive output will be switched to logical '0' (low).

Remarks:

The actual number of available digital outputs is product dependent. Check the drive user manual for the available digital outputs.

If an unavailable digital output is specified, the drive will issue an emergency message.

Object description:

Index	$60FE_h$
Name	Digital outputs
Object code	ARRAY
Data type	UNSIGNED32

Entry description:

Sub-index	0
Description	Number of entries
Access	RO
PDO mapping	No
Value range	1…2
Default value	2

Sub-index	1
Description	Physical outputs
Access	RW
PDO mapping	Possible

Value range	UNSIGNED32
Default value	0

Sub-index	2
Description	Bit mask
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	0

***Table 4.7** Bits mask description:*

	Bit	Description
Manufacturer Specific	31	OUT15 command
	30	OUT14 command
	29	OUT13 command
	28	OUT12 command
	27	OUT11 command
	26	OUT10 command
	25	OUT9 command
	24	OUT8 command
	23	OUT7 command
	22	OUT6 command
	21	OUT5 command
	20	OUT4 command
	19	OUT3 command
	18	OUT2 command
	17	OUT1 command
	16	OUT0 command
Device profile Defined	15…0	Reserved

5.4.3. Object 2045h: Digital outputs status

The actual status of the drive outputs can be monitored using this object.

Object description:

Index	2045_h
Name	Digital outputs status
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	-
Value range	UNSIGNED16
Default value	No

Data description:

Bit	Meaning	Bit	Meaning
15	OUT15 status	7	OUT7 status
14	OUT14 status	6	OUT6 status
13	OUT13 status	5	OUT5 status
12	OUT12 status	4	OUT4 status
11	OUT11 status	3	OUT3 status
10	OUT10 status	2	OUT2 status
9	OUT9 status	1	OUT1 status
8	OUT8 status	0	OUT0 status

If the any of the bits is **SET**, then the corresponding drive output status is logical ‘1’ (high). If the bit is **RESET**, then the corresponding drive output status is logical ‘0’ (low).

5.4.4. Object 2046h: Analogue input: Reference

The object contains the actual value of the analog reference applied to the drive. Through this object one can supervise the analogue input dedicated to receive the analogue reference in the external control modes.

Object description:

Index	2046_h
Name	Analogue input: Reference
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	-
Value range	0 … 65520
Default value	No

5.4.5. Object 2047h: Analogue input: Feedback

The object contains the actual value of the analogue feedback applied to the drive.

Object description:

Index	2047_h
Name	Analogue input: Feedback
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	-
Value range	0 … 65520
Default value	No

5.4.6. Object 2055h: DC-link voltage

The object contains the actual value of the DC-link voltage. The object is expressed in internal voltage units.

Object description:

Index	2055_h
Name	Analogue input: DC-link voltage
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	DC-VU
Value range	0 … 65472
Default value	No

The computation formula for the voltage [IU] in [V] is:

$$Voltage\_measured[V] = \frac{VDCMaxMeasurable[V]}{65520} \cdot Voltage\_measured[IU]$$

where *VDCMaxMeasurable* is the maximum measurable DC voltage expressed in [V]. You can read this value in the “Drive Info” dialogue, which can be opened from the “Drive Setup”.

5.4.7. Object 2058h: Drive Temperature

The object contains the actual drive temperature. The object is expressed in temperature internal units.

Object description:

Index	2058_h
Name	Analogue input for drive temperature
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Units	-
Value range	0 … 65535
Default value	No

Note: if the drive does not have a temperature sensor, this object should not be used.

The computation formula for the temperature [IU] in [°C] is:

$$\mathrm{Temp[°C]} = \frac{3.3}{\mathrm{DriveTempSensorGain} * 65520} * \left(\mathrm{Temp[IU]} - \frac{\mathrm{DriveTempOutAt0oC} * 65520}{3.3} \right)$$

where *DriveTempSensorGain* and *DriveTempOutAt0oC* can be found as *Sensor gain* and *Output at 0 °C* in the “Drive Info” dialogue, which can be opened from the “Drive Setup”.

5.5. Protections Setting Objects

5.5.1. Object 607Dh: Software position limit

The object sets the maximal and minimal software position limits. If the actual position is lower than the negative position limit or higher than the positive one, a software position limit emergency message will be launched. If either of these limits is passed, the motor will start decelerating using the value set in Object 6085h: Quick stop deceleration. Once it has decelerated, the motor will stand still until a new command is given to travel within the space defined by the limits.

Remarks:

A value of -2147483648 for Minimal position limit and 2147483647 for Maximal position limit disables the position limit check.

Object description:

Index	$607D_h$
Name	Software position limit
Object code	ARRAY
Data type	INTEGER32

Entry description:

Sub-index	0
Description	Number of entries
Access	RO
PDO mapping	No
Value range	2
Default value	2

Sub-index	1
Description	Minimal position limit
Access	RW
PDO mapping	Possible
Value range	INTEGER32
Default value	0x80000000

Sub-index	2
Description	Maximal position limit
Access	RW
PDO mapping	Possible

Value range	INTEGER32
Default value	0x7FFFFFFF

5.5.2. Object 2050h: Over-current protection level

The Over-Current Protection Level object together with object Over-Current Time Out (2051_h) defines the drive over-current protection limits. The object defines the value of current in the drive, over which the over-current protection will be activated, if lasting more than a time interval that is specified in object 2051_h. It is set in current internal units.

Object description:

Index	2050_h
Name	Over-current protection level
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Units	CU
Value range	0 … 32767
Default value	No

The computation formula for the current [IU] in [A] is:

$$current[A] = \frac{2 \cdot Ipeak}{65520} \cdot curent[IU]$$

where *Ipeak* is the peak current supported by the drive and *current[IU]* is the command value for object 2050_h.

5.5.3. Object 2051h: Over-current time out

The Over-Current time out object together with object Over-Current Protection Limit (2050_h) defines the drive over-current protection limits. The object sets the time interval after which the over-current protection is triggered if the drive current exceeds the value set through object 2050_h. It is set in time internal units.

Object description:

Index	2051_h
Name	Over-current time out
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW

PDO mapping	Possible
Units	TU
Value range	0 … 65535
Default value	No

5.5.4. Object 2052h: Motor nominal current

The object sets the maximum motor current RMS value for continuous operation. This value is used by the I2t motor protection and one of the start methods. It is set in current internal units. See object 2053 for more details about the I2t motor protection.

Object description:

Index	2052_h
Name	Motor nominal current
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Units	CU
Value range	0 … 32767
Default value	No

The computation formula for the current [IU] in [A] is:

$$current[A] = \frac{2 \cdot Ipeak}{65520} \cdot curent[IU]$$

where *Ipeak* is the peak current supported by the drive and *current[IU]* is the read value from object 2052_h.

5.5.5. Object 2053h: I2t protection integrator limit

Objects 2053_h and 2054_h contain the parameters of the I^2t protection (against long-term motor over-currents). Their setting must be coordinated with the setting of the object 2052_h, motor nominal current. Select a point on the I^2t motor thermal protection curve, which is characterized by the points I_I2t (current, [A]) and t_I2t: (time, [s]) (see **Figure 5.2**)

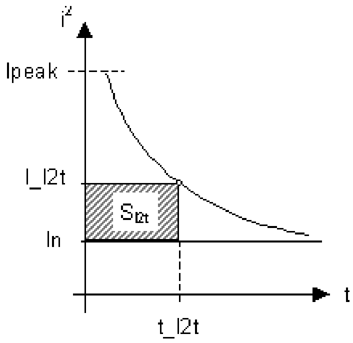


Figure 5.2 *I2t motor thermal protection curve*

The points I_I2t and t_I2t on the motor thermal protection curve together with the nominal motor current **In** define the surface S_{I2t}. If the motor instantaneous current is greater than the nominal current In and the I2t protection is activated, the difference between the square of the instantaneous current and the square of the nominal current is integrated and compared with the SI2t value (see **Figure 5.3**). When the integral equals the SI2t surface, the I2t protection is triggered.

Object description:

Index	2053_h
Name	I2t protection integrator limit
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Units	-
Value range	0 … 2^{31}-1
Default value	No

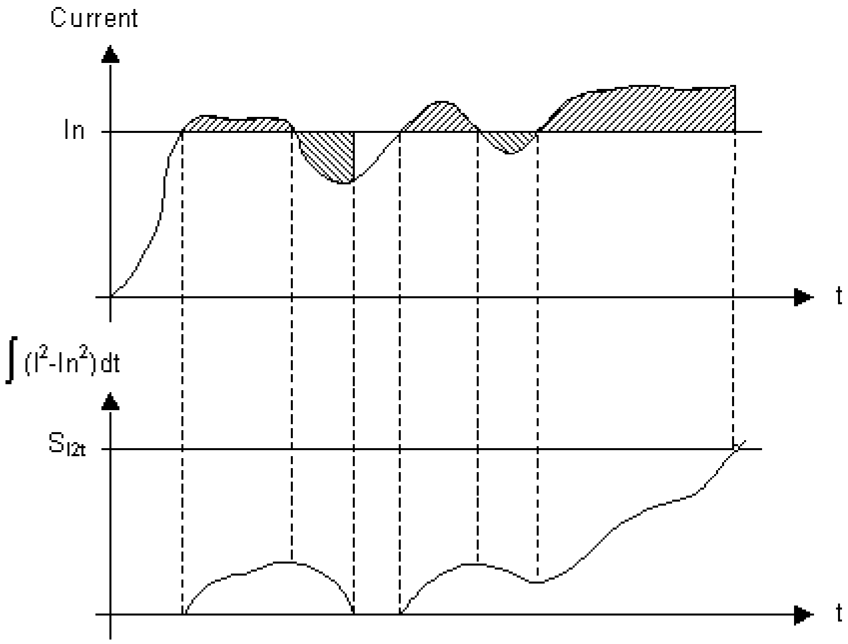


***Figure 5.3** I2t protection implementation*

The computation formula for the i2t protection integrator limit (I2TINTLIM) is

$$I2TINTLIM = \frac{(I\_I2t)^2 - (In)^2}{32767^2} \cdot 2^{26}$$

where I_I2t and In are represented in current units (CU).

5.5.6. Object 2054h: I2t protection scaling factor

Object description:

Index	2054_h
Name	I2t protection scaling factor
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Units	-
Value range	0 … 65535
Default value	No

The computation formula for the i2t protection scaling factor (SFI2T) is

$$SFI2T = 2^{26} \cdot \frac{Ts\_S}{t\_I2t}$$

where Ts_S is the sampling time of the speed control loop [s], and t_I2t is the I2t protection time corresponding to the point on the graphic in **Figure 5.2**

5.5.7. Object 207Eh: Current actual value[1]

The object displays the motor current actual value. This value is given in current internal units.

Object description:

Index	$207E_h$
Name	Current actual value
Object code	VAR
Data type	Integer16

Entry description:

Access	RO
PDO mapping	YES
Units	-
Value range	-32768 … 32767
Default value	No

The computation formula for the current [IU] in [A] is:

$$current[A] = \frac{2 \cdot Ipeak}{65520} \cdot curent[IU]$$

where *Ipeak* is the peak current supported by the drive and *current[IU]* is the read value from object $207E_h$.

5.5.8. Object 207Fh: Current limit[1]

The object defines the maximum current that will pass through the motor. This object is valid only for the configurations using: brushless, DC brushed and stepper closed loop motor. The value is set in current internal units.

Object description:

Index	$207F_h$
Name	Current actual value
Object code	VAR
Data type	Unsigned16

[1] Available starting with firmware revision D.

Entry description:

Access	RW
PDO mapping	YES
Units	-
Value range	0 … 65535
Default value	No

The computation formula for the current_limit [A] to [IU] is:

$$Current\_Limit[IU] = 32767 - \frac{Current\_Limit[A] \cdot 65520}{2 \cdot Ipeak}$$

where *Ipeak* is the peak current supported by the drive, C*urrent_Limit[A]* is the target current in [A] and C*urrent_Limit[IU]* is the target value to be written in object $207E_h$.

5.6. Step Loss Detection for Stepper Open Loop configuration[1]

By using a stepper open loop configuration, the command resolution can be greater than the one used for a normal closed loop configuration. For example if a motor has 200 steps/ revolution and 256 microsteps / step, results in 51200 Internal Units/ revolution position command. If a 1000 lines quadrature encoder is used, it means it will report 4000 Internal Units/ revolution.

By using the step loss detection, it means using a stepper in open loop configuration and an incremental encoder to detect lost steps. When the protection triggers, the drive enters Fault state signaling a Control error.

5.6.1. Object 2083h: Encoder Resolution

Sets the number of encoder counts the motor does for one full rotation. For example, if the quadrature encoder has 500 lines (2000 counts/rev), 2000 must be written into the object. This object is set automatically when configuring the drive setup.

Object description:

Index	2083_h
Name	Encoder resolution
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Yes
Value range	0…65535
Default value	2000

[1] This feature is available starting with firmware revision F

5.6.2. Object 2084h: Stepper Resolution

Sets the number of microsteps the step motor does for one full rotation. For example, if the motor has 100 steps / revolution (see Figure 5.4) and is controlled with 256 microsteps / step (see Figure 2.2), you must write 100x256=25600 into this object. This object is set automatically when configuring the drive setup.

Object description:

Index	2084_h
Name	Stepper resolution
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Yes
Value range	0…65535
Default value	51200

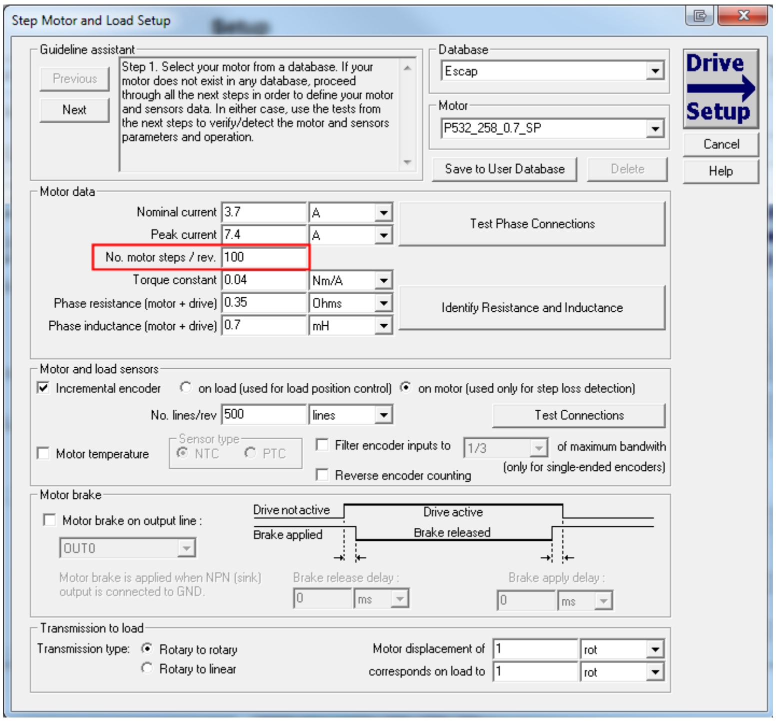


Figure 5.4 *Motor steps / revolution*

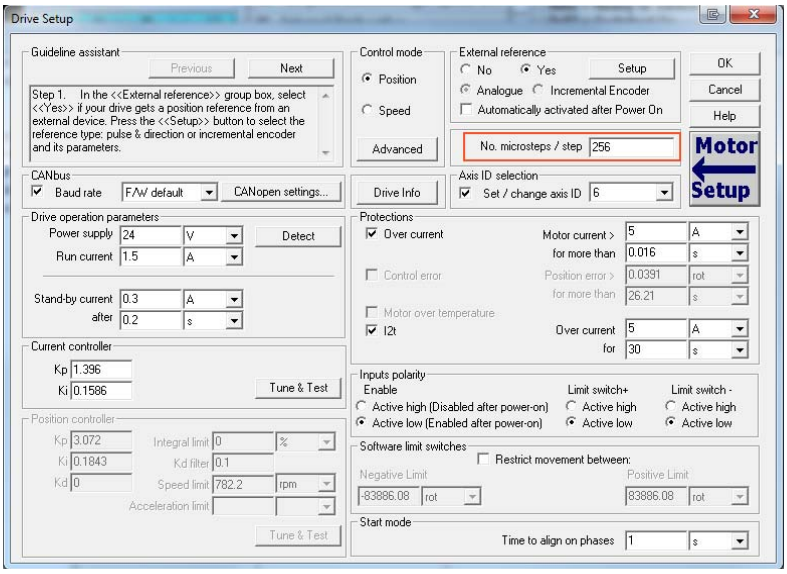


Figure 5.5 *Motor microsteps / step*

5.6.3. Enabling step loss detection protection

Before enabling the step loss detection protection, the *Encoder resolution* in object 2083h and the *Stepper resolution* in object 2084h must be set correctly. Also, the feedback sensor must be set *on motor* in Motor Setup:

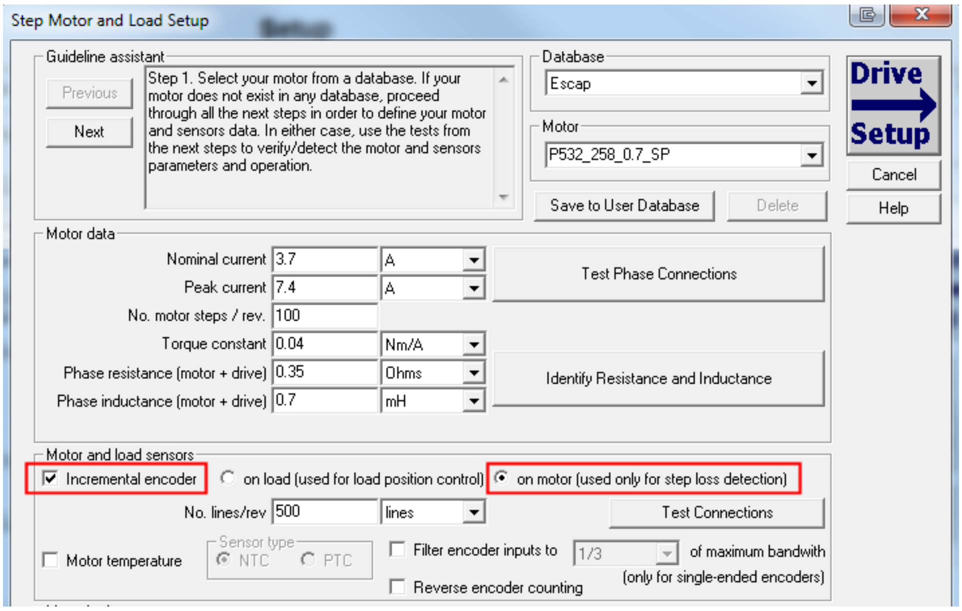


Figure 5.6 *Configuring the feedback sensor for step loss detection*

The step loss detection protection parameters are actually the control error parameters: object *6066h - Following error time* and object *6065h - Following error window*. The protection is triggered if the error between the commanded position and the position measured via the encoder is greater than the value set in object 6065h for a time interval greater than the value set in object 6066h.

The following error window is expressed in microsteps. The Following error time is expressed in multiples of position/speed control loops (0.8ms by default for stepper configurations).

To enable the step loss detection protection, set first the *Following error window* in object 6056h, then set the *Following error time* in object 6066h to a value different from 65535 (0xFFFF). To disable this protection, set a 65535 value in object 6066h.

Example: Following error window is set to 1000 and *Following error time* is set to 20. The step motor has 100 steps/rev and is controlled with 256 microsteps/step. The step loss protection will be triggered if the difference between the commanded position and the measured position is bigger than 1000 microsteps (i.e. 1000/(100*256) rev = 14,06 degrees) for a time interval bigger or equal than 20 control loops of 0.8ms each i.e. 16ms.

Remark: the actual value of the error between the commanded position and the measured position can be read from object 60F4h. It is expressed in microsteps.

5.6.4. Step loss protection setup

The following steps are recommended for optimal setup of the step loss protection parameters:

1. Move your motor with the highest velocity and load planned to be used in your application
2. During the movement at maximal speed, read object 60F4h - *Following error actual value* as often as possible to determine its highest value.

   Remark: *Following error actual value* can be read at every control loop using EasyMotion Studio or Easy Setup by logging the TML variable POSERR.
3. Add a margin of about 25% to the highest error value determined at previous step and set the new obtained value into object 6065h - *Following error window*.
4. Activate the step loss detection by writing a non-zero value in object 6066h - *Following error time out.* Recommended values are between 1 and 10.

5.6.5. Recovering from step loss detection fault

When the step loss detection protection is triggered, the drive enters in Fault state. The CANopen master will receive an emergency message from the drive with control error/following error code. In order to exit from Fault state and restart a motion, the following steps must be performed:

- Send fault reset command to the drive. The drive will enter in Switch On Disabled state;
- Send Disable voltage command into Control Word.
- Send Switch On command into Control Word. At this moment, voltage is applied to the motor and it will execute the phase alignment procedure again. The position error will be reset automatically.
- Start a homing procedure to find again the motor zero position.

5.6.6. Remarks about Factor Group settings when using step the loss detection

When the drive controls stepper motors in open loop, if the factor group settings are activated they are automatically configured for correspondence between motor position in user units and microsteps as internal units. Because the motor position is read in encoder counts, it leads to incorrect values reported in objects 6064h Position actual value and 6062h Position demand value.

Only object 6063h *Position actual internal value* will always show the motor position correctly in encoder counts.

If the factor group settings are not used, i.e. all values reported are in internal units (default), both 6064h *Position actual value* and 6062h *Position demand value* will provide correct values.

5.7. Drive info objects

5.7.1. Object 1000h: Device Type

The object contains information about drive type and its functionality. The 32-bit value contains 2 components of 16-bits: the 16 LSB describe the CiA standard that is followed.

Object description:

Index	1000_h
Name	Device type
Object code	VAR
Data type	UNSIGNED32

Value description:

Access	RO
PDO mapping	NO
Value range	UNSIGNED32
Default value	60192_h for iPOS family

5.7.2. Object 6502h: Supported drive modes

This object gives an overview of the operating modes supported on the Technosoft drives. Each bit from the object has assigned an operating mode. If the bit is set then the drive supports the associated operating mode.

Object description:

Index	6502_h
Name	Supported drive modes
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RO
PDO mapping	Possible
Value range	UNSIGNED32
Default value	$001F0065_h$ for iPOS family

The modes of operation supported by the Technosoft drives, and their corresponding bits, are the following:

Data description:

MSB **LSB**

0	0	x	…	x	0	0	1	1	0	0	1	0	1
Manufacturer specific					reserved		ip	hm	reserved	tq	pv	vl	pp
31	21	20	…	16	15	7	6	5	4	3	2	1	0

Data description – manufacturer specific:

Bit	**Description**
31 … 21	Reserved

20	External Reference Torque Mode
19	External Reference Speed Mode
18	External Reference Position Mode
17	Electronic Gearing Position Mode
16	Electronic Camming Position Mode

5.7.3. Object 1008h: Manufacturer Device Name

The object contains the manufacturer device name in ASCII form, maximum 15 characters.

Object description:

Index	1008_h
Name	Manufacturer device name
Object code	VAR
Data type	Visible String

Entry description:

Access	Const
PDO mapping	No
Value range	No
Default value	iPOS

5.7.4. Object 100Ah: Manufacturer Software Version

The object contains the firmware version programmed on the drive in ASCII form with the maximum length of 15 characters.

Object description:

Index	$100A_h$
Name	Manufacturer software version
Object code	VAR
Data type	Visible String

Entry description:

Access	Const
PDO mapping	No
Value range	No
Default value	Product dependent

5.7.5. Object 2060h: Software version of a TML application

By inspecting this object the user can find out the software version of the TML application (drive setup plus motion setup and eventually cam tables) that is stored in the EEPROM memory of the drive. The object stores the software version coded in a string of 4 elements, grouped in a 32-bit variable. Each byte represents an ASCII character.

Object description:

Index	2060_h
Name	Software version of TML application
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RO
PDO mapping	No
Units	-
Value range	No
Default value	No

Example:

If object 2060_h contains the value 0x322E3156, then the software version of the TML application is read as:

0x56 – ASCII code of letter **V**

0x31 – ASCII code of number **1**

0x2E – ASCII code of character . (point)

0x32 – ASCII code of number **2**
So the version is **V1.2**.

5.7.6. Object 1018h: Identity Object

Contains the unique Vendor ID allocated to Technosoft.

Object description:

Index	1018_h
Name	Identity Object
Object code	RECORD
Data type	Identity

Entry description:

Sub-index	00_h
Description	Number of entries
Access	RO
PDO mapping	No
Value range	1..4
Default value	1

Sub-index	01_h
Description	Vendor ID
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	000001A3h

Sub-index	02_h
Description	Product Code
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	Product dependent

Sub-index	03_h
Description	Revision number
Access	RO
PDO mapping	No

Value range	UNSIGNED32
Default value	0x30313030 (ASCII 0100)

Sub-index	04_h
Description	Serial number
Access	RO
PDO mapping	No
Value range	UNSIGNED32
Default value	Unique number

5.8. Miscellaneous Objects

5.8.1. Object 2025h: Stepper current in open-loop operation

In this object one can set the level of the current to be applied when controlling a stepper motor in open loop operation at runtime.

Object description:

Index	2025_h
Name	Stepper current in open-loop operation
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	Possible
Units	CU
Value range	-32768 … 32767
Default value	No

The computation formula for the current [IU] in [A] is:

$$current[A] = \frac{2 \cdot Ipeak}{65520} \cdot curent[IU]$$

where *Ipeak* is the peak current supported by the drive and *current[IU]* is the commanded value in object 2025_h.

5.8.2. Object 2026h: Stand-by current for stepper in open-loop operation

In this object one can set the level of the current to be applied when controlling a stepper motor in open loop operation in stand-by.

Object description:

Index	2026_h
Name	Stand-by current for stepper in open-loop operation
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	Possible
Units	CU
Value range	-32768 … 32767
Default value	No

5.8.3. Object 2027h: Timeout for stepper stand-by current

In this object one can set the amount of time after the value set in object 2026h, *stand-by current for stepper in open-loop operation* will activate as the reference for the current applied to the motor after the reference has reached the target value.

Object description:

Index	2027_h
Name	Timeout for stepper stand-by current
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Units	TU
Value range	0 … 65535
Default value	No

5.8.4. Object 2075h: Position triggers

This object is used in order to define a set of 4 position values whose proximity will be signaled through bits 17-20 of object 1002_h, *Manufacturer Status Register*. If the *position actual value* is over a certain value set as a position trigger, then the corresponding bit in *Manufacturer Status Register* will be set.

Object description:

Index	2075_h
Name	Position triggers
Object code	ARRAY
Data type	INTEGER32

Entry description:

Sub-index	00_h
Description	Number of sub-indexes
Access	RO
PDO mapping	No
Default value	4

Sub-index	01_h – 04_h
Description	Position trigger 1 - 4
Access	RW
PDO mapping	Possible
Value range	INTEGER32
Default value	No

5.8.5. Object 2085h: Position triggered outputs[1]

The object controls the digital outputs 0, 1 and 5 in concordance with the position triggers 1, 2 and 4 status from the object 1002h *Manufacturer Status Register*.

Object description:

Index	2085_h
Name	Position triggered outputs
Object code	VAR
Data type	UNSIGNED16

Entry description:

[1] This object is available since revision G of the iPOS firmware.

Access	RW
PDO mapping	No
Units	-
Value range	0 … 65535
Default value	No

The *Position triggered outputs* object has the following bit assignment:

Table 5.10 **Bit Assignment in Position triggered outputs**

Bit	**Value**	**Meaning**
12-15	0	Reserved.
11	0	OUT5 = 1 when Position trigger 4 = 0 OUT5 = 0 when Position trigger 4 = 1
	1	OUT5 = 0 when Position trigger 4 = 0 OUT5 = 1 when Position trigger 4 = 1
10	0	Reserved.
9	0	OUT1 = 1 when Position trigger 2 = 0 OUT1 = 0 when Position trigger 2 = 1
	1	OUT1 = 0 when Position trigger 2 = 0 OUT1 = 1 when Position trigger 2 = 1
8	0	OUT0 = 1 when Position trigger 1 = 0 OUT0 = 0 when Position trigger 1 = 1
	1	OUT0 = 0 when Position trigger 1 = 0 OUT0 = 1 when Position trigger 1 = 1
4-7	0	Reserved
3[1]	1	Enable position trigger 4 control of OUT5
	0	Disable position trigger 4 control of OUT5
2	0	Reserved
1	1	Enable position trigger 2 control of OUT1
	0	Disable position trigger 2 control of OUT1
0	1	Enable position trigger 1 control of OUT0
	0	Disable position trigger 1 control of OUT0

Note: Some drives may not have some outputs available. The object will control only the ones that exist.

[1] OUT5 setting is available only on iPOS480x drives.

5.8.6. Object 2076h: Save current configuration

This object is used in order to enable saving the current configuration of the operating parameters of the drive. These parameters are the ones that are set when doing the setup of the drive. The purpose of this object is to be able to save the new values of these parameters in order to be re-initialized at subsequent system re-starts.

Writing any value in this object will trigger the save in the non-volatile EEPROM memory of the current drive operating parameters.

Object description:

Index	2076_h
Name	Save current configuration
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	WO
PDO mapping	No
Value range	UNSIGNED16
Default value	-

5.8.7. Object 2078h: Execute auto-tuning for Linear Halls configuration

This object is used in order to start the automatic sequence of tuning the linear halls sensors in a configuration having a rotary brushless motor with linear hall sensors.

Writing any value in this object will trigger the start of the automatic tuning sequence.

Object description:

Index	2078_h
Name	Execute auto-tuning for Linear Halls configuration
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	WO
PDO mapping	No
Value range	UNSIGNED16
Default value	-

6. Factor group

The iPOS drives family offers the possibility to interchange physical dimensions and sizes into the device internal units. This chapter describes the factors that are necessary to do the interchanges.

The factors defined in Factor Group set up a relationship between device internal units and physical units. The actual factors used for scaling are the *position factor* (object 6093_h), the *velocity encoder factor* (object 6094_h), the *acceleration factor* (object 6097_h) and the *time encoder factor* (object 2071_h). Writing a non-zero value into the respective dimension index objects validates these factors. The notation index objects are used for status only and can be set by the user depending on each user-defined value for the factors.

6.1. Factor group objects

6.1.1. Object 607Eh: Polarity

This object is used to multiply by 1 or -1 position and velocity objects. The object applies only to position profile and velocity profile modes of operation.

Object description:

Index	$607E_h$
Name	Polarity
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW
PDO mapping	Possible
Value range	0..256
Default value	0

The *Polarity* object has the following bit assignment:

Table 6.1 **Bit Assignment in Polarity object:**

Bit	Bit name	Value	Meaning
7	Position polarity	0	Multiply by 1 the values of objects 607Ah, 6062h and 6064h
		1	Multiply by -1 the values of objects 607Ah, 6062h and 6064h
6	Velocity polarity	0	Multiply by -1 the values of objects 60FFh, 606Bh and 606Ch
		1	Multiply by -1 the values of objects 60FFh, 606Bh and 606Ch
5-0	reserved	0	Reserved

6.1.2. Object 6089h: Position notation index

The *position notation index* is used to scale the following objects*:*

- Position actual value
- Position demand value
- Target position
- Position window
- Following error window
- Following error actual value

Object description:

Index	6089_h
Name	Position notation index
Object code	VAR
Data type	INTEGER8

Entry description:

Access	RW
PDO mapping	Possible
Value range	-128 … 127
Default value	0

6.1.3. Object 608Ah: Position dimension index

The *position dimension index* is used to scale the following objects:

- Position actual value
- Position demand value
- Target position
- Position window
- Following error window
- Following error actual value

Object description:

Index	$608A_h$
Name	Position dimension index
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW
PDO mapping	Possible
Value range	0 … 255
Default value	0

6.1.4. Object 608Bh: Velocity notation index

The *velocity notation index* is used to scale the following objects:

- Velocity actual value
- Velocity demand value
- Target velocity
- Profile velocity

Object description:

Index	$608B_h$
Name	Velocity notation index
Object code	VAR
Data type	INTEGER8

Entry description:

Access	RW
PDO mapping	Possible
Value range	-128 … 127
Default value	0

6.1.5. Object 608Ch: Velocity dimension index

The *velocity dimension index* is used to scale the following objects*:*

- Velocity actual value
- Velocity demand value
- Target velocity
- Profile velocity

Object description:

Index	$608C_h$
Name	Velocity dimension index
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW
PDO mapping	Possible
Value range	0 … 255
Default value	0

6.1.6. Object 608Dh: Acceleration notation index

The *acceleration notation index* is used to scale the following objects*:*

- Profile acceleration
- Quick stop deceleration

Object description:

Index	$608D_h$
Name	Acceleration notation index

Object code	VAR
Data type	INTEGER8

Entry description:

Access	RW
PDO mapping	Possible
Value range	-128 … 127
Default value	0

6.1.7. Object 608Eh: Acceleration dimension index

The *acceleration dimension index* is used to scale the following objects:

- Profile acceleration
- Quick stop deceleration

Object description:

Index	$608E_h$
Name	Acceleration dimension index
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW
PDO mapping	Possible
Value range	0 … 255
Default value	0

6.1.8. Object 206Fh: Time notation index

The *time dimension index* is used to scale the following objects:

- Following error time out
- Position window time
- Jerk time
- Max slippage time out
- Over-current time out

Object description:

Index	$206F_h$
Name	Time notation index
Object code	VAR
Data type	INTEGER8

Entry description:

Access	RW
PDO mapping	Possible
Value range	-128 … 127
Default value	0

6.1.9. Object 2070h: Time dimension index

The *time dimension index* is used to scale the following objects:

- Following error time out
- Position window time
- Jerk time
- Max slippage time out
- Over-current time out

Object description:

Index	2070_h
Name	Time dimension index
Object code	VAR
Data type	UNSIGNED8

Entry description:

Access	RW
PDO mapping	Possible
Value range	0 … 255
Default value	0

6.1.10. Object 6093h: Position factor

The *position factor* converts the desired position (in position units) into the internal format (in increments):

$$Position[IU] = Position[UserUnits] \times \frac{PositionFactor.Numerator}{PositionFactor.Divisor}$$

Object description:

Index	6093_h
Name	Position factor
Object code	ARRAY
Number of elements	2
Data type	UNSIGNED32

Entry description:

Sub-index	01_h
Description	Numerator
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

Sub-index	02_h
Description	Divisor
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

6.1.11. Object 6094h: Velocity encoder factor

The *velocity encoder factor* converts the desired velocity (in velocity units) into the internal format (in increments).

$$Velocity[IU] = Velocity[UserUnits] \times \frac{VelocityEncoderFactor.Numerator}{VelocityEncoderFactor.Divisor}$$

Object description:

Index	6094_h
Name	Velocity encoder factor
Object code	ARRAY
Number of elements	2
Data type	UNSIGNED32

Entry description:

Sub-index	01_h
Description	Numerator
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

Sub-index	02_h
Description	Divisor
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

6.1.12.Object 6097h: Acceleration factor

The *acceleration factor* converts the velocity (in acceleration units/sec^2) into the internal format (in increments/sampling^2).

$$Acceleration[IU] = Acceleration[UserUnits] \times \frac{AccelerationFactor.Numerator}{AccelerationFactor.Divisor}$$

Object description:

Index	6097_h
Name	Acceleration factor
Object code	ARRAY

Number of elements	2
Data type	UNSIGNED32

Entry description:

Sub-index	01_h
Description	Numerator
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

Sub-index	02_h
Description	Divisor
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

6.1.13.Object 2071h: Time factor

The *time factor* converts the desired time values (in time units) into the internal format (in speed / position loop samplings).

$$Time[IU] = Time[UserUnits] \times \frac{TimeFactor.Numerator}{TimeFactor.Divisor}$$

Object description:

Index	2071_h
Name	Time factor
Object code	ARRAY
Number of elements	2
Data type	UNSIGNED32

Entry description:

Sub-index	01_h
Description	Numerator
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

Sub-index	02_h
Description	Divisor
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	1

7. Homing Mode

7.1. Overview

Homing is the method by which a drive seeks the home position. There are various methods to achieve this position using the four available sources for the homing signal: limit switches (negative and positive), home switch and index pulse.

A homing move is started by setting bit 4 of the *Control Word* object (index 0x6040). The results of a homing operation can be accessed in the *Status Word* (index 0x6041).

A homing mode is chosen by writing a value to homing_method which will clearly establish:

1. the homing signal (positive limit switch, negative limit switch, home switch)
2. the direction of actuation and where appropriate
3. the position of the index pulse.

The user can specify the home method, the home offset, the speed and the acceleration.

The **home offset** is the difference between the zero position for the application and the machine home position. During homing the home position is found and once the homing is completed the zero position is offset from the home position by adding the home_offset to the home position. This is illustrated in the following diagram.

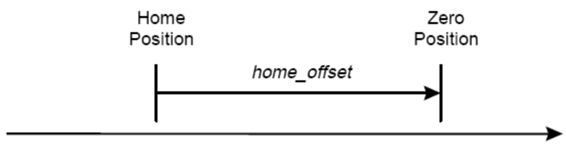


Figure 7.1 *Home Offset*

There are two **homing speeds:** a fast speed (which is used to find the home switch), and a slow speed (which is used to find the index pulse).

The **homing acceleration** establishes the acceleration to be used for all accelerations and decelerations with the standard homing modes.

The homing method descriptions in this document are based on those in the Profile for Drives and Motion Control (DSP402 Standard).

As in the figure below for each homing method we will present a diagram that clearly describes the sequence of homing operation.

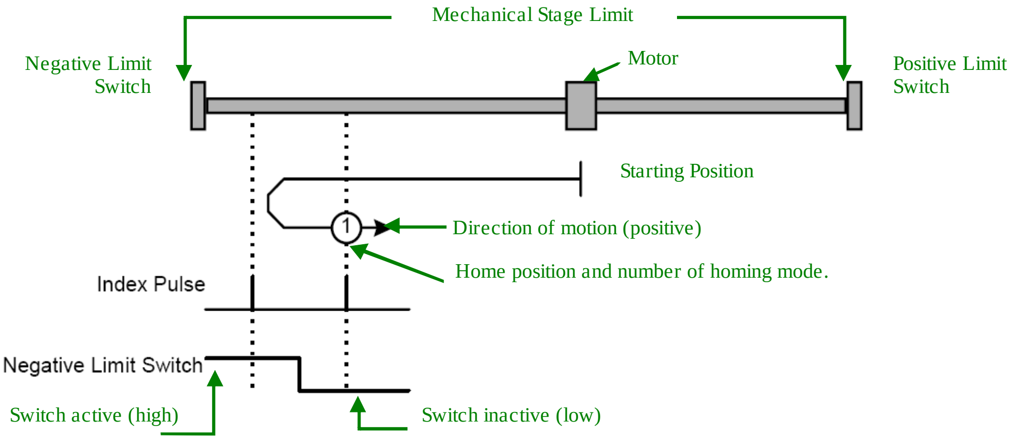


Figure 7.2 *Homing method diagram*

7.2. Homing methods

Method 1: Homing on the Negative Limit Switch.

If the negative limit switch is inactive (low) the initial direction of movement is leftward (negative sense). After negative limit switch is reached the motor will reverse the motion, moving in the positive sense with slow speed. The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.

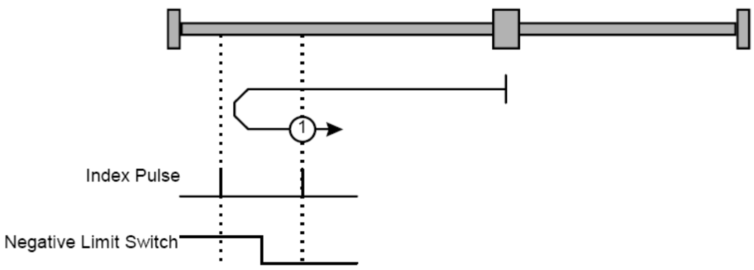


Figure 7.3 *Homing on the Negative Limit Switch*

Method 2: Homing on the Positive Limit Switch.

If the positive limit switch is inactive (low) the initial direction of movement is rightward (negative sense). After positive limit switch is reached the motor will reverse the motion, moving in the negative sense with slow speed. The home position is at the first index pulse to the left of the position where the positive limit switch becomes inactive.

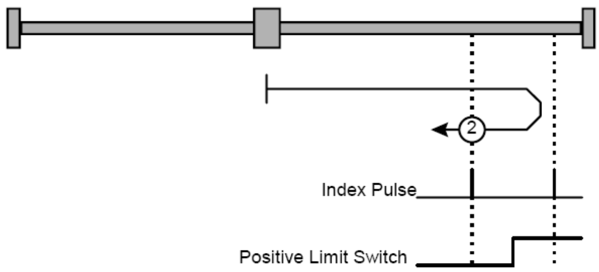


Figure 7.4 *Homing on the Positive Limit Switch*

Methods 3 and 4: Homing on the Positive Home Switch and Index Pulse.

The home position is at the index pulse either after home switch high-low transition (method 3) or after home switch low-high transition (method 4).

The initial direction of movement is dependent on the state of the home switch (if low - move positive, if high - move negative).

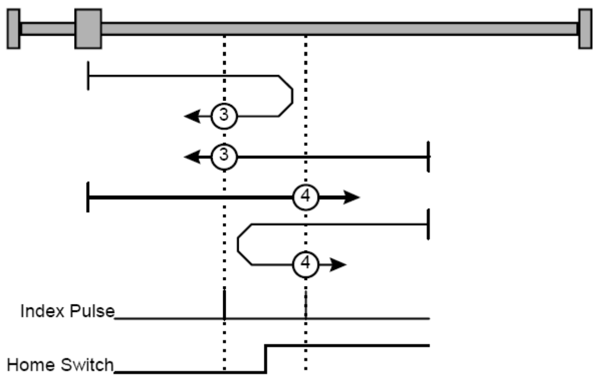


Figure 7.5 *Homing on the Negative Home Switch and Index Pulse*

For **method 3**, if home input is high the initial direction of movement will be negative, or positive if home input is low, and reverse (with slow speed) after home input low-high transition. The motor will stop at first index pulse after home switch high-low transition.

For **method 4**, if home input is low the initial direction of movement will be positive, or negative if home input is high, and reverse (with slow speed) after home input high-low transition. The motor will stop at first index pulse after home switch low-high transition.

In all cases after home switch transition the speed of the movement is slow.

Methods 5 and 6: Homing on the Negative Home Switch and Index Pulse.

The home position is at the index pulse either after home switch high-low transition (method 5) or after home switch low-high transition (method 6).

The initial direction of movement is dependent on the state of the home switch (if high - move positive, if low - move negative).

For **method 5**, if home input is high the initial direction of movement will be positive, or negative if home input is low, and reverse (with slow speed) after home input low-high transition. The motor will stop at first index pulse after home switch high-low transition.

For **method 6**, if home input is low the initial direction of movement will be negative, or positive if home input is high, and reverse (with slow speed) after home input high-low transition. The motor will stop at first index pulse after home switch low-high transition.

In all cases after home switch transition the speed of the movement is slow.

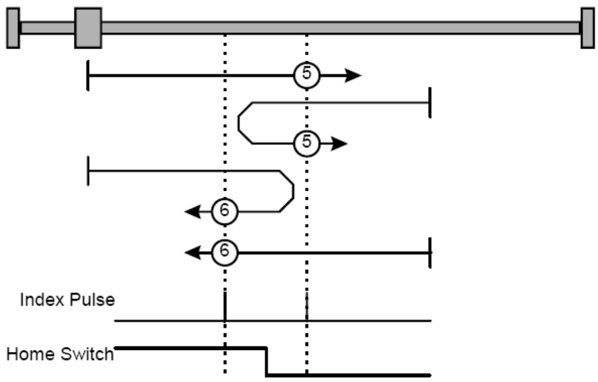


***Figure 7.6** Homing on the Negative Home Switch and Index Pulse*

Methods 7 to14: Homing on the Negative Home Switch and Index Pulse.

These methods use a home switch that is active over only a portion of the travel distance, in effect the switch has a ‘momentary’ action as the axle’s position sweeps past the switch.

Using methods 7 to 10 the initial direction of movement is to the right (positive), and using methods 11 to 14 the initial direction of movement is to the left (negative), except the case when the home switch is active at the start of the motion (initial direction of motion is dependent on the edge being sought – the rising edge or the falling edge).

The home position is at the index pulse on either side of the rising or falling edges of the home switch, as shown in the following two diagrams.

If the initial direction of movement leads away from the home switch, the drive will reverse on encountering the relevant limit switch (negative limit switch for methods 7 to 10, or positive limit switch for methods 11 to 14).

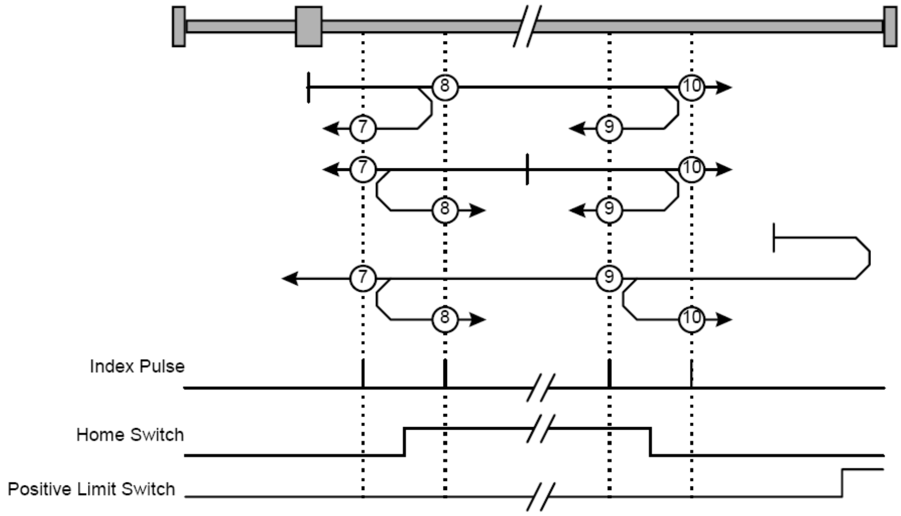


Figure 7.7 *Homing on the Home Switch and Index Pulse – Positive Initial Move*

Using **method 7** the initial move will be positive if home input is low and reverse after home input low-high transition, or move negative if home input is high. Reverse also if the positive limit switch is reached. Stop at first index pulse after home switch active region ends (high-low transition). In all cases after high-low home switch transition the motor speed will be slow.

Using **method 8** the initial move will be positive if home input is low, or negative if home input is high and reverse after home input high-low transition. Reverse also if the positive limit switch is reached. Stop at first index pulse after home switch active region starts (low-high transition). In all cases after low-high home switch transition the motor speed will be slow.

Using **method 9** the initial move will be positive and reverse (slow speed) after home input high-low transition. Reverse also if the positive limit switch is reached. Stop at first index pulse after home switch active region starts (low-high transition).

Using **method 10** the initial move will be positive. Reverse if the positive limit switch is reached, then reverse once again after home input low-high transition. Stop at first index pulse after home switch active region ends (high-low transition). In all cases after high-low home switch transition the motor speed will be slow.

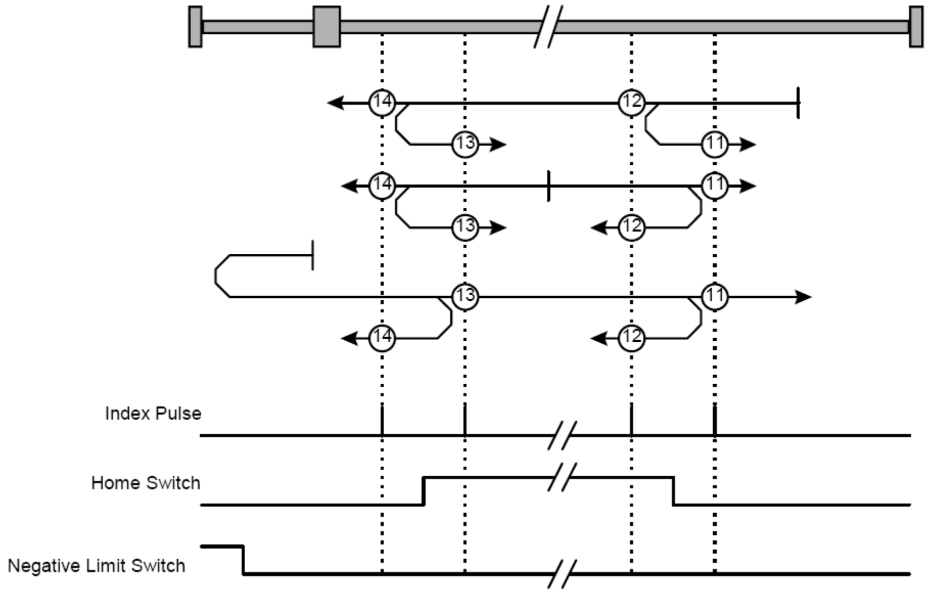


***Figure 7.8** Homing on the Home Switch and Index Pulse – Positive Initial Move*

Using **method 11** the initial move will be negative if home input is low and reverse after home input low-high transition. Reverse also if the negative limit switch is reached. If home input is high move positive. Stop at first index pulse after home switch active region ends (high-low transition). In all cases after high-low home switch transition the motor speed will be slow.

Using **method 12** the initial move will be negative if home input is low. If home input is high move positive and reverse after home input high-low transition. Reverse also if the negative limit switch is reached. Stop at first index pulse after home switch active region starts (low-high transition). In all cases after low-high home switch transition the motor speed will be slow.

Using **method 13** the initial move will be negative and reverse after home input high-low transition. Reverse also if the negative limit switch is reached. Stop at first index pulse after home switch active region starts (low-high transition). In all cases after high-low home switch transition the motor speed will be slow.

Using **method 14** the initial move will be negative. Reverse if the negative limit switch is reached, then reverse once again after home input low-high transition. Stop at first index pulse after home switch active region ends (high-low transition). In all cases after high-low home switch transition the motor speed will be slow.

Methods 15 and 16: Reserved

Methods 17 to 30: Homing without an Index Pulse

These methods are similar to methods 1 to 14 except that the home position is not dependent on the index pulse but only on the relevant home or limit switch transitions.

Using **method 17** if the negative limit switch is inactive (low) the initial direction of movement is leftward (negative sense). After negative limit switch reached the motor will reverse the motion, moving in the positive sense with slow speed. The home position is at the right of the position where the negative limit switch becomes inactive.

Using **method 18** if the positive limit switch is inactive (low) the initial direction of movement is rightward (negative sense). After positive limit switch reached the motor will reverse the motion, moving in the negative sense with slow speed. The home position is at the left of the position where the positive limit switch becomes inactive.

For example methods 19 and 20 are similar to methods 3 and 4 as shown in the following diagram.

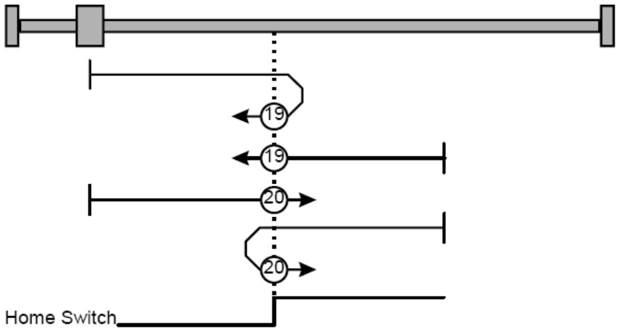


Figure 7.9 *Homing on the Positive Home Switch*

Using **method 19**, if home input is high, the initial direction of movement will be negative, or positive if home input is low, and reverse (with slow speed) after home input low-high transition. The motor will stop right after home switch high-low transition.

Using **method 20**, if home input is low, the initial direction of movement will be positive, or negative if home input is high, and reverse (with slow speed) after home input high-low transition. The motor will stop after right home switch low-high transition.

Using **method 21**, if home input is high, the initial direction of movement will be positive, or negative if home input is low, and reverse (with slow speed) after home input low-high transition. The motor will stop right after home switch high-low transition.

Using **method 22**, if home input is low, the initial direction of movement will be negative, or positive if home input is high, and reverse (with slow speed) after home input high-low transition. The motor will stop right after home switch low-high transition.

Using **method 23** the initial move will be positive if home input is low and reverse after home input low-high transition, or move negative if home input is high. Reverse also if the positive limit switch is reached. Stop right after home switch active region ends (high-low transition).

Using **method 24** the initial move will be positive if home input is low, or negative if home input is high and reverse after home input high-low transition. Reverse also if the positive limit switch is reached. Stop right after home switch active region starts (low-high transition).

Using **method 25** the initial move will be positive and reverse after home input high-low transition. Reverse also if the positive limit switch is reached. Stop right after home switch active region starts (low-high transition).

Using **method 26** the initial move will be positive. Reverse if the positive limit switch is reached, then reverse once again after home input low-high transition. Stop right after home switch active region ends (high-low transition).

Using **method 27** the initial move will be negative if home input is low and reverse after home input low-high transition. Reverse also if the negative limit switch is reached. If home input is high move positive. Stop right after home switch active region ends (high-low transition).

Using **method 28** the initial move will be negative if home input is low. If home input is high move positive and reverse after home input high-low transition. Reverse also if the negative limit switch is reached. Stop right after home switch active region starts (low-high transition).

Using **method 29** the initial move will be negative and reverse after home input high-low transition. Reverse also if the negative limit switch is reached. Stop right after home switch active region starts (low-high transition).

Using **method 30** the initial move will be negative. Reverse if the negative limit switch is reached, then reverse once again after home input low-high transition. Stop right after home switch active region ends (high-low transition).

Methods 31 and 32: Reserved

Methods 33 and 34: Homing on the Index Pulse

Using **methods 33** or **34** the direction of homing is negative or positive respectively. During these procedures, the motor will move only at slow speed. The home position is at the index pulse found in the selected direction.

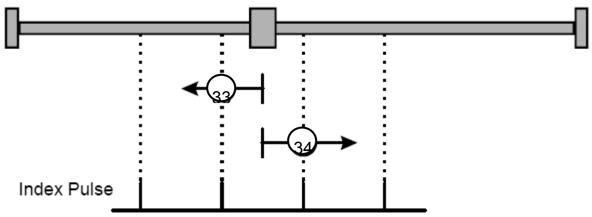


Figure 7.10 *Homing on the Index Pulse*

Method 35: Homing on the Current Position

In **method 35** the current position is taken as the home position.

Method -1: Homing on the Negative Mechanical Limit and Index Pulse

Move negative until the “Current threshold” is reached for a specified amount of time, then reverse and stop at the first index pulse. When the motor current is greater than the *Homing*

Current Threshold (index 0x207B) for a specified amount of time in the *Homing Current Threshold Time* object (index 0x207C), the motor will reverse direction. The home position is at the first index pulse to the left of the positive mechanical limit.

Warning!	The value of *Homing Current Threshold* must be lower than the drive current limit. Otherwise, the homing will not complete successfully (no homing error will be issued). The current limit is set during setup. See Paragraph 1.3. Setting the current limit. *Current Threshold* < *current limit*

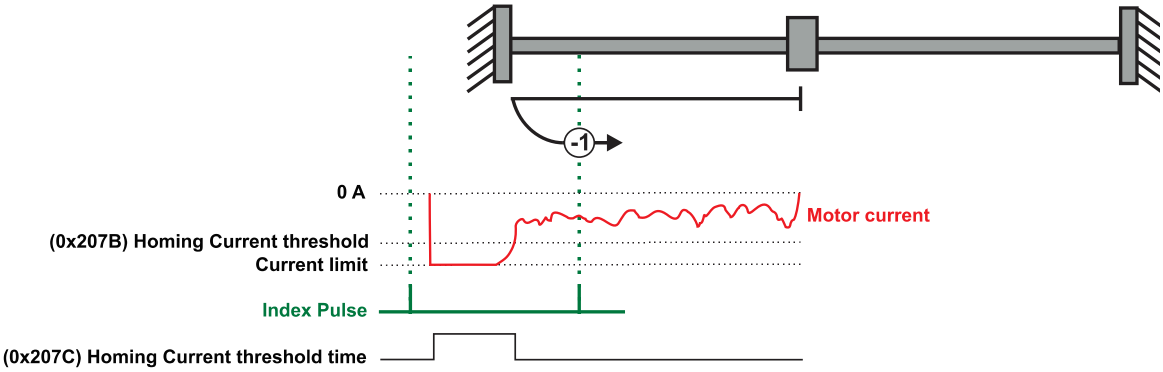


Figure 7.11 *Homing on the Negative Mechanical Limit and Index Pulse*

Method -2: Homing on the Positive Mechanical Limit and Index Pulse

Move positive until the “Current threshold” is reached for a specified amount of time, then reverse and stop at the first index pulse. When the motor current is greater than the *Homing Current Threshold* (index 0x207B) for a specified amount of time in the *Homing Current Threshold Time* object (index 0x207C), the motor will reverse direction. The home position is at the first index pulse to the left of the positive mechanical limit.

Warning!	The value of *Homing Current Threshold* must be lower than the drive current limit. Otherwise, the homing will not complete successfully (no homing error will be issued). The current limit is set during setup. See Paragraph 1.3. Setting the current limit. *Current Threshold* < *current limit*

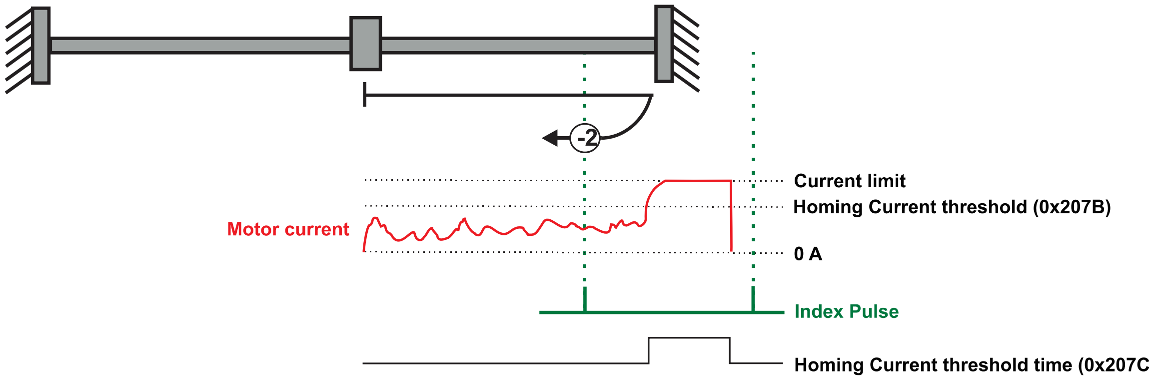


Figure 7.12 *Homing on the Positive Mechanical Limit and Index Pulse*

Method -3: Homing on the Negative Mechanical Limit without an Index Pulse.

Move negative until the “Current threshold” is reached for a specified amount of time, then reverse and stop at the position set in “Home position”. When the motor current is greater than the *Homing Current Threshold* (index 0x207B) for specified amount of time set in the *Homing Current Threshold Time* object (index 0x207C), the motor will reverse direction and stop after it has travelled the absolute value set in *Home offset* (index 0x607C).

Warning!	The value of *Homing Current Threshold* must be lower than the drive current limit. Otherwise, the homing will not complete successfully (no homing error will be issued). The current limit is set during setup. See Paragraph 1.3. Setting the current limit. *Current Threshold* < *current limit*

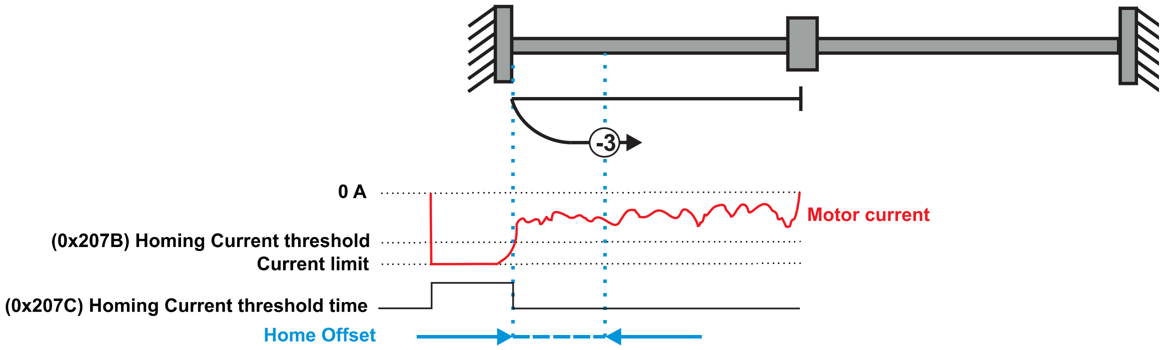


Figure 7.13 *Homing on the Positive Mechanical Limit without an Index Pulse*

Method -4: Homing on the Positive Mechanical Limit without an Index Pulse.

Move positive until the “Current threshold” is reached for a specified amount of time, then reverse and stop at the position set in “Home position”. When the motor current is greater than the *Homing Current Threshold* (index 0x207B) for specified amount of time set in the *Homing Current*

Threshold Time object (index 0x207C), the motor will reverse direction and stop after it has travelled the absolute value set in *Home offset* (index 0x607C).

Warning!	The value of *Homing Current Threshold* must be lower than the drive current limit. Otherwise, the homing will not complete successfully (no homing error will be issued). The current limit is set during setup. See Paragraph 1.3. Setting the current limit. *Current Threshold* < *current limit*

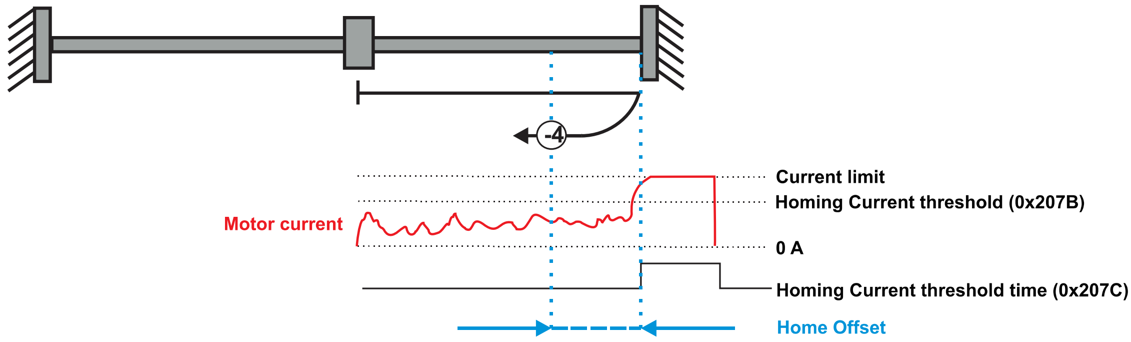


Figure 7.14 *Homing on the Positive Mechanical Limit without an Index Pulse*

7.3. Homing Mode Objects

This chapter describes the method by which the drive seeks the home position. There are 35 built-in homing methods, as described in **paragraph 7.1**. Using the EasyMotion Studio software, one can alter each of these homing methods to create a custom homing method.

You can select which homing method to be used by writing the appropriate number in the object 6098h *homing method*.

The user can specify the speeds and acceleration to be used during the homing. There is a further object *homing offset* that allows the user to displace zero in the user's coordinate system from the home position.

In the homing mode, the bits in *control word* and *status word* have the following meaning:

7.3.1. Control word in homing mode

MSB **LSB**

See 6040h	Halt	See 6040h	Reserved	Homing operation start	See 6040h
15 9	8	7	6 5	4	3 0

Table 7.1 *Control Word bits description for Homing Mode*

Name	Value	Description
Homing operation start	0	Homing mode inactive
	0 -> 1	Start homing mode
	1	Homing mode active
	1 -> 0	Interrupt homing mode
Halt	0	Execute the instruction of bit 4
	1	Stop drive with *homing acceleration*

7.3.2. Status word in homing mode

MSB LSB

See 6041h	Homing error	Homing attained	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 7.2 *Status Word bits description for Homing Mode*

Name	Value	Description
Target reached	0	Halt = 0: Home position not reached Halt = 1: Drive decelerates
	1	Halt = 0: Home position reached Halt = 1: Velocity of drive is 0
Homing attained	0	Homing mode not yet completed
	1	Homing mode carried out successfully
Homing error	0	No homing error
	1	Homing error occurred; homing mode not carried out successfully.

Table 7.3 Definition of bit 10,bit 12 and bit 13

Bit 13	Bit 12	Bit 10	Definition
0	0	0	Homing procedure is in progress
0	0	1	Homing procedure is interrupted or not started
0	1	0	Homing is attained, but target is not reached
0	1	1	Homing procedure is completed successfully
1	0	0	Homing error occurred, velocity is not 0
1	0	1	Homing error occurred, velocity is 0
1	1	X	reserved

7.3.3. Object 607Ch: Home offset

The *home offset* is the difference between the zero position for the application and the machine home position (found during homing), and it is given in position units. All subsequent absolute moves after the homing is finished will be taken relative to this zero position.

Object description:

Index	$607C_h$
Name	Home offset
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	Possible
Units	PU
Value range	INTEGER32
Default value	0

7.3.4. Object 6098h: Homing method

The *homing method* determines the method that will be used during homing.

Object description:

Index	6098_h
Name	Homing method
Object code	VAR
Data type	INTEGER8

Entry description:

Access	RW
PDO mapping	Possible
Value range	INTEGER8
Default value	0

Data description:

Value	Description
-128 … -1	Reserved
0	No homing operation required
1 … 35	Methods 1 to 35
36 … 127	reserved

There are 35 built-in homing methods, conforming to DSP402 device profile. Using the EasyMotion Studio software, one can alter each of these homing methods to create a custom one.

7.3.5. Object 6099h: Homing speeds

This object defines the speeds used during homing. It is given in velocity units. There are 2 homing speeds; in a typical cycle the faster speed is used to find the home switch and the slower speed is used to find the index pulse.

Object description:

Index	6099_h
Name	Homing speeds
Object code	ARRAY
Data type	UNSIGNED32

Entry description:

Sub-index	0
Description	Number of entries
Access	RO
PDO mapping	No
Value range	2
Default value	2

Sub-index	1
Description	Speed during search for switch
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32

Default value	0

Sub-index	2
Description	Speed during search for zero
Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	0

7.3.6. Object 609Ah: Homing acceleration

The *homing acceleration* establishes the acceleration to be used for all the accelerations and decelerations with the standard homing modes and is given in acceleration units.

Object description:

Index	$609A_h$
Name	Homing acceleration
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Units	AU
Value range	UNSIGNED32
Default value	-

7.3.7. Object 207Bh: Homing current threshold

The Homing Current Threshold Level object together with object Homing current threshold time ($207C_h$) defines the protection limits when reaching a mechanical stop during homing methods -1,-2,-3 and -4. The object defines the value of current in the drive, over which the homing procedure determines that the mechanical limit has been reached when it lasts more than the time interval specified in object $207C_h$. The current is set in internal units.

Warning!	The value of *Homing Current Threshold* must be lower than the drive current limit. Otherwise, the homing will not complete successfully (no homing error will be issued). The current limit is set during setup. See Paragraph 1.3. Setting the current limit. *Current Threshold* < *current limit*

Object description:

Index	$207B_h$
Name	Homing current threshold
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	Possible
Units	CU
Value range	-32768 … 32767
Default value	No

7.3.8. Object 207Ch: Homing current threshold time

The Homing current threshold time object together with object Homing current threshold ($207B_h$) defines the protection limits when reaching a mechanical stop during homing methods -1,-2,-3 and -4. The object sets the time interval after the homing current threshold is exceeded. After this time is completed without the current dropping below the threshold, the next step in the homing shall be executed. It is set in time internal units.

Object description:

Index	$207C_h$
Name	Homing current threshold time
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Units	TU
Value range	0 … 65535
Default value	No

7.4. Homing example

Execute homing method number 18.

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Homing speed during search for zero.** Set the speed during search for zero to 150 rpm. By using and 500 lines incremental encoder and 1ms sample rate for position/speed control the corresponding value of object 6099_h sub-index 2 expressed in encoder counts per sample is 50000_h.

Send the following message (SDO access to object 6099_h sub-index 2, 32-bit value 00050000_h):

COB-ID	**606**
Data	**23 99 60 02 00 00 05 00**

6. **Homing speed during search for switch.** Set the speed during search for switch to 600 rpm. By using and 500 lines incremental encoder and 1ms sample rate for position/speed control the corresponding value of object 6099_h sub-index 1 expressed in encoder counts per sample is 140000_h.

Send the following message (SDO access to object 6099_h sub-index 1, 32-bit value 00140000_h):

COB-ID	**606**
Data	**23 99 60 01 00 00 14 00**

7. **Homing acceleration.** The homing acceleration establishes the acceleration to be used with the standard homing moves. Set this value at 5 rot/s^2. By using and 500 lines incremental encoder and 1ms sample rate for position/speed control the corresponding value of object $609A_h$ expressed in encoder counts per square sample is $28F_h$.

Send the following message (SDO access to object $609A_h$, 32-bit value $0000028F_h$):

COB-ID	**606**

Data	**23 9A 60 00 8F 02 00 00**

8. **Home offset.** Set the home offset to 1 rotation. By using and 500 lines incremental encoder the corresponding value of object $607C_h$ expressed in encoder counts is $7D0_h$.

Send the following message (SDO access to object $607C_h$, 32-bit value $000007D0_h$):

COB-ID	**606**
Data	**23 7C 60 00 D0 07 00 00**

9. **Homing method.** Select homing method number 18.

Send the following message (SDO access to object 6098_h, 8-bit value 12_h):

COB-ID	**606**
Data	**2F 98 60 00 12 00 00 00**

10. **Mode of operation.** Select homing mode.

Send the following message (SDO access to object 6060_h, 8-bit value 6_h):

COB-ID	**606**
Data	**2F 60 60 00 06 00 00 00**

11. **Start the homing.**

Send the following message

COB-ID	**206**
Data	**1F 00**

12. **Press for 5s the LSP button.**
13. **Wait for homing to end.**
14. **Check the value of motor actual position.**

Send the following message (SDO access to object 6064_h):

COB-ID	**606**
Data	**40 64 60 00 00 00 00 00**

The node will return the value of motor actual position that should be the same as the value of home offset (plus or minus few encoder counts depending on your position tuning).

8. Position Profile Mode

8.1. Overview

In Position Profile Mode the drive controls the position.

The Position Profile Mode supports 2 motion modes:

- **Trapezoidal profile**. The built-in reference generator computes the position profile with a trapezoidal shape of the speed, due to a limited acceleration. The CANopen master specifies the absolute or relative **Target Position** (index $607A_h$), the **Profile Velocity** (index 6081_h) and the **Profile Acceleration** (6083_h)

  In relative mode, the position to reach can be computed in 2 ways: standard (default) or additive. In standard relative mode, the position to reach is computed by adding the position increment to the instantaneous position in the moment when the command is executed. In the additive relative mode, the position to reach is computed by adding the position increment to the previous position to reach, independently of the moment when the command was issued. Bit 11 of *Control Word* activates the additive relative mode.

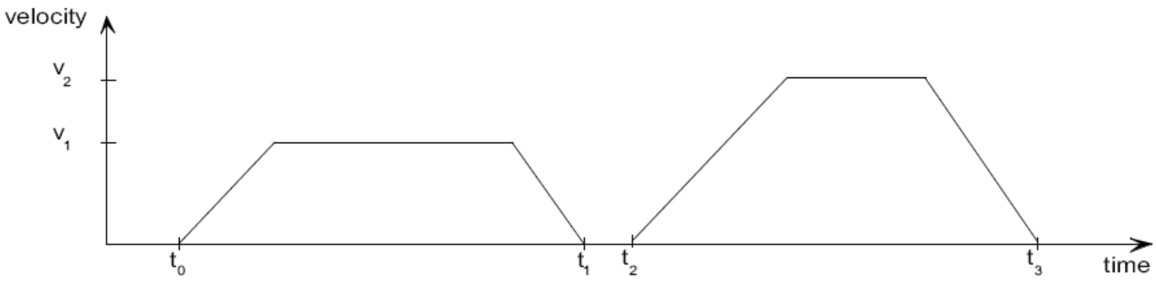
- **S-curve profile** the built-in reference generator computes a position profile with an S-curve shape of the speed. This shape is due to the jerk limitation, leading to a trapezoidal or triangular profile for the acceleration and an S-curve profile for the speed. The CANopen master specifies the absolute or relative **Target Position** (index $607A_h$), the **Profile Velocity** (index 6081_h), the **Profile Acceleration** (6083_h) and the jerk rate. The jerk rate is set indirectly via the **Jerk time** (index 2023_h), which represents the time needed to reach the maximum acceleration starting from zero.

There are two different ways to apply *target positions* to a drive, controlled by the *change set immediately* bit in Control Word:

8.1.1. Discrete motion profile (*change set immediately* = 0)

After reaching the *target position* the drive unit signals this status to a CANopen master and then receives a new set-point. After reaching a *target position* the velocity normally is reduced to zero before starting a move to the next set-point.

After the *target position* is sent to the drive, the CANopen master has to set the *new set-point* bit in *control word*. The drive responds with bit *set-point acknowledge* set in *status word*. After that, the master has to reset bit *new set-point* to 0. Following this action, the drive will signalize that it can accept a new set-point by resetting *set-point acknowledge* bit in *status word* after the reference generator has reached the designated demand position.



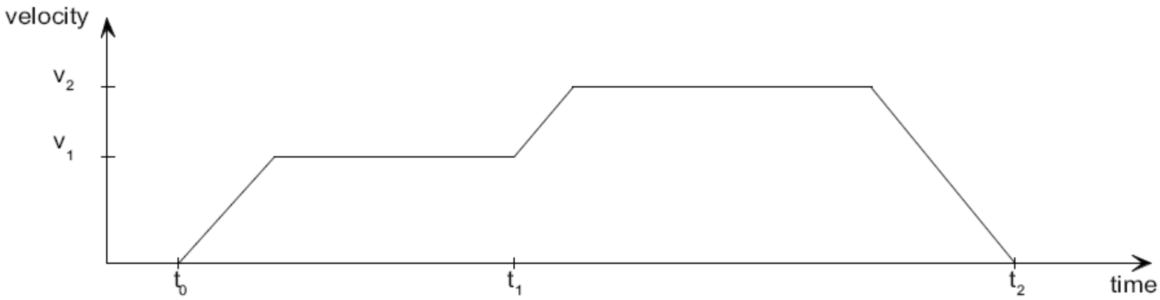
8.1.2. Continuous motion profile (*change set immediately = 1*)

The drive unit immediately processes the next *target position*, even if the actual movement is not completed. The drive readapts the actual move to the new target position.

In this case, the handshake presented for *change set immediately* = 0 is not necessary. By setting the *new set-point* bit, the master will trigger the immediate update of the target position. In this case, if the *target position* is set as relative, also bit 11 is taken into consideration (with or without additive movement).

Remark:

In case object 6086h (Motion Profile Type) is set to 3 (jerk-limited ramp = S-curve profile), then *change set immediately* bit must be 0, else a command error is issued.



8.1.3. Control word in profile position mode

MSB **LSB**

See 6040h	Operation Mode	See 6040h	Halt	See 6040h	Abs/rel	Change set immediately	New set-point	See 6040h
15 12	11	10 9	8	7	6	5	4	3 0

Table 8.1 *Control Word bits description for Position Profile Mode*

Name	Value	Description
Operation Mode	0	Trapezoidal profile - In case the movement is relative, do not add the new target position to the old demand position S-curve profile – Stop the motion with S-curve profile (jerk limited ramp)
	1	Trapezoidal profile - In case the movement is relative, add the new target position to the old demand position to obtain the new target position S-curve profile – Stop the motion with trapezoidal profile (linear ramp)
New set-point	0	Do not assume *target position*
	1	Assume *target position* (update the new motion parameters)
Change set immediately	0	Finish the actual positioning and then start the next positioning
	1	Interrupt the actual positioning and start the next positioning. Valid only for linear ramp profile.
Abs / rel	0	*Target position* is an absolute value
	1	*Target position* is a relative value
Halt	0	Execute positioning
	1	Stop drive with *profile acceleration*

8.1.4. Status word in profile position mode

MSB **LSB**

See 6041h	Following error	Set-point acknowledge	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 8.2 *Status Word bits description for Position Profile Mode*

Name	Value	Description
Target reached	0	Halt = 0: *Target position* not reached Halt = 1: Drive decelerates
	1	Halt = 0: *Target position* reached Halt = 1: Velocity of drive is 0
Set-point acknowledge	0	Trajectory generator will accept a new set-point
	1	Trajectory generator will not accept a new set-point.
Following error	0	No following error
	1	Following error

8.2. Position Profile Mode Objects

8.2.1. Object 607Ah: Target position

The *target position* is the position that the drive should move to in position profile mode using the current settings of motion control parameters such as velocity, acceleration, and *motion profile type* etc. It is given in position units.

The position units are user defined. The value is converted to position increments using the *position factor* (see **Chapter 6 Factor group**).

If Control Word bit 6 = 0 (e.g. absolute positioning), represents the position to reach.

If Control Word bit 6 = 1 (e.g. relative positioning), represents the position displacement to do. When Control Word bit 14 = 0, the new position to reach is computed as: motor actual position (6064h) + displacement. When Control Word bit 14 = 1, the new position to reach is computed as: actual demand position (6062_h) + displacement.

Object description:

Index	$607A_h$
Name	Target position
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	Yes
Value range	$-2^{31} \dots 2^{31}-1$
Default value	No

8.2.2. Object 6081h: Profile velocity

In a position profile, it represents the maximum speed to reach at the end of the acceleration ramp. The *profile velocity* is given in speed units.

The speed units are user defined. The value is converted to internal units using the *velocity encoder factor* (see **Chapter 6 Factor group**).

If no factor is applied, the profile velocity object receives data as a FIXED32 variable. Meaning that the high part represents encoder increments/sample, and the low part represents a subdivision of an increment. So 65536(0x00010000) = 1 encoder increment / sample. The minimum speed is 1 encoder increment / sample.

Object description:

Index	6081_h
Name	Profile velocity
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	-

8.2.3. Object 6083h: Profile acceleration

In position or speed profiles, represents the acceleration and deceleration rates used to change the speed between 2 levels. The same rate is used when *Quick Stop* or *Disable Operation* commands are received. The *profile acceleration* is given in acceleration units.

The acceleration units are user defined. The value is converted to internal units using the *acceleration factor* (see **Chapter 6 Factor group**).

If no factor is applied, the same description as object 6081_h applies. So 65536 IU = 1 encoder increment / sample[2].

Object description:

Index	6083_h
Name	Profile acceleration
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Value range	$0..(2^{32}-1)$
Default value	-

8.2.4. Object 6085h: Quick stop deceleration

The *quick stop deceleration* is the deceleration used to stop the motor if the *Quick Stop* command is received and the *quick stop option code* object (index $605A_h$) is set to 2 or 6. It is also used when the *fault reaction option code* object (index $605E_h$) and the *halt option code* object (index $605D_h$) is 2. *The quick stop deceleration* is given in user-defined acceleration units.

Object description:

Index	6085_h
Name	Quick stop deceleration
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW

PDO mapping	Possible
Value range	0..(2^{32}-1)
Default value	-

8.2.5. Object 2023h: Jerk time

In this object you can set the time to use for S-curve profile (jerk-limited ramp set in Object 6086h – Motion Profile Type). The time units are given in ms.

Object description:

Index	2023_h
Name	Jerk time
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Value range	0 … 65535
Default value	-

8.2.6. Object 6086h: Motion profile type

Object description:

Index	6086_h
Name	Motion profile type
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	Possible
Value range	INTEGER16
Default value	0

Data description:

Profile code	Profile type
-32768 … -1	Manufacturer specific (reserved)
0	Linear ramp (trapezoidal profile)
1,2	Reserved
3	Jerk-limited ramp (S-curve)

4 … 32767	Reserved

8.2.7. Object 6062h: Position demand value

This object represents the output of the trajectory generation. The *position demand value* is given in user-defined position units.

Object description:

Index	6062_h
Name	Position demand value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Value range	$-2^{31} \dots 2^{31}-1$
Default value	-

8.2.8. Object 6063h: Position actual internal value

This object represents the actual value of the position measurement device in increments. It can be used as an alternative to *position actual value* (6064h) in order to save computation time.

Object description:

Index	6063_h
Name	Position actual value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Units	increments
Value range	$-2^{31} \dots 2^{31}-1$
Default value	-

8.2.9. Object 6064h: Position actual value

This object represents the actual value of the position measurement device. The *position actual value* is given in user-defined position units.

Remark: when using a stepper open loop with encoder on motor configuration (for step loss detection), a position value will not be reported.

Object description:

Index	6064_h
Name	Position actual value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Yes
Value range	$-2^{31} \ldots 2^{31}-1$
Default value	-

8.2.10.Object 6065h: Following error window

This object defines a range of tolerated position values symmetrically to the *position demand value*, expressed in position units. If the *position actual value* is above the *following error window* for a period larger than the one defined in *following error time out*, a following error occurs. If the value of the *following error window* is 2^{32}-1, the following control is switched off.

The maximum value allowed for the *following error window* parameter, expressed in increments, is 32767. When this object is written with a higher corresponding value, the *following error window* parameter will be set to its maximum value (32767)

Object description:

Index	6065_h
Name	Following error window
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	-

8.2.11.Object 6066h: Following error time out

See 6065h, *following error window*. The value is given in ms.

Object description:

Index	6066_h
Name	Following error time out
Object code	VAR

Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Units	TU
Value range	0 … 65535
Default value	-

8.2.12.Object 6067h: Position window

The *position window* defines a symmetrical range of accepted positions relative to the *target position*. If the *position actual value* is within the *position window* for a time period defined inside the *position window time* object, this *target position* is regarded as reached. The *position window* is given in position units. If the value of the *position window* is 2^{32}-1, the position window control is switched off and the target position will be regarded as reached when the position reference is reached.

The maximum value allowed for the *position window* parameter, expressed in increments, is 32767.

Object description:

Index	6067_h
Name	Position window
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Value range	UNSIGNED32
Default value	-

8.2.13.Object 6068h: Position window time

See description of object 6067h, *position window*.

Object description:

Index	6068_h
Name	Position window time
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Units	TU
Value range	0 … 65535
Default value	-

8.2.14.Object 60F4h: Following error actual value

This object represents the actual value of the following error, given in user-defined position units.

Object description:

Index	$60F4_h$
Name	Following error actual value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Value range	INTEGER32
Default value	-

8.2.15.Object 60FCh: Position demand internal value

This output of the trajectory generator in profile position mode is an internal value using increments as unit. It can be used as an alternative to *position demand value* (6062h) in order to save computation time.

Object description:

Index	$60FC_h$
Name	Position demand internal value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Units	Increments
Value range	-2^{31} … 2^{31}-1
Default value	-

8.2.16.Object 2022h: Control effort

This object can be used to visualize the control effort of the drive (the reference for the current controller). It is available in internal units.

Object description:

Index	2022_h
Name	Control effort
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RO
PDO mapping	Possible
Value range	INTEGER16
Default value	-

8.2.17.Object 2081h: Set/Change the actual motor position

This object sets the motor position to the value specified.

Object description:

Index	2081_h
Name	Set actual position
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	No
Value range	$-2^{31}\ldots2^{31}-1$
Default value	-

8.3. Position Profile Examples

8.3.1. Absolute trapezoidal example

Execute an absolute trapezoidal profile. First perform 4 rotations, wait motion complete and then set the target position of 16 rotations.

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Mode of operation.** Select position mode.

Send the following message (SDO access to object 6060_h, 8-bit value 1_h):

COB-ID	**606**
Data	**2F 60 60 00 01 00 00 00**

6. **Target position.** Set the target position to 4 rotations. By using and 500 lines incremental encoder the corresponding value of object $607A_h$ expressed in encoder counts is $1F40_h$.

Send the following message (SDO access to object $607A_h$ 32-bit value $00001F40_h$):

COB-ID	**606**
Data	**23 7A 60 00 40 1F 00 00**

7. **Target speed.** Set the target speed normally attained at the end of acceleration ramp to 500 rpm. By using and 500 lines incremental encoder and 1ms sample rate for position/speed control the corresponding value of object 6081_h expressed in encoder counts per sample is $10AAAC_h$(16.667 counts/sample).

Send the following message (SDO access to object 6081_h, 32-bit value $0010AAAC_h$):

COB-ID	**606**
Data	**23 81 60 00 AC AA 10 00**

8. **Start the profile.**

Send the following message

COB-ID	**206**
Data	**1F 00**

9. **Wait movement to finish.**
10. **Reset the set point.**

Send the following message

COB-ID	**206**
Data	**0F 00**

11. **Target position.** Set the target position to 16 rotations. By using and 500 lines incremental encoder the corresponding value of object $607A_h$ expressed in encoder counts is $7D00_h$.

Send the following message (SDO access to object $607A_h$ 32-bit value $00007D00_h$):

COB-ID	**606**
Data	**23 7A 60 00 00 7D 00 00**

12. **Start the profile.**

Send the following message

COB-ID	**206**
Data	**1F 00**

13. **Wait movement to finish.**
14. **Check the value of motor actual position.**

Send the following message (SDO access to object 6064_h):

COB-ID	**606**
Data	**40 64 60 00 00 00 00 00**

15. Check the value of position demand value.

Send the following message (SDO access to object 6062_h):

COB-ID	**606**
Data	**40 62 60 00 00 00 00 00**

At the end of movement the motor position actual value should be equal with position demand value (plus or minus few encoder counts depending on your position tuning) and the motor should rotate 16 times.

8.3.2. Absolute Jerk-limited ramp profile example

Execute an absolute Jerk-limited ramp profile.

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Mode of operation.** Select position mode.

Send the following message (SDO access to object 6060_h, 8-bit value 1_h):

COB-ID	**606**
Data	**2F 60 60 00 01 00 00 00**

6. **Motion profile type.** Select Jerk-limited ramp.

Send the following message (SDO access to object 6086_h, 16-bit value 3_h):

COB-ID	**606**
Data	**2B 86 60 00 03 00 00 00**

7. **Target position.** Set the target position to 5 rotations. By using and 500 lines incremental encoder the corresponding value of object $607A_h$ expressed in encoder counts is 2710_h.

Send the following message (SDO access to object $607A_h$ 32-bit value 00002710_h):

COB-ID	**606**
Data	**23 7A 60 00 10 27 00 00**

8. **Target speed.** Set the target speed to 150 rpm. By using and 500 lines incremental encoder and 1ms sample rate for position/speed control the corresponding value of object 6081_h expressed in encoder counts per sample is 00050000_h(5.0 counts/sample).

Send the following message (SDO access to object 6081_h, 32-bit value 00050000_h):

COB-ID	**606**
Data	**23 81 60 00 00 00 05 00**

9. **Jerk time.** Set the time to use for Jerk-limited ramp. For more information related to this parameter, see the ESM help

Send the following message (SDO access to object 2023_h, 16-bit value $13B_h$):

COB-ID	**606**
Data	**2B 23 20 00 3B 01 00 00**

10. **Start the profile.**

Send the following message

COB-ID	**206**
Data	**1F 00**

11. **Wait movement to finish.**

12. **Check the value of motor actual position.**

Send the following message (SDO access to object 6064_h):

COB-ID	**606**
Data	**40 64 60 00 00 00 00 00**

13. Check the value of position demand value.

Send the following message (SDO access to object 6062_h):

COB-ID	**606**
Data	**40 62 60 00 00 00 00 00**

At the end of movement the motor position actual value should be equal with position demand value (plus or minus few encoder counts depending on your position tuning).

9. Interpolated Position Mode

9.1. Overview

The interpolated Position Mode is used to control multiple coordinated axles or a single axle with the need for time-interpolation of set-point data. The Interpolated Position Mode can use the time synchronization mechanism for a time coordination of the related drive units, based on the SYNC and the High Resolution Time Stamp messages (see object 1013 for details).

The Interpolated Position Mode allows a host controller to transmit a stream of interpolation data to a drive unit. The interpolation data is better sent in bursts because the drive supports an input buffer. The buffer size is the number of *interpolation data records* that may be sent to the drive to fill the input buffer.

The interpolation algorithm can be defined in the *interpolation sub mode select*. Linear (PT – Position Time) interpolation is the default interpolation method.

9.1.1. Internal States

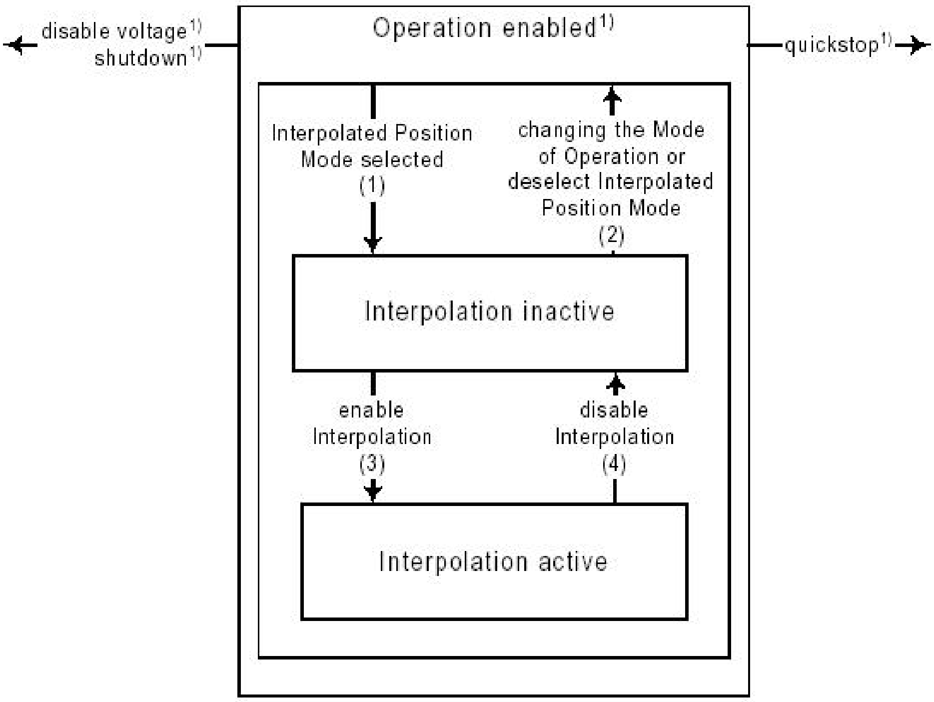


***Figure 9.1** Internal States for the Interpolated Position Mode*

[1)] See state machine

Interpolation inactive: This state is entered when the device is in state Operation enabled and the Interpolated Position Mode is selected. The drive will accept input data and will buffer it for interpolation calculations, but it does not move the motor.

Interpolation active: This state is entered when a device is in state Operation enabled and the Interpolation Position Mode is selected and enabled. The drive will accept input data and will move the motor.

State Transitions of the Internal States

State Transition 1: NO IP-MODE SELECTED => IP-MODE INACTIVE

Event: Select ip-mode with *modes of operations* while inside Operation enable

State Transition 2: IP-MODE INACTIVE => NO IP-MODE SELECTED

Event: Select any other mode while inside Operation enable

State Transition 3: IP-MODE INACTIVE => IP-MODE ACTIVE

Event: Set bit *enable ip mode* (bit4) of the *control word* while in ip-mode and Operation enable

State Transition 4: IP-MODE ACTIVE => IP-MODE INACTIVE

Event: Reset bit *enable ip mode* (bit4) of the *control word* while in ip-mode and Operation enable

9.1.2. Control word in interpolated position mode

MSB LSB

See 6040h	Stop option	See 6040h	Halt	See 6040h	Abs / rel	Reserved	Enable ip mode	See 6040h
15 12	11	10 9	8	7	6	5	4	3 0

Table 9.1 *Control Word bits description for Interpolated Position Mode*

Name	Value	Description
Enable ip mode	0	Interpolated position mode inactive
	1	Interpolated position mode active
Abs / rel	0	Set position is an absolute value
	1	Set position is a relative value
Halt	0	Execute the instruction of bit 4
	1	Stop drive with (*profile acceleration*)
Stop option	0	On transition to inactive mode, stop drive immediately using *profile acceleration*
	1	On transition to inactive mode, stop drive after finishing the current segment.

9.1.3. Status word in interpolated position mode

MSB **LSB**

See 6041h	Reserved	ip mode active	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 9.2 *Status Word bits description for Interpolated Position Mode*

Name	Value	Description
Target reached	0	Halt = 0: Final position not reached Halt = 1: Drive decelerates
	1	Halt = 0: Final position reached Halt = 1: Velocity of drive is 0
ip mode active	0	Interpolated position mode inactive
	1	Interpolated position mode active

9.2. Interpolated Position Objects

9.2.1. Object 60C0h: Interpolation sub mode select

In the Interpolated Position Mode the drive supports two interpolation modes: PT (Position – Time) linear interpolation and PVT (Position – Velocity – Time) cubic interpolation. The interpolation mode is selected with Interpolation sub-mode select object. The sub-mode can be changed only when the drive is in Interpolation inactive state.

Each change of the interpolation mode will trigger the reset of the buffer associated with the interpolated position mode (because the physical memory available is the same for both the sub-modes, size of each data record is different).

Object description:

Index	$60C0_h$
Name	Interpolation sub mode select
Object code	VAR
Data type	INTEGER16

Entry description:

Access	RW
PDO mapping	Possible
Value range	$-2^{15} \ldots 2^{15}-1$
Default value	0

Data description:

Profile code	Profile type
-32768 … -2	Manufacturer specific (reserved)
-1	PVT (Position – Velocity – Time) cubic interpolation
0	PT (Position – Time) Linear Interpolation
+1…+32767	Reserved

9.2.2. Object 60C1h: Interpolation data record

The **Interpolation Data Record** contains the data words that are necessary to perform the interpolation algorithm. The number of data words in the record is defined by the *interpolation data configuration.*

Object description:

Index	$60C1_h$
Name	Interpolation data record
Object code	ARRAY
Number of elements	2
Data Type	Interpolated Mode dependent

Entry description

Sub-index	01_h
Description	X1: the first parameter of ip function
Access	RW
PDO mapping	Possible
Value range	Interpolated Mode dependent
Default value	-

Sub-index	02_h
Description	X2: the second parameter of ip function
Access	RW
PDO mapping	Possible
Value range	Interpolated Mode dependent
Default value	-

Description of the sub-indexes:

X1 and X2 form a 64-bit data structure as defined below:

a) For PVT (Position – Velocity – Time) cubic interpolation:

There are 4 parameters in this mode:

Position – a 24-bit long integer value representing the target position (relative or absolute). Unit - position increments.

Velocity – a 24-bit fixed value representing the end point velocity (16 MSB integer part and 8 LSB fractional part). Unit - increments / sampling

Time – a 9-bit unsigned integer value representing the time of a PVT segment. Unit - position / speed loop samplings.

Counter – a 7-bit unsigned integer value representing an integrity counter. It can be used in order to have a feedback of the last point sent to the drive and detect errors in transmission.

In the example below Position 0 [7…0] represents bits 0..7 of the position value.

<table>
<tr><td>Byte 0</td><td colspan="4">Position 0 [7...0]</td></tr>
<tr><td>Byte 1</td><td colspan="4">Position 1 [15...8]</td></tr>
<tr><td>Byte 2</td><td colspan="4">Velocity 0 [15...8]</td></tr>
<tr><td>Byte 3</td><td colspan="4">Position 2 [23...16]</td></tr>
<tr><td>Byte 4</td><td colspan="4">Velocity 1 [23...16]</td></tr>
<tr><td>Byte 5</td><td colspan="4">Velocity 2 [31...24]</td></tr>
<tr><td>Byte 6</td><td colspan="4">Time [7...0]</td></tr>
<tr><td rowspan="2">Byte 7</td><td colspan="3">Counter[6…0]</td><td>Time[8]</td></tr>
<tr><td>bit 7</td><td>- - - -</td><td>bit1</td><td>bit0</td></tr>
</table>

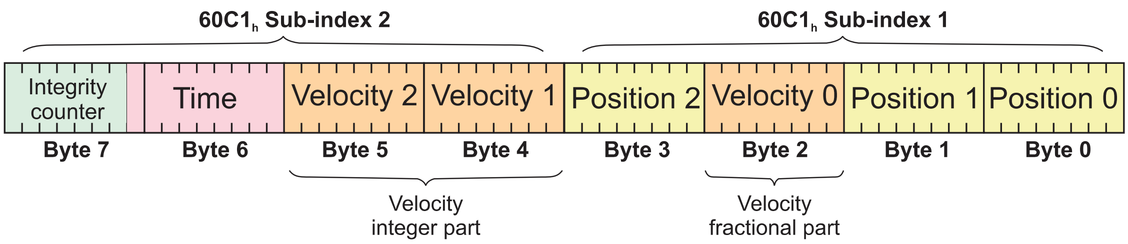


Figure 9.2 *PVT interpolation point 64-bit data structure*

Remarks:

- The integrity counter is written in byte 3 of 60C1h Subindex 2, on the most significant 7 bits (bit 1 to bit 7).

- The integrity counter is 7 bits long, so it can have a value up to 127. When the integrity counter reaches 127, the next value is 0.

b) For PT (Position –Time) linear interpolation:

There are 3 parameters in this mode:

Position – a 32-bit long integer value representing the target position (relative or absolute). Unit - position increments.

Time – a 16-bit unsigned integer value representing the time of a PT segment. Unit - position / speed loop samplings.

Counter – a 7-bit unsigned integer value representing an integrity counter. It can be used in order to have a feedback of the last point sent to the drive and detect errors in transmission.

In the example below Position[7…0] represents bits 0..7 of the position value.

Byte 0	Position [7...0]	
Byte 1	Position [15...8]	
Byte 2	Position [23...16]	
Byte 3	Position [31...24]	
Byte 4	Time [7...0][1]	
Byte 5	Time [15...8][1]	
Byte 6	Reserved	
Byte 7	Counter[6…0]	Reserved

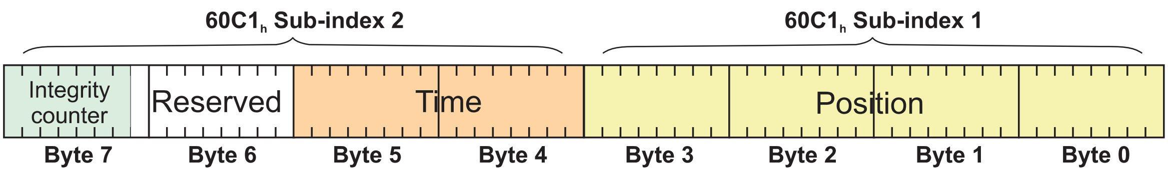


Figure 9.3 *PT interpolation point 64-bit data structure*

Remarks:

- The integrity counter is written in byte 3 of 60C1h Subindex 2, on the most significant 7 bits (bit 1 to bit 7).
- The integrity counter is 7 bits long, so it can have a value up to 127. When the integrity counter reaches 127, the next value is 0.

[1] If object 207Ah Interpolated position 1st order time is used, these bits will we overwritten with the value defined in it

9.2.3. Object 2072h: Interpolated position mode status

The object provides additional status information for the interpolated position mode.

Object description:

Index	2072_h
Name	Interpolated position mode status
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Possible
Value range	UNSIGNED16
Default value	-

Table 9.3 *Interpolated position mode status bit description*

Bit	**Value**	**Description**
15	0	Buffer is not empty
	1	Buffer is empty – there is no point in the buffer.
14	0	Buffer is not low
	1	Buffer is low – the number of points from the buffer is equal or less than the low limit set using object 2074_h.
13	0	Buffer is not full
	1	Buffer is full – the number of points in the buffer is equal with the buffer dimension.
12	0	No integrity counter error
	1	Integrity counter error. If integrity counter error checking is enabled and the integrity counter sent by the master does not match the integrity counter of the drive.
11	0	Valid only for PVT (cubic interpolation): Drive has maintained interpolated position mode after a buffer empty condition (the velocity of the last point was 0).
	1	Valid only for PVT (cubic interpolation): Drive has performed a quick stop after a buffer empty condition because the velocity of the last point was different from 0
10 … 7		Reserved
6 … 0		Current integrity counter value

Remark: *when a status bit changes from this object, an emergency message with the code 0xFF01 will be generated. This emergency message will have mapped object 2072h data onto bytes 3 and 4.*

The Emergency message contains of 8 data bytes having the following contents:

0-1	2	3-4	5-7
Emergency Error Code (0xFF01)	Error Register (Object 1001h)	Interpolated position status (Object 2072h)	Manufacturer specific error field

9.2.4. Object 2073h: Interpolated position buffer length

Through **Interpolated position buffer length** object you can change the default buffer length. When writing in this object, the buffer will automatically reset its contents and then re-initialize with the new length. The length of the buffer is the maximum number of interpolation data that can be queued, and does not mean the number of data locations physically available.

Remark: *It is NOT allowed to write a "0" into this object.*

Object description:

Index	2073_h
Name	Interpolated position buffer length
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	WO
PDO mapping	No
Value range	UNSIGNED16
Default value	7

9.2.5. Object 2074h: Interpolated position buffer configuration

Through this object you can control more in detail the behavior of the buffer.

Object description:

Index	2074_h
Name	Interpolated position buffer configuration
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	WO
PDO mapping	No

Value range	UNSIGNED16
Default value	-

***Table 9.4** Interpolated position buffer configuration*

Bit	Value	Description
15	0	Nothing
	1	Clear buffer and reinitialize buffer internal variables
14	0	Enable the integrity counter error checking
	1	Disable the integrity counter error checking
13	0	No change in the integral integrity counter
	1	Change internal integrity counter with the value specified in bits 0 to 6
12	0	If absolute positioning is set (bit 6 of *control word* is 0), the initial position is read from object 2079_h. It is used to compute the distance to move up to the first PVT point.
	1	If absolute positioning is set (bit 6 of *control word* is 0), the initial position is the current *position demand value*. It is used to compute the distance to move up to the first PVT point.
11 ... 8		New parameter for buffer low signaling. When the number of entries in the buffer is equal or less than buffer low value, bit 14 of object 2072_h will set.
7	0	No change in the buffer low parameter
	1	Change the buffer low parameter with the value specified in bits 8 to 11
6 … 0		New integrity counter value

9.2.6. Object 2079h: Interpolated position initial position

Through this object you can set an initial position for absolute positioning in order to be used to compute the distance to move up to the first point. It is given in position units.

Object description:

Index	2079_h
Name	Interpolated position initial position
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	Possible
Value range	INTEGER32
Default value	0

9.2.7. Object 207Ah: Interpolated position 1^{st} order time

Through this object you can set the time in a PT (Position – Time) Linear Interpolation mode. By setting a value in this object, there is no need to send the time together with the position and integrity counter in **Object 60C1h:** Interpolation data record. This object is disabled when it is set with 0. It is given in IU which is by default 0.8ms for steppers and 1ms for the other configurations.

Object description:

Index	$207A_h$
Name	Interpolated position 1^{st} order time
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Yes
Value range	UNSIGNED16
Default value	0

9.2.8. Loading the interpolated points

If the integrity counter is enabled, the drive considers and loads a valid IP point when it receives a new valid integrity counter number. If the drive receives interpolation data with the same integrity number, it will ignore the point and send an emergency message with the code 0xFF01. If it receives a lower or a +2 higher integrity number, it will ignore the data and send an emergency message with code 0xFF01 and *Object 207Ah: Interpolated position 1st order time* mapped on bytes 4 and 5 showing and integrity counter error. This error will be automatically reset when the data with correct integrity number will be received. The 7 bit integrity counter can have values between 0 and 127. So when the counter reaches the value 127, the next logical value is 0.

After receiving each point, the drive calculates the trajectory it has to execute. Because of this, the points must be loaded after the absolute/relative bit is set in Control Word.

A correct interpolated PT/PVT motion would be like this:

- Enter mode 07 in Modes of Operation
- set the IP buffer size
- Clear the buffer and reinitialize the integrity counter
- Set in controlword the bit for absolute or relative motion
- If the motion is absolute, set in 2079h the actual position of the drive (read from object 6063h)
- If the motion is PT, set in object 207Ah a fixed time interval if not supplied in 60C1 subindex2
- Load the first IP points
- Start the motion by toggling from 0 to 1 bit4 in controlword

- Monitor the interpolated status for buffer low warning (an emergency message will be sent automatically containing the interpolated status when one of the status bits changes)
- Load more points until buffer full bit is active
- Return to monitoring the buffer status and load points until the profile is finished

9.3. PT absolute movement example

Execute an absolute PT movement.

Remark: *Because this is a demo for a single axis the synchronization mechanism is not used here.*

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Disable the RPDO3**. Write zero in object 1602_h sub-index 0, this will disable the PDO.

Send the following message (SDO access to object 1602_h sub-index 0, 8-bit value 0):

COB-ID	**606**
Data	**2F 02 16 00 00 00 00 00**

6. **Map the new objects**.
   a) Write in object 1602_h sub-index 1 the description of the interpolated data record sub-index 1:

Send the following message (SDO access to object 1602_h sub-index 1, 32-bit value $60C10120_h$):

COB-ID	**606**
Data	**23 02 16 01 20 01 C1 60**

   b) Write in object 1601_h sub-index 2 the description of the interpolated data record sub-index 2:

Send the following message (SDO access to object 1602_h sub-index 2, 32-bit value $60C10220_h$):

COB-ID	**606**
Data	**23 02 16 02 20 02 C1 60**

7. **Enable the RPDO3**. Set the object 1601_h sub-index 0 with the value 2.

Send the following message (SDO access to object 1601_h sub-index 0, 8-bit value 2):

COB-ID	**606**
Data	**2F 02 16 00 02 00 00 00**

8. **Mode of operation**. Select interpolation position mode.

Send the following message (SDO access to object 6060_h, 8-bit value 7_h):

COB-ID	**606**
Data	**2F 60 60 00 07 00 00 00**

9. **Interpolation sub mode select**. Select PT interpolation position mode.

Send the following message (SDO access to object $60C0_h$, 16-bit value 0000_h):

COB-ID	**606**
Data	**2E C0 60 00 00 00 00 00**

10. **Interpolated position buffer length**. Set the buffer length to 12. The maximum length is 15.

Send the following message (SDO access to object 2074_h, 16-bit value C_h):

COB-ID	**606**
Data	**2B 74 20 00 00 0C 00 00**

11. **Interpolated position buffer configuration**. By setting the value $A001_h$, the buffer is cleared and the integrity counter will be set to 1. Send the following message (SDO access to object 2074_h, 16-bit value C_h):

COB-ID	**606**

Data	**2B 74 20 00 01 A0 00 00**

12. **Interpolated position initial position**. Set the initial position to 0.5 rotations. By using a 500 lines incremental encoder the corresponding value of object 2079_h expressed in encoder counts is (1000_d) $3E8_h$. By using the settings done so far, if the final position command were to be 0, the drive would travel to (Actual position – 1000).

Send the following message (SDO access to object 2079_h, 32-bit value 0_h):

COB-ID	**606**
Data	**23 79 20 00 E8 03 00 00**

13. **Send the 1st PT point**.

Position= 20000 IU (0x00004E20)   1IU = 1 encoder pulse

Time   = 1000 IU (0x03E8)   1IU = 1 control loop = 1ms by default

IC   = 1 (0x01)   IC=Integrity Counter

The drive motor will do 10 rotations (20000 counts) in 1000 milliseconds.

Send the following message:

COB-ID	**406**
Data	**20 4E 00 00 E8 03 00 02**

14. **Send the 2nd PT point**.

Position= 30000 IU (0x00007530)

Time   = 2000 IU (0x07D0)

IC   = 2 (0x02)

Send the following message:

COB-ID	**406**
Data	**30 75 00 00 D0 07 00 04**

15. **Send the 3rd PT point**.

Position= 2000 IU (0x000007D0)

Time   = 1000 IU (0x03E8)

IC   = 3 (0x03)

Send the following message:

COB-ID	**406**
Data	**D0 07 00 00 E8 03 00 06**

16. **Send the last PT point**.

Set X1=00000000_h (0 counts); X2=080001F4 (IC=4 (0x08), time =500 (0x01F4))

Position= 0 IU (0x00000000)

Time = 500 IU (0x01F4)

IC = 4 (0x04)

Send the following message:

COB-ID	**406**
Data	**00 00 00 00 F4 01 00 08**

17. Start an absolute motion.

Send the following message:

COB-ID	**206**
Data	**1F 00**

After the sequences are executed, if the drive actual position before starting the motion was 0, now it should be -1000 counts because of Step 12.

9.4. PVT absolute movement example

Execute an absolute PVT movement. The PVT position points will be given as absolute positions.

Remark: *Because this is a demo for a single axis the synchronization mechanism is not used here.*

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**

Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Disable the RPDO3**. Write zero in object 1602_h sub-index 0, this will disable the PDO.

Send the following message (SDO access to object 1602_h sub-index 0, 8-bit value 0):

COB-ID	**606**
Data	**2F 02 16 00 00 00 00 00**

6. **Map the new objects**.
   a) Write in object 1602_h sub-index 1 the description of the interpolated data record sub-index 1:

Send the following message (SDO access to object 1602_h sub-index 1, 32-bit value $60C10120_h$):

COB-ID	**606**
Data	**23 02 16 01 20 01 C1 60**

   b) Write in object 1601_h sub-index 2 the description of the interpolated data record sub-index 2:

Send the following message (SDO access to object 1602_h sub-index 2, 32-bit value $60C10220_h$):

COB-ID	**606**
Data	**23 02 16 02 20 02 C1 60**

7. **Enable the RPDO3**. Set the object 1601_h sub-index 0 with the value 2.

Send the following message (SDO access to object 1601_h sub-index 0, 8-bit value 2):

COB-ID	**606**
Data	**2F 02 16 00 02 00 00 00**

8. **Mode of operation**. Select interpolation position mode.

Send the following message (SDO access to object 6060_h, 8-bit value 7_h):

COB-ID	**606**
Data	**2F 60 60 00 07 00 00 00**

9. **Interpolation sub mode select**. Select PVT interpolation position mode.

Send the following message (SDO access to object $60C0_h$, 16-bit value $FFFF_h$):

COB-ID	**606**
Data	**2E C0 60 00 FF FF 00 00**

10. **Interpolated position buffer length**. Set the buffer length to 15. The maximum length is 15.

Send the following message (SDO access to object 2074_h, 16-bit value C_h):

COB-ID	**606**
Data	**2B 73 20 00 00 0F 00 00**

11. **Interpolated position buffer configuration**. By setting the value $B000_h$, the buffer is cleared and the integrity counter will be set to 0.

Send the following message (SDO access to object 2074_h, 16-bit value $B000_h$):

COB-ID	**606**
Data	**2B 74 20 00 00 B0 00 00**

12. **Send the 1st PVT point**.

Position = 88 IU (0x000058) 1IU = 1 encoder pulse

Velocity = 3.33 IU (0x000354) 1IU = 1 encoder pulse/ 1 control loop

Time = 55 IU (0x37) 1IU = 1 control loop = 1ms by default

IC = 0 (0x00) IC=Integrity Counter

Send the following message:

COB-ID	**406**
Data	**58 00 54 00 03 00 37 00**

13. **Send the 2nd PVT point**.

Position = 370 IU (0x000172)

Velocity = 6.66 IU (0x0006A8)

Time = 55 IU (0x37)

IC = 1 (0x01)

Send the following message:

COB-ID	**406**
Data	**72 01 A8 00 06 00 37 02**

14. **Send the 3rd PVT point**.

Position = 2982 IU (0x000BA6)

Velocity = 6.66 IU (0x0006A8)

Time = 390 IU (0x186)

IC = 2 (0x02)

Send the following message:

COB-ID	**406**
Data	**A6 0B A8 00 06 00 86 05**

15. Send the 4th PVT point.

Position = 5631 IU (0x0015FF)

Velocity = 6.66 IU (0x0006A8)

Time = 400 IU (0x190)

IC = 3 (0x03)

Send the following message:

COB-ID	**406**
Data	**FF 15 A8 00 06 00 90 07**

16. Send the 5th PVT point.

Position = 5925 IU (0x001725)

Velocity = 3.00 IU (0x000300)

Time = 60 IU (0x3C)

IC = 4 (0x04)

Send the following message:

COB-ID	**406**
Data	**25 17 00 00 03 00 3C 08**

17. Send the 6th PVT point.

Position = 6000 IU (0x001770)

Velocity = 0.00 IU (0x000000)

Time = 50 IU (0x32)

IC = 5 (0x05)

Send the following message:

COB-ID	**406**
Data	**70 17 00 00 00 00 32 0A**

18. Send the 7th PVT point.

Position = 5127 IU (0x001407)

Velocity = -7.5 IU (0xFFF880)

Time = 240 IU (0xF0)

IC = 6 (0x06)

Send the following message:

COB-ID	**406**
Data	**07 14 80 00 F8 FF F0 0C**

19. Send the 8th PVT point.

Position = 3115 IU (0x000C2B)

Velocity = -13.33 IU (0xFFF2AB)

Time = 190 IU (0xBE)

IC = 7 (0x07)

Send the following message:

COB-ID	**406**
Data	**2B 0C AB 00 F2 FF BE 0E**

20. Send the 9th PVT point.

Position = -1686 IU (0xFFF96A)

Velocity = -13.33 IU (0xFFF2AB)

Time = 360 IU (0x168)

IC = 8 (0x08)

Send the following message:

COB-ID	**406**
Data	**6A F9 AB FF F2 FF 68 11**

21. Send the 10nth PVT point.

Position = -7145 IU (0xFFE417)

Velocity = -13.33 IU (0xFFF2AB)

Time = 410 IU (0x19A)

IC = 9 (0x0A)

Send the following message:

COB-ID	**406**
Data	**17 E4 AB FF F2 FF 9A 13**

22. Send the 11th PVT point.

Position = -9135 IU (0xFFDC51)

Velocity = -7.4 IU (0xFFF899)

Time = 190 IU (0xBE)

IC = 10 (0x0A)

Send the following message:

COB-ID	**406**
Data	**51 DC 99 FF F8 FF BE 14**

23. Send the 12th PVT point. The last.

Position = -10000 IU (0xFFD8F0)

Velocity = -7.4 IU (0x000000)

Time = 240 IU (0xF0)

IC = 11 (0x0B)

Send the following message:

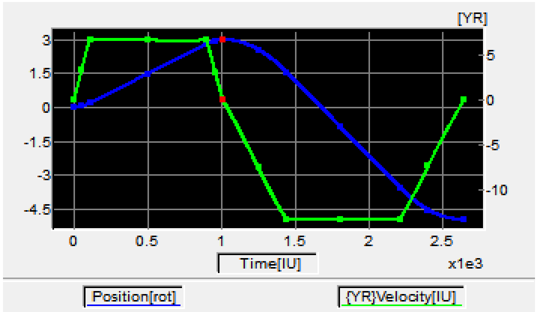
COB-ID	**406**
Data	**F0 D8 00 FF 00 00 F0 16**

24. Start an absolute motion.

Send the following message:

COB-ID	**206**
Data	**1F 00**

The PVT motion should be like the one below.



The motor should rotate 3 positive rotations and another 8 negatively (for a 500 lines encoder). If the initial position before the motion was 0, the final position should be -10000 IU (-5 rotations). All points should be executed within 2.64s, considering the default time base is 1ms.

9.5. PVT relative movement example

Execute a relative PVT movement. The PVT position points will be given as a difference between next and last position.

Remark: *Because this is a demo for a single axis the synchronization mechanism is not used here.*

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Disable the RPDO3**. Write zero in object 1602_h sub-index 0, this will disable the PDO.

Send the following message (SDO access to object 1602_h sub-index 0, 8-bit value 0):

COB-ID	**606**

Data	**2F 02 16 00 00 00 00 00**

6. **Map the new objects**.
   - **a)** Write in object 1602_h sub-index 1 the description of the interpolated data record sub-index 1:

Send the following message (SDO access to object 1602_h sub-index 1, 32-bit value $60C10120_h$):

COB-ID	**606**
Data	**23 02 16 01 20 01 C1 60**

   - **b)** Write in object 1601_h sub-index 2 the description of the interpolated data record sub-index 2:

Send the following message (SDO access to object 1602_h sub-index 2, 32-bit value $60C10220_h$):

COB-ID	**606**
Data	**23 02 16 02 20 02 C1 60**

7. **Enable the RPDO3**. Set the object 1601_h sub-index 0 with the value 2.

Send the following message (SDO access to object 1601_h sub-index 0, 8-bit value 2):

COB-ID	**606**
Data	**2F 02 16 00 02 00 00 00**

8. **Mode of operation**. Select interpolation position mode.

Send the following message (SDO access to object 6060_h, 8-bit value 7_h):

COB-ID	**606**
Data	**2F 60 60 00 07 00 00 00**

9. **Set the relative motion bit.** Set in **Control Word** mapped in RPDO1 the value $4F_h$. For an absolute motion, set $0F_h$ but the example points will not apply.

   Remark: *if the relative motion bit is not set in control word before the PVT points are loaded, the trajectory will not be calculated correctly.*

Send the following message:

COB-ID	**206**
Data	**4F 00**

10. **Interpolation sub mode select**. Select PVT interpolation position mode.

Send the following message (SDO access to object $60C0_h$, 16-bit value $FFFF_h$):

COB-ID	**606**
Data	**2E C0 60 00 FF FF 00 00**

11. **Interpolated position buffer length**. Set the buffer length to 12. The maximum length is 15.

Send the following message (SDO access to object 2074_h, 16-bit value C_h):

COB-ID	**606**
Data	**2B 73 20 00 00 0C 00 00**

12. **Interpolated position buffer configuration**. By setting the value $A001_h$, the buffer is cleared and the integrity counter will be set to 1. Send the following message (SDO access to object 2074_h, 16-bit value C_h):

COB-ID	**606**
Data	**2B 74 20 00 01 A0 00 00**

13. **Interpolated position initial position**. Set the initial position to 0 rotations. The object should receive the drives actual position in Internal Units which can be read from object 6063h or 6062h when using steppers in open loop.

Send the following message (SDO access to object 2079_h, 32-bit value 0_h):

COB-ID	**606**
Data	**23 79 20 00 00 00 00 00**

14. **Send the 1st PVT point**.

Position = 400 IU (0x000190) 1IU = 1 encoder pulse

Velocity = 3.00 IU (0x000300) 1IU = 1 encoder pulse/ 1 control loop

Time = 250 IU (0xFA) 1IU = 1 control loop = 1ms by default

IC = 1 (0x01) IC=Integrity Counter

Send the following message:

COB-ID	**406**
Data	**90 01 00 00 03 00 FA 02**

15. **Send the 2nd PVT point**.

Position = 1240 IU (0x0004D8)

Velocity = 6.00 IU (0x000600)

Time = 250 IU (0xFA)

IC = 2 (0x02)

Send the following message:

COB-ID	**406**
Data	**D8 04 00 00 06 00 FA 04**

16. **Send the 3rd PVT point**.

Position = 1674 IU (0x00068A)

Velocity = 6.00 IU (0x000600)

Time = 250 IU (0xFA)

IC = 3 (0x03)

Send the following message:

COB-ID	**406**
Data	**8A 06 00 00 06 00 FA 06**

17. Send the 4th PVT point.

Position = 1666 IU (0x000682)

Velocity = 6.00 IU (0x000600)

Time = 250 IU (0xFA)

IC = 4 (0x04)

Send the following message:

COB-ID	**406**
Data	**82 06 00 00 06 00 FA 08**

18. Send the 5th PVT point.

Position = 1240 IU (0x0004D8)

Velocity = 3.00 IU (0x000300)

Time = 250 IU (0xFA)

IC = 5 (0x05)

Send the following message:

COB-ID	**406**
Data	**D8 04 00 00 03 00 FA 0A**

19. Send the last PVT point.

Position = 410 IU (0x00019A)

Velocity = 0.00 IU (0x000000)

Time = 250 IU (0xFA)

IC = 6 (0x06)

Send the following message:

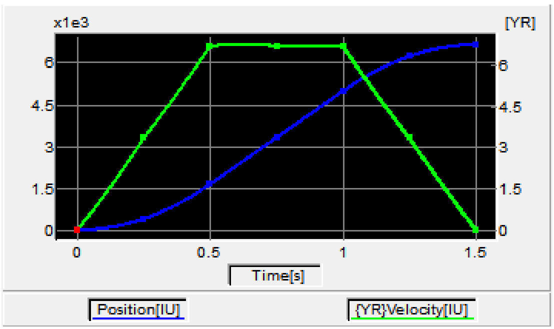
COB-ID	**406**
Data	**9A 01 00 00 00 00 FA 0C**

20. Start a relative motion.

Send the following message:

COB-ID	**206**
Data	**5F 00**

The PVT motion should be like the one below.



If the initial position before the motion was 0, the final position should be 6630 IU (3.315 rotation for a 500line encoder). All points should be executed in 1.5s, considering the default time base is 1ms.

10. Velocity Profile Mode

10.1. Overview

In the Velocity Profile Mode the drive performs speed control. The built-in reference generator computes a speed profile with a trapezoidal shape, due to a limited acceleration. The **Target Velocity** object (index $60FF_h$) specifies the jog speed (speed sign specifies the direction) and the **Profile Acceleration** object (index 6083_h) the acceleration/deceleration rate. While the mode is active, any change of the Target Velocity object by the CANopen master will update the drive's demand velocity enabling you to change on the fly the slew speed and/or the acceleration/deceleration rate. The motion will continue until the **Halt** bit from the Control Word is set. An alternate way to stop the motion is to set the jog speed to zero.

While the mode is active (profile velocity mode is selected in *modes of operation*), every time a write access is performed inside the object *target velocity*, the demand velocity of the drive is updated.

10.1.1. Control word in profile velocity mode

MSB **LSB**

See 6040h	Halt	See 6040h	reserved	See 6040h
15 9	8	7	6 4	3 0

Table 10.1 *Control Word bits for Velocity Profile Mode*

Name	Value	Description
Halt	0	Execute the motion
	1	Stop drive with *profile acceleration*

10.1.2. Status word in profile velocity mode

MSB **LSB**

See 6041h	Max slippage error	Speed	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 10.2 *Status word bits for Velocity Profile*

Name	Value	Description
Target reached	0	Halt = 0: *Target velocity* not (yet) reached Halt = 1: Drive decelerates

	1	Halt = 0: *Target velocity* reached Halt = 1: Velocity of drive is 0
Speed	0	Speed is not equal to 0
	1	Speed is equal to 0
Max slippage error	0	Maximum slippage not reached
	1	Maximum slippage reached

***Remark**: In order to set / reset bit 12 (speed), the object 606F$_h$, velocity threshold is used. If the actual velocity of the drive / motor is below the velocity threshold, then bit 12 will be set, else it will be reset.*

10.2. Velocity Mode Objects

10.2.1.Object 6069h: Velocity sensor actual value

This object describes the value read from the velocity encoder in increments.

The velocity units are user defined speed units. The value is converted to internal units using the *velocity factor*

If no factor is applied 65536 IU = 1 encoder increment / sample.

Object description:

Index	6069$_h$
Name	Velocity sensor actual value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Value range	INTEGER32
Default value	-

10.2.2.Object 606Bh: Velocity demand value

This object provides the output of the trajectory generator and is provided as an input for the velocity controller. It is given in user-defined velocity units.

Object description:

Index	606B$_h$
Name	Velocity demand value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Value range	INTEGER32
Default value	-

10.2.3.Object 606Ch: Velocity actual value

The *velocity actual value* is given in user-defined velocity units and is read from the velocity sensor.

Object description:

Index	$606C_h$
Name	Velocity actual value
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Yes
Value range	INTEGER32
Default value	-

10.2.4.Object 606Fh: Velocity threshold

The *velocity threshold* is given in user-defined velocity units and it represents the threshold for velocity at which it is regarded as zero velocity. Based on its value, bit 12 of *status word* (speed) will be set or reset.

Object description:

Index	$606F_h$
Name	Velocity threshold
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Value range	UNSIGNED16
Default value	-

10.2.5.Object 60FFh: Target velocity

The *target velocity* is the input for the trajectory generator and the value is given in user-defined velocity units.

Object description:

Index	$60FF_h$
Name	Target velocity
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	possible
Value range	INTEGER32
Default value	-

10.2.6.Object 60F8h: Max slippage

The *max slippage* monitors whether the maximal slippage has actually been reached. The value is given in user-defined velocity units. When the *max slippage* has been reached, the corresponding bit 13 *max slippage error* in the *status word* is set.

Object description:

Index	$60F8_h$
Name	Max slippage
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	possible
Value range	INTEGER32
Default value	-

10.2.7.Object 2005h: Max slippage time out

Time interval for *max slippage*. The value is given in ms.

Object description:

Index	2005_h
Name	Max slippage time out
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	-

10.3. Speed profile example

Execute a speed control with 600 rpm target speed.

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **Mode of operation.** Select speed mode.

Send the following message (SDO access to object 6060_h, 8-bit value 3_h):

COB-ID	**606**
Data	**2F 60 60 00 03 00 00 00**

6. **Target velocity.** Set the target velocity to 600 rpm. By using and 500 lines incremental encoder and 1ms sample rate for position/speed control the corresponding value of object $60FF_h$ expressed in encoder counts per sample is 140000_h.

Send the following message (SDO access to object $60FF_h$ 32-bit value 00140000_h):

COB-ID	**606**
Data	**23 FF 60 00 00 00 14 00**

7. **Check the motor actual speed.** It should rotate with 600 rpm.

Send the following message (SDO access to read object $606C_h$ Velocity actual value):

COB-ID	**606**
Data	**40 6C 60 00 00 00 00 00**

11. Electronic Gearing Position (EGEAR) Mode

11.1. Overview

In Electronic Gearing Position Mode the drive follows the position of an electronic gearing master with a programmable gear ratio.

The electronic gearing slave can get the position information from the electronic camming master via CANbus communication channel, from another Technosoft CANopen drive set as electronic gearing master with object **Master Settings** (index 2010_h). The position is sent using TechnoCAN, an extension of the CANopen protocol, developed by Technosoft.

The online reference received via communication channel is set with object **External Reference Type** (index $201D_h$).

The drive set as slave in electronic gearing mode performs a position control. At each slow loop sampling period, the slave computes the master position increment and multiplies it with its programmed gear ratio. The result is the slave position reference increment, which added to the previous slave position reference gives the new slave position reference.

Remark: *The slave executes a relative move, which starts from its actual position*

The gear ratio is specified via **EGEAR multiplication factor** object (index 2013_h). EGEAR ratio numerator (sub-index 1) is a signed integer, while EGEAR ratio denominator (sub-index 2) is an unsigned integer. The EGEAR ratio numerator sign indicates the direction of movement: positive – same as the master, negative – reversed to the master. The result of the division between EGEAR ratio numerator and EGEAR ratio denominator is used to compute the slave reference increment.

The **Master Resolution** object (index 2012_h) provides the master resolution, which is needed to compute correctly the master position and speed (i.e. the position increment). If master position is not cyclic (i.e. the resolution is equal with the whole 32-bit range of position), set master resolution to 0x80000001.

You can smooth the slave coupling with the master, by limiting the maximum acceleration of the slave drive. This is particularly useful when the slave has to couple with a master running at high speed, in order to minimize the shocks in the slave. The feature is activated by setting ControlWord.5=1 and the maximum acceleration value in **Profile Acceleration** object (index 6083_h).

11.1.1.Control word in electronic gearing position mode (slave axis)

MSB **LSB**

See 6040h	Halt	See 6040h	Reserved	Activate Acceleration Limitation	Enable Electronic Gearing Mode	See 6040h
15 9	8	7	6	5	4	3 0

Table 10.3 *Control Word bits for Electronic Gearing Position Mode*

Name	**Value**	**Description**
Enable Electronic Gearing Mode	0	Do not start operation
	0 -> 1	Start electronic gearing procedure
	1	Electronic gearing mode active
	1 -> 0	Do nothing (does not stop current procedure)
Activate Acceleration Limitation	0	Do not limit acceleration when entering electronic gear mode
	1	Limit acceleration when entering electronic gear mode to the value set in *profile acceleration* (object 6083_h)
Halt	0	Execute the instruction of bit 4
	1	Stop drive with *profile acceleration*

11.1.2.Status word in electronic gearing position mode

MSB **LSB**

See 6041h	Following error	Reserved	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 11.1 *Status Word bits for Electronic Gearing Position Mode*

Name	**Value**	**Description**
Target reached	0	Halt = 0: Always 0 Halt = 1: Drive decelerates
	1	Halt = 0: Always 0 Halt = 1: Velocity of drive is 0
Following error	0	No following error
	1	Following error occurred

11.2. Gearing Position Mode Objects

11.2.1.Object 2010h: Master settings

This object contains key settings for the master of EGEAR / ECAM mode. A master in EGEAR / ECAM mode is a drive that controls a motor (irrespective of the control mode) and that will be designated to send the information about its position (demanded position or actual position) via communication to one or more slaves (programmed accordingly).

This object also allows setting the address of the slave to which the master will send its position, or, if there are more slaves to receive simultaneously the position from the master, the Group ID of these slaves.

Object description:

Index	2010_h
Name	Master settings
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Possible
Units	-
Value range	0 … 65535
Default value	0

Table 11.2 *Master Settings bits description*

Bit	Value	Description
15	0	Master is not active – the master drive does not send any position values
	1	Master is active – the master drive starts sending its position to the slave axis
14 … 10	0	Reserved
9	0	The master sends its feedback (the position actual value)
	1	The master sends the demand position
8	0	Address is an axis ID
	1	Address is a group ID
7 … 0	x	Address of the slave drive(s)

11.2.2.Object 2012h: Master resolution

This object is used in order to set the master resolution in increments per revolution. This object is valid for the slave axis.

Object description:

Index	2012_h
Name	Master resolution
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Units	Increments
Value range	0 … 2^{31}-1
Default value	80000001h (full range)

11.2.3.Object 2013h: EGEAR multiplication factor

In digital external mode, this object sets the gear ratio, or gear multiplication factor for the slaves. The sign indicates the direction of movement: positive – same as the master, negative – reversed to the master. The slave demand position is computed as the master position increment multiplied by the gear multiplication factor.

Example: if the gear ratio is Slave/Master = 1/3, the following values must be set: 1 in EGEAR ratio numerator (sub-index 1) and 3 in EGEAR ratio denominator (sub-index 2) .

Remark: the gear ratio is computed after sub-index 2 is written. So sub-index1 must be written first and then sub-index 2. Even if sub-index 2 has the same value as before, it must be written again for the gear ratio to be computed correctly.

Object description:

Index	2013_h
Name	EGEAR multiplication factor
Object code	RECORD
Number of elements	2

Entry description:

Sub-index	1
Description	EGEAR ratio numerator (slave)
Object code	VAR
Data type	INTEGER16
Access	RW
PDO mapping	Possible
Value range	-32768 … 32767

Default value	1

Sub-index	2
Description	EGEAR ratio denominator (master)
Object code	VAR
Data type	UNSIGNED16
Access	RW
PDO mapping	Possible
Value range	0 … 65535
Default value	1

11.2.4.Object 2017h: Master actual position

The actual position of the master can be monitored through this object, regardless of the way the master actual position is delivered to the drive (on-line through a communication channel or from the digital inputs of the drive). The units are increments.

Object description:

Index	2017_h
Name	Master actual position
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	Possible
Value range	$-2^{31} \ldots 2^{31}-1$
Default value	0

11.2.5.Object 2018h: Master actual speed

This object is used to inform the user of the actual value of the speed of the master, regardless of the way the master actual position is delivered to the drive (on-line through a communication channel or from the digital inputs of the drive). The units are increments / sampling. 1 IU = 1 encoder increment / sample.

Object description:

Index	2018_h
Name	Master actual speed
Object code	VAR

Data type	INTEGER16

Entry description:

Access	RO
PDO mapping	Possible
Value range	-32768 … 32767
Default value	0

11.2.6.Object 201Dh: External Reference Type

This object is used to set the type of external reference for use with electronic gearing position, electronic camming position, position external, speed external and torque external modes.

Object description:

Index	$201D_h$
Name	External Reference Type
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Value range	UNSIGNED16
Default value	-

Table 11.3 *External Reference Type bit description*

Value	**Description**
0	Reserved
1	On-line. In case of External Reference Position / Speed / Torque Modes, select this option in order to read the reference from the object 201C, *External Online Reference* In case of Electronic Gearing and Camming Position Modes, select this option in order to read the master position received from a master drive via communication
2	Analogue. In case of External Reference Position / Speed / Torque Modes, select this option in order to read the reference from the dedicated analogue input.
4 … 65535	Reserved

11.3. Electronic gearing through CAN example

This example is split in two parts:

Part1: Start an electronic gearing master profile on CAN.

1. **Start remote node**. Send a NMT message to start the node id 7.

Send the following message:

COB-ID	**0**
Data	**01 07**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**207**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**207**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**207**
Data	**0F 00**

5. **Modes of operation.** Select speed mode.

Send the following message (SDO access to object 6060_h, 8-bit value 3_h):

COB-ID	**607**
Data	**2F 60 60 00 03 00 00 00**

6. **Target Velocity.** Set speed to 15 IU.

Send the following message (SDO access to object $60FF_h$, 32-bit value F_h):

COB-ID	**607**
Data	**23 FF 60 00 00 00 0F 00**

The master motor should start rotating with 15IU speed.

7. **Master Settings.** Set the drive as master and program it to send it's reference to axis 6.

Send the following message (SDO access to object 2010_h 32-bit value 00008006_h):

COB-ID	**607**
Data	**2B 10 20 00 06 80 00 00**

Part2: Start an Electronic Gearing Slave on CAN

1. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

5. **External reference type.** Slave receives reference through CAN.

Send the following message (SDO access to object $201D_h$):

COB-ID	**606**
Data	**2B 1D 20 00 01 00 00 00**

6. **Modes of operation.** Select Electronic Gearing mode.

Send the following message (SDO access to object 6060_h, 8-bit value -1):

COB-ID	**606**
Data	**2F 60 60 00 FF 00 00 00**

7. **Master resolution.** Set the master resolution.

Send the following message (SDO access to object 6060_h, 32-bit value 2000):

COB-ID	**606**
Data	**23 12 20 00 D0 07 00 00**

8. **Electronic gearing multiplication factor.**

Set EG numerator to 1.

Send the following message (SDO access to object 2013_h,sub-index 1, 16-bit value 1):

COB-ID	**606**
Data	**2B 13 20 01 01 00 00 00**

Set EG denominator to 1.

Send the following message (SDO access to object 2013_h,sub-index 2, 16-bit value 1):

COB-ID	**606**
Data	**2B 13 20 02 01 00 00 00**

9. **Enable EG slave** in control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**1F 00**

The slave motor should start rotating with the same speed as the master motor.

12. Electronic Camming Position (ECAM) Mode

12.1. Overview

In Electronic Camming Position the drive executes a cam profile function of the position of an electronic camming master. The cam profile is defined by a cam table – a set of (X, Y) points, where X is cam table input i.e. the position of the electronic camming master and Y is the cam table output i.e. the corresponding slave position. Between the points the drive performs a linear interpolation.

The electronic camming slave can get the position information from the electronic camming master via CANbus communication channel, from another Technosoft drive set as electronic camming master with object **Master Settings** (index 2010_h). The position is sent using TechnoCAN, an extension of the CANopen protocol, developed by Technosoft.

The reference type is received online via communication channel and it is set with object **External Reference Type** (index $201D_h$). The electronic camming position mode can be: **relative** (if ControlWord.6 = 0) or **absolute** (if ControlWord.6 = 1).

In the relative mode, the output of the cam table is added to the slave actual position. At each slow loop sampling period the slave computes a position increment **dY = Y – Yold**. This is the difference between the actual cam table output Y and the previous one Yold. The position increment dY is added to the old demand position to get a new demand position. The slave detects when the master position rolls over, from 360 degrees to 0 or vice-versa and automatically compensates in dY the difference between **Ymax** and **Ymin**. Therefore, in relative mode, you can continuously run the master in one direction and the slaves will execute the cam profile once at each 360 degrees with a glitch-free transition when the cam profile is restarted.

When electronic camming is activated in relative mode, the slave initializes **Yold** with the first cam output computed: **Yold = Y = f(X)**. The slave will keep its position until the master starts to move and then it will execute the remaining part of the cam. For example if the master moves from X to Xmax, the slave moves with Ymax – Y.

In the absolute mode, the output of the cam table Y is the demand position to reach.

Remark: *The absolute mode must be used with great care because it may generate abrupt variations on the slave demand position if:*

- Slave position is different from Y at entry in the camming mode
- Master rolls over and Ymax < Ymin

In the absolute mode, you can introduce a maximum speed limit to protect against accidental sudden changes of the positions to reach. The feature is activated by setting ControlWord.5=1 and the maximum speed value in object **Profile Velocity** (index 6081_h).

Typically, the cam tables are first downloaded into the EEPROM memory of the drive by the CANopen master or with EasyMotion Studio. Then using the object **CAM table load address** (index 2019_h) they are copied in the RAM address set in object **CAM table run address** (index $201A_h$). It is possible to copy more than one cam table in the drive/motor RAM memory. When the ECAM mode is activated it uses the CAM table found at the RAM address contained in **CAM table run address**.

A CAM table can be shifted, stretched or compressed.

12.1.1.Control word in electronic camming position mode

MSB						LSB
See 6040h	Halt	See 6040h	Abs / Rel	Activate Speed Limitation	Enable Electronic Camming Mode	See 6040h
15 9	8	7	6	5	4	3 0

Table 12.1 *Control word bits for electronic camming position mode*

Name	Value	Description
Enable Electronic Camming Mode	0	Do not start operation
	0 -> 1	Start electronic camming procedure
	1	Electronic camming mode active
	1 -> 0	Do nothing (does not stop current procedure)
Activate Speed Limitation	0	Do not limit speed when entering absolute electronic camming mode
	1	Limit speed when entering absolute electronic camming mode at the value set in *profile velocity* (ONLY for absolute mode)
Abs / Rel	0	Perform relative camming mode – when entering the camming mode, the slave will compute the cam table relative to the starting moment.
	1	Perform absolute camming mode – when entering the camming mode, the slave will go to the absolute position on the cam table
Halt	0	Execute the instruction of bit 4
	1	Stop drive with *profile acceleration*

12.1.2.Status word in electronic camming position mode

MSB					LSB
See 6041h	Following error	Reserved	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 12.2 *Status word bits for electronic camming position mode*

Name	Value	Description
Target reached	0	Halt = 0: Always 0 Halt = 1: Drive decelerates
	1	Halt = 0: Always 0 Halt = 1: Velocity of drive is 0
Following error	0	No following error
	1	Following error occurred

12.2. Electronic Camming Position Mode Objects

12.2.1.Object 2019h: CAM table load address

This is the **load address** of the CAM table. The CAM table is stored in EEPROM memory of the drive starting from the load address. The initialization of the electronic camming mode requires the CAM table to be copied from the EEPROM memory to the RAM memory of the drive, starting from the **run address**, set in object $201A_h$, for faster processing. The copy is made every time object 2019_h is written by SDO access.

Remark: *The* ***CAM table run address*** *object must be set before writing the object* ***CAM table load address*** *to assure a proper copy operation from EEPROM to RAM memory.*

Object description:

Index	2019_h
Name	CAM table load address
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Units	-
Value range	UNSIGNED16
Default value	Variable depending on motor + feedback configuration

12.2.2.Object 201Ah: CAM table run address

This is the run address of the CAM table e.g. the RAM address starting from which the CAM table is copied into the RAM during initialization of the electronic camming mode. (See also 2019_h).

Object description:

Index	$201A_h$
Name	CAM table run address
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	No
Units	-

Value range	UNSIGNED16
Default value	9E00h

12.2.3.Object 201Bh: CAM offset

This object may be used to shift the master position in electronic camming mode. The position actually used as X input in the cam table is not the master actual position (2017_h) but (master actual position – CAM offset) computed as modulo of master resolution (2012_h) The CAM offset must be set before enabling the electronic camming mode. The *CAM offset* is expressed in increments.

Object description:

Index	$201B_h$
Name	CAM offset
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Value range	0 … 2^{32}-1
Default value	0

12.2.4.Object 206Bh: CAM: input scaling factor

You can use this scaling factor in order to achieve a scaling of the input values of a CAM table. Its default value of 00010000h corresponds to a scaling factor of 1.0.

Object description:

Index	$206B_h$
Name	CAM input scaling factor
Object code	VAR
Data type	FIXED32

Entry description:

Access	RW
PDO mapping	Possible
Units	-
Value range	FIXED32
Default value	00010000_h

12.2.5.Object 206Ch: CAM: output scaling factor

You can use this scaling factor in order to achieve a scaling of the output values of a CAM table. Its default value of 00010000h corresponds to a scaling factor of 1.0.

Object description:

Index	$206C_h$
Name	CAM output scaling factor
Object code	VAR
Data type	FIXED32

Entry description:

Access	RW
PDO mapping	Possible
Units	-
Value range	FIXED32
Default value	00010000_h

12.2.6.Building a CAM profile and saving it as an .sw file example

Build your own cam profile in any program you like.

In this example we have used MS Excell.

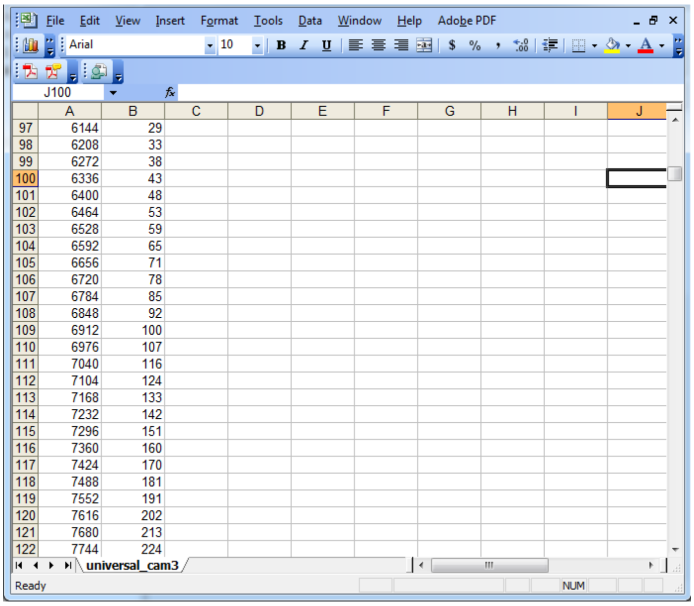


Figure 12.1 *MS Excell interface*

The numbers in the columns represent the input and output of the cam file. They are position points represented in the drive's internal units. Let's say that we have a 500 line quadrature encoder on the motor. This means that we will have 2000 counts per motor revolution. So the drive will rotate the rotor once if it receives a position command of 2000 internal units, or it will return 2000 internal units if the rotor turned once.

The first column represents the input position. It is a series of numbers that represent an interpolation step. Meaning that the difference between the values must be a number from the following: 2^0, 2^1, 2^2, 2^3, 2^4, 2^5, 2^6, 2^7. So let's say that we choose interpolation step of 2^6 (64). The first number in the first column must be 0, the second number must be 64,the third number must be 128 and so on.

The second column represents the Output of the cam file. This number can be anything that fits in an Integer32 bit variable.

For example let's say we have in the first column the number 640 (which is a multiple of 2^6) and in the second column we have the number 4000. This means that if the master is at position 640 (internal units), the slave must be at the position 4000 (internal units).

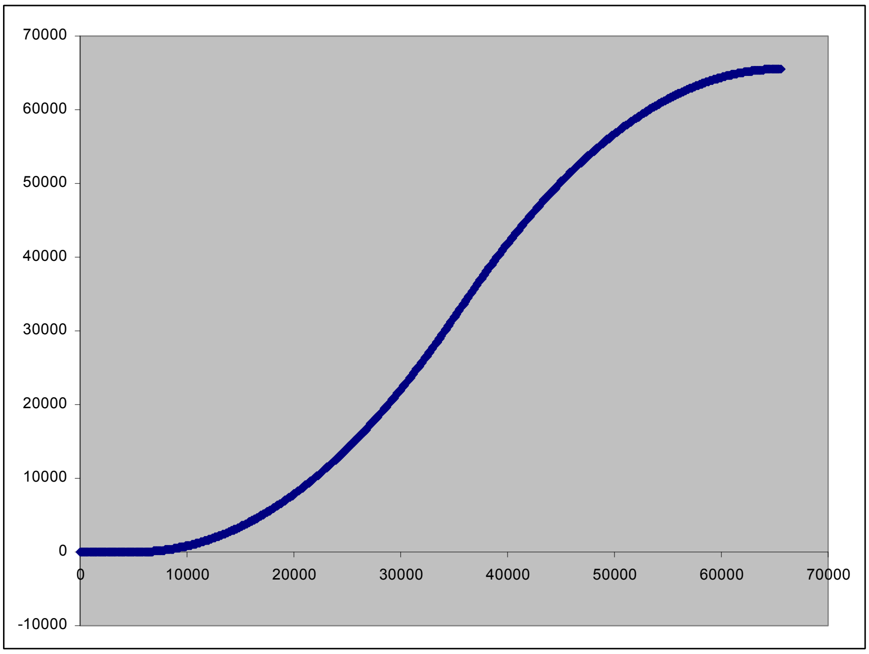


Figure 12.2 *Cam example*

After the cam is ready, save it as Text (Tab delimited) (*.txt) file.

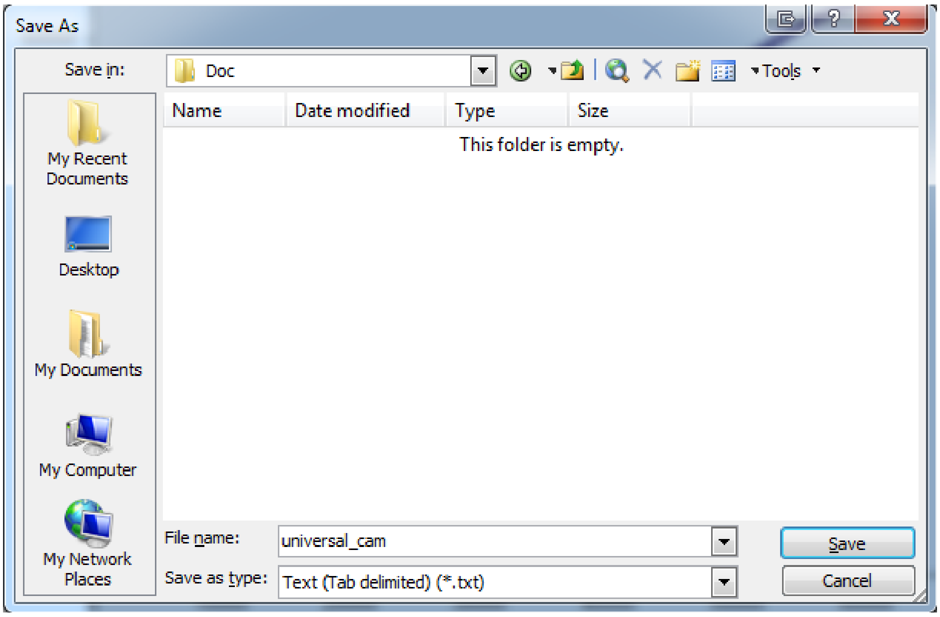
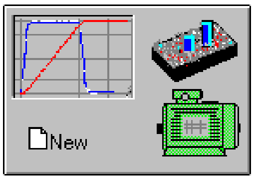


Figure 12.3 *Save As example.*

Once you have your cam file saved, start EasyMotion Studio, even the demo[1] version.

Press **New** button 

and select your drive type.

[1] ESM demo version available in download section here.

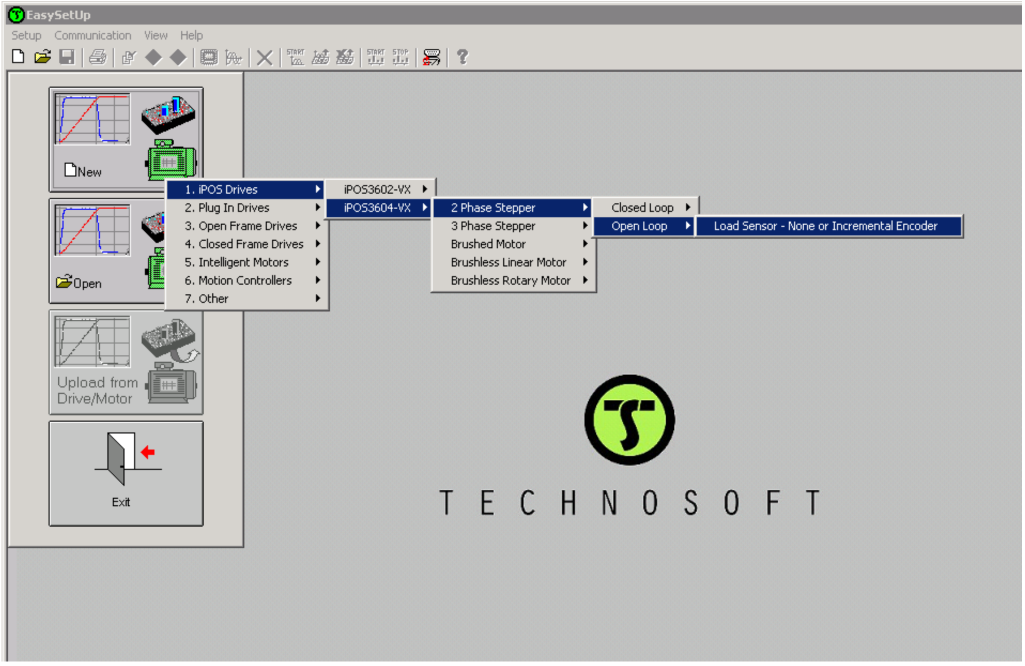


Figure 12.4 Choose drive configuration.

After the project opens, select CAM Tables tab from the left of the screen. Press the import button and choose your recently saved cam file (see **Figure 12.5**).

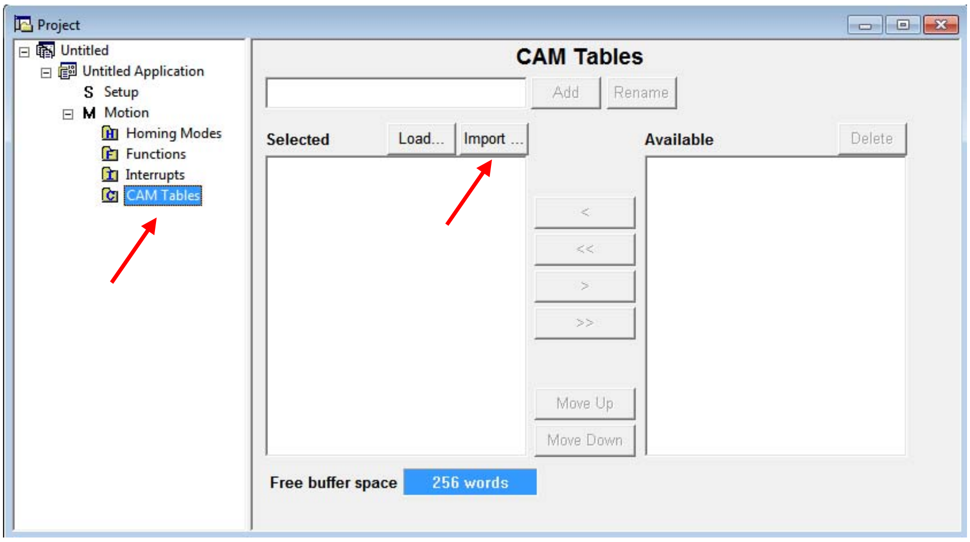


Figure 12.5 *CAM tab.*

If the CAM file loaded it should look like this:

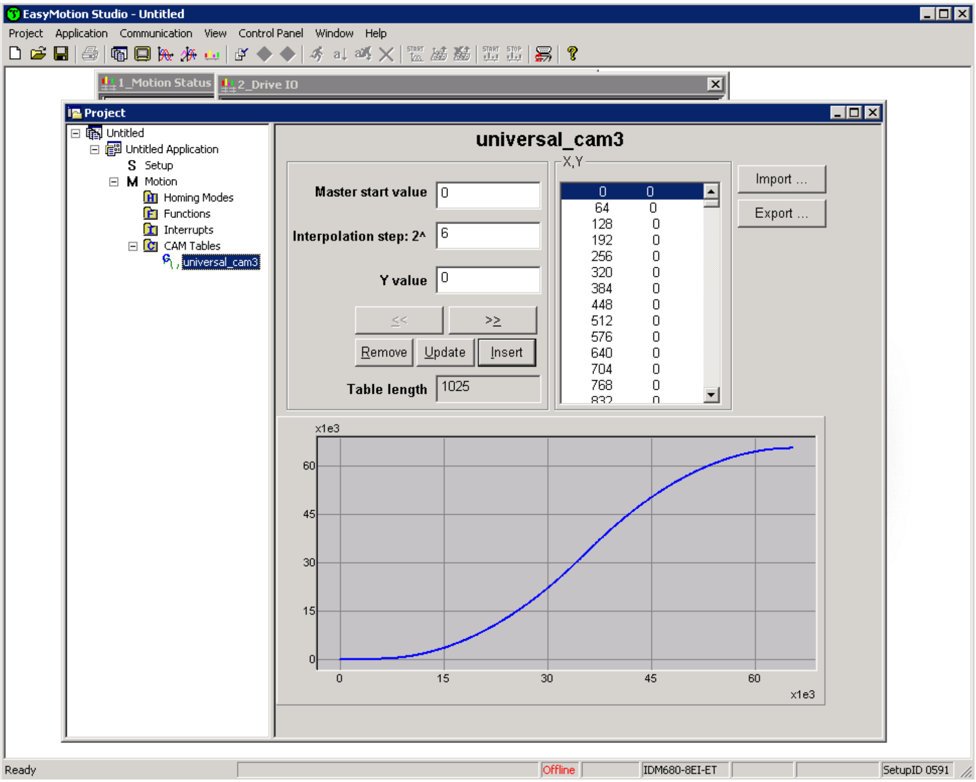
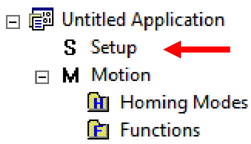
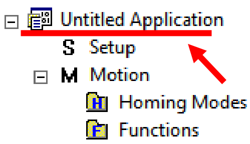


Figure 12.6 *CAM file loaded.*

After loading the CAM file successfully, click over the Setup  tab and load your saved setup[1].

Click the tab with the name of the application .

Press the memory settings button (like in the figure below).

[1] To create a setup file, please check your drive's user manual.

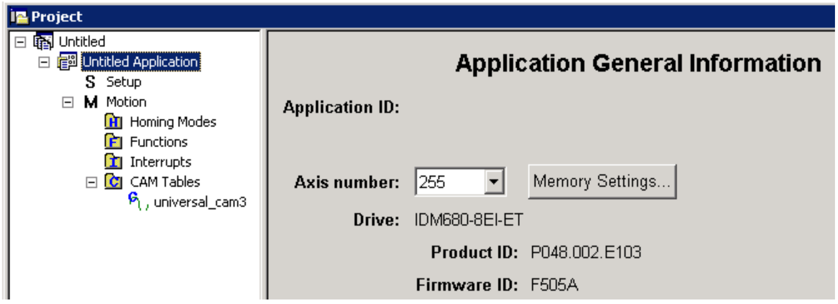


Figure 12.7 *Memory Settings location.*

In the window below see if necessary CAM space is larger than reserved cam space. If it is, write a slightly larger number than the necessary CAM space in the reserved one (Figure below).

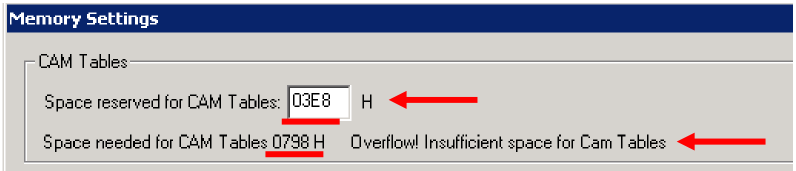


Figure 12.8 *Adjusting the necessary CAM space.*

In Memory Settings window look inside EEPROM memory section under CAM Tables. The first number is the **cam table Load Address** which must be set also in object **2019h** afterwards.

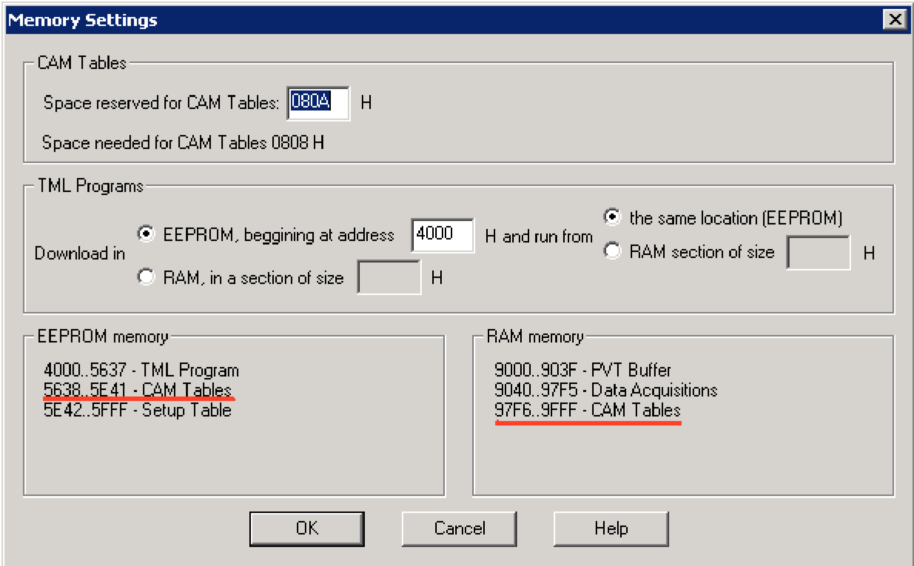


Figure 12.9 *Cam table load and run addresses.*

Under the RAM memory section the fist number in CAM Tables is the **cam table Run Address** which must also be set in object **201Ah** afterwards.

Save the project and select Application -> Create EEPROM programmer file -> Motion and Setup… like in the figure below. Save the eeprom file that includes your setup and motion (including CAM data) onto your PC.

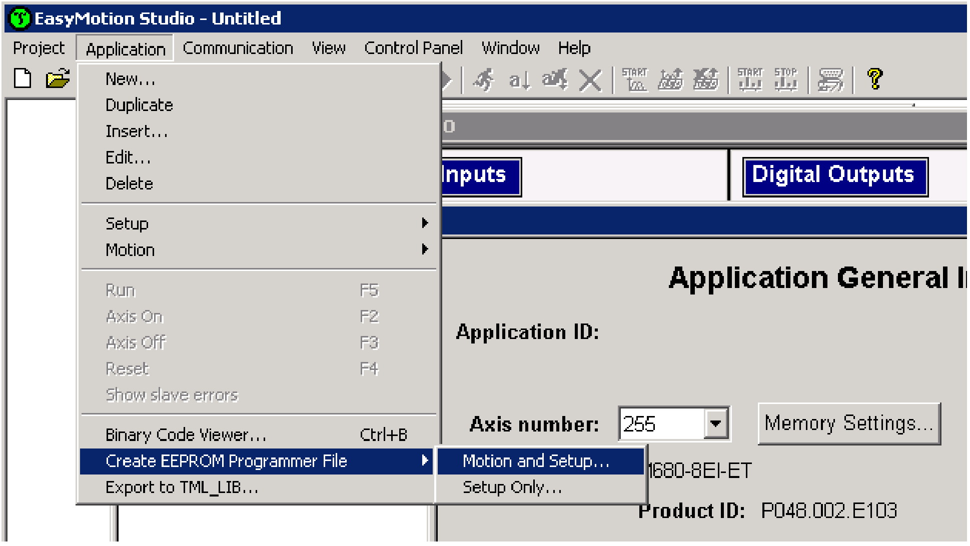


Figure 12.10 *Create .sw file.*

12.2.6.1. Extracting the cam data from the motion and setup .sw file

Open the recently saved .sw file with any text editor.

Inside the .sw file search for the number that corresponds to the CAM Table load address.

This number shall be delimited by an empty new line just before it (**Figure 12.11**) (the numbers before it represent the setup data).

Select all these numbers that represent the cam file until you find another empty new line (**Figure 12.12**).

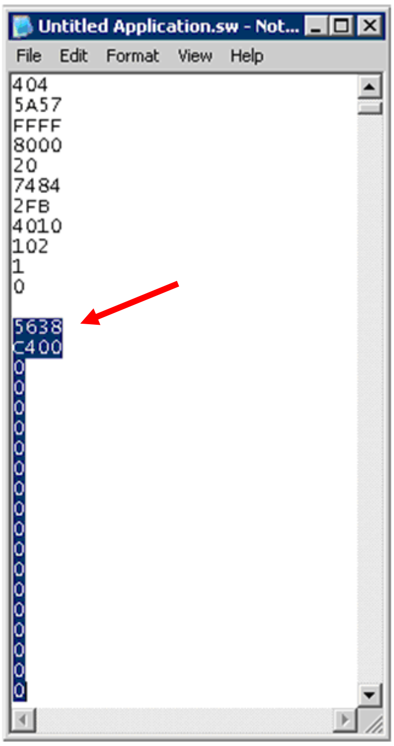


Figure 12.11 .sw file structure example

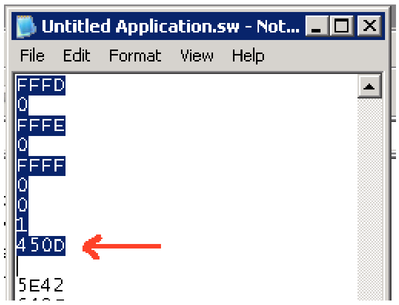


***Figure 12.12** .sw file empty line*

Copy all these numbers and save them as a new text file with the extension .sw instead of .txt.

Now you have a file that can be loaded onto the drive either with THS EEPROM Programmer (supplied free with EasySetup or ESM) or load it with the help of **2064_h 2065_h** objects explained in next sub chapter.

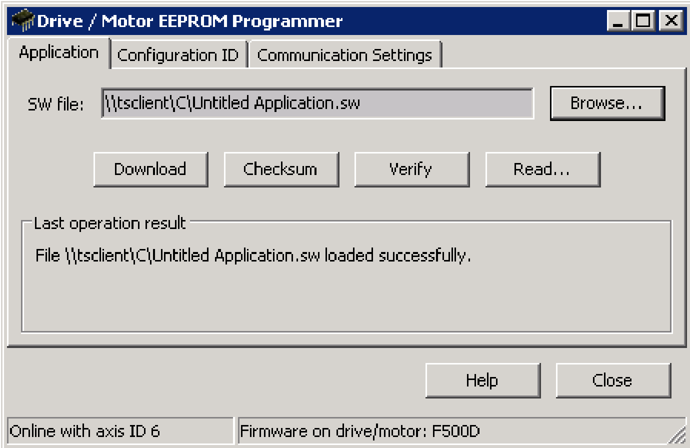


Figure 12.13 *THS EEPROM Programmer.*

Note: with THS EEPROM programmer you can write the entire setup and motion .sw file, not just the CAM .sw file created in this example.

12.2.6.2. Downloading a CAM .sw file with objects 2064$_h$ and 2065$_h$ example

In order to download the data block pointed by the red arrow found in **Figure 11.11**, first the block start address i.e. **5638$_h$** must be set using an SDO access to object 2064$_h$:

COB-ID	**60A**
Data	**23 64 20 00 08 00 38 56**

The above configuration command also indicates that the next read or write operation shall be executed with drive's EEPROM memory using 16-bit data and auto increment of address. All the numbers from the lines after **5638$_h$** until the following blank line represent data to write in the EEPROM memory at consecutive addresses starting with 5638$_h$. The data writes are done using an SDO access to object **2065$_h$**. First data word **C400$_h$** is written using:

COB-ID	**60A**
Data	**23 65 20 00 00 C4 00 00**

Next data word 0000$_h$ is written with:

COB-ID	**60A**
Data	**23 65 20 00 00 00 00 00**

and so on, until the end the CAM .sw file.

12.3. Electronic camming through CAN example

This example is split in two parts:

Part1: Start an Electronic Camming Slave on CAN

1. First load a cam table onto the drive as presented in chapter12.2.6 .
2. **Start remote node**. Send a NMT message to start the node id 6.

Send the following message:

COB-ID	**0**
Data	**01 06**

3. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**06 00**

4. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**07 00**

5. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**0F 00**

6. **External reference type.** Slave receives reference through CAN.

Send the following message (SDO access to object $201D_h$):

COB-ID	**606**
Data	**2B 1D 20 00 01 00 00 00**

7. **Cam table load address.** Set cam table load address as **5638_h**.

The cam table load address can be discovered as explained in chapter**12.2.6** .

Send the following message (SDO access to object 2019_h):

COB-ID	**606**
Data	**2B 19 20 00 1E 5A 00 00**

8. **Cam table run address.** Set cam table load address as **97F6**$_h$.

The cam table run address can be discovered as explained in chapter **12.2.6** .

Send the following message (SDO access to object 201A$_h$):

COB-ID	**606**
Data	**2B 1A 20 00 F6 97 00 00**

9. **Modes of operation.** Select Electronic Camming mode.

Send the following message (SDO access to object 6060$_h$, 8-bit value -2):

COB-ID	**606**
Data	**2F 60 60 00 FE 00 00 00**

10. **Master resolution.** Set the master resolution.

Send the following message (SDO access to object 2012$_h$, 32-bit value 2000):

COB-ID	**606**
Data	**23 12 20 00 D0 07 00 00**

11. **Cam offset.** Set cam offset to 6000 counts (1770$_h$).

If the master resolution is 2000 counts/revolution, the slave shall start applying the cam when the master is at position 6000 + CamX value.

Send the following message (SDO access to object 201B$_h$, 32-bit value 1770$_h$):

COB-ID	**606**
Data	**23 1B 20 00 70 17 00 00**

12. **Cam input scaling factor.** Set it to 1.

Send the following message (SDO access to object 206B$_h$, 32-bit value 1):

COB-ID	**606**
Data	**23 6B 20 00 00 00 01 00**

13. **Cam output scaling factor.** Set it to 1.

Send the following message (SDO access to object 206C$_h$, 32-bit value 1):

COB-ID	**606**
Data	**23 6C 20 00 00 00 01 00**

14. **Enable ECam slave mode** in control word associated PDO.

Send the following message:

COB-ID	**206**
Data	**3F 00**

The slave shall start moving and applying the cam after the master starts.

Part2: Start an electronic camming master on CAN.

1. **Start remote node**. Send a NMT message to start the node id 7.

Send the following message:

COB-ID	**0**
Data	**01 07**

2. **Ready to switch on.** Change the node state from *Switch on disabled* to *Ready to switch on* by sending the shutdown command via control word associated PDO.

Send the following message:

COB-ID	**207**
Data	**06 00**

3. **Switch on.** Change the node state from *Ready to switch on* to *Switch on* by sending the switch on command via control word associated PDO.

Send the following message:

COB-ID	**207**
Data	**07 00**

4. **Enable operation.** Change the node state from *Switch on* to *Operation enable* by sending the enable operation command via control word associated PDO.

Send the following message:

COB-ID	**207**
Data	**0F 00**

5. **Modes of operation.** Select speed mode.

Send the following message (SDO access to object 6060_h, 8-bit value 3_h):

COB-ID	**607**
Data	**2F 60 60 00 03 00 00 00**

6. **Target Velocity.** Set speed to 15 IU.

Send the following message (SDO access to object $60FF_h$, 32-bit value F_h):

COB-ID	**607**
Data	**23 FF 60 00 00 00 0F 00**

The master motor should start rotating with 15IU speed.

7. **Master Settings.** Set the drive as master and program it to send it's reference to axis 6.

Send the following message (SDO access to object $607A_h$ 32-bit value 00002710_h):

COB-ID	**607**
Data	**2B 10 20 00 06 80 00 00**

After the master is at position 6000 IU (cam offset), the slave (axis 06) shall rotate depending on the set cam values.

13. External Reference Position Mode

13.1. Overview

In this operating mode the drive performs position control with the demand position read from the external reference provided by another device.

There are 2 types of external references:

- Analogue – read by the drive via a dedicated analogue input (12-bit resolution)
- Online – received online via the CAN bus communication channel from the CANopen master in object **External On-line Reference** (index $201C_h$)

The reference type is selected with object **External Reference Type** (index $201D_h$).

In external reference position mode with analogue or online reference, you can limit the maximum speed at sudden changes of the position reference and thus to reduce the mechanical shocks. This feature is activated by setting ControlWord.6=1 and the maximum speed value in object **Profile Velocity** (index 6081_h).

13.1.1. Control word in external reference position mode

MSB | LSB

See 6040h	Halt	See 6040h	Reserved	Activate Speed Limitation	Enable External Position Mode	See 6040h
15 9	8	7	6	5	4	3 0

Table 13.1 *Control Word bit description for External Reference Position mode*

Name	Value	Description
Enable External Position Mode	0	External position mode inactive
	1	External position mode active
Activate Speed Limitation	0	Do not limit speed on the inactive to active mode transition
	1	Limit speed when enabling the External Position mode
Halt	0	Execute the instruction of bit 4
	1	Stop drive with *profile acceleration*

In order to correctly set an external reference position mode, you have to set the way the reference is received (either on-line or analogue), using the object 201Dh, *External Reference Type*.

13.1.2.Status word in external reference position mode

MSB **LSB**

See 6041h	Following error	Reserved	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 13.2 *Status Word bit description for External Reference Position mode*

Name	Value	Description
Target reached	0	Halt = 0: Always 0 Halt = 1: Drive decelerates
	1	Halt = 0: Always 0 Halt = 1: Velocity of drive is 0
Following error	0	No following error
	1	Following error occurred

13.2. External Reference Position Mode Objects

13.2.1.Object 201Ch: External On-line Reference

This is used to set the reference in case the *External Reference Type* (Object 201Dh) is set for *online*. The unit for this object is the internal unit defined for each drive mode (position / speed / torque).

Object description:

Index	$201C_h$
Name	External online reference
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RW
PDO mapping	Possible
Units	Internal, operating mode dependant
Value range	INTEGER32
Default value	0

14. External Reference Speed Mode

14.1. Overview

In this mode, the drive performs speed control with demand velocity read from the external reference provided by other devices.

There are 2 types of external references:

- Analogue – read by the drive via a dedicated analogue input (12-bit resolution)
- Online – received online via the CAN bus communication channel from the CANopen master in object **External On-line Reference** (index $201C_h$)

The reference type is selected with object **External Reference Type** (index $201D_h$).

In external reference speed mode, you can limit the maximum acceleration at sudden changes of the speed reference and thus to get a smoother transition. This feature is activated by setting ControlWord.5=1 and the maximum acceleration value in object Profile Acceleration (6083_h).

14.1.1. Control word in external reference speed mode

MSB **LSB**

See 6040h	Halt	See 6040h	Reserved	Activate Acceleration Limitation	Enable External Speed Mode	See 6040h
15 9	8	7	6	5	4	3 0

Table 14.1 *Control Word bit description for External Reference Speed Mode*

Name	Value	Description
Enable External Speed Mode	0	External speed mode inactive
	1	External speed mode active
Activate Speed Limitation	0	Do not limit acceleration on the inactive to active mode transition
	1	Limit acceleration when enabling the External Speed mode
Halt	0	Execute the instruction of bit 4
	1	Stop drive with *profile acceleration*

14.1.2. Status word in external reference speed mode

MSB LSB

See 6041h	Max slippage error	Speed	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 14.2 *Status Word bit description for External Reference Speed Mode*

Name	**Value**	**Description**
Target reached	0	Halt = 0: Always 0 Halt = 1: Drive decelerates
	1	Halt = 0: Always 0 Halt = 1: Velocity of drive is 0
Speed	0	Speed is not equal to 0
	1	Speed is equal to 0
Max slippage error	0	Maximum slippage not reached
	1	Maximum slippage reached

Remark: *In order to set / reset bit 12, the object from index 606F$_h$, velocity threshold from profile velocity mode will be used. If the actual velocity of the drive / motor is below the velocity threshold, then bit 12 will be set, else it will be reset.*

15. External Reference Torque Mode

15.1. Overview

In this mode, the drive is controlled in torque mode and the external reference is interpreted as torque/current reference.

There are 2 types of external references:

- Analogue – read by the drive via a dedicated analogue input (12-bit resolution)
- Online – received online via the CAN bus communication channel from the CANopen master in object **External On-line Reference** (index $201C_h$)

The reference type is selected with object **External Reference Type** (index $201D_h$).

15.1.1. Control word in external reference torque mode

MSB **LSB**

See 6040h	Halt	See 6040h	Reserved	Reserved	Enable External Torque Mode	See 6040h
15 9	8	7	6	5	4	3 0

Table 15.1 *Control Word bit description for External Reference Torque Mode*

Name	Value	Description
Enable External Torque Mode	0	External torque mode inactive
	1	External torque mode active
Halt	0	Execute the instruction of bit 4
	1	Stop drive – set torque reference to 0

15.1.2. Status word in external reference torque mode

MSB **LSB**

See 6041h	Reserved	Reserved	See 6041h	Target reached	See 6041h
15 14	13	12	11	10	9 0

Table 14.3 *Status Word bit description for External Reference Torque Mode*

Name	Value	Description
Target reached		Always 0

16. Touch probe functionality[1]

16.1. Overview

The Touch probe functionality offers the possibility to capture the motor current position when a configurable digital input trigger event happens.

Remark: do not use the touch probe functionality objects during a homing procedure. It may lead to incorrect results.

16.2. Touch probe objects

16.2.1. Object 60B8h: Touch probe function

This object indicates the configuration function of the touch probe.

Object description:

Index	$60B8_h$
Name	Touch probe function
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RW
PDO mapping	Yes
Value range	0 … 65535
Default value	0

The *Touch probe function* has the following bit assignment:

[1] This feature is available since firmware revision F

Table 16.1 *Bit Assignment of the Touch probe function*

Bit	Value	Description
14,15	-	Reserved
13	0	Switch off sampling at negative edge of touch probe 2
	1	Enable sampling at negative edge of touch probe 2*
12	0	Switch off sampling at positive edge of touch probe 2
	1	Enable sampling at positive edge of touch probe 2*
11,10	00_b	Trigger with touch probe 2 input (LSN input)
	01_b	Trigger with zero impulse signal
	10_b	Reserved
	11_b	Reserved
9	0	Trigger first event
	1	Reserved
8	0	Switch off touch probe 2
	1	Enable touch probe 2
7	-	Reserved
6	0	Enable limit switch functionality. The motor will stop, using quickstop
	1	Disable limit switch functionality. The motor will not stop when a limit switch is
5	0	Switch off sampling at negative edge of touch probe 1
	1	Enable sampling at negative edge of touch probe 1*
4	0	Switch off sampling at positive edge of touch probe 1
	1	Enable sampling at positive edge of touch probe 1*
3,2	00_b	Trigger with touch probe 1 input (LSP input)
	01_b	Trigger with zero impulse signal
	10_b	Reserved
	11_b	Reserved
1	0	Trigger first event
	1	Reserved
0	0	Switch off touch probe 1
	1	Enable touch probe 1

***Remarks:**

- The position cannot be captured on both positive and negative edges simultaneously using the zero impulse signal as a trigger.
- The position cannot be captured when touch probe 1 and 2 are active and the trigger is set on the zero impulse signal.
- The following bit settings are reserved:

  -Bit 3 and Bit2 = 1;

  -Bit 13 and Bit12 = 1;

  -Bit11 and Bit2 = 1;
- The homing procedures also utilize the capture function. Using this object during a homing procedure may lead to unforeseen results.

16.2.2. Object 60B9h: Touch probe status

This object provides the status of the touch probe.

Object description:

Index	$60B9_h$
Name	Touch probe status
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO
PDO mapping	Yes
Value range	0 … 65535
Default value	0

The *Touch probe status* has the following bit assignment:

***Table 16.2** Bit Assignment of the Touch probe status*

Bit	Value	Description
11 to 15	-	Reserved
10	0	Touch probe 2 no negative edge value stored
	1	Touch probe 2 negative edge position stored in object $60BD_h$
9	0	Touch probe 2 no positive edge value stored
	1	Touch probe 2 positive edge position stored in object $60BC_h$
8	0	Touch probe 2 is switched off
	1	Touch probe 2 is enabled
7	-	Reserved
6	0	Limit switch functionality enabled.
	1	Limit switch functionality disabled.
3 to 5	-	Reserved
2	0	Touch probe 1 no negative edge value stored
	1	Touch probe 1 negative edge position stored in object $60BB_h$
1	0	Touch probe 1 no positive edge value stored
	1	Touch probe 1 positive edge position stored in object $60BA_h$
0	0	Touch probe 1 is switched off
	1	Touch probe 1 is enabled

Note: Bit 1 and bit 2 are set to 0 when touch probe 1 is switched off (object $60B8_h$ bit 0 is 0). Bit 9 and 10 are set to 0 when touch probe 2 is switched off (object $60B8_h$ bit 8 is 0). Bits 1,2,9 and 10 are set to 0 when object $60B8_h$ bits 4,5,12 and 13 are set to 0.

16.2.3. Object 60BAh: Touch probe 1 positive edge

This object provides the position value of the touch probe 1 at positive edge.

Object description:

Index	$60BA_h$
Name	Touch probe 1 positive edge

Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	YES
Value range	$-2^{31}…2^{31}-1$
Default value	-

16.2.4. Object 60BBh: Touch probe 1 negative edge

This object provides the position value of the touch probe 1 at negative edge.

Object description:

Index	$60BB_h$
Name	Touch probe 1 negative edge
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	YES
Value range	$-2^{31}…2^{31}-1$
Default value	-

16.2.5. Object 60BCh: Touch probe 2 positive edge

This object provides the position value of the touch probe 2 at positive edge.

Object description:

Index	$60BC_h$
Name	Touch probe 2 positive edge
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	YES
Value range	$-2^{31}…2^{31}-1$
Default value	-

16.2.6. Object 60BDh: Touch probe 2 negative edge

This object provides the position value of the touch probe 2 at negative edge.

Object description:

Index	$60BD_h$
Name	Touch probe 2 negative edge
Object code	VAR
Data type	INTEGER32

Entry description:

Access	RO
PDO mapping	YES
Value range	$-2^{31}\ldots2^{31}-1$
Default value	-

17. Data Exchange between CANopen master and drives

17.1. Checking Setup Data Consistency

During the configuration phase, a CANopen master can quickly verify using the checksum objects and a reference **.sw** file whether the non-volatile EEPROM memory of the iPOS drive contains the right information. If the checksum reported by the drive doesn't match the one computed from the **.sw** file, the CANopen master can download the entire **.sw** file into the drive EEPROM using the communication objects for writing data into the drive EEPROM.

In order to be able to inspect or to program any memory location of the drive, as well as for downloading of a new TML program (application software), three manufacturer specific objects were defined: Object 2064_h – Read/Write Configuration Register, 2065_h – Write Data at address specified in 2064_h, 2066_h – Read Data from address specified in 2064_h, 2067_h – Write data at specified address.

17.2. Image Files Format and Creation

An image file (with extension **.sw**) is a text file that can be read with any text editor. It contains blocks of data separated by an empty line. Each block of data starts with the block start address, followed by data values to place in ascending order at consecutive addresses: first data – to write at start address, second data – to write at start address + 1, etc. All the data are hexadecimal 16-bit values (maximum 4 hexadecimal digits). Each line contains a single data value. When less then 4 hexadecimal digits are shown, the value must be right justified. For example 92 represent 0x0092.

The **.sw** software files can be generated either from EasySetUp or from EasyMotion Studio.

In EasySetUp you create a **.sw** file with the command **Setup | EEPROM Programmer File…** The software file generated, includes the setup data and the drive/motor configuration ID with the user programmable application ID.

In EasyMotion Studio you create a **.sw** file with one of the commands: **Application | EEPROM Programmer File | Motion and Setup** or **Setup Only**. The option **Motion and Setup** creates a **.sw** file with complete information including setup data, TML programs, cam tables (if present) and the drive/motor configuration ID. The option **Setup Only** produces a **.sw** file identical with that produced by EasySetUp i.e. having only the setup data and the configuration ID.

The **.sw** file can be programmed into a drive:

- from a CANopen master, using the communication objects for writing data into the drive EEPROM
- using the EEPROM Programmer tool, which comes with EasySetUp but may also be installed separately. The EEPROM Programmer was specifically designed for repetitive fast and easy programming of **.sw** files into the Technosoft drives during production.

17.3. Data Exchange Objects

17.3.1. Object 2064h: Read/Write Configuration Register

Object Read/Write Configuration Register 2064_h is used to control the read from drive memory and write to drive memory functions. This object contains the current memory address that will be used for a read/write operation. It can also be specified through this object the type of memory used (EEPROM, data or program) and the data type the next read/write operation refers to. Additionally, it can be specified whether an increment of the memory address should be performed or not after the read or write operation. The auto-increment of the memory address is particularly important in saving valuable time in case of a program download to the drive as well when a large data block should be read from the device.

Object description:

Index	2064_h
Name	Read/Write configuration register
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	Possible
Units	-
Value range	0 … 2^{32}-1
Default value	0x84

Table 17.1 *Read/Write Configuration Register bit description*

Bit	Value	Description
31…16	x	16-bit memory address for the next read/write operation
15…8	0	Reserved (always 0)
7	0	Auto-increment the address after the read/write operation
	1	Do not auto-increment the address after the read/write operation
6…4	0	Reserved (always 0)
3,2	00	Memory type is program memory
	01	Memory type is data memory
	10	Memory type is EEPROM memory
	11	Reserved
1	0	Reserved (always 0)
0	0	Next read/write operation is with a 16-bit data
	1	Next read/write operation is with a 32-bit data

17.3.2. Object 2065h: Write 16/32 bits data at address set in Read/Write Configuration Register

The object is used to write 16 or 32-bit values using the parameters specified in object 2064_h – Read/Write Configuration Register. After the successful write operation, the memory address in object 2064_h, bits 31…16 will be auto-incremented or not, as defined in the same register. The auto-incrementing of the address is particularly useful in downloading a program (software application) in the drives memory.

Object description:

Index	2065_h
Name	Write data at address set in 2064_h (16/32 bits)
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	WO
PDO mapping	Possible
Units	-
Value range	0 … 2^{32}-1
Default value	No

The structure of the parameter is the following:

Bit	Value	Description
31…16	0	Reserved if bit 0 of object 2064_h is 0 (operation on 16 bit variables)
	X	16-bit MSB of data if bit 0 of object 2064_h is 1 (operation on 32 bit variables)
15…0	X	16 bit LSB of data

17.3.3. Object 2066h: Read 16/32 bits data from address set in Read/Write Configuration Register

This object is used to read 16 or 32-bit values with parameters that are specified in object 2064_h – Read/Write Configuration Register. After the successful read operation, the memory address in object 2064_h, bits 31…16, will be auto-incremented or not, as defined in the same register.

Object description:

Index	2066_h
Name	Read data from address set in 2064_h (16/32 bits)
Object code	VAR

Data type	UNSIGNED32

Entry description:

Access	RO
PDO mapping	No
Units	-
Value range	UNSIGNED32
Default value	No

The structure of the parameter is the following:

Bit	Value	Description
31…16	0	Reserved if bit 0 of object 2064_h is 0 (operation on 16 bit variables)
	X	16-bit MSB of data if bit 0 of object 2064_h is 1 (operation on 32 bit variables)
15…0	X	16 bit LSB of data

17.3.4.Object 2067h: Write data at specified address

This object is used to write a single 16-bit value at a specified address in the memory type defined in object 2064_h – Read/Write Configuration Register. The rest of the bits in object 2064_h do not count in this case, e.g. the memory address stored in the Read/Write Control Register is disregarded and also the control bits 0 and 7. The object may be used to write only 16-bit data. Once the type of memory in the Read/Write Control Register is set, the object can be used independently. If mapped on a PDO, it offers quick access to any drive internal variable.

Object description:

Index	2067_h
Name	Write data at specified address
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	WO
PDO mapping	Possible
Units	-
Value range	UNSIGNED32
Default value	No

Bit	Value	Description
31…16	x	16-bit memory address
15…0	X	16 bit data value to be written

17.3.5.Object 2069h: Checksum configuration register

This object is used to specify a start address and an end address for the drive to execute a checksum of the E2ROM memory contents. The 16 LSB of this object are used for the start address of the checksum, and the 16 MSB for the end address of the checksum.

Note: The end address of the checksum must be computed as the start address to which you add the length of the section to be checked. The drive will actually compute the checksum for the memory locations between start address and end address.

The checksum is computed as a 16 bit unsigned addition of the values in the memory locations to be checked. When the object is written through SDO access, the checksum will be computed and stored in the read-only object $206A_h$.

Object description:

Index	2069_h
Name	Checksum configuration register
Object code	VAR
Data type	UNSIGNED32

Entry description:

Access	RW
PDO mapping	No
Units	-
Value range	UNSIGNED32
Default value	No

The structure of the parameter is the following:

Bit	Value	Description
31…16	X	16-bit end address of the checksum
15…0	X	16 bit start address of the checksum

17.3.6.Object 206Ah: Checksum read register

This object stores the latest computed checksum.

Object description:

Index	$206A_h$
Name	Checksum read register
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	RO

PDO mapping	No
Units	-
Value range	UNSIGNED16
Default value	No

17.4. Downloading an image file (.sw) to the drive using CANopen objects example

The structure of an image file (.sw) is described in paragraph 17.2 and shown in ***Figure 17.1***.

In order to download the data block pointed by the red arrow, first the block start address i.e. 5638_h must be set using an SDO access to object 2064_h.

- Send the following message: SDO access to object **2064_h**, 32-bit value **5638**0008_h.

The above configuration command also indicates that next read or write operation shall be executed with drive's EEPROM memory using 16-bit data and auto increment of address. All the numbers from the lines after 5638_h until the following blank line represents data to write in the EEPROM memory at consecutive addresses starting with 5638_h. The data writes are done using an SDO access to object 2065_h. First data word $C400_h$ is written using:

- Send the following message: SDO access to object **2065_h**, 32-bit value **C400**0008_h.

Next data word 0000_h is written with:

- Send the following message: SDO access to object **2065_h**, 32-bit value **0000**0008_h.

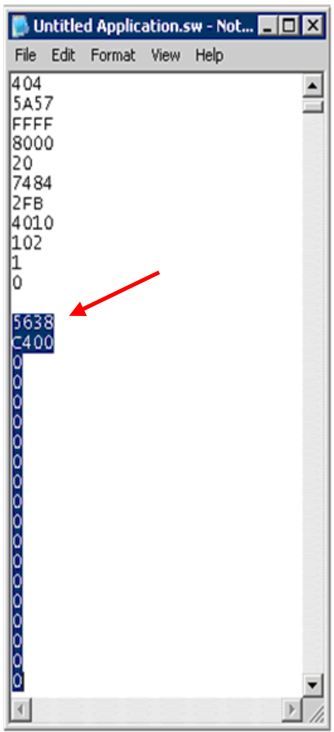


Figure 17.1 *.sw file structure example*

and so on, until the next blank line from the .sw file. As next data after a blank line is again an address, and the above process repeats. Finally to verify the integrity of the information stored in the drive EEPROM, checksum objects 2069_h and $206A_h$ can be used to compare the checksum computed by the drive with that computed on the master.

Warning!	When object 2064_h bit 7=0 (auto-incrementing is ON), do not read the object list in parallel with a read/write operation using a script. By reading object 2066h in parallel with another application, the target memory address will be incremented and will lead to incorrect data writing or reading.

17.5. Checking and loading the drive setup via .sw file using CANopen commands example.

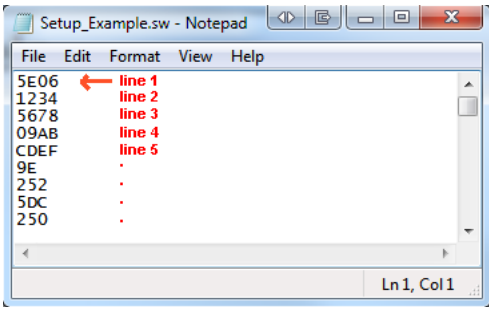
Check the integrity of the setup data on a drive and update it if needed.

Before reading this example, please read **paragraph 17.4.**

To create a .sw file containing only the setup data do the following:

- In Easy Motion Studio, go to Application (in the menu bar at the top)-> Create EEPROM Programmer File -> Setup Only… . Choose where to save the .sw file.
- In EasySetup, Setup (in the menu bar at the top) -> Create EEPROM Programmer File… . Choose where to save the .sw file.

Let's suppose that the setup data of a Technosoft drive is located at EEPROM addresses between 0x**5E06** and 0x**5EFF**. Here are the steps to be taken in order to check the setup data integrity and to re-program the drive if necessary:



1. **Compute the checksum in the .sw file**. Let's suppose that the computed checksum is 0x1234.
2. **Access object 2069_h in order to compute the checksum of the setup table located on the drive.** Write the value 0x**5EFF5E06**

   Send the following message: SDO write to object 2069_h sub-index 0, 32-bit value $5EFF5E06_h$.

Following the reception of this message, the drive will compute the checksum of the EEPROM locations 0x**5E06** to 0x**5EFF**. The result is stored in the object $206A_h$.

3. Read the computed checksum from object $206A_h$.

Read by SDO protocol the value of object $206A_h$.

Let's assume the drive returns the following message (Object $206A_h$ = 0x2345):

As the returned checksum (0x2345) does not match the checksum computed from the .sw file, the setup table has to be configured from the .sw file.

4. Prepare the Read/Write Configuration Register for EEPROM write. Let's assume the address 0x**5E06** is the first 16 bit number found in the .sw file where setup data begins**.** Write the value 0x**5E06**0009 into the object 2064_h (write 32-bit data at EEPROM address 0x**5E06** and auto-increment the address after the write operation).

Send the following message: SDO write to object 2064_h sub-index 0, 32-bit value $5E060009_h$.

5. Write the sw file data 32 bits at a time. Supposing that the next 2 entries in the .sw file after the start address 0x**5E06** are 0x**1234** and 0x**5678**, you have to write the value 0x**56781234** into object 2065_h.

Send the following message (SDO write to object 2065_h sub-index 0, 32-bit value 56781234_h):

The number 0x**1234** will be written at address 0x**5E06** and 0x**5678** will be at 0x**5E07**.

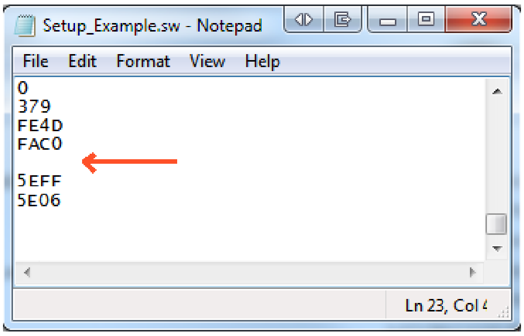
6. Assuming the next data after 0x**5678** will be 0x**09AB** and 0x**CDEF**, write the value 0x**CDEF09AB** into object 2065_h.

Send the following message (SDO write to object 2065_h sub-index 0, 32-bit value $CDEF09AB_h$):

The number 0x**09AB** will be written at address 0x**5E08** and 0x**CDEF** will be at 0x**5E09**.

7. Repeat step 5 until a blank line is found in the .sw file.

This means that all the setup data is written, even if there is more data after the blank line.



8. Re-check the checksum (repeat steps 2 and 3). If ok, go to step 9

9. Reset the drive in order to activate the new setup.

Send with the Cob ID 0x0 the data 0x81 0x0A. Where 0x0A means Axis ID 10.

Warning!	When object 2064_h bit 7=0 (auto-incrementing is ON), do not read the object list in parallel with a read/write operation using a script. By reading object 2066h in parallel with another application, the target memory address will be incremented and will lead to incorrect data writing or reading.

18. Advanced features

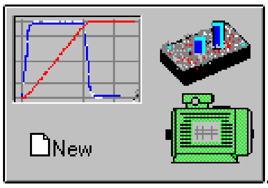
Due to its embedded motion controller, a Technosoft intelligent drive offers many programming solutions that may simplify a lot the task of a CANopen master. This paragraph overviews a set of advanced programming features which can be used when combining TML programming at drive level with CANopen master control. All features presented below require usage of EasyMotion Studio as TML programming tool.

Remark: *If you don't use the advanced features presented below you don't need EasyMotion Studio.*

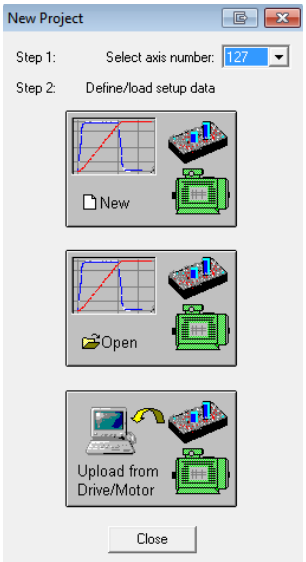
18.1. Using EasyMotion Studio

18.1.1. Starting a new project

Before starting a new project, establish serial communication with the drive. To do this, first read **Paragraph 1.1.3.** The same method for establishing communication applies to EasyMotion Studio as for EasySetUp.

Press **New** button 

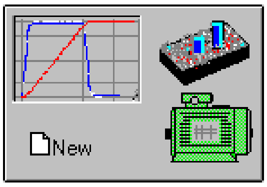
. A new window will appear.



Step 1, selects the axis number for your drive. By default the drive is delivered with axis number 255.

In Step 2, a setup is defined. The setup data can be opened from a previous save, uploaded from the drive, or select a new one for a new drive.

18.1.2. Choosing the drive, motor and feedback configuration

Press **New** button 

and select your drive category: iPOS Drives (all drives from the new iPOS line), Plug In Drives (all plug-in drives, except iPOS line), Open Frame Drives, (all open-frame drives except iPOS line), Closed Frame Drives (all close-frame drives except iPOS line), etc. If you don't know your drive category, you can find it on Technosoft web page.

Continue the selection tree with the motor technology: rotary or linear brushless, brushed, 2 or 3 phase stepper, the control mode in case of steppers (open-loop or closed-loop) and type of feedback device, if any (for example: none or incremental encoder).

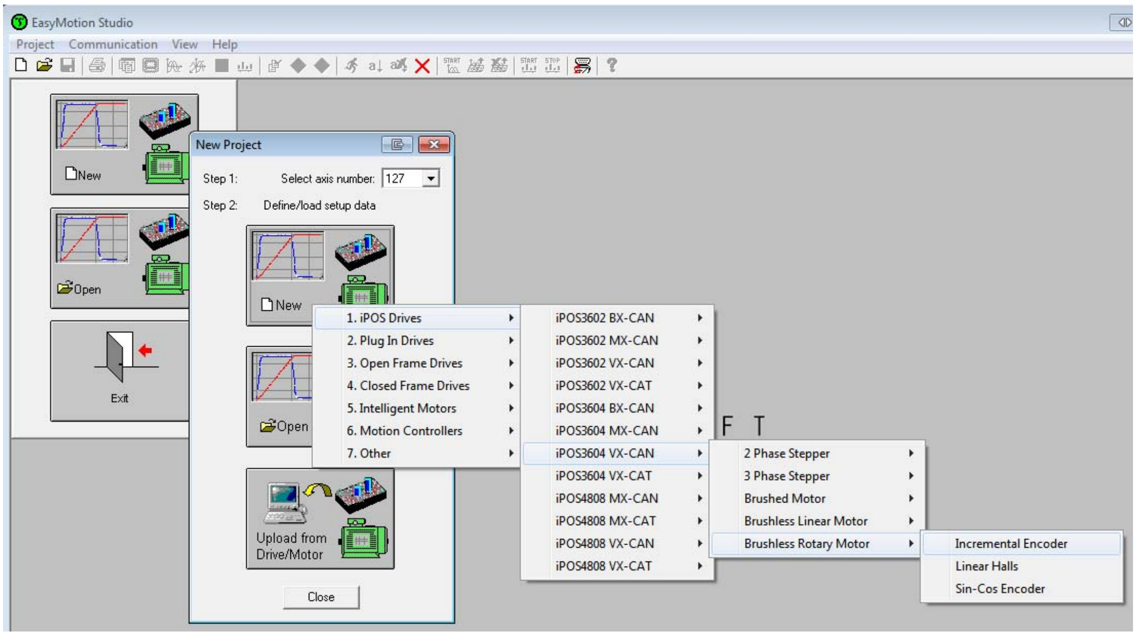


Figure 18.1 *EasyMotion Studio – Selecting the drive, motor and feedback*

New windows are loaded which show the project information and current axis number for the selected application. In the background, other customizable windows appear. These are control panels that show and control the drive status through the serial communication interface.

In the left tree, click ***S*** *Setup* item.

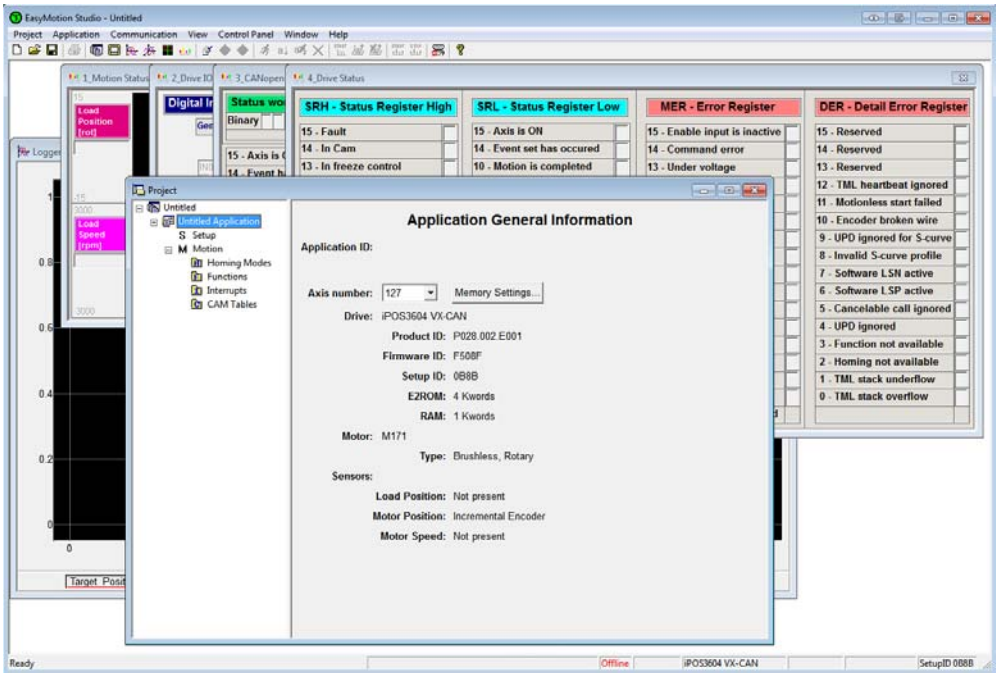


Figure 18.2 *EasyMotion Studio – Project information*

To edit the setup, click *View / Modify* button.

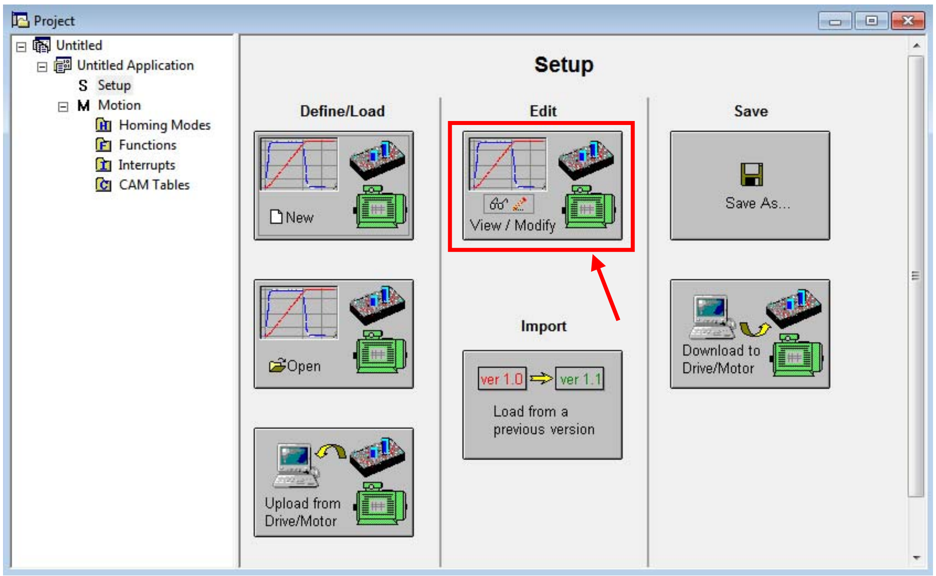


Figure 18.3 *EasyMotion Studio – Editing drive setup*

The selection opens 2 setup dialogues: for **Motor Setup** and for **Drive setup** through which you can introduce your motor data and commission the drive, plus several predefined control panels customized for the drive selected.

For introducing motor data and configuring the drive parameters, please read **Paragraph 1.1.5** and **1.1.6 .**

18.1.3. Downloading setup data to drive/motor

Closing the Drive setup dialogue with **OK**, keeps the new settings only in the EasyMotion Studio project. In order to store the new settings into the drive you need to press the **Download to Drive/Motor** button 

or the  button on the menu toolbar. This downloads the entire setup data in the drive EEPROM memory. The new settings become effective after the next power-on, when the setup data is copied into the active RAM memory used at runtime.

18.2. Using TML Functions to Split Motion between Master and Drives

With Technosoft intelligent drives you can really distribute the intelligence between a CANopen master and the drives in complex multi-axis applications. Instead of trying to command each step of an axis movement, you can program the drives using TML to execute complex tasks and inform the master when these are done. Thus for each axis, the master task may be reduced at: calling TML functions (with possibility to abort their execution) stored in the drives EEPROM and waiting for a message, which confirms the finalization of the TML functions execution.

18.2.1.Build TML functions within EasyMotion Studio

The following steps describes how to create TML functions with EasyMotion Studio

1. **Define the TML functions.** Open the EasyMotion Studio project and select the Functions entry from the project tree. On the right side of the project panel add the TML functions executed by the drive. You may also remove, rename and change the functions download order.

Remark: *You can call up to 10 TML functions using the CANopen objects.*

2. **Add the TML code.** The added functions are listed in the project tree under the **Functions** entry. Select each function from the list and add the TML code that will be executed by the function.
3. **Download the TML functions into the drive memory**. Use the menu command **Application | Motion | Build** to create the executable code and the menu command **Application | Motion | Download Program** to download the TML code into the drive memory.

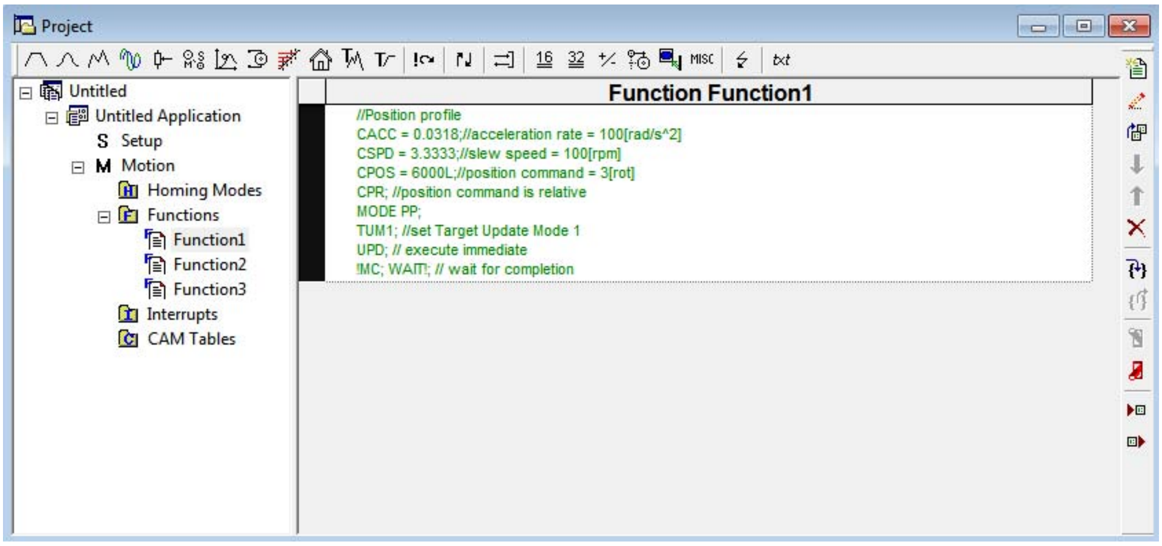


Figure 18.4 *EasyMotion Studio project window – functions edit view*

18.2.2.TML Function Objects

18.2.2.1. Object 2006h: Call TML Function

The object allows the execution of a previously downloaded TML function. When a write is performed to this object, the TML function with the index specified in the value provided is called. The TML function body is defined using EasyMotion Studio and saved in the EEPROM memory of the drive. The function index represents an offset in a predefined table of TML callable functions.

It is not possible to call another TML function, while the previous one is still running. In this case bits 7 (warning) from the Status Word and 14 (command error) from Motion Error Register are set, and the function call is ignored. The execution of any called TML function can be aborted by setting bit 13 in Control Word.

There are 10 TML functions that can be called through this mechanism (the first 10 TML functions defined using the EasyMotion Studio advanced programming environment). Any attempt to call another function (writing a number different from 1...10 in this object) will be signaled with an SDO abort code 0609 0030h (Value range of parameter exceeded). If a valid value is entered, but no TML function is defined in that position, an SDO abort code will be issued: 0800 0020h (Data cannot be transferred or stored to the application).

Object description:

Index	2006_h
Name	Call TML function
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	WO
PDO mapping	No
Units	-
Value range	1...10
Default value	-

18.3. Executing TML programs

The distributed control concept can go on step further. You may prepare and download into a drive a complete TML program including functions, homing procedures, etc. The TML program execution can be started simply by writing a value in the dedicated object.

18.3.1.Object 2077h: Execute TML program

This object is used in order to execute the TML program from either EEPROM or RAM memory. The TML program is downloaded using the EasyMotion Studio software or by the CANopen master using the .sw file created in EasyMotion Studio.

Writing any value in this object (through the SDO protocol) will trigger the execution of the TML program in the drive. If no TML program is found on the drive, an SDO abort code will be issued: 0800 0020h (Data cannot be transferred or stored to the application).

Object description:

Index	2077_h
Name	Execute TML program
Object code	VAR
Data type	UNSIGNED16

Entry description:

Access	WO
PDO mapping	No
Value range	UNSIGNED16
Default value	-

18.4. Loading Automatically Cam Tables Defined in EasyMotion Studio

Apart from CiA402 standard operation modes, Technosoft iPOS drives include others like: electronic gearing, electronic camming, external modes with analogue or digital reference etc. When electronic camming is used, the cam tables can be loaded in the following ways:

a) The master downloads the cam points into the drive active RAM memory after each power on;

b) The cam points are stored in the drive EEPROM and the master commands their copy into the active RAM memory

c) The cam points are stored in the drive EEPROM and during the drive initialization (transition to Ready to switch on status) are automatically copied from EEPROM to the active RAM

For the last 2 options the cam table(s) are defined in EasyMotion Studio and are included in the information stored in the EEPROM together with the setup data and the TML programs/functions.

Remark: *The cam tables are included in the* ***.sw*** *file generated with EasyMotion Studio. Therefore, the master can check the cam presence in the drive EEPROM using the same procedure as for testing of the setup data.*

18.4.1.CAM table structure

The cam tables are arrays of X, Y points, where X is the cam input i.e. the master position and Y is the cam output i.e. the slave position. The X points are expressed in the master internal position units, while the Y points are expressed in the slave internal position units. Both X and Y points 32-bit long integer values. The X points must be positive (including 0) and equally spaced at: 1, 2, 4, 8, 16, 32, 64 or 128 i.e. having the interpolation step a power of 2 between 0 and 7. The maximum number of points for one cam table is 8192.

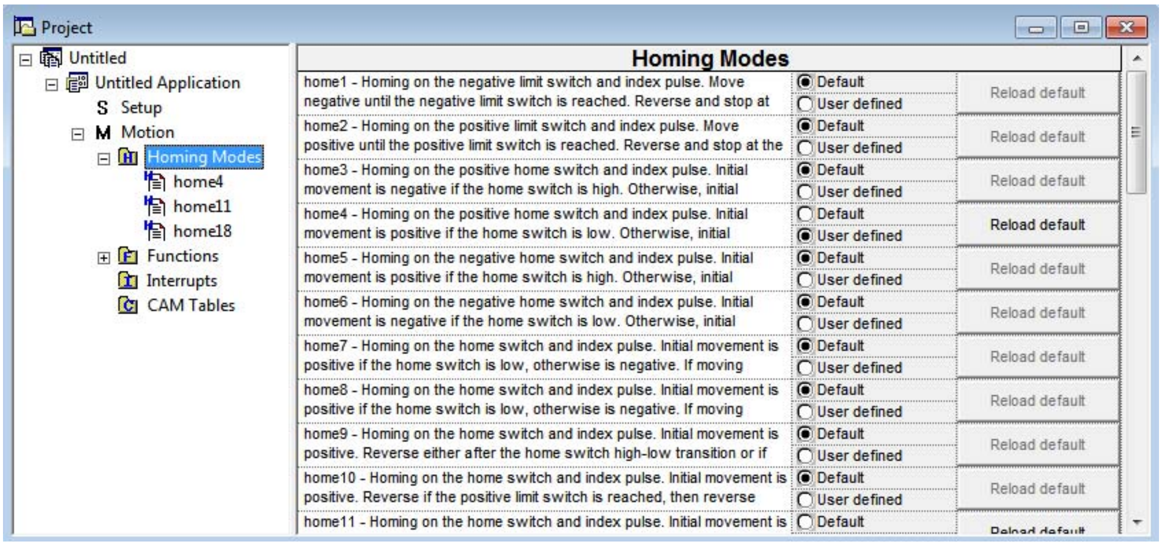
As cam table X points are equally spaced, they are completely defined by two data: the **Master start value** or the first X point and the **Interpolation step** providing the distance between the X points. This offers the possibility to minimize the cam size, which is saved in the drive/motor in the following format:

- 1st word (1 word = 16-bit data):
  - Bits 15-13 – the power of 2 of the interpolation step. For example, if these bits have the binary value 010 (2), the interpolation step is $2^2 = 4$, hence the master X values are spaced from 4 to 4: 0, 4, 8, 12, etc.
  - Bits 12-0 – the length -1 of the table. The length represents the number of points (one point occupies 2 words)
- 2nd and 3rd words: the Master start value (long), expressed in master position units. 2nd word contains the low part, 3rd word the high part
- 4th and 5th words: Reserved. Must be set to 0
- Next pairs of 2 words: the slave Y positions (long), expressed in position units. The 1st word from the pair contains the low part and the 2nd word from the pair the high part

Last word: the cam table checksum, representing the sum modulo 65536 of all the cam table data except the checksum word itself.

18.5. Customizing the Homing Procedures

The homing methods defined by the CiA402 are highly modifiable to accommodate your application. If needed, any of these homing modes can be customized. In order to do this you need to select the Homing Modes from your EasyMotion Studio application and in the right side to set as "User defined" one of the Homing procedures. Following this operation the selected procedure will occur under Homing Modes in a sub tree, with the name *HomeX* where X is the number of the selected homing.



If you click on the *HomeX* procedure, on the right side you'll see the TML function implementing it. The homing routine can be customized according to your application needs. Its calling name and method remain unchanged.

18.6. Customizing the Drive Reaction to Fault Conditions

Similarly to the homing modes, the default service routines for the TML interrupts can be customized according to your application needs. However, as most of these routines handle the drive reaction to fault conditions, it is mandatory to keep the existent functionality while adding your application needs, in order to preserve the correct protection level of the drive. The procedure for modifying the TML interrupts is similar with that for the homing modes.

Appendix A: Object Dictionary by Index

Index	Sub-index	Description
1000h	00h	Device type
1001h	00h	Error register
1002h	00h	Manufacturer status register
1003h		Predefined error field
	00h	Number of errors in history
	01h	Standard error field (history 1)
	02h	Standard error field (history 2)
	03h	Standard error field (history 3)
	04h	Standard error field (history 4)
	05h	Standard error field (history 5)
1005h	00h	COB-ID of the SYNC message
1006h	00h	Communication cycle period
1008h	00h	Manufacturer device name
100Ah	00h	Manufacturer software version
100Ch	00h	Guard time
100Dh	00h	Lifetime factor
1010h		Store parameters
	00h	Number of entries
	01h	Save all parameters
1011h		Restore default parameters
	00h	Number of entries
	01h	Restore all default parameters
1013h	00h	High resolution time stamp
1014h	00h	COB-ID Emergency object
1017h	00h	Producer heartbeat time
1018h		Identity Object
	00h	Number of entries
	01h	Vendor ID
	02h	Product Code
	03h	Revision Number
	04h	Serial Number
1200h		Server SDO parameter
	00h	Number of entries

	01h	COB-ID Client -> Server (rx)
	02h	COB-ID Client -> Server (tx)
1400h		Receive PDO1 communication parameters
	00h	Number of entries
	01h	COB-ID RPDO1
	02h	Transmission type
1401h		Receive PDO2 communication parameters
	00h	Number of entries
	01h	COB-ID RPDO2
	02h	Transmission type
1402h		Receive PDO3 communication parameters
	00h	Number of entries
	01h	COB-ID RPDO3
	02h	Transmission type
1403h		Receive PDO4 communication parameters
	00h	Number of entries
	01h	COB-ID RPDO4
	02h	Transmission type
1600h		RPDO1 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6040h – control word
1601h		RPDO2 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6040h – control word
	02h	2nd mapped object – 6060h – modes of operation
1602h		RPDO3 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6040h – control word
	02h	2nd mapped object – 607Ah – target position
1603h		RPDO4 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6040h – control word
	02h	2nd mapped object – 60FFh – target velocity
1800h		TPDO1 communication parameters
	00h	Number of entries
	01h	COB-ID TPDO1
	02h	Transmission type
	03h	Inhibit Time
	04h	Reserved

	05h	Event timer
1801h		TPDO2 communication parameters
	00h	Number of entries
	01h	COB-ID TPDO2
	02h	Transmission type
	03h	Inhibit Time
	04h	Reserved
	05h	Event timer
1802h		TPDO3 communication parameters
	00h	Number of entries
	01h	COB-ID TPDO3
	02h	Transmission type
	03h	Inhibit Time
	04h	Reserved
	05h	Event timer
1803h		TPDO4 communication parameters
	00h	Number of entries
	01h	COB-ID TPDO4
	02h	Transmission type
	03h	Inhibit Time
	04h	Reserved
	05h	Event timer
1A00h		TPDO1 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6041h – status word
1A01h		TPDO2 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6041h – status word
	02h	2nd mapped object – 6061h – modes of operation display
1A02h		TPDO3 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 6041h – status word
	02h	2nd mapped object – 6064h – position actual value
1A03h		TPDO4 mapping parameters
	00h	Number of entries
	01h	1st mapped object – 606Bh – velocity demand value
	02h	2nd mapped object – 606Ch – velocity actual value
2000h	00h	Motion Error Register
2001h	00h	Motion Error Register mask

2002h	00h	Detailed Error Register
2004h	00h	COB-ID High resolution time stamp
2005h	00h	Max slippage time out
2006h	00h	Call TML function
2010h	00h	Master settings
2012h	00h	Master resolution
2013h		EGEAR multiplication factor
	00h	Number of entries
	01h	EGEAR ratio numerator (slave)
	02h	EGEAR ratio denominator (master)
2017h	00h	Master actual position
2018h	00h	Master actual speed
2019h	00h	CAM table load address
201Ah	00h	CAM table run address
201Bh	00h	CAM offset
201Ch	00h	External on-line reference
201Dh	00h	External reference type
2022h	00h	Control effort
2023h	00h	Jerk time
2025h	00h	Stepper current in open loop operation
2026h	00h	Stand-by current for stepper in open loop operation
2027h	00h	Timeout for stepper stand-by current
2045h	00h	Digital outputs status
2046h	00h	Analogue input: Reference
2047h	00h	Analogue input: Feedback
2050h	00h	Over current protection level
2051h	00h	Over current time out
2052h	00h	Motor nominal current
2053h	00h	I2t protection integrator limit
2054h	00h	I2t protection scaling factor
2055h	00h	DC-link voltage
2058h	00h	Drive temperature
2060h	00h	Software version of the TML application
2064h	00h	Read/Write configuration register
2065h	00h	Write data at address set in object 2064h (16/32 bits)
2066h	00h	Read data from address set in object 2064h (16/32 bits)
2067h	00h	Write data at specified address
2069h	00h	Checksum configuration register
206Ah	00h	Checksum read register

206Bh	00h	CAM input scaling factor
206Ch	00h	CAM output scaling factor
206Fh	00h	Time notation index
2070h	00h	Time dimension index
2071h		Time factor
	00h	Number of entries
	01h	Numerator
	02h	Divisor
2072h	00h	Interpolated position mode status
2073h	00h	Interpolated position buffer length
2074h	00h	Interpolated position buffer configuration
2075h		Position triggers
	00h	Number of entries
	01h	Position trigger 1
	02h	Position trigger 2
	03h	Position trigger 3
	04h	Position trigger 4
2076h	00h	Save current configuration
2077h	00h	Execute TML program
2078h	00h	Execute auto-tuning for Linear Halls config
2079h	00h	Interpolated position initial position
207Bh	00h	Homing current threshold
207Ch	00h	Homing current threshold time
207Dh	00h	Dummy
207Eh	00h	Current actual value
207Fh	00h	Current limit
2081h	00h	Set/Change the actual motor position value
2083h	00h	Encoder resolution
2084h	00h	Stepper resolution
2085h	00h	Position triggered outputs
6007h	00h	Abort connection option code
6040h	00h	Control word
6041h	00h	Status word
605Ah	00h	Quick stop option code
605Bh	00h	Shutdown option code
605Ch	00h	Shutdown option code
605Dh	00h	Disable operation option code
605Eh	00h	Fault reaction option code
6060h	00h	Modes of operation

6061h	00h	Modes of operation display
6062h	00h	Position demand value
6063h	00h	Position actual internal value
6064h	00h	Position actual value
6065h	00h	Following error window
6066h	00h	Following error time out
6067h	00h	Position window
6068h	00h	Position window time
6069h	00h	Velocity sensor actual value
606Bh	00h	Velocity demand value
606Ch	00h	Velocity actual value
606Fh	00h	Velocity threshold
607Ah	00h	Target position
607Ch	00h	Home offset
607Dh		Software position limit
	00h	Number of entries
	01h	Minimum position range limit
	02h	Maximum position range limit
607Eh	00h	Polarity
6081h	00h	Profile velocity
6083h	00h	Profile acceleration
6085h	00h	Quick stop deceleration
6086h	00h	Motion profile type
6089h	00h	Position notation index
608Ah	00h	Position dimension index
608Bh	00h	Velocity notation index
608Ch	00h	Velocity dimension index
608Dh	00h	Acceleration notation index
608Eh	00h	Acceleration dimension index
6093h		Position factor
	00h	Number of entries
	01h	Numerator
	02h	Divisor
6094h		Velocity encoder factor
	00h	Number of entries
	01h	Numerator
	02h	Divisor
6097h		Acceleration factor
	00h	Number of entries

	01h	Numerator
	02h	Divisor
6098h	00h	Homing method
6099h		Homing speeds
	00h	Number of entries
	01h	Speed during search for switch
	02h	Speed during search for zero
609Ah	00h	Homing acceleration
60B8h	00h	Touch probe function
60B9h	00h	Touch probe status
60BAh	00h	Touch probe 1 positive edge
609Ah	00h	Touch probe 1 negative edge
60BBh	00h	Touch probe 2 positive edge
60BCh	00h	Touch probe 2 negative edge
60BDh	00h	Interpolation sub mode select
60C0h	00h	Interpolation sub mode select
60C1h		Interpolation Data Record
	00h	Number of entries
	01h	The first parameter
	0nh	The n-th parameter
60F4h	00h	Following error actual value
60F8h	00h	Max slippage
60FCh	00h	Position demand internal value
60FDh	00h	Digital inputs
60FEh		Digital outputs
	00h	Number of entries
	01h	Physical outputs
	02h	Bit mask
60FFh	00h	Target velocity
6502h	00h	Supported drive modes

T E C H N O S O F T