User's Manual

Profinet Attachment

Manual Code: MB00601E00 V_2.3

INDEX

1 INTRODUCTION

1.1 ABOUT THIS MANUAL

This manual is meant as a brief explanation of how to work new OPDE PROFINET Module. The manual contains the following chapters:

- **Introduction** provides information background about the manual;
- **Mechanical Installation** contains the instructions on mounting the OPDE PROFINET Module;
- **Electrical Installation** contains cabling instruction and general information about PROFINET connections;
- **Getting Started** contains a quick guide for setting-up the OPDE with a PROFINET master,
  provides the most important informations about PROFINET and other protocols, provides the information to solve possible problems and wrong configurations;

1.2 COMMON SYMBOLS AND ABBREVIATIONS

Abbreviations	Explanations
AR	Application Relation
ADU	Application Data Unit
CR	Communication Relation
CRC	Cyclic Redundancy Check
DCP	Discovering and Configuration Protocol
FSU	Fast Start Up
GSDML	General Station Description Markup Language
I&M	Identification & Maintenance
IO	Input / Output
IP	Internet Protocol
IRT	Isochronous Real-Time (PROFINET IO operating mode)
NRT	Non Real Time
OPDE	Open Drive Explorer
OPD Explorer	OPD Explorer Supervisory Software
PI	PROFIBUS/PROFINET International (www.profibus.com)
PNIO	PROFINET IO
PLL	Phase Locked Loop
PDU	Protocol Data Unit
RT	Real Time
XML	eXtensive Markup Language

1.3 INTENDED AUDIENCE

The manual is intended for those persons who are responsible for commissioning and using an OPDE PROFINET Module. The reader should have some basic knowledge of networking, electrical fundamentals, electrical wiring practices and how to work the OPDE drive and OPD Explorer.

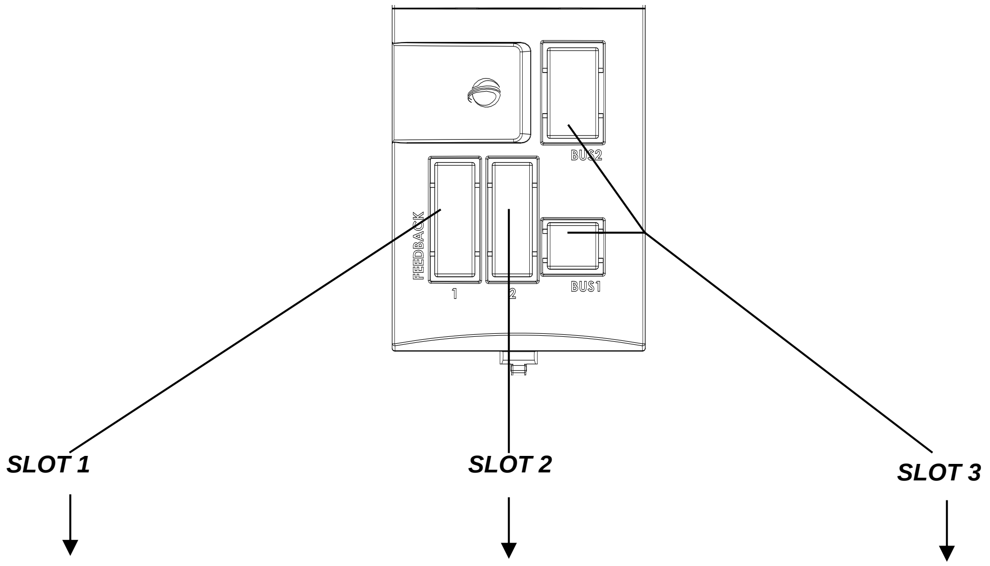
1.4 BEFORE YOU START

It is necessary that the drive is installed correctly and ready to use before starting the installation of the OPDE PROFINET Module.

2 MECHANICAL INSTALLATION

2.1 GENERAL INFORMATION ABOUT OPDE OPTIONAL BOARDS

In the OPDE drive are present three slots where is possible to connect some optional boards (Fig. 2.1). Depending on the slot is allowed to connect only some cards as follows (for more information, see the OPDE installation manual):



SLOT 1	SLOT 2	SLOT 3	
Resolver (4S0013)	Resolver (4S0013)	**BUS 1**	**BUS 2**
TTL/Hall sensor encoder (4S0017)	TTL/Hall sensor encoder (4S0017)	Empty	PROFINET RJ45 Connectors
SinCos encoder (4S0011)	SinCos encoder (4S0011)		
Endat/Biss encoder (4S0012)	Endat/Biss encoder (4S0012)		
High resolution resolver (4S0014)	High resolution resolver (4S0014)		
High resolution analog input (4S0015)	High resolution analog input (4S0015)		

Fig. 2.1 – Slots area in OPDE

2.2 MOUNTING THE OPDE PROFINET MODULE

The OPDE PROFINET Module (4B0010) must be inserted into its specific position in the drive: **SLOT 3**. The following figures show how to install the optional boards (Fig. 2.2).

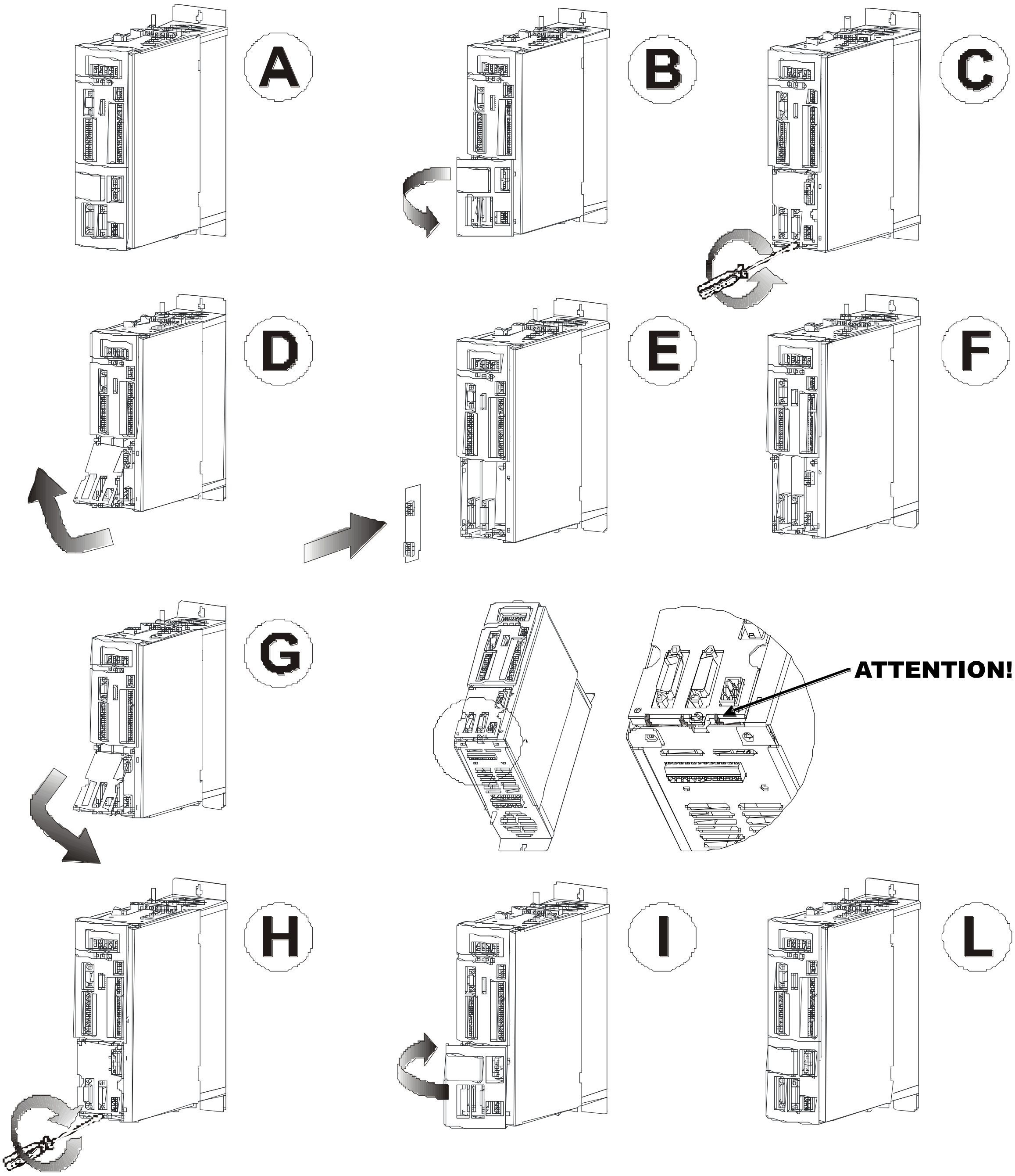


Fig. 2.2 – Optional board installation in OPDE mod 03A ÷ 60A

Pay Attention: before installing or removing the optional boards in the OPDE drive, ensure AC main supply has been disconnected for at least 5 minutes and the drive power supply has been switched-off.

The expansion slots have a metal cover plate that is holded by 4 brass spacers: normally the upper couple have a "T" tip for fast locking while the bottom couple have screws.
Due to mechanical constrains on OPDE PROFINET Module all the 4 brass spacers that hold the metal cover plate must be of screw type so the upper couple have to be replaced.

3 ELECTRICAL INSTALLATION

3.1 BUS INTERFACE

The OPDE PROFINET Module incorporates two 10/100 Base TX RJ45 connectors. The individual contacts of each RJ-45 socket are allocated as in following table:

RJ45 PIN	CONN "IN" (MDI)	CONN "OUT" (MDI-X)
1	TX+	RX+
2	TX-	RX-
3	RX+	TX+
4	-	-
5	-	-
6	RX-	TX-
7	-	-
8	-	-

Tab. 3.1 – RJ45 pinout

Socket OUT have switched transmission/reception pairs (MDI-X): this allows better start-up time as in a daisy chained configuration there's no need of crossover cable to avoid auto MDI/MDI-X negotiation delays and then helps achieving FSU (Fast Start Up).

3.2 RECOMMENDED CABLES

Ethernet patch or crossover cables in **CAT5e** quality can be used as the connection cable. CAT5e is an Ethernet network cable standard defined by the EIA/TIA. CAT5e is the fifth generation of twisted pair Ethernet technology and the most popular of all twisted pair cables in use today. CAT5e cable runs are limited to a maximum recommended run length of 100m.
Also TDE Macno strongly recommends shielded cables (STP, FTP, SFTP) for environments where proximity to power cable, high power or RF equipments may introduce crosstalk.
Better quality cables, like CAT6, are also suitable.

3.3 PROFINET CONNECTIONS

TDE Macno recommends, as PROFINET network topology, the classic lined daisy chain (Fig. 3.2). In daisy chain topology the PROFINET slave (OPDE drive) has an IN and an OUT RJ45 socket. The PROFINET cable (coming from the direction of the PNIO controller) is plugged into the IN socket. The OUT socket is connected to the next station.

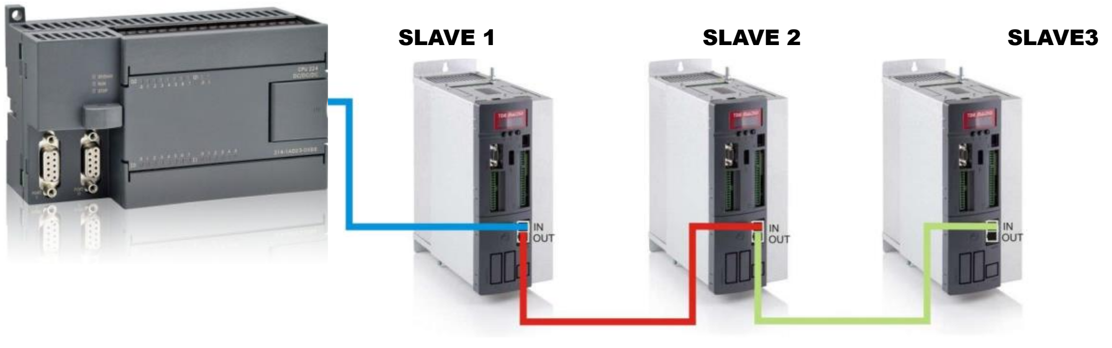


Fig. 3.2 – Daisy chain network

For different topologies (like star o mixed line/star), in order to preserve IRT capabilitiies, special PROFINET switches are required.

4 GETTING STARTED

4.1 DRIVE CONFIGURATION

After the OPDE PROFINET Module has been mechanically and electrically installed according to the instructions in the previous chapters, the drive must be prepared for communication with the module.
Normally, the drive parameters must be adjusted to activate the communication. The parameter values can be changed by using the OPDE keypad or OPD Explorer software.
The main PROFINET parameters are those shown in the Tab. 4.1. In OPD Explorer the PROFINET parameters can be found in the submenu item ***Profinet \ Configuration and State*** (Tab. 4.1).

Name	Description	Min	Max	Default	UM	Scale
EN_FLDBUS	C64 - Enable fieldbus manage	0	5	0		1
EN_BIG_ENDIAN	Most significant byte in multi-byte data types	0	1	0		1
FLDBUS_STATE	Anybus/Profinet module state					1
PN_LED_STATUS	Profinet Led Status				Bin	1
IP_ADDR_00	Network IP Address 00	0	255	192		1
IP_ADDR_01	Network IP Address 01	0	255	168		1
IP_ADDR_02	Network IP Address 02	0	255	0		1
IP_ADDR_03	Network IP Address 03	0	255	1		1
SUBNET_MASK_00	Network Subnet Mask 00	0	255	255		1
SUBNET_MASK_01	Network Subnet Mask 01	0	255	255		1
SUBNET_MASK_02	Network Subnet Mask 02	0	255	255		1
SUBNET_MASK_03	Network Subnet Mask 03	0	255	0		1
GATEWAY_00	Network Gateway 00	0	255	0		1
GATEWAY_01	Network Gateway 01	0	255	0		1
GATEWAY_02	Network Gateway 02	0	255	0		1
GATEWAY_03	Network Gateway 03	0	255	0		1

Tab. 4.1 - OPDE EtherCAT parameters

EN_FLDBUS (C64)

This parameter enables the OPDE PROFINET Module. To enable the OPDE PROFINET Module is necessary to set to "**5**" the connection parameter C64, if you use the keypad.

To enable the OPDE EtherCAT Module is necessary to select the value "Profinet" from drop-down menu of the EN_FLDBUS parameter, if you use the supervisory software.

The OPDE PROFINET Module is correctly recognized by the drive if in the *Slot3 FieldBus* field compares the **Profinet** sign (the Fig 4.1 is get from the OPD Explorer main page).

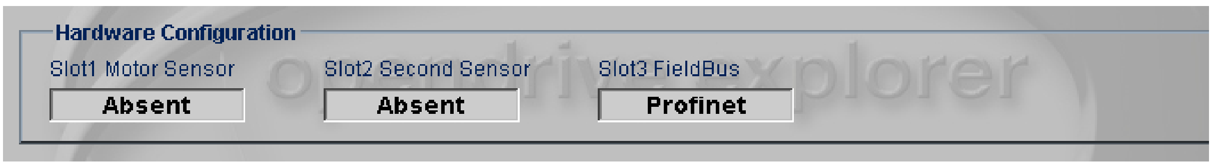


Fig. 4.1 - Hardware configuration

The EN_FLDBUS (C64) parameter is a Reserved Parameter (see OPDE Manual for more information). Key P60 has to be open in order to change it.

EN_BIG_ENDIAN

Data words are received and sent by the drive in Little Endian format (less significant byte first/at lower address) unless the Big Endian format (most significant byte first/at lower address) is enabled.

Use this parameterto set data format accordingly to the format expected by the PNIO controller (PROFINET master).

IP_ADDR_0x, SUBNET_MASK_0x, GATEWAY_0x

These parameters allow setting of network IP address, subnet mask and gateway address used by the drive for communication. The **IP address must be set univocally** in the network in order to allow proper communication. The subnet mask and gateway allow identification of local sub-network boundaries and specify a path to reach outside hosts.

PNIO controller (PROFINET master) usually can set the device name, IP address, subnet mask and gateway of PNIO devices (PROFINET slaves) by DCP services.

Although all these can be temporary changed by the master **via DCP, only the device name can be permanent stored** by the OPDE: at power-up all other settings are over-written with the values saved into OPDE parameters.

FLDBUS_STATE

This read-only parameter monitor the state of filedbus interface:

SETUP	Fieldbus setup in progress.
IDLE	The network interface is idle. This happens if there are no connection on the sockets or if no PNIO controller (PROFINET master) has established an AR/CR with the drive.
PRCS_ACT	AR/CR with PNIO controller (PROFINET master) are on and cyclic data are exchanging.
ERROR	Fieldbus error / board error.

PN_LED_STATUS

This read-only parameter monitor the state of OPDE PROFINET Module leds.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
1 = blinking / 0 = not blinking								1 = on (still) / 0 = off or blinking							
x	x	x	x	**MR**	**MD**	**SF**	**BF**	x	x	**P2 Link**	**P1 link**	**MR**	**MD**	**SF**	**BF**

Bits b4 and b5 reflect the status of link led on the 2 RJ45 sockets (ethernet port 1 and port 2): these leds are on when the related port is wired to a another ethernet port and a valid link is established.

Bits b0 to b3 (for still state) and b8 to b11 (for blinking state) are related the PROFINET leds (that are not visible with cover on) and they are very useful for troubleshooting:

BF	**Bus communication** (led L4, red): ON: no Link status available. Flashing: Link status ok; no communication link to a PROFINET-Controller. OFF: The PROFINET-Controller has an active communication link to this PROFINET-Device.
SF	**System Fail** (led L3, red): ON: PROFINET diagnostic exists. OFF: No PROFINET diagnostic.

MD	**Maintenance** (led L1, yellow): ON: PROFINET diagnostic alarm with maintenance state required or demaned. OFF: No diagnostic alarm with maintenance state required or demaned pending.
MR	**Device ready** (led L2, green): OFF: interface has not started correctly. Flashing: interface is waiting for the synchronization of the Host CPU. ON: interface has started correctly.

After executing configuration:

• Save the data in FLASH (C63=1)
• Turn the drive off and on.

4.2 CYCLIC COMMUNICATION

Cyclic communication consists of few data (**maximum 10 words for each direction**) exchanged quickly and frequently (from some ms down to hundreds μs cycle): I/O, diagnostic, set point, internal values… the so called "PROCESS DATA".
Depending on loaded application these references may be used for control only if connection "Enable Fieldbus references" is enabled: please check for specific documentation about the application.

It's possible to map the desired objects with OPDExplorer into submenu item ***Profinet \ Cyclic Mapping*** that allow mapping up to 10 CANopen Dictionary objects both in transmission and reception.

Name	Description
RX0_INDEX	Receive Object0 Index
RX0_SUB_INDEX	Receive Object0 Sub-Index
RX1_INDEX	Receive Object1 Index
RX1_SUB_INDEX	Receive Object1 Sub-Index

………..
………..

RX9_INDEX	Receive Object9 Index
RX9_SUB_INDEX	Receive Object9 Sub-Index

TX0_INDEX	Transmit Object0 Index
TX0_SUB_INDEX	Transmit Object0 Sub-Index
TX1_INDEX	Transmit Object1 Index
TX1_SUB_INDEX	Transmit Object1 Sub-Index

………..
………..

TX9_INDEX	Transmit Object9 Index
TX9_SUB_INDEX	Transmit Object9 Sub-Index

For the process area configuration:

1. Programme the objects being received and transmitted by indicating the index and sub-index of the objects in the CANopen Dictionary (the sub-index is 0 for VAR objects or the array index for ARRAY objects).
   Every mapped object can be 16 or 32 bit wide and then use 1 or 2 data words.
   The max number of words can be 10 in RX and 10 in TX.
   RX and TX direction are related to the drive point of view so:
   - **RX** refers to data sent by the master to the slave (**master data output**)
   - **TX** refers to data sent by the slave to the master (**master data input**).
2. Save the data in FLASH (C63=1).
3. Switch the drive off and then on again.

After it has been turned on again, verify the mapping outcome by checking in the OPDExplorer the following internal sizes:

Name	Display	Description
MAP_ERROR_CODE	Ok	successful configuration
	OBJ_NOTFOUND	the object listed in the following MAP_ERROR_OBJ was not found in the dictionary
	OBJ_NOTMAPPABLE	the object listed in the following MAP_ERROR_OBJ is not mappable
	OBJ_INVDATASIZE	the object listed in the following MAP_ERROR_OBJ has sizes exceeding long
	OBJ_NOTWRITABLE	the object listed in the following MAP_ERROR_OBJ is not writable
	OBJ_NOTREADABLE	the object listed in the following MAP_ERROR_OBJ is not readable
	MAXRX_DATA	Too many words to read (more than 10)
	MAXTX_DATA	Too many words to write (more than 10)
MAP_ERROR_OBJ	Mapping Error Object	

4.2.1 DICTIONARY OF CANOPEN OBJECTS

The following table shows the CANopen Dictionary with the relevant sizes.
At application level it is possible to extend the Dictionary objects.

The variables shown in bold are mappable in the process area.

Index (hex)	Object	Type	Name	Description	Access
200D	ARRAY	INTEGER16	Tab_par [200]	Actual values of the parameters (P00…P199)	reading/writing
200E	ARRAY	INTEGER16	Tab_con [100]	Actual values of the connection (C00…C99)	reading/writing
200F	ARRAY	INTEGER16	Tab_int [128]	Actual values of the internal words (D00…D127)	reading
2010	ARRAY	INTEGER16	Tab_inp_dig[32]	Actual values of the logical input's functions (I00…I31)	reading
2011	ARRAY	INTEGER16	Tab_out_dig[64]	Actual values of the logical output's functions (o00…o63)	reading
2012	ARRAY	INTEGER16	Tab_osc [100]	Actual values of the checked words (o00…o99 see in real time graph)	reading
2013	VAR	UNSIGNED8	Inp_dig_connettore	Logical status of the 8 inputs of the terminal board (physical input status)	reading
2014	VAR	UNSIGNED8	ingressi_hw	Logical status of the 3 inputs from the	reading
2015	VAR	UNSIGNED8	uscite	Logical status of the 4 digit outputs (physical output status)	reading
2016	VAR	UNSIGNED 32	Out_dig_appl	Reading application outputs	reading
2017	VAR	UNSIGNED16	stato	Variable of the drive's status	reading
2018	VAR	UNSIGNED16	allarmi	Drive alarms' status	reading
2019	VAR	UNSIGNED16	abilitazione_allarmi	Mask for enabling drive's alarms	reading
201A	VAR	INTEGER16	rif_fieldbus	Speed reference in % of n_{MAX} in 16384	reading/writing
201B	VAR	INTEGER16	limitrif_fieldbus	torque limit in % di Tnom in 4095	reading/writing
201C	VAR	INTEGER16	trif_fieldbus	torque reference in % di Tnom in 4095	reading/writing
201D	VAR	INTEGER16	theta_fieldbus	Speed reference in electr. pulses x Tpwm	reading/writing
201E	ARRAY	INTEGER16	Tab_dati_applicazione [100]	Actual values of the application parameters (E00…E99)	reading/writing
201F	VAR	UNSIGNED32	Inp_dig_field	Logical inputs function by fielbus	reading/writing
2020	VAR	UNSIGNED32	Inp_dig	Actual values of the logical input's functions (I00…I31)	reading
2021	VAR	UNSIGNED32	Out_dig	Actual values of the logical output's functions (o00…o63)	reading
2022	VAR	UNSIGNED16	word_vuota	Unused Word	reading/writing
2023	VAR	UNSIGNED32	double_vuota	Unused Double word	reading/writing
2024	VAR	DOMAIN	Tab_formati_appl	Formats of application parameters (E00...E99)	reading
2025	ARRAY	INTEGER16	Tab_codice_allarmi[16]	Alarms subcode	reading
2026	VAR	UNSIGNED32	Quota_att	Actual multi-turn position	reading
2027	ARRAY	UNSIGNED16	tabProcessData	Process variable mapping	reading/writing
2028	VAR	UNSIGNED32	letto	Actual position on turn	reading
2029	VAR	UNSIGNED32	letto_senza_top	Actual incremental position on turn	reading
202A	VAR	INTEGER16	letto2	Actual second sensor position on turn	reading
202B	ARRAY	INTEGER16	Tab_extra_int [70]	Actual extra internal values	reading
202C	ARRAY	INTEGER16	Tab_comandi [12]	Utilities commands (U00...U09)	reading/writing

The content of some objects is shown more specifically below:

- Index 0x200F “Tab_int” on the internal sizes (word)

Name	Description	UM	Scale
FW_REV	D00 – Software version		256
ACTV_POW	D01 – Active power generated	kW	16
PRC_TOT_APP_SPD_REF	D02 – Speed reference before the ramps	% MOT_SPD_MAX	163.84
PRC_END_SPD_REF	D03 – Speed reference after the ramps	% MOT_SPD_MAX	163.84
PRC_MOT_SPD	D04 – Measured speed	% MOT_SPD_MAX	163.84
PRC_T_REF	D05 – Torque request	% MOT_T_NOM	40.96
PRC_IQ_REF	D07 – Torque current request	% DRV_I_NOM	40.96
PRC_ID_REF	D08 – Reactive current request	% DRV_I_NOM	40.96
V_REF	D09 – Maximum voltage reference	% MOT_E_NOM	40.96
PRC_APP_T_REF	D10 – Torque request from application	% MOT_T_NOM	40.96
MOT_I	D11 – Current module	A rms	16
REF_FRQ_IN	D12 – Input frequency	KHz	16
EL_FRQ	D13 – Electric size frequencies	Hz	16
PRC_APP_FRQ_SPD_REF	D14 – Speed reference in frequency from application	% MOT_SPD_MAX	163.84
PRC_IQ	D15 – Measured torque current	% DRV_I_NOM	40.96
PRC_ID	D16 – Measured reactive current	% DRV_I_NOM	40.96
MOT_V	D17 – Generated statoric voltage	V rms	16
PRC_MOT_V	D18 – Generated statoric voltage	% MOT_E_NOM	40.96
MOD_INDEX	D19 – Modulation index		40.96
PRC_VQ_REF	D20 – Statoric voltage reference axis Q	% DRV_E_NOM	40.96
MOT_SPD	D21 – Motor rotation speed	rpm	1
PRC_VD_REF	D22 – Statoric voltage reference axis D	% DRV_E_NOM	40.96
MOT_POS	D23 – Current position on the turn	±16384	1
DC_BUS	D24 – DC Bus voltage	V	16
DRV_TEMP	D25 – Radiator temperature	°C	16
MOT_TEMP	D26 – Motor temperature	°C	16
PRC_DRV_I_THERM	D28 – Motor thermal current	% soglia All	40.96
PRC_DRV_I_MAX	D29 – Current limit	% DRV_I_NOM	40.96
PRC_DRV_T_MAX	D30 – Maximum positive torque	% MOT_T_NOM	40.96
PRC_DRV_I_T_MAX	D31 – Maximum torque from positive limit	% MOT_T_NOM	40.96
PRC_APP_T_MAX	D32 – Maximum torque from application	% MOT_T_NOM	40.96
PRC_APP_SPD_REF	D33 – Speed reference from application	% MOT_SPD_MAX	163.84
PRC_MOT_T	D35 – Torque produced	% MOT_T_NOM	40.96
MOT_TURN_POS	D36 – Absolute mechanical position on current turn	±16384	1
MOT_N_TURN	D37 – Number of turns completed		1
OFFSET_SINCOS_ENC	D38 –Analogue/digital compensation term of the Sin/Cos	impulses	1
SENSOR_FRQ_IN	D39 – Sensor input frequency	kHz	16
REG_CARD_TEMP	D40 – Adjustment card temperature	°C	16
MOT_PRB_RES	D41 – Measured motor thermal resistance	Ohm	1
AI1	D42 – Analogue input AI1	%	163.84
AI2	D43 – Analogue input AI2	%	163.84
AI3	D44 – Analogue input AI3	%	163.84
SPD_ISR	D45 – Speed routine duration	us	64
I_ISR	D46 – Current routine duration	us	64
I_LOOP_BAND	D47 – Current ring passing band	Hz	1
PRC_APP_T_MIN	D48 – Minimum torque from the application	% MOT_T_NOM	40.96
WORK_HOURS	D49 – Working hours	hours	1
ENC_HALL_SECTOR	D50 – Encoder-read sensor and Hall probes		1
SENS2_SPD	D51 – Rotation speed of sensor two	rpm	1
SENS2_TURN_POS	D52 – Absolute mechanical position on the current turn of sensor two	±16384	1
SENS2_N_TURN	D53 – Number of turns completed by sensor two		1
SENS2_FRQ_IN	D54 – Input frequency of sensor two	KHz	16
SENS1_ZERO_TOP	D55 – Sensor1 Top Zero	impulses	1
SENS2_ZERO_TOP	D56 – Sensor2 Top Zero	impulses	1
SYNC_DELAY	D57 – Synchronisation of the SYNC	us	1
PWM_SYNC_OFFSET	D58 - PWM offset for SYNC control	pulses	1
SERIAL_NUMBER	D59 - Drive Serial Number		1
FLD_CARD	D60 –Fieldbus card present		1
APPL_REV	D61 – Revision of the application		40.96
HW_SENSOR2	D63 – Decoding card Sensor 2		1
HW_SENSOR1	D63 – Decoding card Sensor 1		1

At application level it is possible to define other 64 internal sizes from D64 to D127.

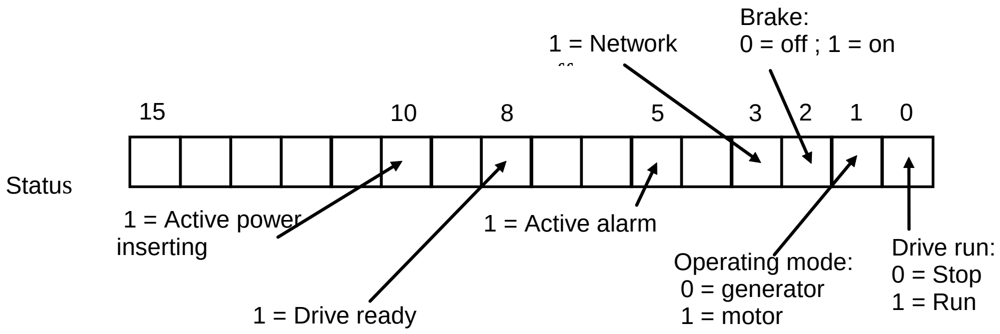
- Index 0x2012 “Tab_osc” on monitor sizes

Name	Description	UM	Scale
ACT_POS	O00 – Current position read by the sensor		327.67
ELECTRIC_POS	O01 – Current electric power		327.67
PRC_TOT_APP_SPD_REF	O02 – Speed reference before the ramps	% MOT_SPD_MAX	163.84
PRC_END_SPD_REF	O03 – Speed reference after the ramps	% MOT_SPD_MAX	163.84
PRC_MOT_SPD	O04 – Measured speed	% MOT_SPD_MAX	163.84
PRC_T_REF	O05 – Torque request	% MOT_T_NOM	40.96
PRC_IQ_REF	O07 – Torque current request	% DRV_I_NOM	40.96
PRC_ID_REF	O08 – Reactive current request	% DRV_I_NOM	40.96
PRC_V_REF	O09 – Maximum voltage reference	% MOT_E_NOM	40.96
ALARMS	O10 – Active alarms		1
PRC_MOT_I	O11 – Current module	% DRV_I_NOM	40.96
ZERO_TOP	O12 – Zero top	pulses	1
PRC_IU	O13 – Phase current U	% DRV_I_MAX	40.96
INPUTS	O14 – Physical input		1
PRC_IQ	O15 – Measured torque current	% DRV_I_NOM	40.96
PRC_ID	O16 – Measured reactive current	% DRV_I_NOM	40.96
TU	O17 – Duty cycle phase U		327.67
PRC_MOT_V	O18 – Generated statoric voltage	% MOT_E_NOM	40.96
MOD_INDEX	O19 – Modulation index		40.96
PRC_VQ_REF	O20 – Statoric voltage reference axis Q	% DRV_E_NOM	40.96
PRC_POWER	O21 – Supplied power	%MOT_POW_NOM	40.96
PRC_VD_REF	O22 – Statoric voltage reference axis D	% DRV_E_NOM	40.96
PRC_T_OUT	O23 – Supplied torque	% MOT_T_NOM	40.96
PRC_DC_BUS	O24 – DC Bus voltage	%900V	40.96
PRC_DRV_TEMP	O25 – Radiator temperature	%37.6°	40.96
PRC_MOT_TEMP	O26 – Motor temperature	% 80°	40.96
PRC_DRV_I_THERM	O28 – Motor thermal current	% soglia All	40.96
PRC_DRV_I_MAX	O29 – Current limit	% DRV_I_NOM	40.96
PRC_DRV_T_MAX	O30 – Maximum torque	% MOT_T_NOM	40.96
PRC_DRV_T_MIN	O31 – Minimum torque	% MOT_T_NOM	40.96
OUTPUTS	O32 – physical outputs		1
PRC_IV	O34 – Phase current V	% DRV_I_MAX	40.96
PRC_IW	O35 – Phase current W	% DRV_I_MAX	40.96
ALFA_FI	O36 – Electric angle		327.67

Name	Description	UM	Scale
AI1	O37 – AI1		163.84
AI2	O38 – AI2		163.84
AI3	O39 – AI3		163.84
SYS_SPD_PERC_REF	O41 – Speed reference from application	% MOT_SPD_MAX	163.84
SYS_T_PERC_REF	O42 – Torque reference from application	% MOT_T_NOM	40.96
SYS_T_MAX	O43 – Maximum torque limit from application	% MOT_T_NOM	40.96
SYS_SPD_REF_PULS	O44 – Speed reference as impulses from the application		1
SYS_POS_REF_PULS	O45 – Position reference as impulses from the application		1
RES_AMPLITUDE	O46 – Resolver retroaction amplitude		1
RES_SIN	O47 – Resolver sine/absolute sin cos		1
RES_COS	O48 – Revolver cosine /absolute sin cos		40.96
PRC_MOT_SPD	O49 – Unfiltered measured speed	% MOT_SPD_MAX	163.84
PULSES_RD	O50 – Delta impulses read at frequency input		1
MEM_POS_LSW	O51 – Overlapping space ring memory (lsw)	electric impulses	1
MEM_POS_MSW	O52 – Overlapping space ring memory (msw)		1
INCR_SIN	O53 – Sine in the incremental sin cos		1
INCR_COS	O54 – Cosine in the incremental sin cos		1
INIT_RESET	O55 – Initial reset cycle		1
PTM_TH_PRB	O56 – Motor thermal Pellet		40.96
PTR_TH_PRB	O57 – Radiator thermal Pellet		40.96
SENS_PULSES_RD	O58 – Delta impulses read by the sensor		1
PRC_SENS2_SPD	O59 – Unfiltered measured speed according to sensor	% MOT_SPD_MAX	163.84
ACT_SENS2_POS	O60 – Current position read by the second sensor		327.67
SENS2_SIN	O61 – Sensor two sine		1
SENS2_COS	O62 – Sensor two cosine		1
SYNC_DELAY	O63 – Delay in receiving SYNC		1
SYS_T_MIN	O64 – Minimum torque limit from the application	% MOT_T_NOM	40.96
BRAKE_EN	O65 – Energy dissipated while braking		1

At application level, it is possible to define other 32 monitor sizes from O68 to O99.

- Index 0x2017 a converter status variable is available with the following meaning:



- Index 0x2018 shows the status of the various converter alarms bit per bit, that is to say A8 is associated with bit 8.

- Index 0x2019 is the alarm enabling mask, also here the meaning is bit by bit.

- Index 0x201A “f_fieldbus” = speed reference as a percentage of the maximum set speed. The representation basis is 16384: therefore 16384 equals 100%

- Index 0x201D “theta_fieldbus” = speed reference as impulses per PWM period, considering that there are 65536 impulses on the turn.

- Index 0x201C trif_fieldbus = torque reference as percentage of the nominal motor torque. The representation basis is 4095: therefore 4095 equals 100%

- Index 0x201A limit_fieldbus = torque limit as percentage of the nominal motor torque (which will be an alternative to the other existing limits, the most restrictive applies). The representation basis is 4095: therefore 4095 equals 100%

4.2.2 CONFIGURATION EXAMPLE

At drive level, in order to receive in the process part in the first 2 words the logic input function command and in the third word the speed reference and to have as output in the first 2 words the logic output function status and the current speed, it is necessary to set:

RX0_INDEX	201F	input logic function writing
RX0_SUB_INDEX	0	
RX1_INDEX	201A	speed reference writing
RX1_SUB_INDEX	0	

TX0_INDEX	2021	output logic function reading
TX0_SUB_INDEX	0	
TX1_INDEX	2012	current speed reading
TX1_SUB_INDEX	4	

While cyclic communication is running it's possible to monitor the exchanged data using OPDExplorer submenu item ***Profinet \ Cyclic Data Exchange*** that allow mapping up to 10 CANopen Dictionary objects both in transmission and reception

4.3 PROFINET DEVICE DESCRIPTION FILE

The GSDML are XML files that specify the properties of the slave device for the PROFINET master.
The file can be downloaded from the TDE Macno website. It should be placed in the directory specified by the master or imported into the master network configuration tool (please refer to the master documentation about how extend the device catalog with custom GSDML files).

The **OPDE converter is a modular PROFINET slave, classified as a generic I/O Device**: this allow an extended compatibility with most PNIO controllers and require no specific device profile support.

Modular PROFINET devices have slots (MODULES) that can be populated with different kind of sub-slot (SUBMODULES) and so can be configured for different functions.

Specifically, the OPDE converter is defined as a **RT and IRT capable device with 3 modules**:

0. MAIN module
1. INPUTS module
2. OUTPUTS module

The Main module (0) contains 3 standard sub-modules for device I&M (Identification and Maintenance) with data and status about the device and link ports.

The Inputs module (1) must be populated with 1 sub-module that can be choosed among a collection of different sized data INPUT, from 1 up to 10 words.

The Outputs module (2) must be populated with 1 sub-module that can be choosed among a collection of different sized data OUTPUT, from 1 up to 10 words.

Input and Output are related to PNIO controller point of view, so input is data send by the slave to the master and output is data send by the master to the slave.

In order to accept CR (Communication Relation) for cyclic data OPDE requires that the size of input data matches the size of output data so **Input and Output sub-modules have to be of same size**.
Also, the data **size configured into the modules in PNIO controller configurator tool have to match to the size of data configured into OPDE by Cyclic Mapping**.

PNIO controller network configuration tool allow also for setting the device name and IP address (by DCP services).
The PROFINET master uses device name and IP address to univocally identify the devices connected to the network and to establish AR (Application Relation) to them so the default name ("opde") and IP address (192.168.0.1) of OPDE have to be changed properly.
Please notice that while the **device name assigned by master via DCP can be permanentely stored by OPDE**, the IP address will be over-written at next power-up or reset so **the IP address assigned into the network configurator have to be also setted into OPDE configuration by OPDExplorer** (see Drive Configuration chapter).

4.4 ACYCLIC COMMUNICATION

In addition to the cyclic I/O data exchange PROFINET allows also for acyclic communication from master to slaves using **Record-Data Read and Write services** that act like a mailbox system.
There are several Data Records pre-defined by PROFINET standard and used for device configuration and management.

OPDE support an additional custom Data Record for asyncronous accessing to all the converter parameters and run-time data: this is Data Record with i**ndex 502 (0x1F6)**.
The index was choosen intentionally equal to the TCP/IP port used by Modbus/TCP servers because the **data exchanged has to be coded like in Modbus/RTU**.

The PNIO controller can write in the Record-Data a **Modbus/RTU ADU** (Application Data Unit) composed by **Node Address** + **PDU**.
The Node Address is the same used for RS485 communication (parameter P92).
The PDU (Process Data Unit) is composed by **Modbus Function Code** and related **Data**.
Please notice that like in Modbus/TCP **there is no CRC field** in ADU because the frame integrity is already guaranteed by the CRC32 present in the TCP/IP frame that envelope the PROFINET Record-Data write request.

After receiving, the Modbus request is analyzed by converter and a reply (if any) is prepared.

The PNIO controller can then issue Record-Data reads till it found the reply data that will be in the format expected by Modbus/RTU (again with the relevant exception of CRC as the PROFINET Record-Data read reply is checked too by TCP/IP CRC32).

Using this the PROFINET master can access to all the OPDE data accessible by Modbus (exactly like OPDExplorer) and especially to the Parameters (Pxxx) and Connections (Cxx) that can't be mapped to cyclic data exchange.

For exaustive information about supported Modbus Function Codes and the addresses of Modbus registers and coils associated to the OPDE configuration and run-time data, please refer to the Modbus Protocol User Manual (MB00001B00_MODBUS_PROTOCOL V_1.3 IT-EN.pdf) available for download from TDE Macno website.

4.4.1 Acyclic Communication Example

If the PROFINET master write into Record-Data 502 the following 6 bytes:

0x01	0x03	0x01	0x08	0x00	0x01

the reply readed back from Record-Data 502 will be the following 5 bytes:

0x01	0x03	0x02	0x00	0x05

The Modbus request to the node 0x01 is a Read Holding Registers (0x03) starting from register address 0x0108 and involving just one register (0x0001).
The Modbus reply comes from node 0x01 for a Read Hold Register (0x03) request with a total data lenght of 0x02 bytes (1 register) that are 0x0005.

So register 0x0108 (264) is equal do 5: that's not surprising as 264 is the address of Connection C64 and value 5, as we see before, is enabling the PROFINET management!

4.5 ALARMS

OPDE has an **active alarms status register** (that depend on internal and external working conditions) and an **alarms mask register** (that can be configured). Both register are 16bit wide and each bit is related to a main converter alarm (from A.0 to A.15).
Each converter main alarm can have **sub-alarm codes** that specify more detailed the kind or source of the alarm.
All these alarm related registers can be accessed by Modbus and by CANopen objects (that can also be mapped to cyclic data exchange).

PNIO controller (PROFINET master) could then manage OPDE alarm status both by cyclic and/or acyclic communication. PROFINET anyway provide a more efficient way to handle alarms from slaves.
Alarms signalling is automatically carried by PROFINET into the cyclic I/O frame, so the PNIO controller can be immediately notified.

Every time that the OPDE active alarms status changes, and the alarms mask don't hide it, the OPDE PROFINET Module issues an "alarms update" to the connected master.
Notice that this happen both when a new alarm arises and also when the alarm is resetted.

All the relevant informations about alarm status is also sent to the master, that will receive 19 words of alarm data details:

Alarm data word	Content
0	details struct code (0x0000)
1	alarm mask register
2	active alarms register
3	alarm A.0 subcode
4	alarm A.1 subcode
...	...

17	alarm A.14 subcode
18	alarm A.15 subcode

4.6 MODBUS/TCP

PROFINET has the uncommon feature to allow normal network traffic to be carried in the same link with fieldbus related traffic. This is due to a set of hw and sw prioritizing tecniques that grant the real-time packets to be exchanged within the expected cycle time-bounds while the non real-time packets share the remaining bandwidth.

OPDE PROFINET Module with fw 2.0.0 or newer exploits this feature implementing a Modbus/TCP server.

In this way the OPDE will be accessible not only by PROFINET cyclic and acyclic communication protocols but also, at the same time, by a number of Modbus/TCP clients.

The Modbus/TCP server respond to the same IP address assigned to PROFINET slave (see Drive Configuration chapter) and **port 502 (0x1F6)**: that's the standard registered port for Modbus/TCP.

Up to 8 simultaneous sockets can be managed by the server so **up to 8 Modbus/TCP clients can be connected at same time** (that's in addition to AR and CR links established with a PROFINET master).

The Modbus/TCP protocol is very similar to Modbus/RTU over serial line.

Modbus/TCP server accepts command packets called **ADU** (Application Data Unit) composed by an **MBAP header** and a **PDU**, reply packets have the same structure.

The MBAP (ModBus Application Protocol) header is 7 bytes long and has the following fields:

Transaction Identifier (2 bytes)		**Protocol Identifier** (2 bytes)		**Length** (2 bytes)		**Unit Identifier** (1 byte)
1	2	3	4	5	6	7
high	low	high	low	high	low	
identifies a MODBUS request/responce transaction, initialized by client on request and copied by server on reply		0 = MODBUS protocol, initialized by client on request and copied by server on reply		number of following bytes (Unit Identifier and PDU), initialized by client on request and by the server on reply		identification of remote slave, initialized by client on request and copied by server on reply

The Unit Identifier is the same used for RS485 communication (parameter P92).

The PDU (Process Data Unit) is composed by **Modbus Function Code** and related **Data**.
Please notice that in Modbus/TCP **there is no CRC field** in ADU because the frame integrity is already guaranteed by the CRC32 present in the TCP/IP frame.

After receiving the Modbus request is analyzed by converter and a reply (if any) is prepared and sent back to the client.

For exaustive information about supported Modbus Function Codes and the addresses of Modbus registers and coils associated to the OPDE configuration and run-time data, please refer to the Modbus Protocol User Manual (MB00001B00_MODBUS_PROTOCOL V_1.3 IT-EN.pdf) available for download from TDE Macno website.

All parameters and data accessible by Modbus/RTU over serial line is also accesiible by Modbus/TCP: this means that also **OPDExplorer can be used over the LAN**, taking advantage of the bigger speed of Ethernet bus.

4.6.1 LIMITATIONS

Despite the great capabilities of Modbus/TCP protocol the current implementation in the OPDE PROFINET Module has some relevant limitations compared to Modbus/RTU natively available on RS485 interface.

First of all the availability: **Modbus/TCP server is reacheable only when the OPDE PROFINET Module is up and running**.
This means that fieldbus related parameters has to be already setted (especially C64 and the IP address/mask, but also the Cyclic Mapping have to be a valid configuration) via built-in keypad or RS485 serial line.

The second limitation is that **it's not possible to update the firmware core nor the application** of the drive through the Modbus/TCP connection.
All other OPDExplorer functionallities are working but please don't try to update the drive's firmware or application: you'll experience unexpected and unpredictable results.

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