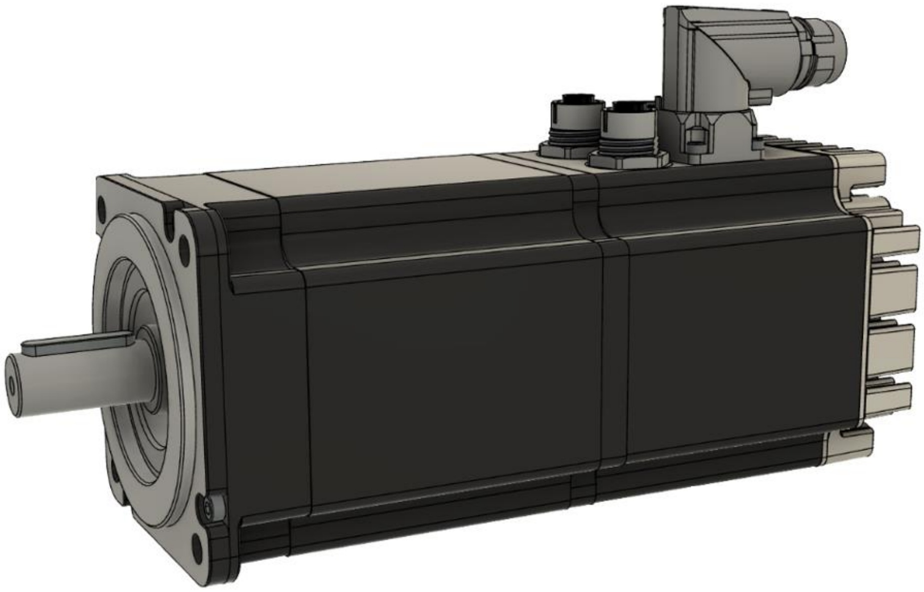
Profinet Reference Manual

DUET AD



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1. Sommario

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2. General

Introduction

This manual describes, in detail, the PROFINET implementation of Motor Power Company DUET AD.

Notice:

This guide is delivered subject to the following conditions and restrictions: This guide contains proprietary information belonging to Motor Power Company srl. Such information is supplied solely for the purpose of assisting users of the Motor Power Company devices and servo drive in its installation and configuration.

- The text and graphics included in this manual are for the purpose of illustration and reference only. The specifications on which they are based are subject to change without notice.
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PROFINET Compatibility

This document is compatible with the following FW and EDS version and superior:

GSDML Version	***FW version***	***Note***
1.2.x	1.2.X	-

Document Versioning

Version	***Date***	***Author***	***Note***
1.0	20/01/2023	Michele Piacentini Lorenzo Bedogni Anouar Irhlam	First Release

Profinet documentation

PROFINET (**PRO**cess **FI**eld **NET**work) is a standard developed by the German association PROFIBUS Nutzerorganisation e.V. A complete description of the fieldbus systems can be found in the following standards:

IEC 61158 "Digital data communication for measurement and control – Fieldbus for use in industrial control systems": This standard has several parts and defines the "Fieldbus Protocol Types". In accordance with these types, PROFINET is specified as type 10.

IEC 61784-2 "Industrial communication networks - Profiles - Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3 (IEC 61784-2:2014)": This standard defines the real-time classes (RTC = real-time class) based on the reaction time.

DUET AD only support PROFINET RT conformance Class A/B.

Further information, contact addresses etc. can be found under www.profibus.com.

3. Wiring and pin assignment

Connection

For the DUET AD series, the PROFINET interface has been realized with two M12 female jacks.

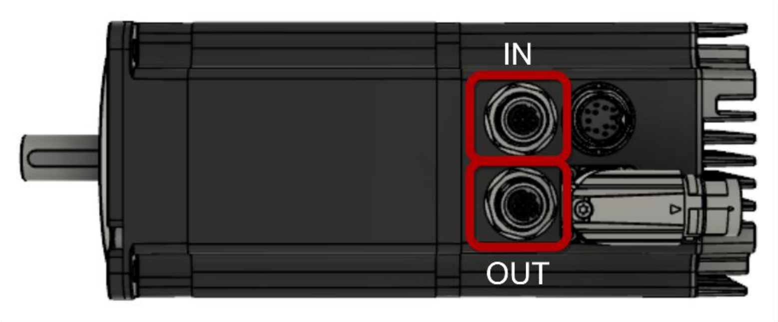

FIGURE 1 DUETAD PROFINET CONNECTION

Follow the *Installation Guide* (available at www.motorpowerco.com in dedicated section) of the device to find out the entire pinout configuration.

Usually, a series connection could be implemented as in figure below:

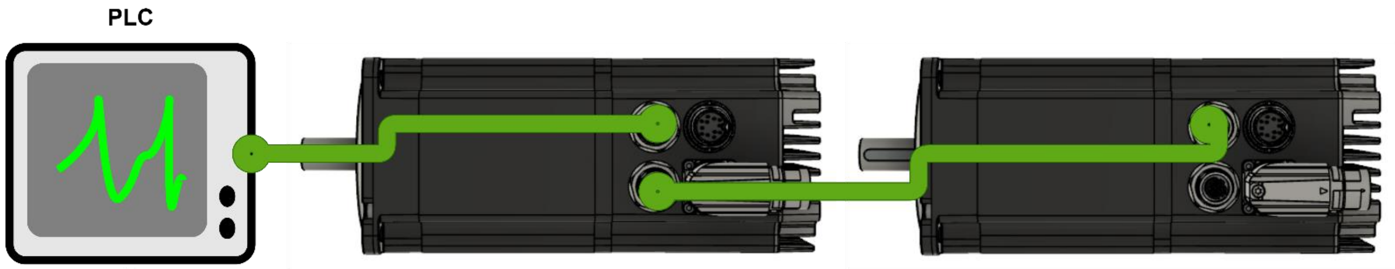

FIGURE 2 TYPICAL PROFINET MULTIPLE NODE CONFIGURATION

Both connectors can act as input or output.

Pin assignment

N° PIN	CN M12 4p Female D Type IN & OUT Connectors *PROFINET Option*
1	TX+
2	RX+
3	TX-
4	RX-

FIGURE 3 PIN ASSIGNMENT OF PROFINET INTERFACE

Bus cable

A PROFINET copper cable is usually a 4-core, shielded copper cable. Like in the case of standard Ethernet applications, the maximum distance that can be covered by way of copper cables is limited to 100 m between the communication endpoints. The link is defined as a PROFINET end-to-end link.

	The only cables that can be used in automation systems are PROFINET cables. PROFINET cables have a corresponding manufacturer's declaration. The joint use of power cables and copper cables for communication purposes is subject to regulations to minimize the electromagnetic influence of the power cables on the communication cables. When setting up the PROFINET network, it is essential to follow the advice that is given in the technical literature and to comply with the information and notes hereinafter in order to realise a stable, trouble-free system.

4. PROFINET connection

Introduction

PROFINET IO (Input - Output) enables the connection of decentralised field devices, such as I/Os, drives, valves, transducers, or analysis devices, to a central automation device, such as a PLC, PC, or process control system. Data transfer is based on the Fast Ethernet standard transmission with 100 Mbit/s. PROFINET IO follows the provider-consumer model for the data exchange. This is the only supported protocol in DuetAD series (no PROFIdrive or PROFIBUS standard are supported).

The set-up of a fully functional PROFINET connection requires several steps. Some of these settings should or must be performed prior to the activation or start of the bus communication. This chapter provides an overview of the required steps. The exact procedure is described in the following chapters.

Slave overview

This section provides an overview of the necessary steps for the parameterisation and configuration of the slave. Since some of the parameters will not become effective until after they have been stored and a reset has been performed, we recommend the following workflow:

- Configuration of the telegrams with the the setting of proper **mode of operation, chapter 5**
- Selection and parameterisation of the **physical units, chapter 7**
- Configuration and activation of the **operating parameters, chapter 8**

The total length of the IO exchanged is fixed at 16 bytes, even though the mapping can be changed by selecting the proper mode of operation for the device.

For a complete configuration of the device a specific parametrization via records may be necessary-

Important process data concerning the position, speed, and acceleration are handed over in **physical units**. These should be parameterised prior to starting the communication, since they define the interpretation of the data in the servo drive.

Master overview

This section provides an overview of the necessary steps for the parameterisation and configuration of the master. The following procedure is recommended:

- Add the GSDML file
- Add servo drive to PROFINET network
- Specify the device name

On the master side, the servo drive must be integrated into the PROFINET network. The following section describes this, based on an example using integration under SIEMENS SIMATIC S7. For a complete example refer to chapter 9.

Add the GSDML file

If the servo drive is not included in the device or hardware catalogue, the GSDML file must be installed first. The GSDML file can be found in the software folder in the specific download area at www.motorpowerco.com. To install it go to "*Options>Manage general station description files*".

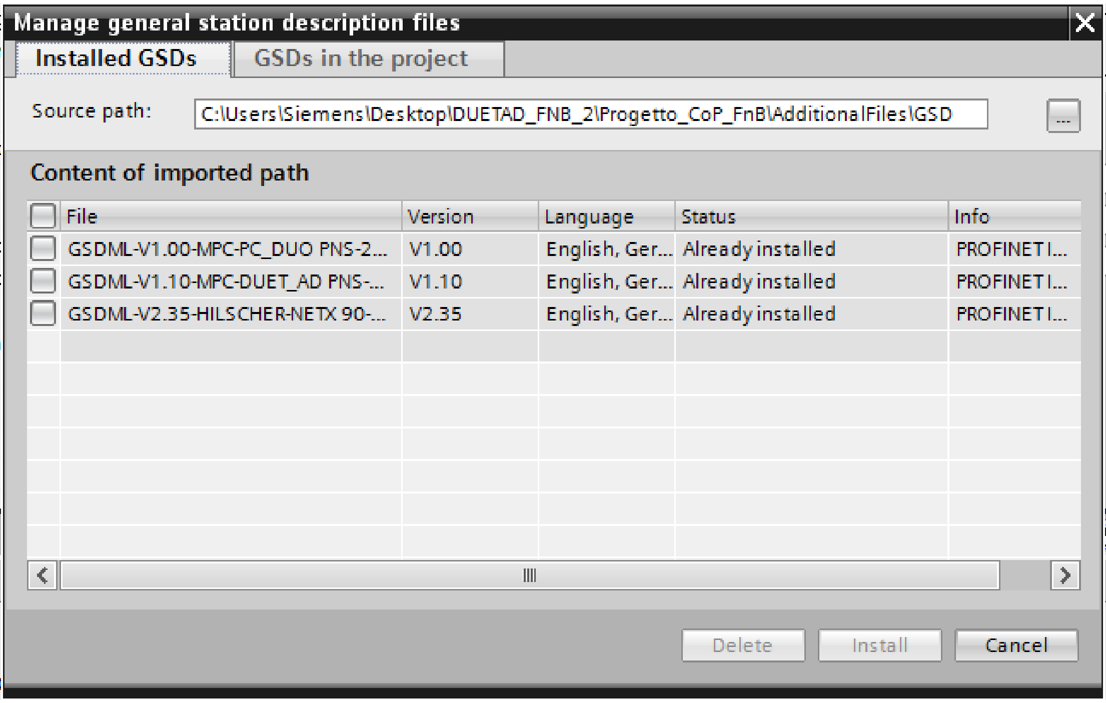

FIGURE 4 - MANAGE GENERAL STATION DESCRIPTION FILES

NOTE: GSDML file is available at www.motorpowerco.com

Add servo drive to PROFINET network

To integrate the servo drive into the PROFINET network, the servo drive must be selected in the hardware catalog. The DuetAD device can be found in "*Other field devices > PROFINET IO > I/O > Hilscher Gesellschaft fur Systemautomation mbH > PNS*"

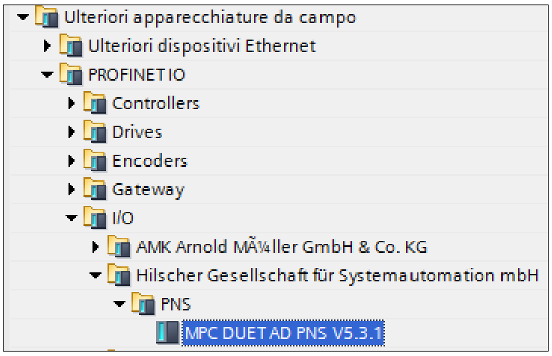

FIGURE 5 PROFINET DEVICE SELECTION IN HARDWARE CATALOG

The *DuetAD* head module must be dragged and dropped into the topology view of the device configuration. After the selection of the network view, the servo drive must be assigned to an I/O controller via the link "Not assigned".

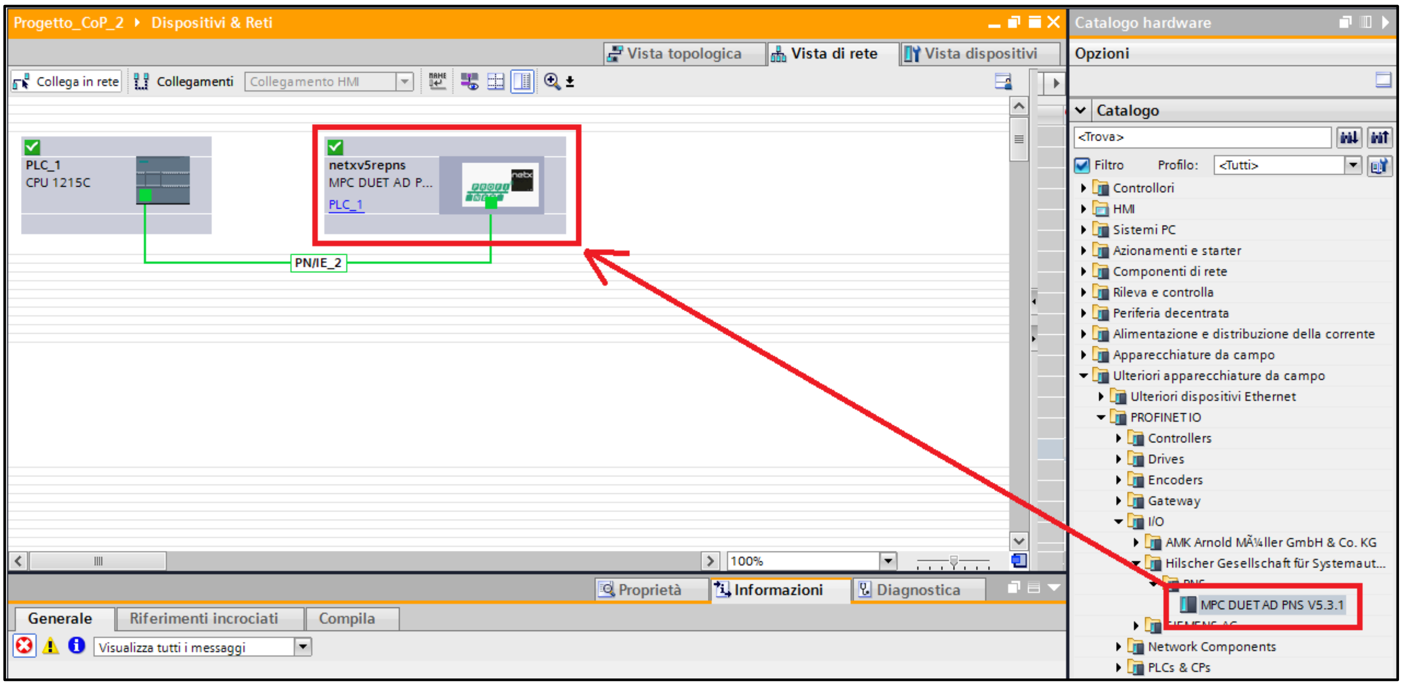

FIGURE 6 ADDING GSDML FILE IN TIA PORTAL

Specify the device name

Then, the device name must be specified. This method has been chosen for PROFINET, since names are easier to handle than complex IP addresses. After clicking the netX logo of the servo drive, the device name can be changed under "General" in the "Properties" window. The name of the configured device must later be assigned to the physical device.

User has several ways to do that. Here are described two of them:

1. Directly from SIEMENS TIA Portal
2. SIEMENS PRONETA tool

SIEMENS PRONETA tool

The PROFINET network analyzer PRONETA Basic is a simple tool intended for the rapid analysis and configuration of PROFINET networks and the simple testing of ET 200 distributed IO systems and other components.

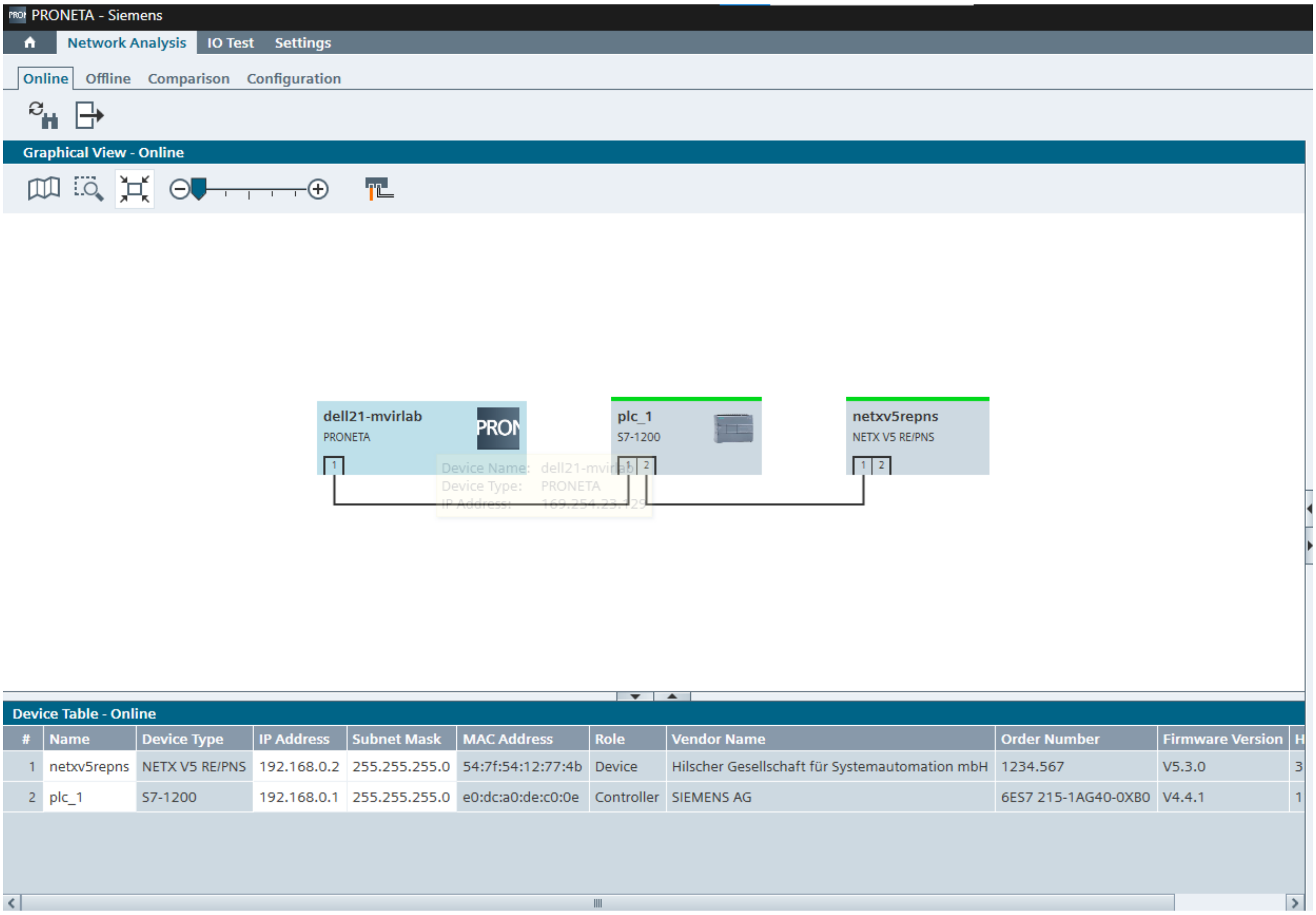

FIGURE 7-PRONETA TOOL OVERVIEW

PRONETA Basic is well suited for solving two tasks fundamental to the commissioning of PROFINET installations:

- The "Network Analysis" task gives a quick overview of the devices connected to PROFINET. It features simple configuration options, like setting network parameters or assigning a network name to the devices which are part of the subnet the PRONETA PC is connected. The application also provides powerful mechanisms to compare several network topologies with each other, for example to compare an "ideal" topology intended for a project with the actual installation.
- The "IO Test" task is a simple and intuitive method to test the IO wiring of an installation with numerous distributed IO devices. It allows for checks of the wiring and will automatically set up a protocol of the test procedure which can be exported for documentation purposes.

Both tasks can be performed before a CPU is integrated in the network. Since there are no other engineering tools required, PRONETA Basic allows fast and convenient checks of the system configuration from early on.

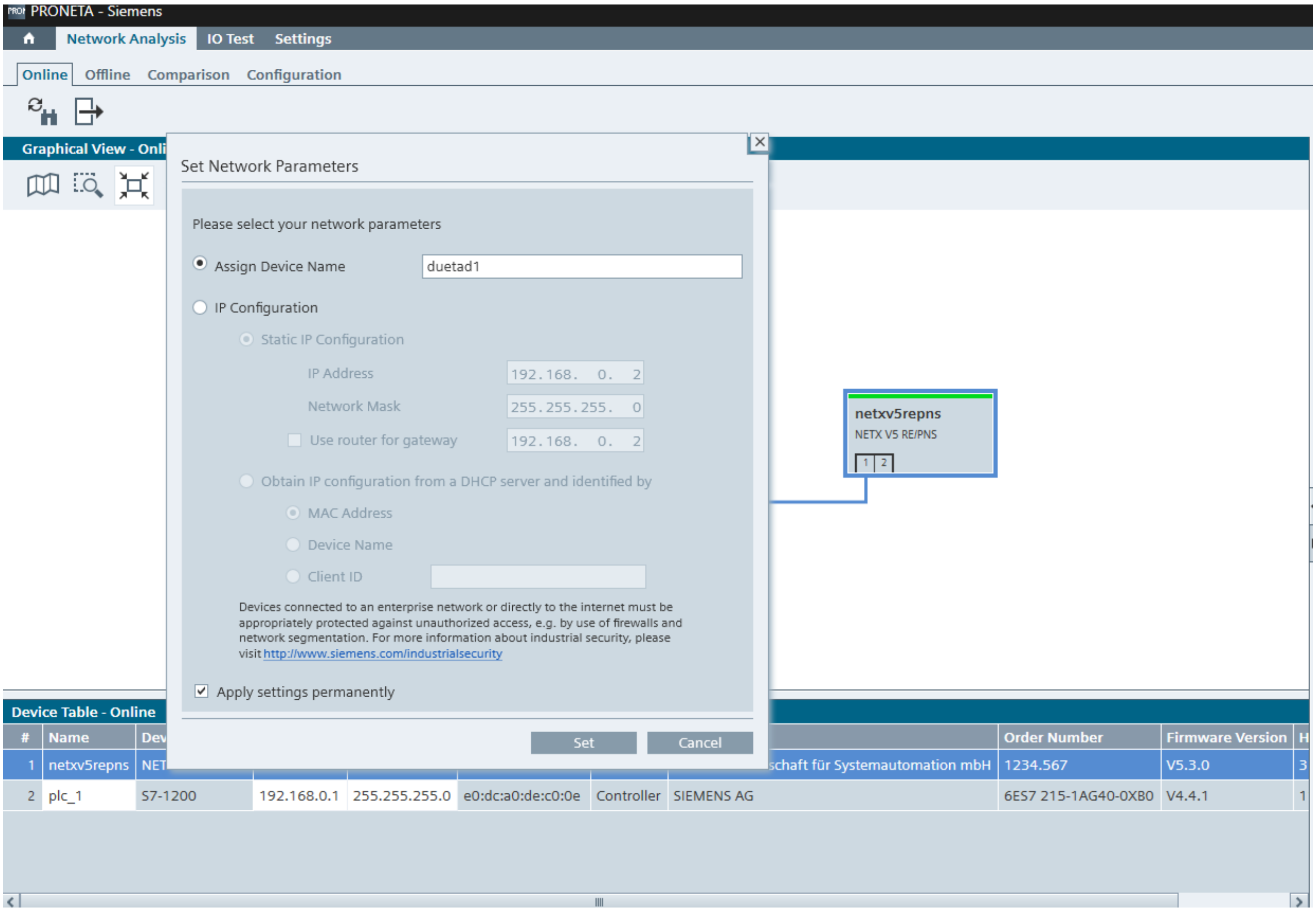

FIGURE 8-DEVICE NAME AND IP CONFIGURATION FOR THE STATION WITH PRONETA

5. I/O Cyclic Data

Cyclic I/O data are transmitted via the "IO Data CR" unacknowledged as real-time data between provider and consumer in an assignable time base.

The cycle time can be specified individually for connections to the individual devices and are thus adapted to the requirements of the application.

Likewise, different cycle times can be selected for the input and output data, within the range of from 250 µs to 512 ms.

The connection is monitored using a time monitoring setting that is derived from a multiple of the cycle time. During data transmission in the frame, the data of a subslot are followed by a provider status.

This status information is evaluated by the respective consumer of the I/O data. It can use this information to evaluate the validity of the data from the cyclic data exchange alone. In addition, the consumer statuses for the counter direction are transmitted.

The connection is monitored using a time monitoring setting that is derived from a multiple of the cycle time. During data transmission in the frame, the data of a subslot are followed by a provider status. This status information is evaluated by the respective consumer of the I/O data. It can use this information to evaluate the validity of the data from the cyclic data exchange alone. In addition, the consumer statuses for the counter direction are transmitted

Only one standard and defined Telegram is supported in the DUET AD exchanges 32 bytes on the fieldbus; 16 bytes are set as controller inputs and 16 bytes are set as controller output

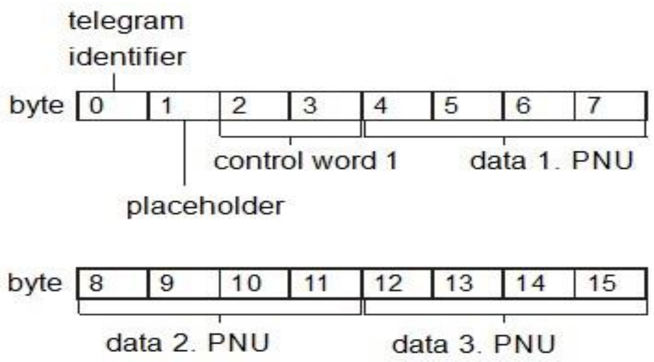

FIGURE 9- TELEGRAM MODEL

As stated I/O data are fixed in size but their data are flexible to support all mode of operation described in previous chapter.

Changing mode of operation also change the content variables for data input and output.

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In next chapter will be described the mapping for any mode of operation supported by DUETAD..

⚠	**NOTE**: Changing mode of operation also change the content variables for data input and output, this is done automatically by drive

Controller data input in profile position mode (Mode of operation 1):

⚠	**NOTE**: Current limitation is not active if set to 0 in controller data output!

Byte	Parameter	Designation	Type	Comments
0-1	Statusword	Drive's statusword	UNIT16	
2	Mode of Operation Display	Drive's mode of operation	INT8	**This value must be 1 for proper operation**
3-6	Position actual value	Actual position	INT32	
7	Spare	Spare byte	BYTE	NOT USED
8-9	Actual motor current	Motor current consumption	INT 16	Actual motor current expressed in per thousand of motor nominal current
10-15	Spare	Spare bytes	BYTES	NOT USED

Controller data output in profile position mode (Mode of operation 1):

Byte	Parameter	Designation	Type	Comments
0-1	Controlword	Drive's controlword	UNIT16	
2	Mode of Operation	Drive's mode of operation	INT8	**This value must be 1 to set drive in profile position mode**
3	Homing Method	Drive's homing method	INT8	Homing methods only takes effect in homing mode
4-7	Position Target	Drive's target position	INT32	
8-9	Current limitation	Motor current limitation	INT 16	Motor current limitation expressed in per thousand of motor nominal

				current. When 0 this function is disabled.
10-15	Spare	Spare bytes	BYTES	NOT USED

Controller data input in profile velocity mode (Mode of operation 3):

Byte	Parameter	Designation	Type	Comments
0-1	Statusword	Drive's statusword	UNIT16	
2	Mode of Operation Display	Drive's mode of operation	INT8	**This value must be 3 for proper operation**
3-6	Velocity actual value	Actual position	INT32	
7	Spare	Spare byte	BYTE	NOT USED
8-9	Actual motor current	Motor current consumption	INT 16	Actual motor current expressed in per thousand of motor nominal current
10-15	Spare	Spare bytes	BYTES	NOT USED

Controller data output in profile velocity mode (Mode of operation 1):

Byte	Parameter	Designation	Type	Comments
0-1	Controlword	Drive's controlword	UNIT16	
2	Mode of Operation	Drive's mode of operation	INT8	**This value must be 3 to set drive in profile position mode**
3	Homing Method	Drive's homing method	INT8	Homing methods only takes effect in homing mode
4-7	Target velocity	Drive's target position	INT32	
8-9	Current limitation	Motor current limitation	INT 16	Motor current limitation expressed in per thousand of motor nominal current. When 0 this function is disabled.
10-15	Spare	Spare bytes	BYTES	NOT USED

Controller data input in current mode (Mode of operation 4):

Byte	Parameter	Designation	Type	Comments
0-1	Statusword	Drive's statusword	UNIT16	

2	Mode of Operation Display	Drive's mode of operation	INT8	**This value must be 4 for proper operation**
3-4	Actual Current	Actual position	Int16	
5-6	Spare	Spare byte	BYTES	NOT USED
7	Spare	Spare byte	BYTE	NOT USED
8-9	Actual motor current	Motor current consumption	INT 16	Actual motor current expressed in per thousand of motor nominal current
10-15	Spare	Spare bytes	BYTES	NOT USED

Controller data output in current mode (Mode of operation 4):

Byte	Parameter	Designation	Type	Comments
0-1	Controlword	Drive's controlword	UNIT16	
2	Mode of Operation	Drive's mode of operation	INT8	**This value must be 4 to set drive in profile position mode**
3	Homing Method	Drive's homing method	INT8	Homing methods only takes effect in homing mode
4-5	Target Current	Drive's target position	INT16	
6-7	Spare	Spare bytes	BYTES	NOT USED
8-9	Current limitation	Motor current limitation	INT16	Motor current limitation expressed in per thousand of motor nominal current. When 0 this function is disabled.
10-15	Spare	Spare bytes	BYTES	NOT USED

6. Device Control

i

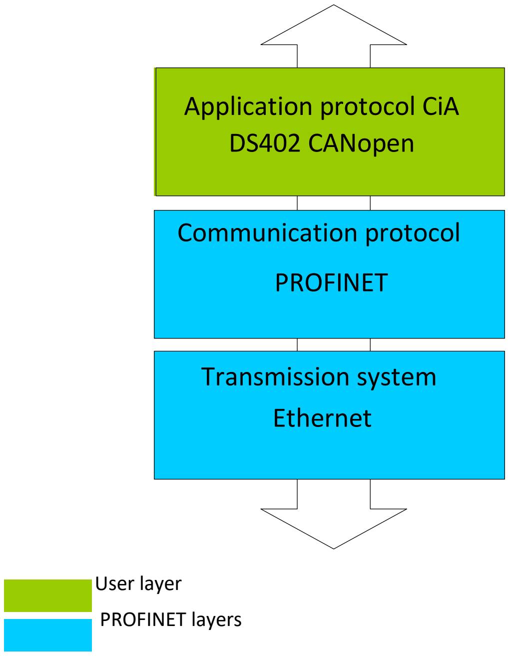

FIGURE 10-COMMUNICATION MODEL FOR DUETAD PN

Device Control and State Machine

The power drive system finite-state automaton (PDS FSA) is a mathematical model that defines the behavior of the power drive system. Because a power drive system is required to provide local control even when the communication network is not functioning properly, the communication FSA and the PDS FSA are only loosely coupled. Figure shows how the power drive system operates remotely via the network, or locally.

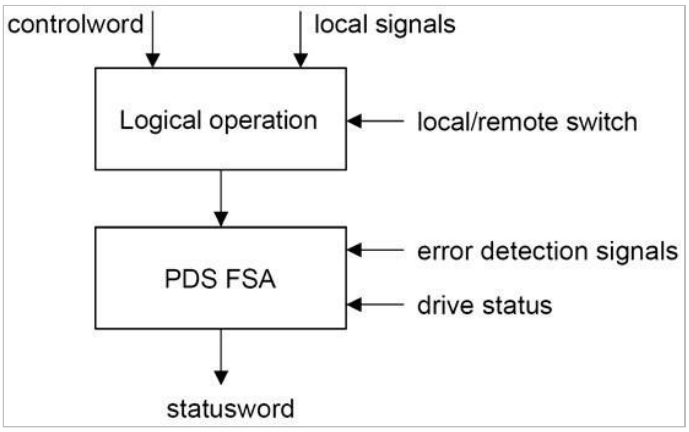

FIGURA 1 - REMOTE AND LOCAL CONTROL

The power drive system is operated by the Controlword sent by the control device via the network. The state of the power drive system is reported by the Statusword produced by the drive device. The FSA is also controlled by error detection signals.

The PDS FSA defines the power drive system status and the possible control sequence of the power drive system. A single state represents a special internal or external behavior. The state of the power drive system also determines which commands are accepted. For example, it is only possible to start a point-to-point move when the drive is in the operation enabled state.

Indicating the Operating State

After switching on, and when an operating mode is started, the power drive system goes through a number of operating states. The operating states are internally monitored and influenced by monitoring functions

Figure illustrates the PDS FSA behavior. It takes into consideration the control of the power electronics, in accordance with user commands and internal drive faults.

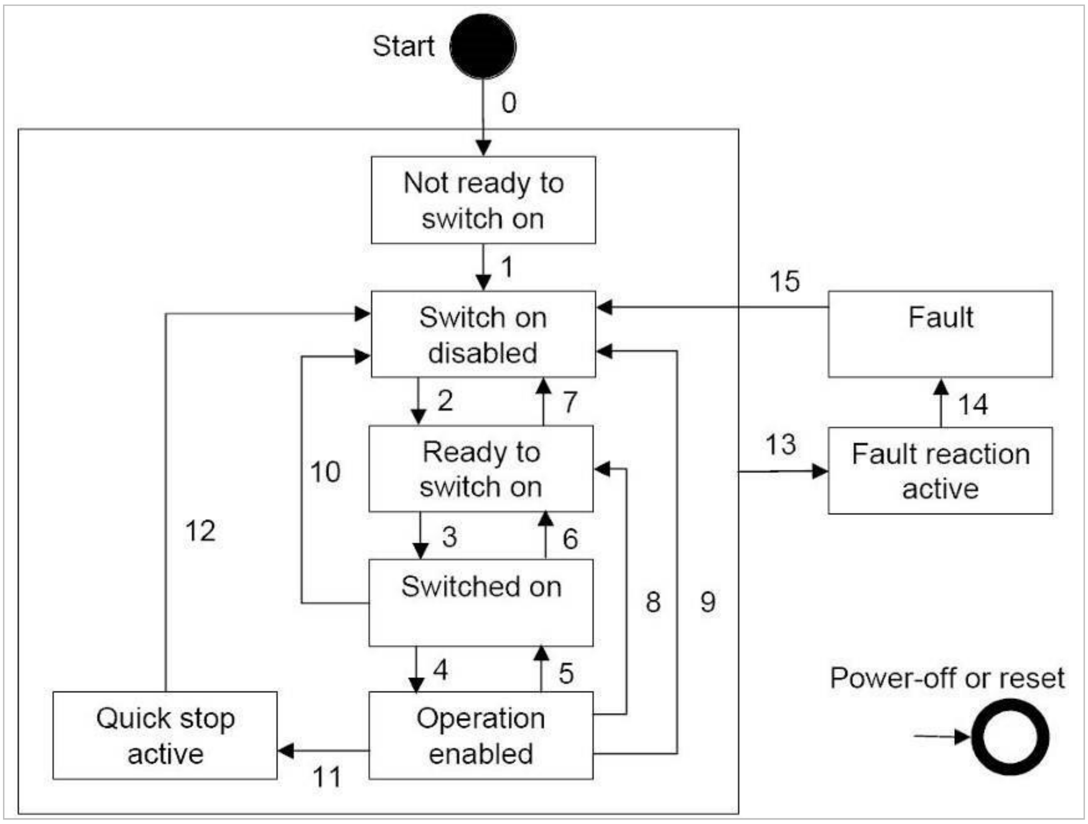

FIGURA 2 - POWER DRIVE SYSTEM STATE DIAGRAM

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Notes:

Not Ready to Switch On	"Not ready to operate" received from the controller.
Switch On Disabled	Ready to operate. Can read and write parameters. Motion functionality cannot be executed.
Ready to Switch On	Ready to operate. Can read and write parameters. Motion functionality cannot be executed. Bus voltage must be switched on.
Operation Enabled	Drive power stage is enabled. No fault is present. Motion functionality can be executed.
Quick Stop Active	Drive was stopped using controlled stop. Power stage is enabled. Motion functionality cannot be executed.
Fault Reaction Active	A fault has occurred. Drive is in the process of ramping down to 0 velocity (Active Disable process).
Fault	A fault has occurred. Power stage is disabled.

Bits 0, 1, 2, 3, 5 and 6 of the parameter Statusword provide information on the operating state.

	Operating State	**Bit 6: Switch On Disabled**	**Bit 5: Quick Stop**	**Bit 3: Fault**	**Bit 2: Operation Enabled**	**Bit 1: Switch On**	**Bit 0: Ready to Switch On**
2	Not Ready To Switch On	0	X	0	0	0	0
3	Switch On Disabled	1	X	0	0	0	0
4	Ready To Switch On	0	1	0	0	0	1
5	Switched On	0	1	0	0	1	1
6	Operation Enabled	0	1	0	1	1	1
7	Quick Stop Active	0	0	0	1	1	1
8	Fault Reaction Active	0	X	1	1	1	1
9	Fault	0	X	1	0	0	0

Parameter Name	**Bit Assignments**	**Data Type R/W**
Statusword	Bits 0–3 = Status bits	Unsigned16
	Bit 4 = Voltage enabled	Read Only
	Bits 5–6 = Status bits	
	Bit 7 = Warning	
	Bit 8 = Reserved	
	Bit 9 = Remote	

	Bit 10 = Target reached	
	Bit 11 = Internal limit is active	
	Bit 12 = Operating mode-specific	
	Bit 13 = Operating mode-specific	
	Bit 14 = Manufacturer-specific	
	Bit 15 = Manufacturer-specific	

Notes:

Bit 4	Bit 4=1 indicates whether the DC bus voltage is correct. If the voltage is missing or is too low, the device does not transition from operating state 3 to operating state 4.
Bit 7	If bit 7 (warning) of the status word is 1, it indicates the presence of a warning condition. Warning is not an error or fault (e.g., temperature limit exceeded, job refused). The status of the PDS FSA does not change. The cause of the warning may be given in the fault code parameter object (603Fh).
Bit 9	If bit 9 is set, the device carries out commands via the fieldbus. If Bit 9 is reset, the device is controlled via a different interface. In such a case, it is still possible to read or write parameters via the fieldbus.
Bit 10	Bit 10 is used for monitoring the current operating mode.
Bit 12	Bit 12 is used for monitoring the current operating mode.
Bit 13	Bit 13 only becomes 1 if an error needs to be resolved prior to further processing.

Changing the operating state

The parameter Controlword can be used to switch between operating states.

Parameter Name	**Bit Assignments**	**Data Type R/W**
Controlword	Bit 0 = Switch On	Unsigned16
	Bit 1 = Enable Voltage	Read Only
	Bit 2 = Quick Stop	
	Bit 3 = Enable Operation	
	Bits 4–6 = Operating Mode specific	
	Bit 7 = Fault Reset	
	Bit 8 = Halt	
	Bit 9 = Reserved	
	Bits 10–15 = Reserved (must be 0)	
	Changed settings become active immediately.	

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Bits 0, 1, 2, 3 and 7 of the parameter Controlword allow you to switch between the operating states.

Fieldbus Command	State Transitions	State Transition To	Bit 7: Fault Reset	Bit 3: Enable Operate	Bit 2: Quick Stop	Bit 1: Enable Voltage	Bit 0: Switch On
Shutdown	T2, T6, T8	4 – Ready To Switch On	X	X	1	1	0
Switch On	T3	5 – Switched On	X	X	1	1	1
Disable Voltage	T7, T9, T10, T12	3 – Switch On Disabled	X	X	X	0	X
Quick Stop	T7, T10 T11	3 – Switch On Disabled 7 – Quick Stop Active	X	X	0	1	X
Disable Operation	T5	5 – Switched On	X	0	1	1	1
Enable Operation	T4, T16	6 – Operation Enabled	X	1	1	1	1
Fault Reset	T15	3 – Switch On Disabled	0 » 1	X	X	X	X

Notes:

Bit 4—6	Bits 4 to 6 are used for the operating mode-specific settings.
Bit 8	A Halt can be triggered with bit 8=1.
Bit 9–15	Reserved.

Starting and Changing an Operating Mode

The parameter Mode of Operation (PNU 128 or the corresponding one mapped on second byte telegram) is used to set the desired operating mode.

Parameter Name	Description	Data Type R/W
Mode of operation	Operating mode 1 Profile Position	Integer8 Read/Write

	3	Profile Velocity	
	4	Profile Torque	
	6	Homing	

The parameter Mode of operation display (PNU 670) can be used to read the current operating mode, it could be read at byte 2 of Controller Data Input (IO).

Profile Position Mode

Description

In the operating mode Profile Position, a movement to a desired target position is performed.

In this chapter, all parameters are described which are necessary for a closed loop position control. The control loop is fed with the position demand value as one of the outputs of the trajectory generator and with the output of the position detection unit (position actual value) of encoder as input parameters. The behavior of the control may be influenced by control parameters which are externally applicable. To keep stable the loop, a relative limitation of the output using the previous control effort is possible. In order not to exceed physical limits of a drive, an absolute limit function is implemented for the control effort. The control effort may be a velocity demand value, a position demand value or any other output value, depending on the modes of operation implemented by a manufacturer. Especially in cascaded control structures, where a position control is followed by a torque control, e.g. the control effort of the position control loop is used as an input for a further calculation.

Functional Description

Two different ways to apply target positions to a drive, are supported by this device profile.

Set of set-points:
After reaching the target position the drive unit immediately processes the next target position which results in a move where the velocity of the drive normally is not reduced to zero after achieving a set-point.

Single set-point:
After reaching the target position the drive unit signals this status to a host computer 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.

The two modes are controlled by the timing of the bits ‘new set-point’ and ‘change set immediately’ in the controlword and ‘set-point acknowledge’ in the statusword. These bits allow to set up a request-response mechanism in order to prepare a set of setpoints while another set still is processed in the drive unit. This minimizes reaction times within a control program on a host computer.

Procedure

- Set [Mode of operation (PNU 128)] to operating mode Profile position (1).
- Set [Target position (PNU 556)] to the target position (unit = pulse).
- Set [Profile velocity (PNU 161)] to profile velocity (unit = pulses per second).
- Set [Controlword (PNU 540)] to start the movement.
- Query [Position actual value (PNU 693)] to get the actual position of the motor.
- Query [Statusword (PNU 668)] to get the current status of following error, set- point acknowledge and target reached.

Optional

Additional information on the operating mode Profile Position:

- Query [Position demand value (PNU 697)] to get the internal reference value (unit = pulse).

Following error:

- Set [Following error window (PNU 163)] to the permissible following error (unit = pulse).
- Query [Following error actual value (PNU 699)] to get the current following error (unit = pulse).

Standstill window:

- Set [Position window (PNU 165)] to the value for the standstill window. If the difference between the target position and the current motor position remains in the standstill window for the time Position window time (PNU 163), the target position is considered to have been reached (unit = pulse).
- Set [Position window time (PNU 175)] to the value for the standstill window. If the difference between the target position and the current motor position remains in the standstill window for the time Position window time (PNU 163), the target position is considered to have been reached (unit = pulse).

Associated Objects

Index	Parameter	Data Type	Takes Effect
PNU 540	Controlword	Unsigned16	Immediately
PNU 668	Statusword	Unsigned16	-
PNU 128	Modes of operation	Integer8	Immediately
PNU 670	Modes of operation display	Integer8	-

PNU 697	Position demand value	Integer32	-
6063h	Position actual value	Integer32	-
PNU 693	Position actual value	Integer32	-
PNU 163	Following error window	Unsigned32	-
PNU 165	Position window	Unsigned32	-
PNU 175	Position window time	Unsigned16	Immediately
PNU 161	Profile velocity	Unsigned32	Next movement
PNU 699	Following error actual value	Integer32	-
PNU 691	Position demand value	Integer32	-

Example: Profile Position

Starting the Operating Mode

The operating mode must be set in the parameter Mode of operation (PNU 128). Writing the parameter value activates the operating mode. The movement is started via the Controlword.

Controlword

Bits 4–6 and bit 8 in the parameter Controlword (PNU 540) start a movement.

Bit 5: Change Set Point Immediately	**Bit 4: New Target Value**	**Meaning**
0	0 » 1	Starts a movement to a target position. New target values transmitted during a movement become effective only when the previous target is reached. The movement is stopped at the current target position.*

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1	0 » 1	Starts a movement to a target position. New target values transmitted during a movement become immediately effective. Previous target will be ignored. The movement is stopped at the current target position.*

Note: Target values include target position, target velocity, acceleration and deceleration.

Parameter Value	Meaning
Bit 6 = Absolute / relative	0: Absolute movement 1: Relative movement
Bit 8 = Halt	Stop movement with Halt

Terminating the Operating Mode

The operating mode is terminated when the motor is at a standstill and one of the following conditions is met:

- Target position reached
- Stop caused by Halt or Quick Stop
- Stop caused by an error

Statusword
Information on the current movement is available via bits 10 and 12–15 in the parameter Statusword (PNU 668).

Parameter Value	Meaning
Bit 10 = Target reached	0 = Target position not reached 1 = Target position reached
Bit 12 = Target value acknowledge	0 = New position possible 1 = New target position accepted
Bit 13 = Following error bit	0 = No following error 1 = Following error
Bit 14 = Manufacturer-specific	

Bit 15 = Manufacturer-specific	

Homing Mode

Description

In the operating mode Homing, a movement is performed to a defined position. This position is defined as the reference point.

This chapter describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point). There are various methods of achieving this using limit switches at the ends of travel or a home switch (zero point switch) in midtravel, most of the methods also use the index (zero) pulse train from an incremental encoder.

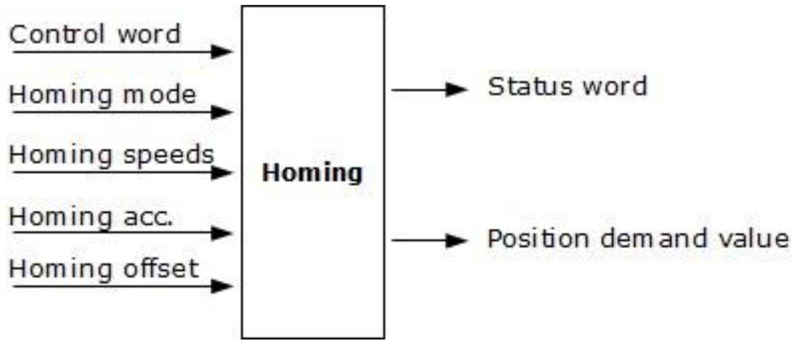

FIGURA 3: HOMING FUNCTION

Procedure

- Set [Mode of operation (PNU 128)] to operating mode Homing (6).
- Set [Home offset (PNU 181)].
- Set [Home method (PNU 179)], the value range is 1 to 35 and specifies the different homing methods.
- Set [Home speeds to switch(PNU 183)] to the value for velocity for the search for the limit switches (unit = min-1).
- Set [Home speeds to zero (PNU 185)]] to the value for velocity for the search for the index pulse (unit = min-1).
- Set [Home acceleration (PNU 187)] to the value for the acceleration ramp (unit = milliseconds form 0 to 3000 min-1).
- Set [Controlword (PNU 540)] to start the operating mode.
- Start Homing.
- Query [Statusword (PNU 668)] to get the device status.

Associated Objects

Index	Parameter	Data Type	Takes Effect
PNU 540	Controlword	Unsigned16	Immediately
PNU 668	Statusword	Unsigned16	-
PNU 128	Modes of operation	Integer8	Immediately
PNU 670	Modes of operation display	Integer8	-
PNU 181	Home offset	Integer32	Next movement
PNU 179	Homing method	Integer8	Next movement
PNU 183	Speed during search for switch	Unsigned32	Next movement
PNU 185	Speed during search for zero	Unsigned32	Next movement
PNU 187	Homing acceleratio n	Unsigned32	Next movement

Functional description

By choosing a method of homing by writing a value to homing method will clearly establish:

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

The home position and the zero position are offset by the home offset, see the definition of home offset for how this offset is used. Various homing positions are illustrated in the following diagrams. An encircled number indicates the code for selection of this homing position. The direction of movement is also indicated.

There are five sources of homing signal available, these are the negative and positive limit switches, the home switch and the index pulse from an encoder and the hardhome.

In the diagrams of homing sequences shown below, the encoder count increases as the axis position moves to the right, in other words the left is the minimum position and the right is the maximum position. For the operation of positioning drives, an exact knowledge of the absolute position is normally required. Since for cost reasons, drives often do not have an absolute encoder, a homing operation is necessary. There are several, application-specific methods. The homing method is used for selection. The exact sequence of the homing operation is clearly described by the method. In some circumstances, a device has several methods to choose from, using the homing method.

Homing methods

The following sub-sections describe the details of how each of the homing modes shall function.

Method 1: Homing on the negative limit switch and index pulse

Using this method the initial direction of movement is leftward if the negative limit switch is inactive (here shown as low). The home position is at the first index pulse to the right of the position where the negative limit switch becomes inactive.

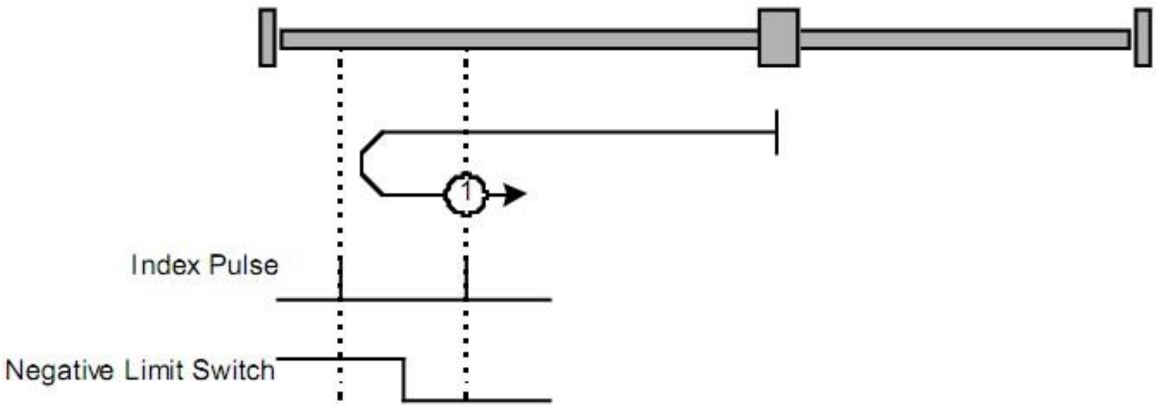

FIGURA 4- HOMING ON NEGATIVE LIMIT SWITCH AND INDEX PULSE

Method 2: Homing on the positive limit switch and index pulse

Using this method the initial direction of movement is rightward if the positive limit switch is inactive (here shown as low). The position of home is at the first index pulse to the left of the position where the positive limit switch becomes inactive.

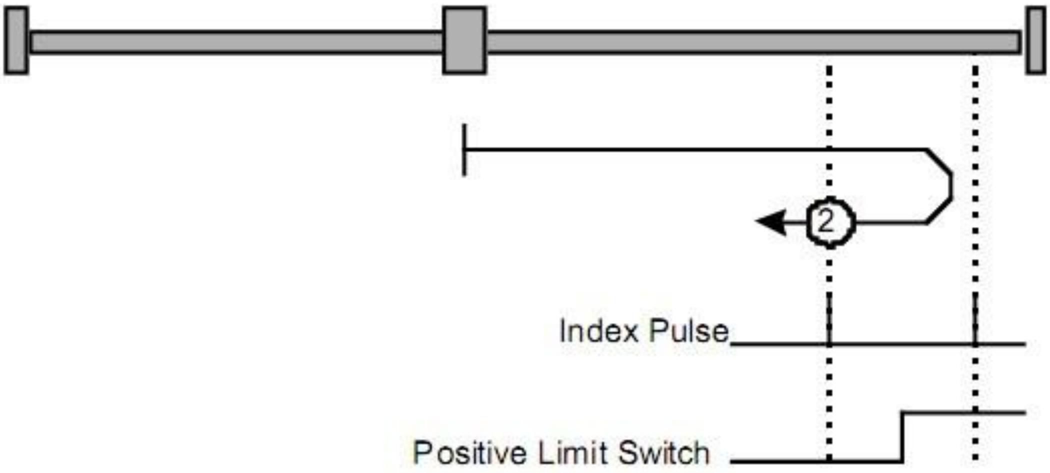

FIGURA 5- HOMING ON POSITIVE LIMIT SWITCH AND INDEX PULSE

Methods 3 and 4: Homing on the positive home switch and index pulse

Using methods 3 or 4 the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

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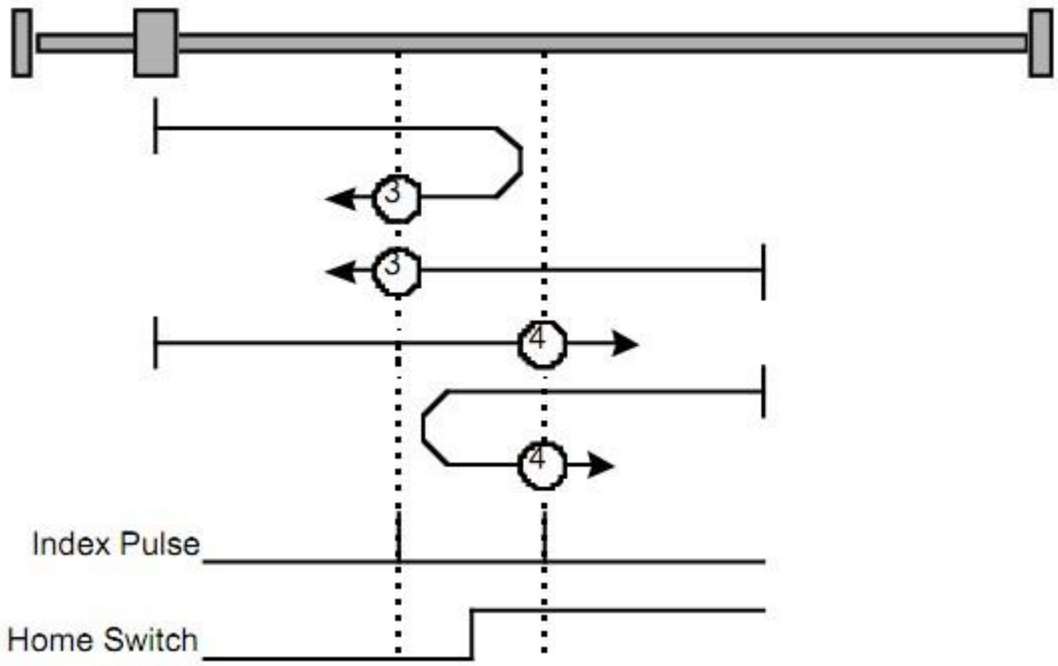

FIGURA 6- HOMING ON POSITIVE HOME SWITCH AND INDEX PULSE

Methods 5 and 6: Homing on the negative home switch and index pulse

Using methods 5 or 6 the initial direction of movement is dependent on the state of the home switch. The home position is at the index pulse to either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement must reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

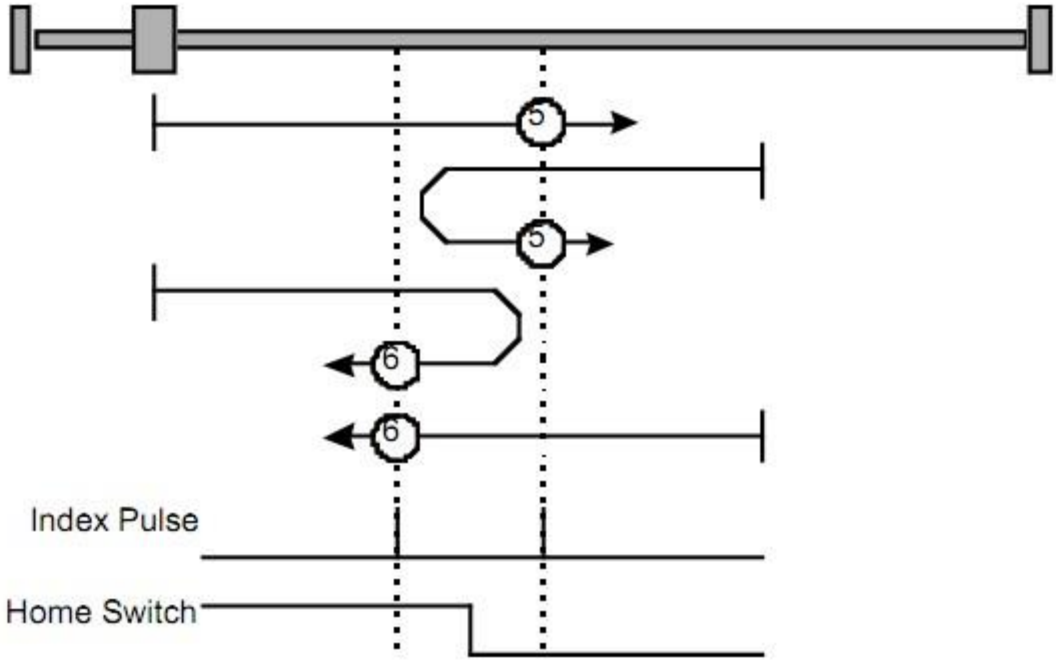

FIGURA 7- HOMING ON NEGATIVE HOME SWITCH AND INDEX PULSE

Methods 7 to 14: Homing on the home switch and index pulse

These methods use a home switch which is active over only portion of the travel, 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, and using methods 11 to 14 the initial direction of movement is to the left except if the home switch is active at the start of the motion.

In this case the initial direction of motion is Dependent on the edge being sought. 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 must reverse on encountering the relevant limit switch.

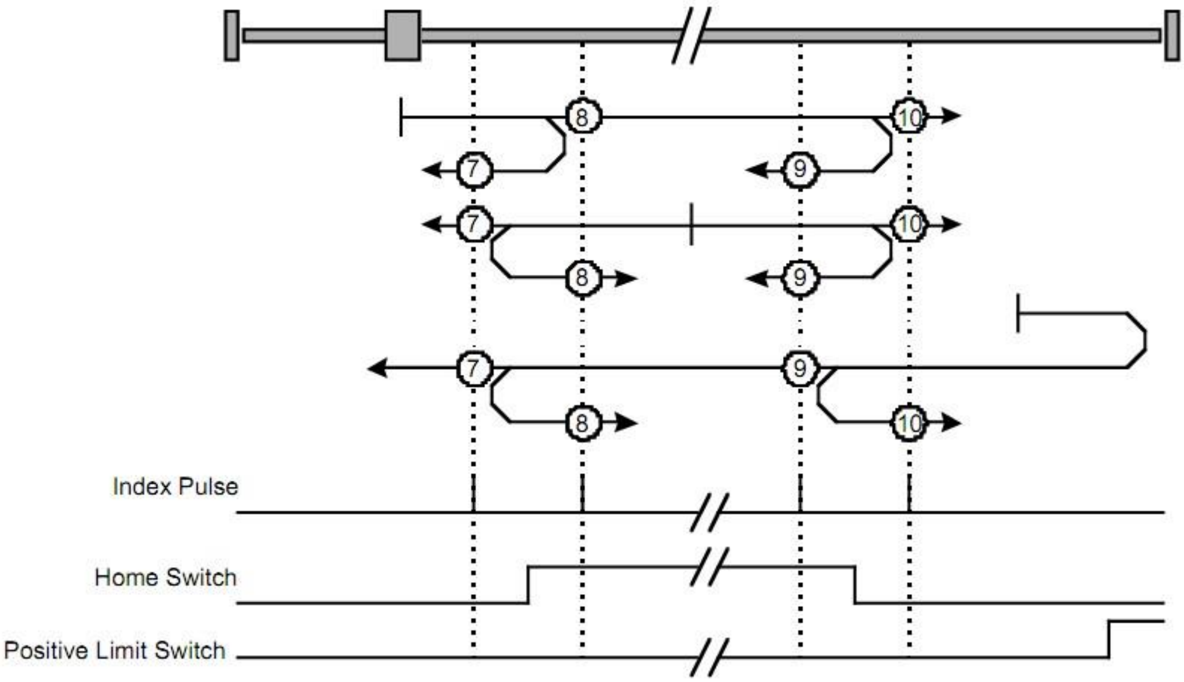

FIGURA 8- : HOMING ON THE HOME SWITCH AND INDEX PULSE - POSITIVE INITIAL MOVE

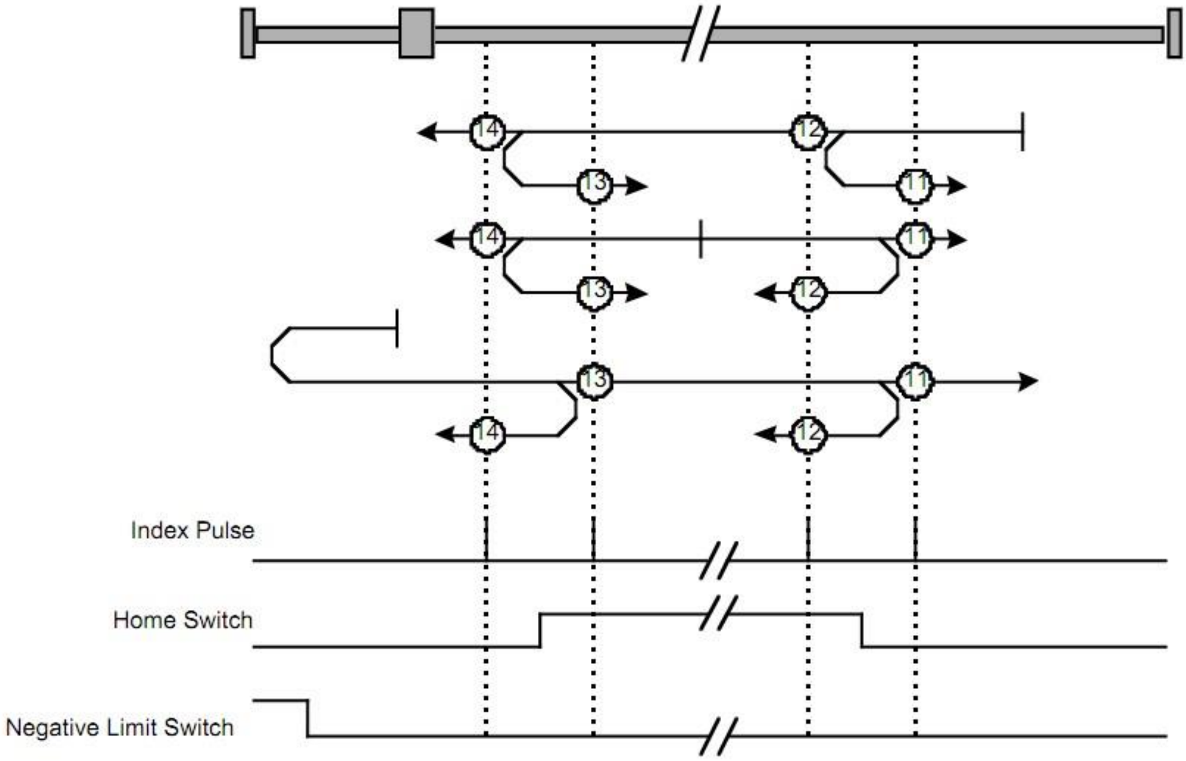

FIGURA 9 HOMING ON THE HOME SWITCH AND INDEX PULSE - NEGATIVE INITIAL MOVE

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 dependent on the relevant home or limit switch transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in the following diagram.

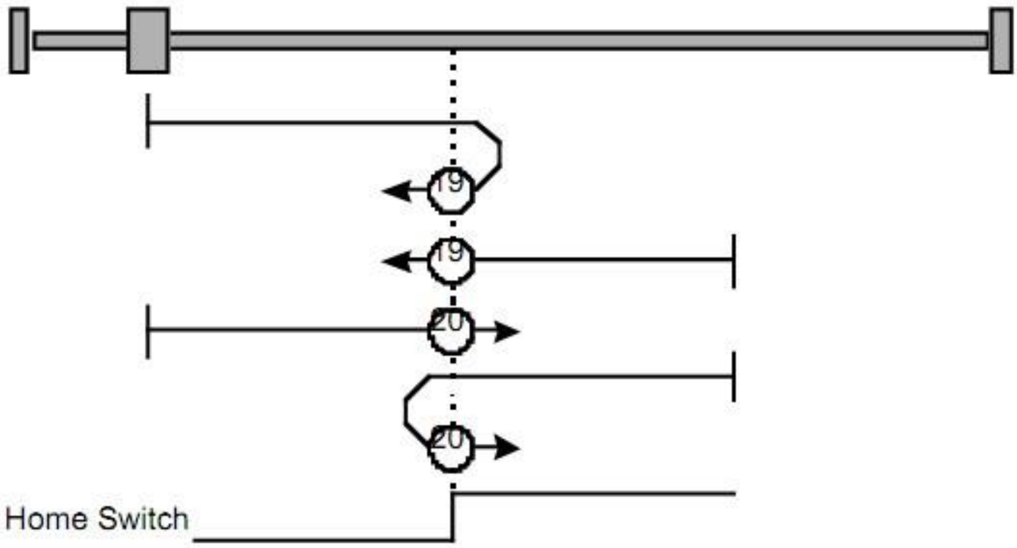

FIGURA 10- HOMING WITHOUT AND INDEX PULSE

Methods 33 to 34: Homing on the index pulse

Using methods 33 or 34 the direction of homing is negative or positive respectively. The home position is at the index pulse found in the selected direction.

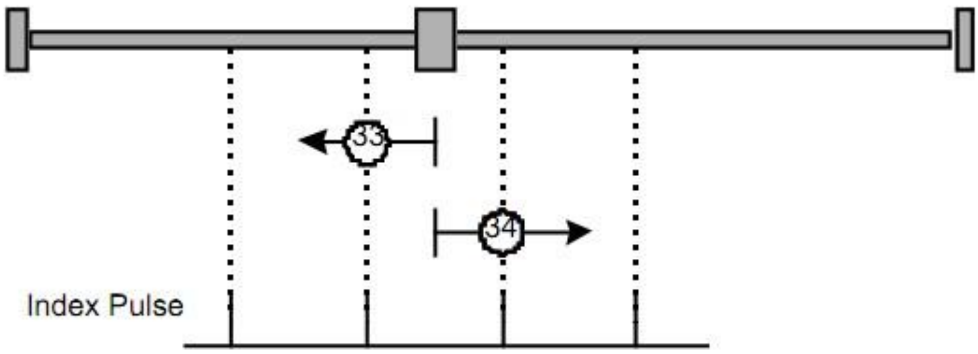

FIGURA 11 HOMING ON INDEX PULSE

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Method 35: Homing on the current position

In method 35 the current position is taken to be the home position.

Example: Homing

Starting the Operating Mode:

The operating mode must be set in the parameter Mode of operation (PNU 128). Writing the parameter value activates the operating mode.

The movement is started via the Controlword.

Controlword

Bits 4 in the parameter Controlword (PNU 540) starts a movement, bit 8 terminates the movement.

Parameter Value	Meaning
Bit 4 = Homing operation start	Start Homing
Bit 5 = Reserved	Not relevant for this operating mode
Bit 6 = Reserved	Not relevant for this operating mode
Bit 8 = Halt	Stop movement with Halt

Terminating the Operating Mode

The operating mode is terminated when the motor is at a standstill and one of the following conditions is met:

- Homing successful
- Stop caused by Halt or Quick Stop
- Stop caused by an error

Statusword

Information on the current movement is available via bits 10 and 12–15 in the parameter Statusword (PNU 668).

Parameter Value	Meaning
Bit 10 = Target reached	0 = Homing not completed 1 = Homing completed
Bit 12 = Homing attained	1 = Homing successfully completed

Bit 13 = Homing error	1 = Homing error
Bit 14 = Manufacturer-specific	
Bit 15 = Manufacturer-specific	

Profile Velocity Mode

Description
In the operating mode Profile Velocity, a movement is made with a desired target velocity.

Procedure

- Set [Mode of operation (PNU 128)] to operating mode Profile Velocity (3).
- Set [Controlword (PNU 540)] to start the operating mode.
- Set [Target velocity (PNU 554)] to the target velocity. If the power stage is enabled, the new target velocity will become active immediately and the movement will start. The value is reset to zero if the operating mode is changed, the power stage is disabled or a Quick Stop is triggered.
- Query [Statusword (PNU 668)] to get the device status.

Optional

- Query [Velocity demand value (PNU 687)] to get the reference velocity.
- Query [Velocity actual value (PNU 683)] to get the actual velocity.
- Set [Velocity window (PNU 173)] to the value of the velocity window.
- Set [Velocity window time (PNU 176)] to the duration in the velocity window required to consider the velocity to have been reached unit = milliseconds).
- Query [Velocity threshold (PNU 699)] to set the standstill window.

Associated Objects

PNU	**Paeameter**	**Data Type**	**Takes Effect**
PNU 540	Controlword	Unsigned16	Immediately
PNU 668	Statusword	Unsigned16	-
PNU 128	Modes of Operation	Integer8	Immediately
PNU 670	Modes of Operation Display	Integer8	-

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PNU 687	Velocity Demand Value	Integer32	-
606Ch	Velocity Actual Value	Integer32	-
PNU 173	Velocity Window	Unsigned16	Immediately
PNU 176	Velocity Window Time	Unsigned16	Immediately
606Fh	Velocity Threshold	Unsigned16	Immediately
PNU 554	Target Velocity	Integer32	Immediately

Example: Profile Velocity

Starting the Operating Mode

The operating mode must be set in the parameter Mode of operation (PNU 128). Writing the parameter value activates the operating mode.

The parameter Target velocity (PNU 554) starts the movement.

Parameter Name	**Description**	**Data Type R/W**
Target Velocity	Target velocity for operating mode Profile Velocity Changed settings become active immediately.	Integer32 Read/Write

Controlword
Bit 8 in parameter Controlword (PNU 540) is used to stop a movement with Halt.

Parameter Value	Meaning
Bit 4 = Reserved	Not relevant for this operating mode
Bit 5 = Reserved	Not relevant for this operating mode
Bit 6 = Reserved	Not relevant for this operating mode
Bit 8 = Halt	Stop movement with Halt
Bit 9 = Change on set point	Not relevant for this operating mode

Terminating the Operating Mode
The operating mode is terminated when the motor is at a standstill and one of the following conditions is met:

- Stop caused by Halt or Quick Stop
- Stop caused by an error

Statusword
Information on the current movement is available via bits 10 and 12 in the parameter Statusword (PNU 668).

Parameter Value	Meaning
Bit 10 = Target reached	0 = Target velocity not reached 1 = Target velocity reached
Bit 12 = Velocity	0 = Velocity > 0 1 = Velocity = 0
Bit 14 = Manufacturer-specific	
Bit 15 = Manufacturer-specific	

Profile Torque Mode

Description
In the operating mode Profile Torque, a movement is made with a desired target torque.

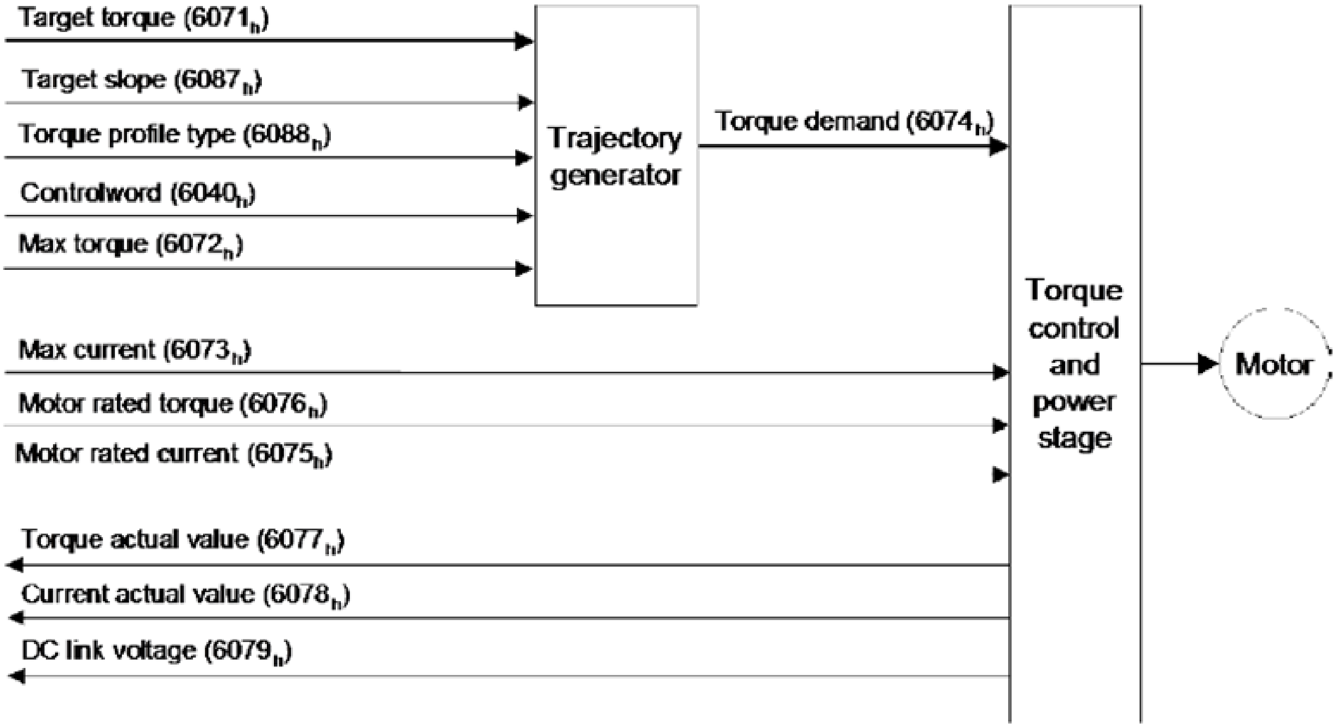

FIGURA 12-STRUCTURE OF THE PROFILE TORQUE MODE

Procedure

- Set [Mode of operation (PNU 128)] to operating mode Profile Torque (4).
- Set [Controlword (PNU 540)] to start the operating mode.
- Set [Motor rated current (PNU 142)] to a value according to motor specifications (unit = A/100).
- Set [Target torque (PNU 552h)] to the value for the target torque.
- Set [Controlword (PNU 540)] to start the movement.

Optional

- Query [Torque rated current (PNU 142h)] to get the nominal current depending on the motor and the drive (unit = multiples of mA).
- Query [Current actual value (PNU 674)] to get the actual current.

Associated Objects

.

Index	Object	Data Type	Takes Effect
PNU 540	Controlword	Unsigned16	Immediately

PNU 668	Statusword	Unsigned16	-
PNU 128	Modes of Operation	Integer8	Immediately
PNU 670	Modes of Operation Display	Integer8	-
PNU 552h	Target Torque	Integer16	Immediately
PNU 142h	Motor rated current	Unsigned32	-

7. Units

This chapter define the available units and how to change for Gear Units, Position Units, Encoder Resolution, Acceleration Units and Velocity units.

They are changeable directly by the UI with ModBus or via ProfiNET/IO records r/w.

Opening the conversion factor window let one change the factors.

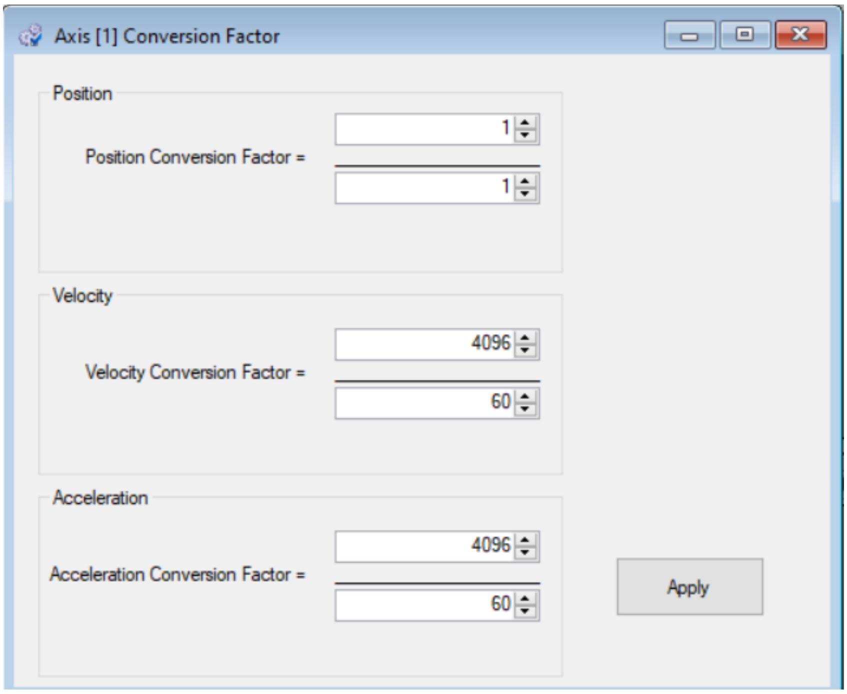

FIGURE 11-CONVERSION FACTORS WINDOW

Encoder resolution

Changing the (PNU 149) parameter or its equivalent in Axis parameters by UI you can change encoder Line Per Revolution. Default Value is 1024 line per revolution.

Note: only expert users can do this, max encoder increments per revolution is 14 bits.

Conversion factor for position units

The factor n is calculated from the factor for numerator (PNU 233) divided by the factor for denominator (PNU 235).

So the final units for position is:

$$Position\ Units = Encoder\ Increment * \frac{\text{PNU 233}}{\text{PNU 235}}$$

PNU	Parameter	Default Value
233	Position Conversion Factor Num	1
235	Position Conversion Factor Den	1

With default values encoder increments are equal to position increments.

Conversion factor for the speed units

The factor n is calculated from the factor for numerator (PNU 237) divided by the factor for denominator (PNU 237).

This factor converts velocity in internal formats units $(\text{increments/seconds})$

$$Velocity\ Units = \frac{Encoder\ Increment}{s} * \frac{\text{PNU 237}}{\text{PNU 239}}$$

PNU	Parameter	Default Value
237	Velocity Conversion Factor Num	4096
239	Velocity Conversion Factor Den	60

Default values for Velocity Units is RPM (Rounds per minute).

Example:

- Velocity data from the driver are in increments/s.
- Desired outputs/inputs are in RPM.
- Which is the proper conversion factor?
- 1 rounds=4096 inc

Finding the right factors:

$$\frac{round}{minuts} = \frac{4096\ inc}{60\ seconds} = \frac{4096\ (\text{PNU 237})}{60\ (\text{PNU 239})}$$

Conversion factor for the acceleration units

The factor n is calculated from the factor for numerator (PNU 241) divided by the factor for denominator (PNU 241).

This factor converts acceleration in internal drive units $(\mathrm{increments/seconds}^2)$

$$Acceleratuin\ Units = \frac{Encoder\ Increment}{s} * \frac{\mathrm{PNU}\ 241}{\mathrm{PNU}\ 243}$$

PNU	Parameter	Default Value
241	Acceleration Conversion Factor Num	4096
243	Acceleration Conversion Factor Den	60

8. Manufacturer Specific Parameters Objects

How to read/write parameters records

Acyclic data exchange using the "Record Data CR" can be used for parameter assignment or configuration of IO devices or reading out status information. This is accomplished with the read/ write frames using standard IT services via TCP/IP1,in which the different data records are distinguished by their index. Data records are freely definable by device manufacturers.

The controller can send read/write record to the device. Each record is composed by 16 or 32 bits.

Parameters are based on 16bit register regardless on their type. 32bit parameters uses 2 16bit register.

For instance a given parameter whose type is Int8 (1 byte) will need anyway to use 16bit (2 byte has to be exchange) memory via records exchange in PROFINET, whereas an Uint32 (4 byte) will use 2 16 bit register and then 4 bytes of data exchange.

NOTE: Using function block for read/write parameters by Tia Portal (WRREC and RDREC) library means that all bytes to be written or bytes red have to be swapped for endianness reason

FUNCTION BLOCK FOR R/W PARAMETERS

You can use the RDREC (Read data record) and WRREC (Write data record) instructions with PROFINET.

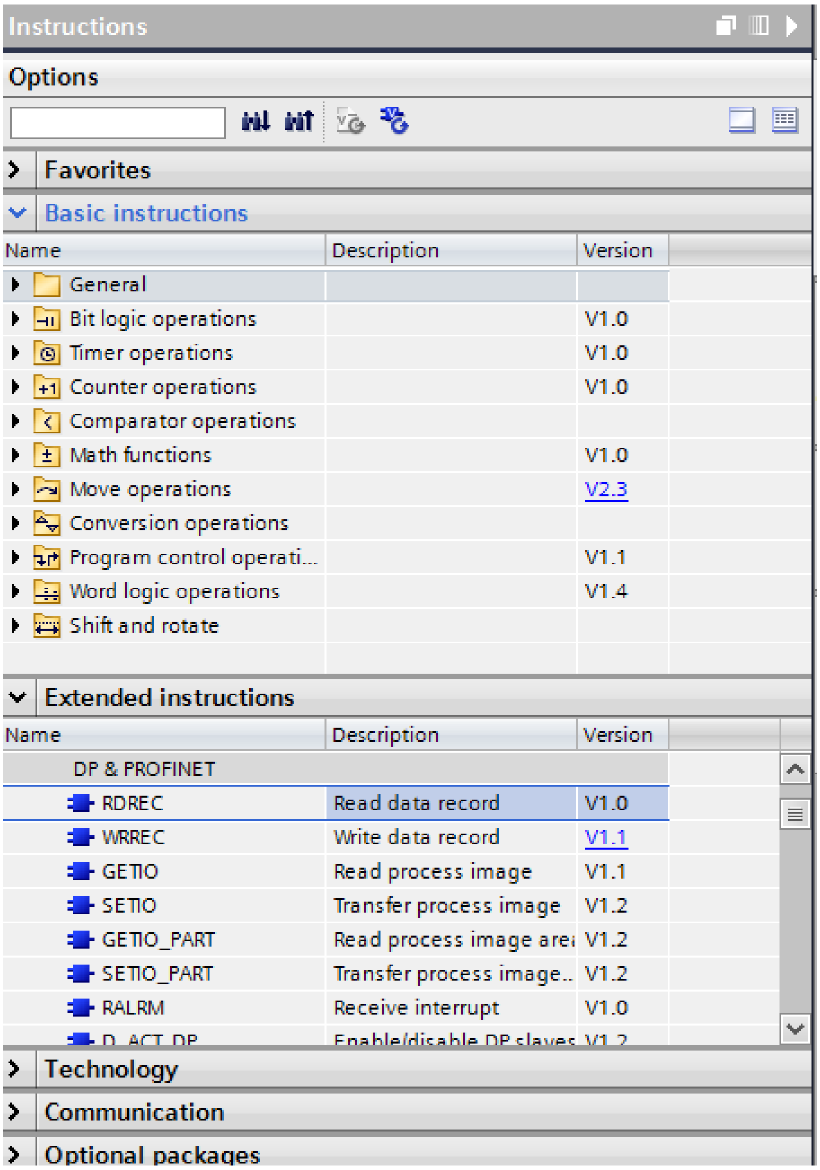

FIGURE 12-RDREC&WRREC FB IN TIAPORTAL

FB WRREC

Use the WRREC instruction to transfer a data RECORD with the record number INDEX to a DP slave/PROFINET IO device component addressed by ID, such as a module in the central rack or a distributed component (PROFINET IO).Assign the byte length of the data record to be transmitted. The selected length of the source area RECORD should, therefore, have at least the length of LEN bytes.

"WRREC_DB"(

- req:=_bool_in_,
- ID:=_word_in_,
- index:=_dint_in_,
- len:=_uint_in_,
- done=>_bool_out_,
- busy=>_bool_out_,
- error=>_bool_out_,
- status=>_dword_out_,
- record:=_variant_inout_

);

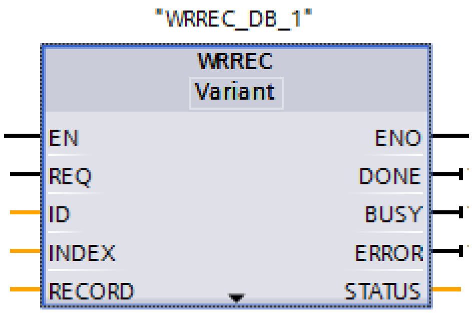

FIGURE 13-WRREC FB

FB RDREC

Use the RDREC instruction to read a data record with the number INDEX from the component addressed by the ID, such as a central rack or a distributed component(PROFINET IO).Assign the maximum number of bytes to read in MLEN. The selected length of the target area RECORD should have at least the length of MLEN bytes.

"RDREC_DB"(

- req:=_bool_in_,
- ID:=_word_in_,
- index:=_dint_in_,
- mlen:=_uint_in_,
- valid=>_bool_out_,
- busy=>_bool_out_,
- error=>_bool_out_,
- status=>_dword_out_,
- len=>_uint_out_,
- record:=_variant_inout_

)

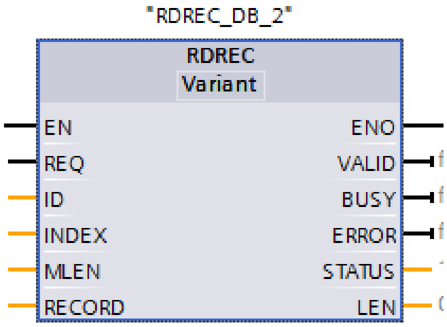

FIGURE 14-RDREC

Device parameters list

Here below a table with description, size and address of each parameter to be considered for DUETAD PROFINET:

NOTE: for a complete description of parameters please refer to DUET AD EtherCAT manual or to CANopen DS402 standard.

PNU	Name	Type	Size (byte)	Description	R/W	Unit	Range
2	DC Bus Link voltage	Unit16	2	DC Bus voltage	R/W	V	24-60 V
128	Mode Of Operation	Int8	2	The parameter modes of operation switches the actually chosen operation mode.	R/W		-127…128
134	Current Kp	Unit16	2	Current PI – proportional factor	R/W		0 … 65536
135	Current Ki	Unit16	2	Current PI – integral factor	R/W		0 … 65536
136	Velocity Kp	Unit16	2	Velocity PI – proportional factor	R/W		0 … 65536
137	Velocity Ki	Unit16	2	Velocity PI – integral factor	R/W		0 … 65536
138	Position Kp	Unit16	2	Position PI – proportional factor	R/W		0 … 65536
142	Nominal cur rent	Unit16	2	Contains the rated current of the motor in Arm/100.	R/W	Arms/ 100	0 … 65536
143	Peak curren t	Unit16	2	Motor peak current	R/W	Arms	0 … 65536

145	I2T Time	Unit16	2	I2T Time	R/W	mS	0 … 65536
149	LPR	Unit32	4	Line Per Revolution	R/W	Coun t	0 … 4294967296
151	Max Motor Velocity	Unit32	4	The maximum speed allowed for the motor in either direction. It is used to protect the motor and is taken from the motor data sheet.	R/W	User Unit	0 … 4294967296
155	Profile Acceleratio n	Unit32	4	The profile acceleration is given in user defined acceleration units. It is converted to position increments per second2 using the normalizing factors	R/W	User Unit	0 … 4294967296
157	Profile Deceleratio n	Unit32	4	The profile deceleration is given in user defined deceleration units. It is converted to position increments per second2 using the normalizing factors	R/W	User Unit	0 … 4294967296
159	Quckstop Deceleratio n	Unit32	4	The quick stop deceleration is the deceleration used to stop the motor if the 'Quick Stop' command is given. The quick stop deceleration is given in the same units as the profile acceleration.	R/W	User Unit	0 … 4294967296
161	Profile Velocity	Unit32	4	The profile velocity is the velocity normally attained at the end of the acceleration ramp during a profiled move and is valid for both directions of motion. The profile velocity is given in user defined speed units. It is converted to position increments per second using the velocity encoder factor.	R/W	User Unit	0 … 4294967296
163	Position Following Error Window	Unit32	4	The following error window defines a range of tolerated position values symmetrically to the position	R/W	User Unit	0 … 4294967296

				demand value. As it is in most cases used with user defined units, a transformation into increments with the position factor is necessary. If the position actual value is out of the following error window, an error occur.			
165	Position Radius	Unit32	4	The position window defines a symmetrical range of accepted positions relatively to the target position. If the actual value of the position encoder is within the position window, this target position is regarded as reached.	R/W	User Unit	0 … 4294967296
167	Velocity Following Error Window	Unit32	4	Velocity Following Error Window in Velocity Mode	R/W	User Unit	0 … 4294967296
169	Overvelocit y	Unit32	4	Value for Overvelocity Error	R/W	User Unit	0 … 4294967296
171	Velocity Radius	Unit32	4	The velocity window monitors whether the required process velocity has been achieved after an eventual acceleration or deceleration (braking) phase. It is given in velocity units.	R/W	User Unit	0 … 4294967296
173	Velocity Threshold	Unit32	4	As soon as the velocity actual value exceeds the velocity threshold longer than the velocity threshold time bit 12 velocity = 0 is reset in the statusword. Below this threshold the bit is set and indicates that the axle is stationary. The value is given in velocity units.	R/W	User Unit	0 … 4294967296
174	Following Error Timeout	Unit16	2	When a following error occurs longer than the defined value of the time-	R/W	mS	0 … 65536

				out given in multiples of milliseconds, the corresponding bit 13 following error in the status word will be set to one. The reaction of the drive when a following error occurs, is manufacturer specific.			
175	Position Radius Time	Unit16	2	When the actual position is within the position window during the defined position window time which is given in multiples of milliseconds, the corresponding bit 10 target reached in the statusword will be set to one.	R/W	mS	0 … 65536
176	Velocity Threshld Time	Unit16	2	The velocity threshold time is given in multiples of milliseconds.	R/W	mS	0 … 65536
177	Velocity Error Radius Time	Unit16	2	Velocity Error Radius Time	R/W	mS	0 … 65536
178	Velocity Radius Time	Unit16	2	The corresponding bit 10 target reached is set in the statusword when the difference between the target velocity and the velocity actual value is within the velocity window longer than the velocity window time. The value of the velocity window time is given in multiples of milliseconds.	R/W	mS	0 … 65536
179	Homing Method	Unit16	2	The homing method object determines the method that will be used during homing.	R/W		-127 … 128
181	Homing Offset	Unit32	4	The home offset object is the difference between the zero position for the application and the machine home position (found during homing), it is measured in position units.	R/W	User Unit	0 … 4294967296

				During homing the machine 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. All subsequent absolute moves shall be taken relative to this new zero position. This is illustrated in the following diagram.			
183	Homing Speed To Switch	Unit32	4	Homing Speed To Switch	R/W	User Unit	0 … 4294967296
185	Homing Speed To Zero	Unit32	4	Homing Speed To Zero	R/W	User Unit	0 … 4294967296
187	Homing Acceleratio n	Unit32	4	The homing acceleration establishes the acceleration to be used for all accelerations and decelerations with the standard homing modes and is given in acceleration units.	R/W	User Unit	0 … 4294967296
188	Homing Timeout	Unit16	2	Homing Timeout	R/W	User Unit	0 … 65536
196	Homing Current Threshold	Unit16	2	Homing Current Threshold	R/W	% of In	0 … 65536
197	Homing Current Threshold Time	Unit16	2	Homing Current Threshold Time	R/W	mS	0 … 65536
233	Position Factor Num	Unit32	4	Position Factor Num	R/W	User Unit	0 … 4294967296
235	Position Factor Div	Unit32	4	Position Factor Div	R/W	User Unit	0 … 4294967296
237	Velocity Factor Num	Unit32	4	Velocity Factor Num	R/W	User Unit	0 … 4294967296
239	Velcity Factor Div	Unit32	4	Velcity Factor Div	R/W	User Unit	0 … 4294967296

241	Acceleration Factor Num	Unit32	4	Acceleration Factor Num	R/W	User Unit	0 … 4294967296
243	Acceleration Factor Div	Unit32	4	Acceleration Factor Div	R/W	User Unit	0 … 4294967296
256	I2T Protection type	Unit16	2	I2T Protection type	R/W	User Unit	0…2
261	Load Inertia	Unit16	2	Load inertia	R/W	kg*cm^2	0 … 65536
514	Save to EEPROM	Bool	2	Store actual parameters	W		0…1
535	Output Pin	Unit16	2	Set Output Pin	W		0 … 65536
540	Control Word	Unit16	2	Control Word	R/W		0 … 65536
552	Current Target	Int16	2	Input value for torque controller in profile torque mode. It is expressed in Ampere/100.	R/W	A/100	-32.768… 32.767
554	Speed Target	Int32	4	The target velocity is the input for the trajectory generator and the value is given in velocity units.	R/W	User Unit	-2147483648 … 2147483648
556	Position Target	Int32	4	Position Target	R/W	User Unit	-2147483648 … 2147483648
640	Firmware version	Unit16	2	Firmware version del drive	R		0 … 65536
648	Serial number	Unit32	4	Serial number of drive	R		0 … 4294967296
653	Actual DC BUS voltage	Unit16	2	The Bus voltage measured by the sensor. It is the instantaneous power voltage DC Link active at the driver power stage.	R	mV	0 … 65536
662	Drive temperature	Unit16	2	Actual drive temperature*100	R	°C	0 … 65536
663	Input Status	Unit16	2	Input Status	R		0 … 65536
664	Output Status	Unit16	2	Output Status	R		0 … 65536

666	Bootloader version		2	Bootloader version	R		0 … 65536
668	Status Word	Unit16	2	Status Word	R		0 … 65536
669	Fault register	Unit16	2	This Parameter returns the error code of the last error occurred.	R		0 … 65536
670	Mode Of Operation Display	Int8	2	The modes of operation display show the current mode of operation. The meaning of the returned value corresponds to that of the modes of operation option code (index PNU 128).	R		0 … 255
671	Analog In	Int16	2	Analog In	R	mV	0 … 10000
674	Actual Iq	Int16	2	Actual Iq	R	mA	-32.768… 32.767
675?	Iq Demand	Int16	2	The output value for the current controller.	R	mA	32.768… 32.767
683	Actual Velocity	Int32	4	The velocity actual value is also represented in velocity units and is coupled to the velocity used as input to the velocity controller.	R	User Unit	-2147483648 … 2147483648
685	Velocity Error	Int32	4	Velocity Error	R	User Unit	-2147483648 … 2147483648
687	Velocity Demand	Int32	4	The output value of the trajectory generator may be corrected by the output value of the position control function. It is then provided as a demand value for the velocity controller and given in the velocity units.	R	User Unit	-2147483648 … 2147483648
689	Velocity Tracking Error	Int32	4	Velocity Tracking Error	R	User Unit	-2147483648 … 2147483648
691	Position Target	Int32	4	The target position is the position that the drive should move to in position profile mode using the	R	User Unit	-2147483648 … 2147483648

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				current settings of motion control parameters such as velocity, acceleration, deceleration, motion profile type etc. The target position is given in user defined position units. It is converted to position increments using the position factor. The target position will be interpreted as absolute or relative depending on the 'abs / rel' flag in the control word.			
693	Actual Position	Int32	4	The actual value of the position measurement in user units.	R		-2147483648 … 2147483648
695	Position Error	Int32	4	Position Error	R		-2147483648 … 2147483648
697	Position Demand	Int32	4	The position demand value is given in position units.	R		-2147483648 … 2147483648
699	Position Tracking Error	Int32	4	Position Tracking Error	R		-2147483648 … 2147483648

PNU 669: Fault Register

Fault register contains the last error occurred in the device.

Parameter size is 16bits.

Bit number	**Fault type**	**Description**	**Value (hex)**
0	OVER_VOLTAGE	Power supply voltage goes above to the maximum admitted value	0x01
1	UNDER_VOLTAGE	Power supply voltage goes below to the maximum admitted value	0x02
2	PEAK_MOTOR_CURRENT	Motor peak current exceeded	0x04
3	RATED_MOTOR_CURRENT	Motor rated current exceeded	0x08
4	SHORT_CIRCUIT		0x10
8	POSITION_TRACKING_ERROR	Position following error exceeded	0x100

9	VELOCITY_TRACKING_ERROR	Speed following error exceeded	0x200
10	OVERVELOCITY	Maximum motor velocity exceeded	0x400
11	DRIVE_OVERTEMPERATURE	Maximum motor velocity reached	0x800
13	FIELDBUS_CYCLE_TIME	Profinet cyclic messages timeout	0x2000

PNU 663: Digital Inputs

Indicates the state of the digital inputs. The digital inputs object has 32 bits.
The first 16 bits (bits 0-15) indicate the status of various types of switches. Those switches are functions assigned to some of the digital inputs (**not predefined, functions have to be assigned via UI**).

bit 0 = negative limit switch

- If bit is 0 on, the digital input assigned to the negative limit switch is on.
- If bit 0 is off, the digital input assigned to the negative limit switch is off.

bit 1 = positive limit switch

- If bit 1 is on, the digital input assigned to the positive limit switch is on.
- If bit 1 is off, the digital input assigned to the positive limit switch is off.

bit 2 = home switch

- If bit 2 is on, the digital input assigned to the home switch is on.
- If bit 2 is off, the digital input assigned to the home switch is off.

The last 16 bits indicate the status of each digital input, regardless of the input's functionality.

bit 16 = digital input 1

bit 17 = digital input 2

bit 18 = digital input 2

bit 19 = digital input 2

The bit values have the following meaning: 0 = switch is off

1 = switch is on Thus, for example:

If digital input 1 is on, bit 16 is set.

If digital input 2 is on, bit 17 is set.

If digital input 3 is on, bit 18 is set.

PNU 664: Digital Outputs

Indicates the state of the digital outputs.

Sub-index 1 of this object indicates the state of the digital outputs. This sub-index has 32 bits.

The bits in the first word (bits 0-15) indicates the status of the brake.

- **bit 0** = brake*****

If bit 0 is on, the digital output assigned to the brake is on.

If bit 0 is off, the digital output assigned to the brake is off.

The bits in the second word (bits 16-31) indicate the state of each digital output, regardless of the output's functionality.

- **bit 16** = digital output 1
- **bit 17** = digital output 2

The bit values have the following meaning:

- 0 = off
- 1 = on

For example, to read the status of digital output 1 (regardless of its functionality; it can be idle), read bit 16.

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9. PROFINET function blocks and data blocks for SIEMENS S7

Overview

For the DUET AD and Siemens PLC systems (SIMATIC S7 control systems), special function block have been written. They support the easy integration of a servo drive into a PLC program with PROFINET functionality. The function blocks and data blocks (FB, DB) are assigned to a specific operating mode.

Example programs have been written in order to explain and demonstrate the handling of the function blocks.

As their name indicates, the example programs are only examples and they are provided in order to explain the basic handling of the various function blocks and data blocks.

If the example programs are used in customer-specific applications, the user must check whether all of the function- and safety-relevant conditions are fulfilled.

The following chapters explain the fundamental hardware configuration and the use of the function blocks in an example project.

Hardware configuration

The hardware components can be selected from the hardware catalog. Select the desired hardware components in the hardware catalog by way of the mouse and drag and drop them into the topology view of the TIA portal.

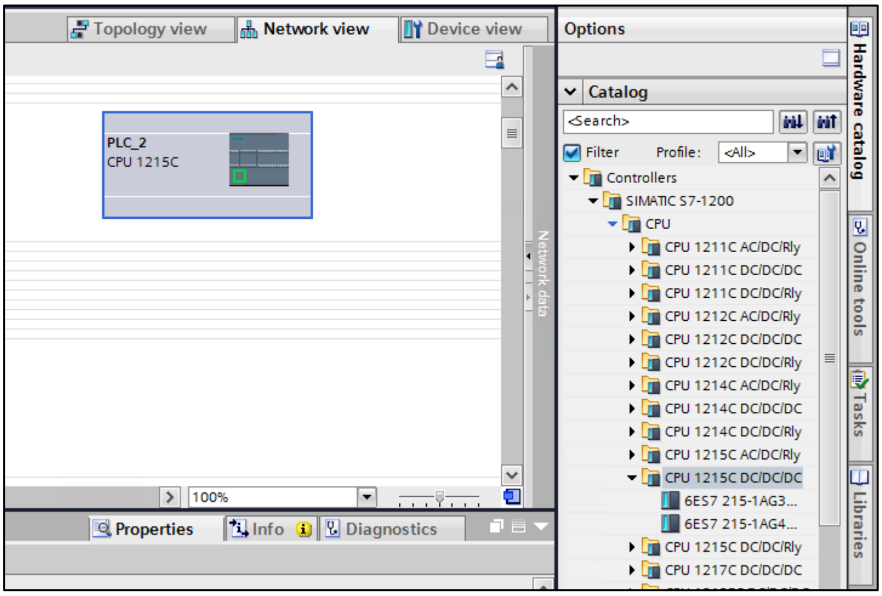

FIGURE 15 - HARDWARE CONFIGURATION

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Integration of the servo drive

In order to integrate the DuetAD into the PROFINET network, the servo drive must be selected in the hardware catalog. The DuetAD head module must be dragged and dropped into the topology view of the device configuration. Dragging the mouse from one PROFINET port to another PROFINET port connects the integrated devices. After the selection of the network view, the servo drive must be assigned to an I/O controller via the link "Not assigned" (see Figure 14-4).

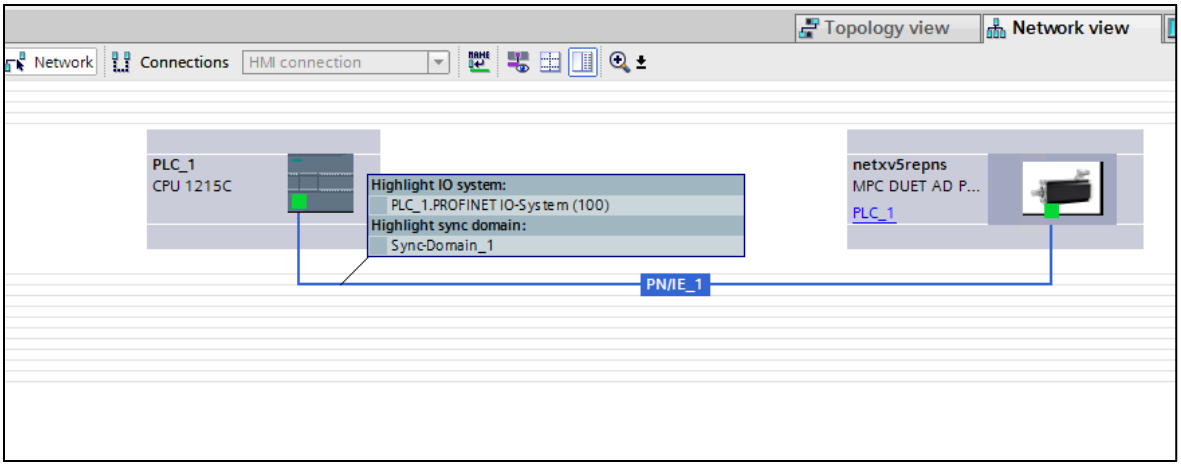
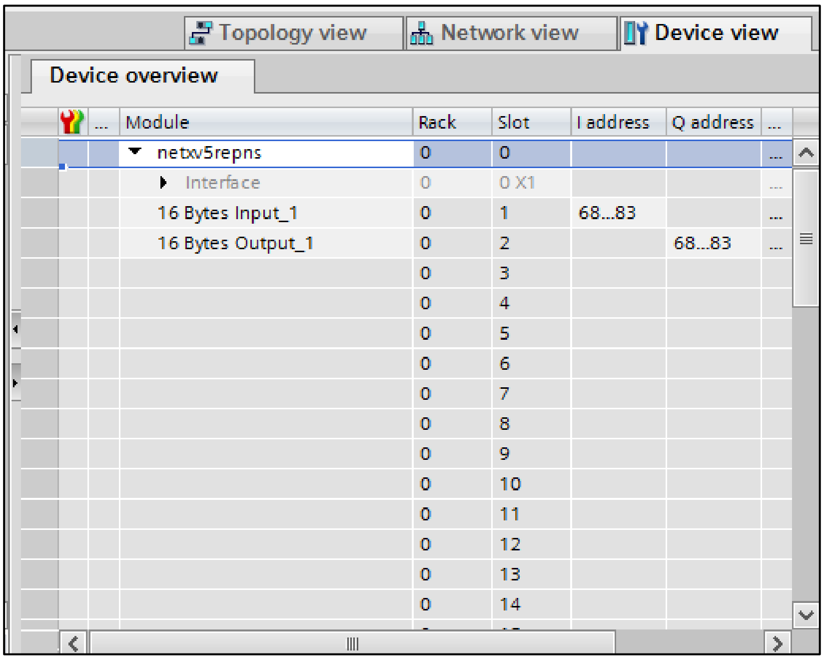


FIGURE 16 - IO CONTROLLER ASSIGNMENT

NOTE: GSDML file is available at www.motorpowerco.com

The device name is automatically assigned to the servo drive. After clicking the DuetAD logo of the servo drive, the device name can be changed under the menu item General in the Properties window.

This is followed by the configuration of the telegram data. The IN and OUT modules are transferred from the hardware catalog into the blank lines of the device view by drag & drop. The input and output addresses are automatically assigned, but it is possible to change them manually.



Module	Rack	Slot	I address	Q address
netxv5repns	0	0		
Interface	0	0 X1		
16 Bytes Input_1	0	1	68...83	
16 Bytes Output_1	0	2		68...83
	0	3		
	0	4		
	0	5		
	0	6		
	0	7		
	0	8		
	0	9		
	0	10		
	0	11		
	0	12		
	0	13		
	0	14		

FIGURE 17 - TELEGRAM DATA

When selecting the modules, the respective telegram length must be taken into consideration. This means:

- The module *16 Bytes Input_1* must be selected for the setpoint telegram for the position control mode, speed control mode or homing mode.
- The module *16 Bytes Output_1* must be selected for the actual value telegram

The integration of the DuetAD is now complete and the

Function blocks for DUET AD

I/O data association in Tia Portal v15.1

In order to ensure a proper IO exchange in FB it is necessary to associate IO data to PLC tags.

In these pages it is provided an example by Motor Power Company.

First of all, create or copy a proper structure for the IO of the communication to ensure a proper mapping on the controller.

PN_IO_Input_Type

	Name	Data type	Default value	Accessible f...	Writa...	Visible in ...	Setpoint
1	StatusWord_0	Byte	16#0	☑	☑	☑	☐
2	StatusWord_1	Byte	16#0	☑	☑	☑	☐
3	OpMode	Byte	16#0	☑	☑	☑	☐
4	Feedback_0	Byte	16#0	☑	☑	☑	☐
5	Feedback_1	Byte	16#0	☑	☑	☑	☐
6	Feedback_2	Byte	16#0	☑	☑	☑	☐
7	Feedback_3	Byte	16#0	☑	☑	☑	☐
8	PlaceHolder	Byte	16#0	☑	☑	☑	☐
9	ActCurrent_0	Byte	16#0	☑	☑	☑	☐
10	ActCurrent_1	Byte	16#0	☑	☑	☑	☐
11	Spare_0	Byte	16#0	☑	☑	☑	☐
12	Spare_1	Byte	16#0	☑	☑	☑	☐
13	Spare_2	Byte	16#0	☑	☑	☑	☐
14	Spare_3	Byte	16#0	☑	☑	☑	☐
15	Spare_4	Byte	16#0	☑	☑	☑	☐
16	Spare_5	Byte	16#0	☑	☑	☑	☐

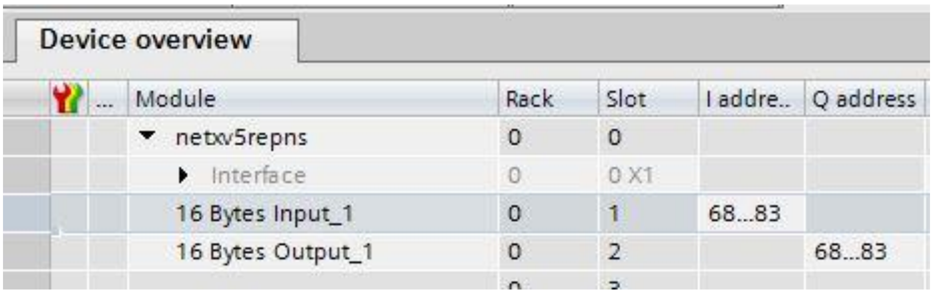
FIGURE 18-CONTROLLER INPUTS WITH MAPPING

PN_IO_Output_Type

	Name	Data type	Default value	Accessible f...	Writa...	Visible in ...	Setpoint
1	ControlWord_0	Byte	16#0	☑	☑	☑	☐
2	ControlWord_1	Byte	16#0	☑	☑	☑	☐
3	Opmode	Byte	16#0	☑	☑	☑	☐
4	HomingMethod	Byte	16#0	☑	☑	☑	☐
5	Target_0	Byte	16#0	☑	☑	☑	☐
6	Target_1	Byte	16#0	☑	☑	☑	☐
7	Target_2	Byte	16#0	☑	☑	☑	☐
8	Target_3	Byte	16#0	☑	☑	☑	☐
9	CurrentLimit_0	Byte	16#0	☑	☑	☑	☐
10	CurrentLimit_1	Byte	16#0	☑	☑	☑	☐
11	Spare_0	Byte	16#0	☑	☑	☑	☐
12	Spare_1	Byte	16#0	☑	☑	☑	☐
13	Spare_2	Byte	16#0	☑	☑	☑	☐
14	Spare_3	Byte	16#0	☑	☑	☑	☐
15	Spare_4	Byte	16#0	☑	☑	☑	☐
16	Spare_5	Byte	16#0	☑	☑	☑	☐

FIGURE 19- CONTROLLER OUTPUTS WITH MAPPING

Then create the TAG TABLE with the address given to the device by the Tia Portal.

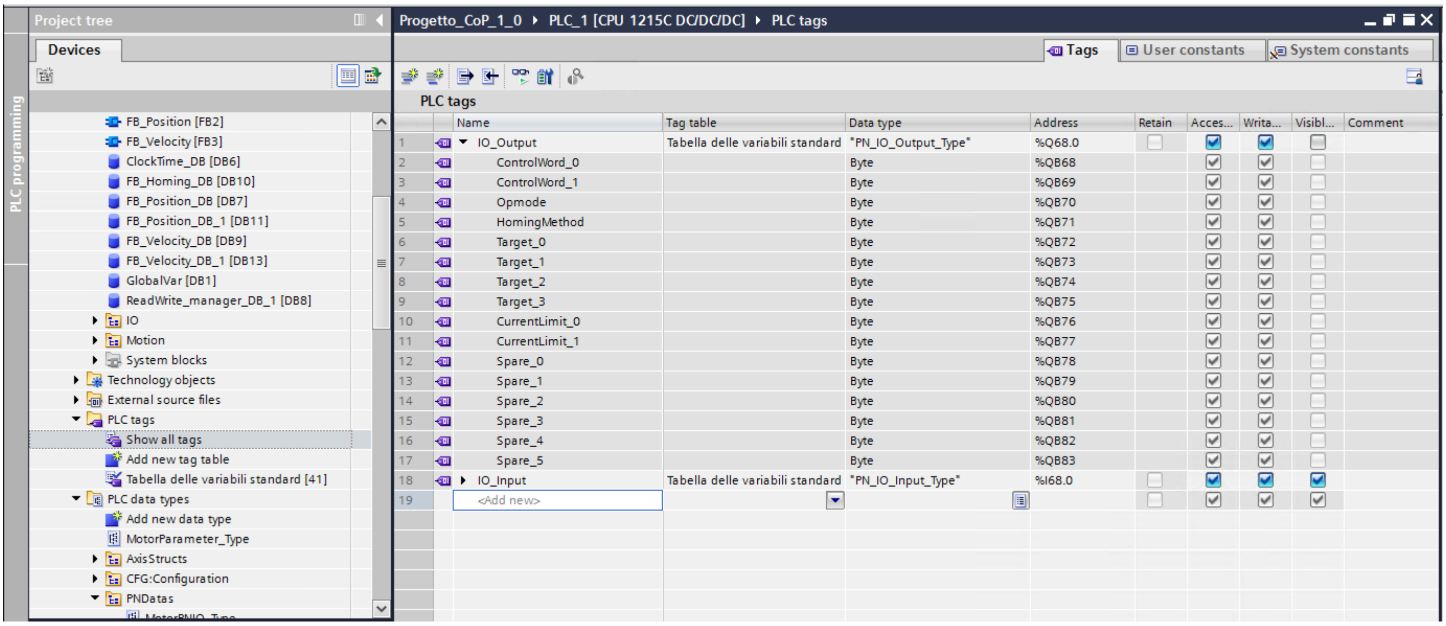


Device overview

Module	Rack	Slot	I addre..	Q address
netxv5repns	0	0		
Interface	0	0 X1		
16 Bytes Input_1	0	1	68...83	
16 Bytes Output_1	0	2		68...83

FIGURE 20-IO ADRESSESS FOR DEVICE IN TIA PORTAL

Use these addresses (I68 to I80 and Q68 to Q83) to fill the PLC Tag for Inputs and Ouputs by incrementing recusively the values.



	Name	Tag table	Data type	Address	Retain	Acces...	Writa...	Visibl...	Comment
1	IO_Output	Tabella delle variabili standard	"PN_IO_Output_Type"	%Q68.0					
2	ControlWord_0		Byte	%QB68					
3	ControlWord_1		Byte	%QB69					
4	Opmode		Byte	%QB70					
5	HomingMethod		Byte	%QB71					
6	Target_0		Byte	%QB72					
7	Target_1		Byte	%QB73					
8	Target_2		Byte	%QB74					
9	Target_3		Byte	%QB75					
10	CurrentLimit_0		Byte	%QB76					
11	CurrentLimit_1		Byte	%QB77					
12	Spare_0		Byte	%QB78					
13	Spare_1		Byte	%QB79					
14	Spare_2		Byte	%QB80					
15	Spare_3		Byte	%QB81					
16	Spare_4		Byte	%QB82					
17	Spare_5		Byte	%QB83					
18	IO_Input	Tabella delle variabili standard	"PN_IO_Input_Type"	%I68.0					
19	<Add new>								

FIGURA 13-PLC TAGS PAGE

Once PLC Tags have been created they have to be used in FB in Input and Output as variables.

FIGURE 21-PLC TAG USED IN FUNCTION BLOCKS

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FB for velocity mode

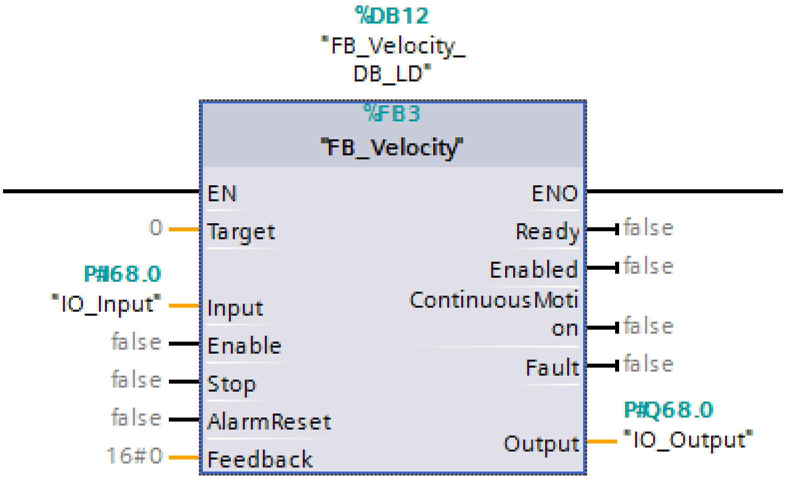

FIGURE 22-FB FOR PROFILE VELOCITY MODE

- **Inputs:**
  - **Target:**

    Number of the data block containing the data for the Velocity Target(INT).
  - **Input:**

    I/O Data of the IO device that are input for the controller. (IO_Input Data Type)
  - **Enable:**

    This input is used to enable the servo drive in the Profile Velocity Mode. Target Value will be ative immediately. (BOOL)
  - **AlarmReset:**

    This flag will try to clear the fault if set to true. Alarm reset is active on positive edge of the value. (BOOL)
  - **Feedback:**

    Actual position value for the motor feedback.
  - **Stop:**

    Axis will stop with quick stop deceleration profile (if true). With the falling edge from true to false axis will restart with Profile Velocity Mode values.

- **Outputs:**
  - **Output:**

    I/O Data of the IO device that are output for the controller. (IO_Output Data Type)

- **Ready:**

  This flag is set if motor is in operation enabled status. (BOOL)
- **Enabled:**

  This flag is set if motor is enabled. (BOOL)
- **Continuos Motion:**

  This flag is set if the motor is moving according to the thresholds set.(BOOL)
- **Fault:**

  This flag is set if motor is in fault status.(BOOL)

FB for profile position mode

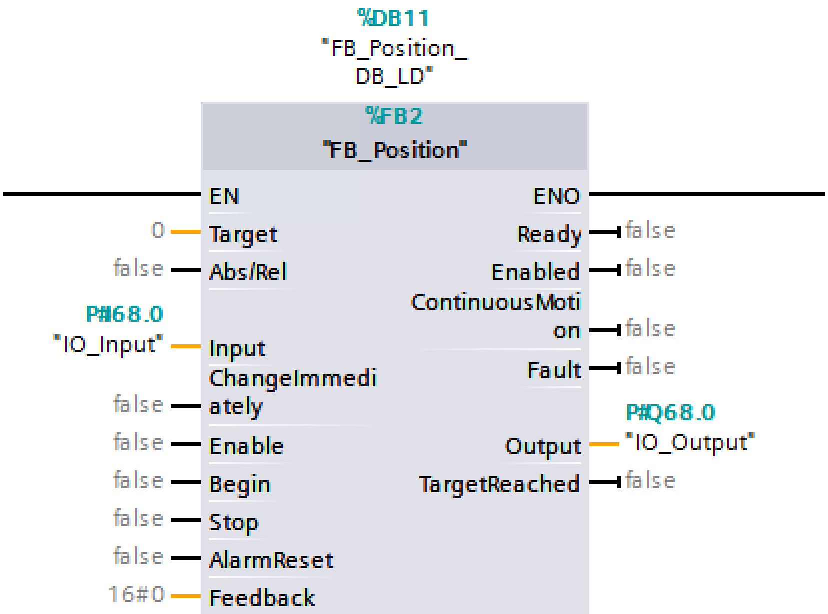

FIGURE 23 FB FOR PROFILE POSITION MODE

- **Inputs:**
  - **Enable:**

    This input is used to enable the servo drive in the Profile Position Mode. (BOOL)
  - **Target**

    Position Target to be reached(INT).
  - **Input:**

    I/O Data of the IO device that are input for the controller. (IO_Input Data Type)

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- **Begin:**

  Starts a movement to a target position. (BOOL)

- **Abs/Rel:**

  Next movement will take absolute target position (if false) or relative with respect to actual position (true). (BOOL)

- **Change Immediately**

  See Profile Position Mode chapter and examples for proper use of this bit. (BOOL)

- **Alarm Reset:**

  This flag will try to clear the fault if set to true. Alarm reset is active on positive edge of the value. (BOOL)

- **Feedback:**

  Actual position value for the motor feedback.

- **Stop:**

  Axis will stop with quick stop deceleration profile (if true). With falling edge from true to false axis will restart with Profile Position Mode values.

- **Outputs:**
  - **Output:**

    I/O Data of the IO device that are output for the controller. (IO_Output Data Type)

  - **Ready:**

    This flag is set if motor is in operation enabled status. (BOOL)

  - **Enabled:**

    This flag is set if motor is enabled. (BOOL)

  - **Continuous Motion:**

    This flag is set if the motor is moving according to the thresholds set.(BOOL)

  - **Fault:**

    This flag is set if motor is in fault status.(BOOL)

  - **Target Reached:**

    This flag is set if target reached for Profile Position Mode is set, according to the axis threshold for this bit. (BOOL)

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FB for homing mode

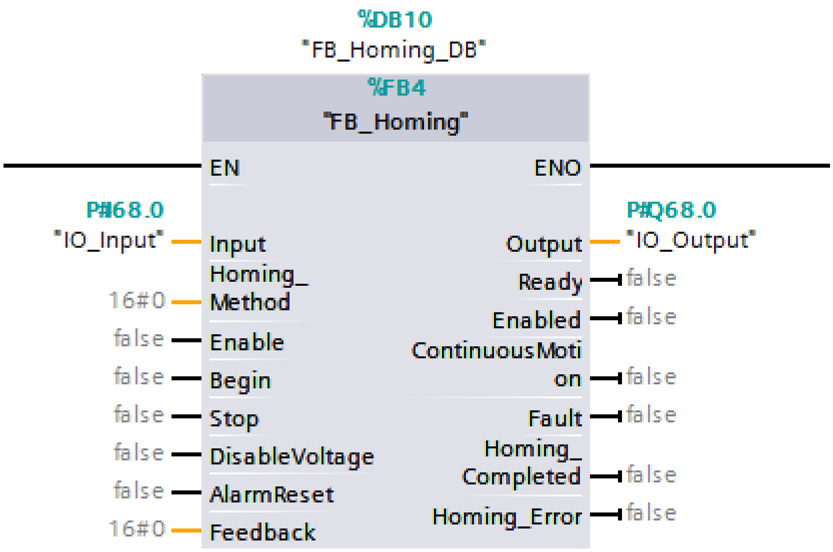

FIGURE 24-FB FOR HOMING MODE

- **Inputs:**
  - **Homing Method:**

    Homing type to be performed(INT8).
  - **Input:**

    I/O Data of the IO device that are input for the controller. (IO_Input Data Type)
  - **Enable:**

    This input is used to enable the servo drive in the Homing Mode. (BOOL)
  - **Begin:**

    This flag starts the homing procedure.(BOOL)
  - **AlarmReset:**

    This flag will try to clear the fault if set to true. Alarm reset is active on positive edge of the value. (BOOL)
  - **Feedback:**

    Actual position value for the motor feedback.
  - **Stop:**

Axis will stop with quick stop deceleration profile (if true). With falling edge from true to false axis will restart with Profile Position Mode values.

- **Outputs:**
  - **Output:**

    I/O Data of the IO device that are output for the controller. (IO_Output Data Type)
  - **Ready:**

    This flag is set if motor is in operation enabled status. (BOOL)
  - **Enabled:**

    This flag is set if motor is enabled. (BOOL)
  - **Continuos Motion:**

    This flag is set if the motor is moving according to the thresholds set.(BOOL)
  - **Fault:**

    This flag is set if motor is in fault status.(BOOL)
  - **Homing Complete:**

    This flag is set if homing procedure was successful. (BOOL)

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Example project: Moving the Axis in Velocity Profile Mode

Download the example project from www.motorpowerco.it in DUET AD area.

After the example project has been successfully loaded into the TIA portal, the program blocks shown in are listed in the Project tree area.

In the project tree window FBs are available.

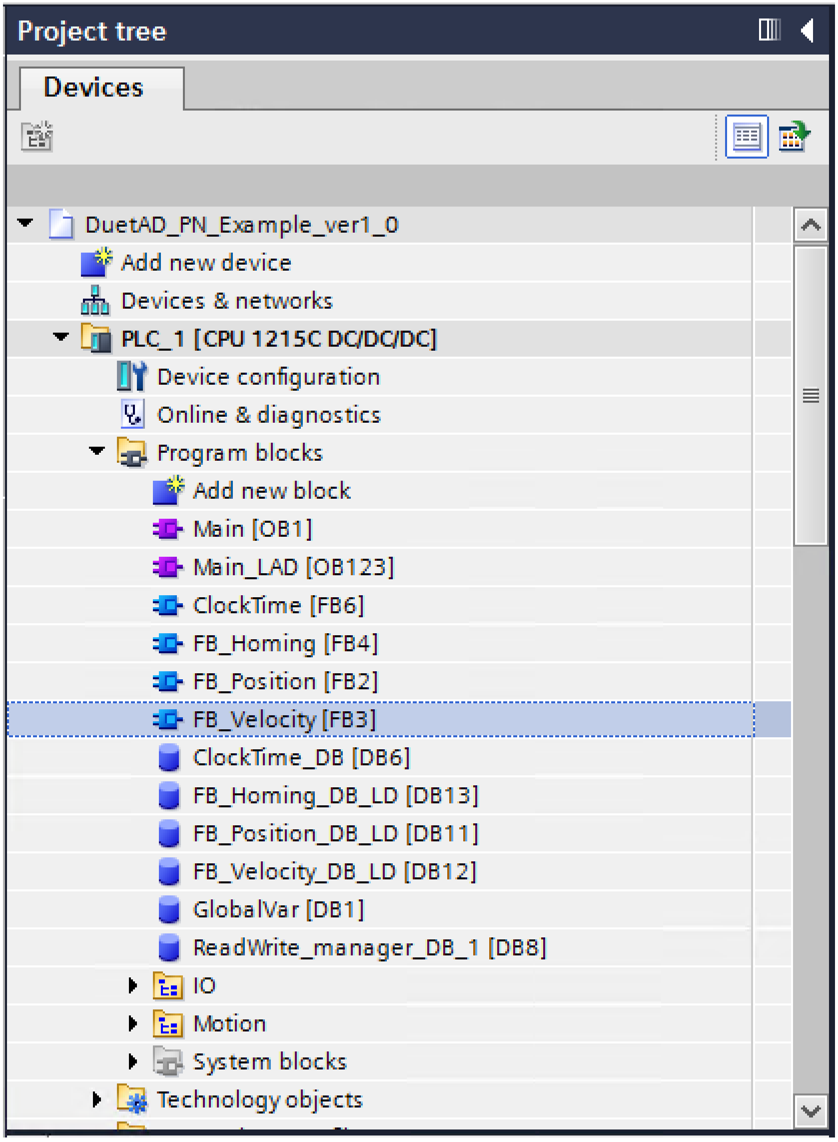

FIGURE 25-EXAMPLE PROJECT TREE

The IO data association has been done according to the **I/O data association in Tia Portal** chapter.

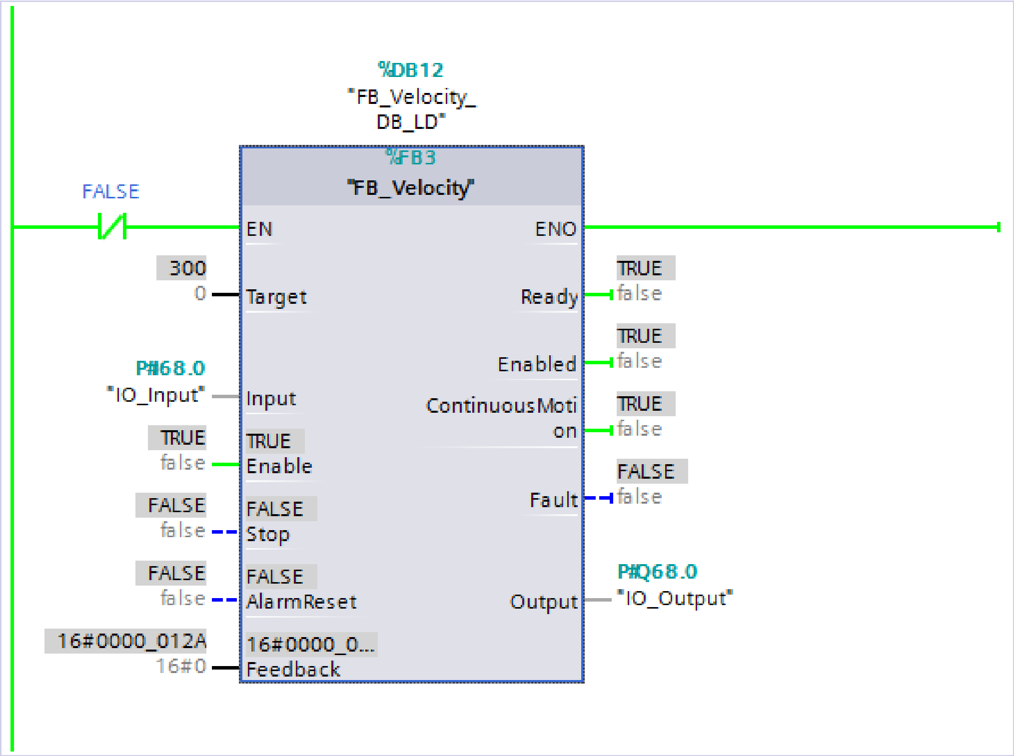

FIGURE 26-USING THE DEVICE WITH FB VELOCITY MODE