MDC
MotorNet – DC

User's manual

Rev. 0.4
July 2013

This user manual is for the standard version of the converter.
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Cod 1307….

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1 Safety instructions

1.1 Symbols and signals

Several symbols and signals are used in this safety instruction.
Pay attention to the following meanings :

DANGER — Extremely severe risk. Disregarding the following advise may involve danger of life.

WARNING — Severe risk. Disregarding the following advise may involve serious personal injury.

CAUTION — Medium risk. Disregarding the following advise may involve personal injury

1.2 General information

- Only persons who are qualified and trained for the use and operation of the equipment may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, transportation, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions. The user must also observe local safety regulations.

- Before installing and commissioning the drive, read carefully this documentation and strictly observe all technical, safety and wiring information, including identifying labels placed on the drive (ratings). In case of doubt contact the Parker Hannifin service centre.

- Drives are to be intended as components for use in machine or systems. Therefore they can be used only in machine or systems that are in compliance with the low voltage directive and with the electro-magnetic compatibility directive.

- Electronic equipments are generally not "fail-safe" components. Therefore the machine manufacturers should carry out a risk analysis for the whole machine in order to ensure that moving parts (motors) cannot bring personal injury in case of failures of electronic devices.

1.3 Safety instructions for transportation and storage

- The ambient conditions given in the product documentation must be observed for transportation and storage (temperature, humidity, mechanical stress and aggressive atmosphere).
- Drives contain components sensitive to electrostatic charges which can be damaged by inappropriate handling. Therefore during installation / removal of drives, provide the necessary safety precautions against electrostatic discharges (discharge electrostatic charges of the human body before touching the drive, always place the drive above conductive plates and avoid touching it with insulating material like synthetic fibres, polymeric materials etc…)

Risk of injury by incorrect handling !

- Incorrect handing of the equipment may cause severe personal injury. Use appropriate tools for transportation, lifting, handling and mounting. Wear appropriate clothing for accident-prevention (safety shoes, safety glasses, safety gloves, etc...).

1.4 Safety instructions for commissioning

- The high voltages inside the drive imply risk of electric shock. Make sure that drive and motor are properly grounded accordingly to national regulations. Furthermore the supplier, before switching it on, must be closed in a protective cabinet in order to avoid direct contact with accessible live parts.
- Only qualified and trained personnel is allowed to perform installation and commissioning, using appropriate tools and following the safety precautions given in this instruction. Make sure that supply voltage has been switched off before installing and wiring.
- Suppliers are only allowed to be operated on TT, TN grounded industrial mains having maximum 480V+10% line to line rms voltage, as specified in the user manual. Do not directly install the supplier on ungrounded (IT) or asymmetrically grounded mains. In case of ungrounded mains, coupling with Dyn transformer with grounded secondary circuit is necessary. Refer to PSU technical data and wiring instruction.
- All the components used in the cabinet in which the supplier is installed, (cables, contactors, inductors and transformers, fuses, etc...), must be in compliance with the specification given in the product documentation, in addition to national regulations. Make sure that the maximum temperature inside the cabinet does not exceed 45°C (113°F). If necessary, use an appropriate air conditioning.
- The size and temperature rating of wires and cables used for connecting the drive must be in compliance with the specification given in the instruction manual (see NEC 310-16 for USA). Use also the specified tightening torque.
- Make sure about the correct drive-motor matching: voltage and current ratings must be compatible.

- The user is responsible for over-current and short circuit protection of the drive. Read carefully the specification given in the user manual.

1.5 Safety instructions for operation

DANGER

High voltage ! Risk of electric shock ! Danger of life !

- All live parts must be protected against direct contact. The supplier must be closed inside a cabinet before switching it on.
- Working on power live parts (terminals) must be conducted with the drive switched-off. Dangerous voltages may be present at power terminals even after the supply has been switched off and the motor stopped. Make sure the equipment can not be switched on unintentionally. Wait at least 6 minutes before working on live parts after the unit has been switched-off.
- The drive and the motor must be permanently connected to earth accordingly to the connection diagram, even for brief measurements or tests.

DANGER

High leakage current ! Risk of electric shock ! Danger of life !

- Earth leakage current during operation may exceed 3,5 mA AC or 10mA DC.
- Earth connection must be permanent : use copper wire having a minimum size of $10mm^2$ throughout all the length.
- Before switching the equipment on, make sure that all devices, are permanently connected to earth, even for brief test or measurements, as shown in the wiring diagrams. Otherwise high voltages may appear on equipment conductive surfaces with danger of electrical shock.
- Always refer to current local regulations for grounding. For installation within European Community refer to EN61800-5-1 product standard, section 4.2.5.4.2. For installation in the USA refer to NEC (National Electric Code) and NEMA (National Electric Manufacturers Association). The product installation should always comply with the above said standards.

WARNING

Hot surfaces ! Danger of injury ! Danger of burns !

- Some external surfaces of the equipment and same internal part may reach very high temperatures. Danger of burn and injury if touching these parts.
- After switching the equipment , wait at least 15 minutes to allow it to cool before touching it.

DANGER

Dangerous movements ! Danger of life !

- Dangerous movements can be caused by faulty control of the connected motor.
  Same common example are:

  - ❍ Improper or wrong installation and wiring
  - ❍ Wrong input parameters before or during operation (programming)
  - ❍ Defective components (drive, motor, wires, sensors, etc...)
  - ❍ Incorrect control (software or firmware errors)

- In order to prevent personal injury due to unintended dangerous motor movements, pay the maximum attention and work on the machine with a qualified and tested safety system:

  - ❍ Isolate the supplier power connection.
  - ❍ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before start-up. Don't operate on the machine if the emergency stop is not working.
  - ❍ Install properly fences, guards, coverings and light barriers in order to prevent people from accidentally entering the machine's range of motion.
  - ❍ Secure vertical axes against falling or dropping after switching off the motor power
  - ❍ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.

1.6 Safety instructions for maintenance

WARNING

- It is extremely dangerous to remove covers or part of the external enclosure from the equipment. Risk of personal injury. The warranty immediately decay.
- In case of malfunction consult the alarm list described in the user manual or address Parker Hannifin. The drives are not field repairable.

1.7 Compatibility with RCD devices

CAUTION

The use of RCD (Residual Current Devices) is strongly not recommended.
If the use of RCD is mandatory, use type B only (for DC and AC prospective earth current).
Set the trip level at 300mA (fire protection level) or more.
Setting the trip level at 30mA (protection level against direct contact) is possible only using time-delayed RCD and low leakage current EMC filters, but in any case the drives are not guaranteed to operate with 30mA trip level.

1.8 Applicable standards

Safety [EN61800-5-1:2007]

2006/95/EC	Low voltage directive

Rotating electrical machines [EN60034-1:2006]

	Part 1: Rating and performances

Electromagnetic Compatibility (Immunity/Emission) [EN61800-3:2004]

2004/108/EC	EMC directive

The drives are to be intended as components to be used in a second environment (industrial environment) and category C3, together with specific EMC filters and installed accordingly to the recommendation given in the user manual. When used in the first environment (residential / commercial environment), drives may produce radio-frequency interference dangerous for other equipments : additional filtering measures must be implemented by the user.

1.9 Materials and disposal

- zinc coated steel sheet, thickness 1mm and 2mm
- extruded aluminium AlSi
- adhesive polycarbonate (front label)

Electrolytic capacitor contains electrolyte and printed circuit boards contains lead, both of which are classified as hazardous waste and must be removed and handled according to local regulations.

Parker Hannifin Manufacturing, together with local distributors and in accordance with EU standard 2002/96/EC, undertakes to withdraw and dispose of its products, fully respecting environmental considerations.

1.10 Warranty

The warranty duration is 1 (one) year. The converter must not be opened, accessed or modified in any of its part. Any attempt to do so would cause the 1-year warranty to be cancelled with immediate effect. Parker Hannifin declines any responsibility for damages that may be caused by inappropriate use of the converter.

2 INTRODUCTION

Read carefully all the sections.

2.1 Product description

The MDC is a motor with electronic control integrated. Motor size from 1 Nm to 7,5 Nm of the SMB motor series (high performance brushless).

The DC bus supply and the auxiliary control supply require the connection to PSU and PSI units.

As feedback the MDC can support the resolver or the absolute encoder with EnDat interface.

It can use in motion control by EtherCAT protocol or by CANopen DS402.

2.2 Identification

The converters of the MDC series are available in different models. The number that follows the MDC abbreviation corresponds to the rated current of the converter in amperes.
Use the following table to specify the order code:

MDC			60	30	5	9						E	64	2
	E	A	70	52	8	11	S	Hxx	F4	M	R	D	65	4
			82	60		14								
			100			19								
						24								

Where :

MDC	MotorNET DC
E	Encoder
A	Brake (n.a.)
60	Motor size (60, 70, 82, 100)
30	Motor Speed (3000, 5200, 6000 rpm)
5,8	Flange type (type 5 on size 60, 70, 82, 100; type 8 on size 60)
9…24	Shaft diameter
	With keyway
S	Without keyway
	Standard shaft
Hxx	Hollow shaft (xx = internal diameter – only for MDC70, 100 with resolver)
	Resolver
F4	Encoder EnDat
M	Increased inertia (n.a.)
R	Safe torque off
D	CANopen DS402
E	EtherCAT
64	IP level (65 IP level n.a.)
2	Power supply voltage: 230V
4	Power supply voltage: 400V

A label attached of the device contains all the essential information to correctly identify the unit:

- Serial number
- Model
- Nominal plate data

It is important to refer to this label before requesting any kind of technical information to Parker Hannifin Manufacturing

3 Main hardware features

3.1 Ambient conditions

temperature	operation	Class 3K3, 0 … +40 °C (+32 …+104 °F)
	storage	Class 1K4, -25 … +55 °C (-4 …+131 °F)
	transportation	Class 2K3, -25 … +70 °C (-13…+158 °F)
humidity	operation	Class 3K3, 5-85 % without ice and condensation
	storage	Class 1K3, 5-95 % without ice and condensation
	transportation	Class 2K3, 95% at 40°C
altitude (*)		≤ 1000 m slm (≤ 3281 feet asl)
Protection degree		IP64 UL open type equipment
Pollution degree		2 or lower (no conductive dust allowed)

(*)For higher installation altitude, derate the output current by 1.5% each 100m up to 2000m maximum

3.2 Vibrations and shocks

	frequency [Hz]	amplitude [mm]	acceleration [m/s^2]
operation (3M1 class)	2 ≤ f < 9	0,3	-
	9 ≤ f < 200	-	1
transportation (2M1 class)	2 ≤ f < 9	3,5	-
	9 ≤ f < 200	-	10
	200 ≤ f < 500	-	15
	free fall 0,25m max		

3.3 Motor data

Model	Stall torque ΔT=65K T_{065} [Nm]	Stall torque ΔT=105K T_{0105} [Nm]	Max stall torque at S3 10% T_{max} [Nm]	Inertia J [10^{-3}kgm^2]	Nominal speed ω [rpm]	Torque at nominal speed ΔT=65K T_{n65} [Nm]	Stall current ΔT=65K I_{065} [Arms]	Max stall current at S3 10% I_{max} [Arms]	Current at nominal torque ΔT=65K I_{n65} [Arms]	E.m.f. costant Ke [Vs]	Torque costant Kt [Nm/Arms]	FCEM at 1000rpm V1000 [Vrms]	Phase-phase resistance R [Ω]	Phase-phase inductance L [mH]	Voltage rating Vn [Vrms]
MDC 60															
230V															
MDC 60 30 01	1	-	4	0,0302	**3000**	0,9	**1,21**	4,93	1,11	0,468	0,81	-	**12,8**	**32,3**	164
MDC 60 60 0,9	0,9				**6000**	0,55	**1,92**	8,5	1,17	0,271	0,47	-	**5,1**	**10**	177
400V															
MDC 60 30 01	1	-	4	0,0302	**3000**	0,9	**0,66**	2,72	0,6	0,854	1,48	-	**52,8**	**107**	304
MDC 60 60 0,9	0,9				**6000**	0,55	**1,11**	4,93	0,68	0,468	0,81	-	**12,8**	**32,3**	305
MDC 70															
230V															
MDC 70 30 2,5	2,5	-	11	0,1	**3000**	2,0	**2,9**	12,6	2,3	0,5	0,87	-	**2,7**	**9,7**	164
MDC 70 60 1,9	1,9		7		**6000**	0,5	**3,9**	14,3	1	0,28	0,49	-	**1,02**	**3,14**	179
400V															
MDC 70 30 2,6	2,6	-	11	0,1	**3000**	2,0	**1,6**	6,67	1,2	0,951	1,65	-	**10**	**42**	314
MDC 70 60 2,2	2,2		7		**6000**	0,5	**2,5**	8,05	0,6	0,5	0,87	-	**2,7**	**9,7**	316
MDC 100															
230V															
MDC 100 30 6,5	6,5	-	15	-	**3000**	4,4	**6,4**	14,7	4,3	0,59	1,02	-	**0,78**	**6,21**	190
400V															
MDC 100 30 7,5	7,5	-	26,7	-	**3000**	4,4	**4,2**	15	2,4	1,028	1,78	-	**2,4**	**19**	332
MDC 100 52 5,7	5,7		15		**5200**	1,0	**5,6**	14,7	1	0,59	1,02	-	**0,78**	**6,21**	322

Motor poles: 8.

3.4 Power supply

AUX VOLTAGE SUPPLY			
Input voltage	V=		24 – 48VDC (0%...+10%)
Max rated input current	A		20 *
Control stage			
Input power		W	12
Stationary brake			
Input power	Size		Power
	60	W	11
	82	W	11

* the Max rated input current is the rated current that the aux. voltage supplies to the overall MDC chain. To evaluate the maximum MDC number the user must consider also the input braking current

Power stage		
Max DC voltage supply	V=	750V

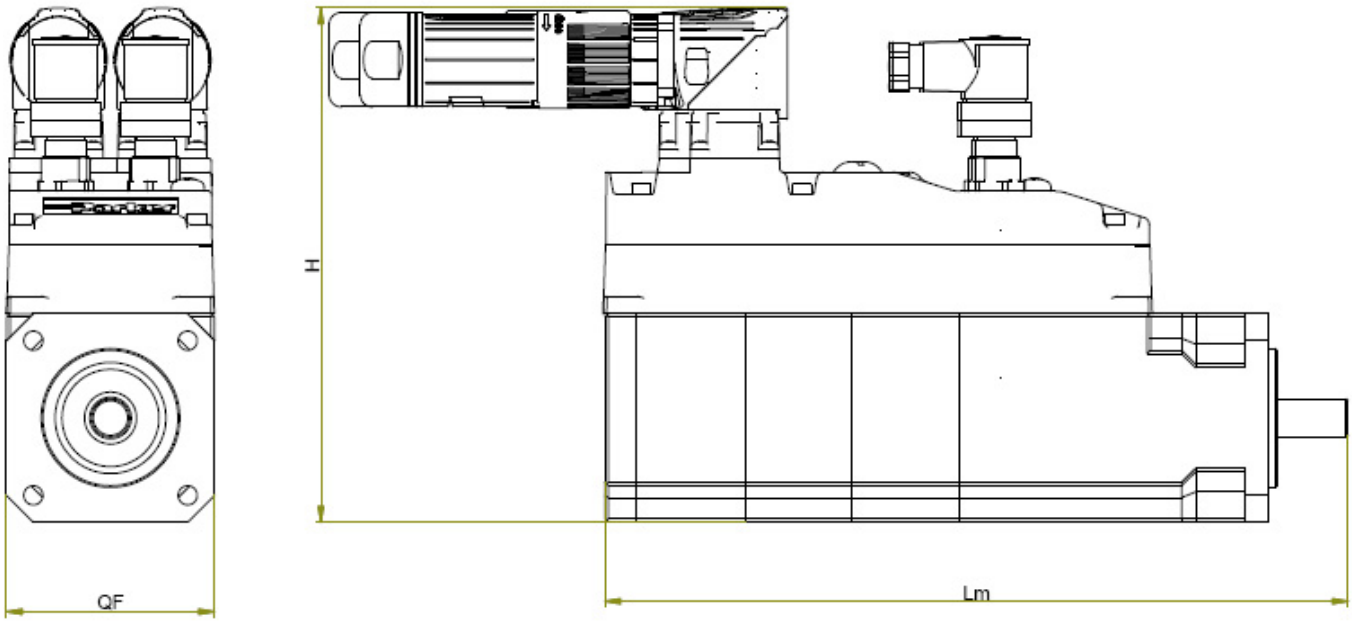
3.5 Other characteristics

2 digital inputs (opto-insulation)		
input impedance	kΩ	
Type of driving required	-	
Reaction time	µs	PNP

2 digital outputs PNP (opto-insulation)		
External supply	Vdc	24 (±10%)
Max current for single output (by internal supply)	mA	100
Max current for single output (by external supply)	mA	600

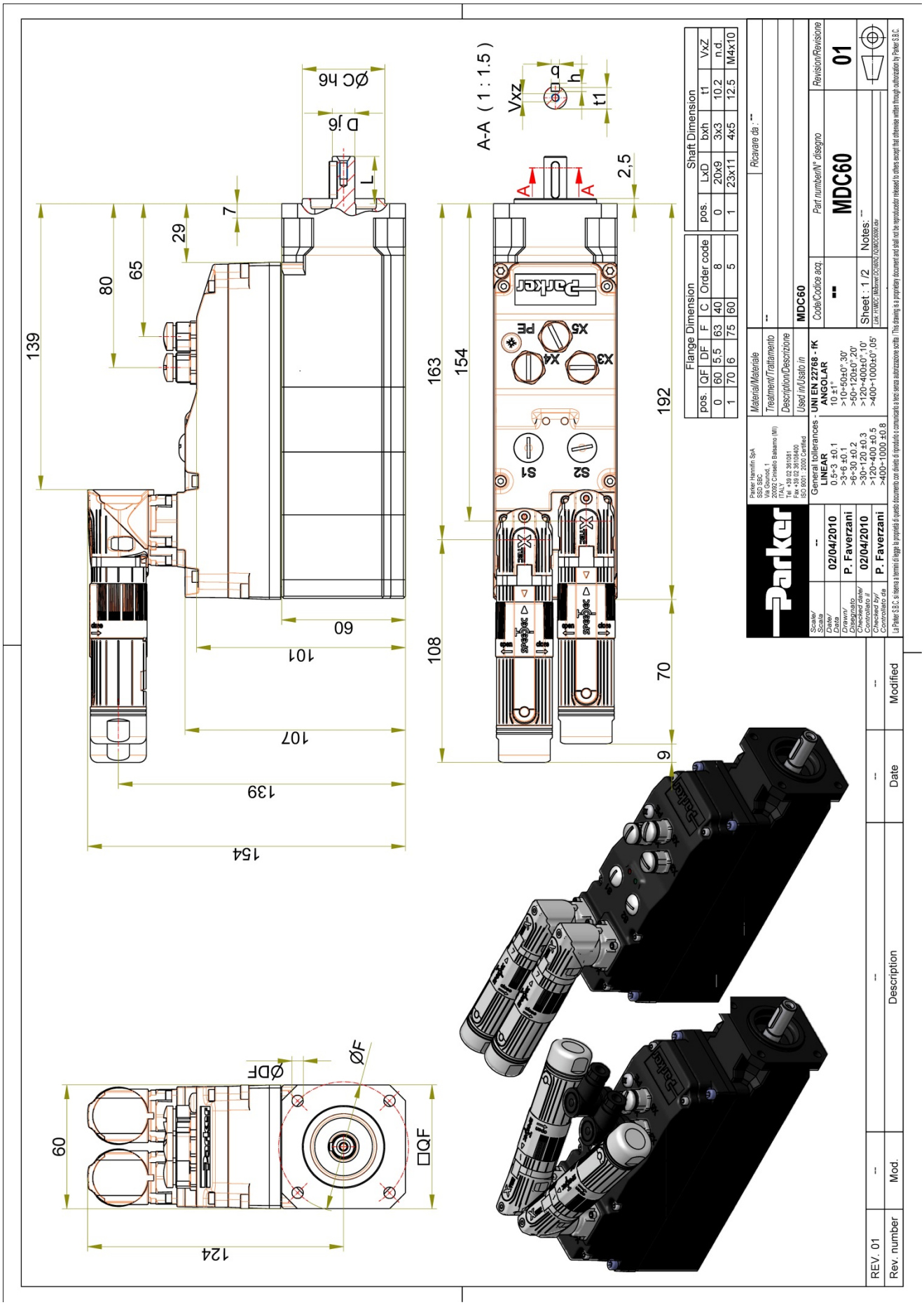
4 MOUNTING

4.1 Dimensions and weights



* the connectors of I/O cables are not included

Type	Lm	H	QF	Weight
MDC60	192+shaft	154	60	?
MDC70	287+shaft	164	70	?
MDC100	262+shaft	194	100	?


A-A (1 : 1.5)
Flange Dimension
pos. QF DF F C Order code
0 60 5,5 63 40 8
1 70 6 75 60 5
Shaft Dimension
pos. LxD bxh t1 VxZ
0 20x9 3x3 10.2 n.d.
1 23x11 4x5 12.5 M4x10
Parker Hannifin SpA
SSD SBC
Via Gounod 1
20092 Cinisello Balsamo (MI)
ITALY
Tel +39 02 361081
Fax +39 02 36108400
ISO 9001 : 2000 Certified
Material/Materiale --
Treatment/Trattamento
Description/Descrizione
Used in/Usato in MDC60
Ricavare da : --
Code/Codice acq. --
Part number/N° disegno MDC60
Revision/Revisione 01
Sheet : 1 /2
Notes: --
General tollerances - UNI EN 22768 - fK
LINEAR
0.5÷3 ±0.1
>3÷6 ±0.1
>6÷30 ±0.2
>30÷120 ±0.3
>120÷400 ±0.5
>400÷1000 ±0.8
ANGOLAR
10 ±1°
>10÷50±0° 30'
>50÷120±0° 20'
>120÷400±0° 10'
>400÷1000±0° 05'
Scale/ Scala --
Date/ Data 02/04/2010
Drawn/ Disegnato P. Faverzani
Checked date/ Controllato il 02/04/2010
Checked by/ Controllato da P. Faverzani
REV. 01 -- -- --
Rev. number Mod. Description Date Modified
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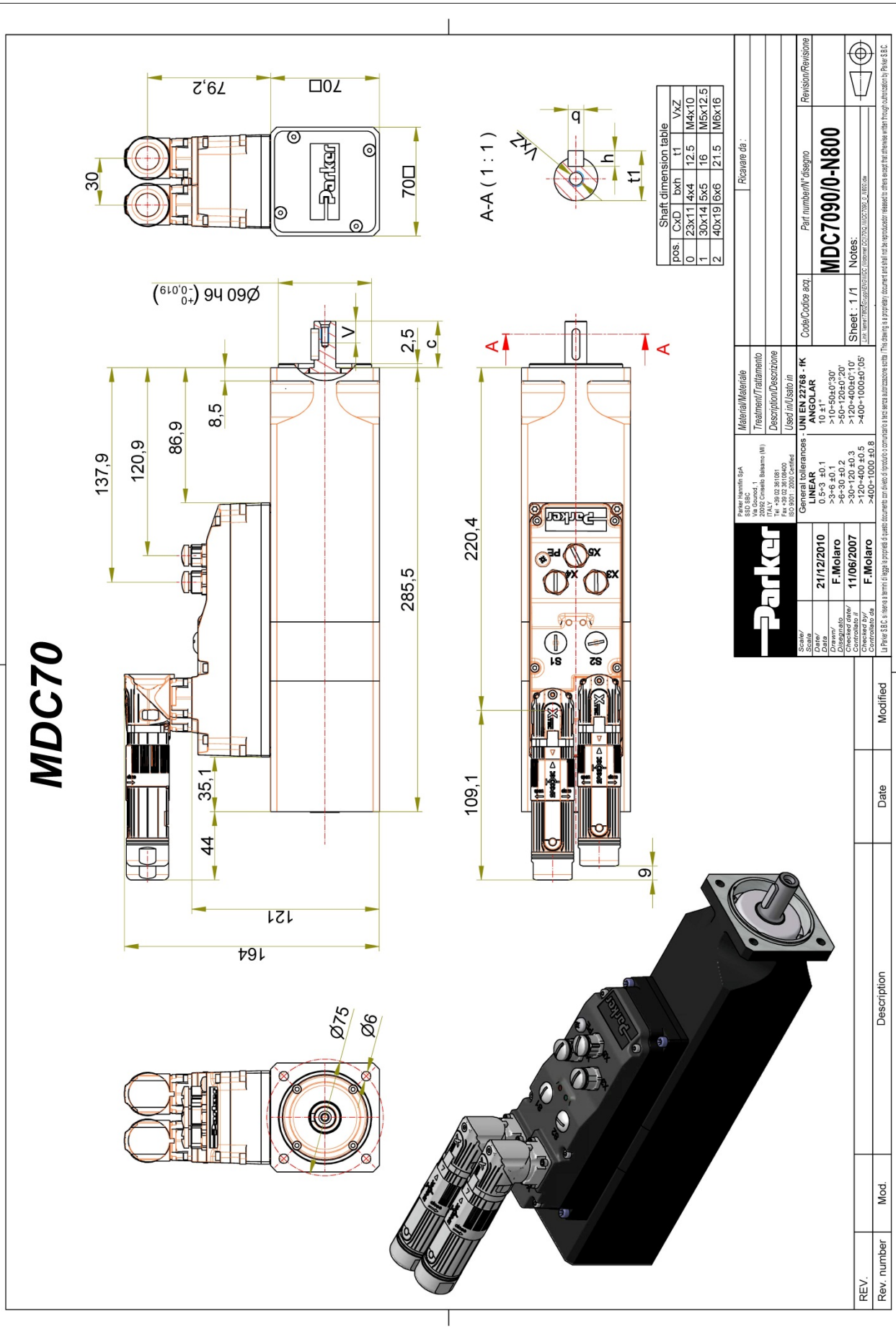
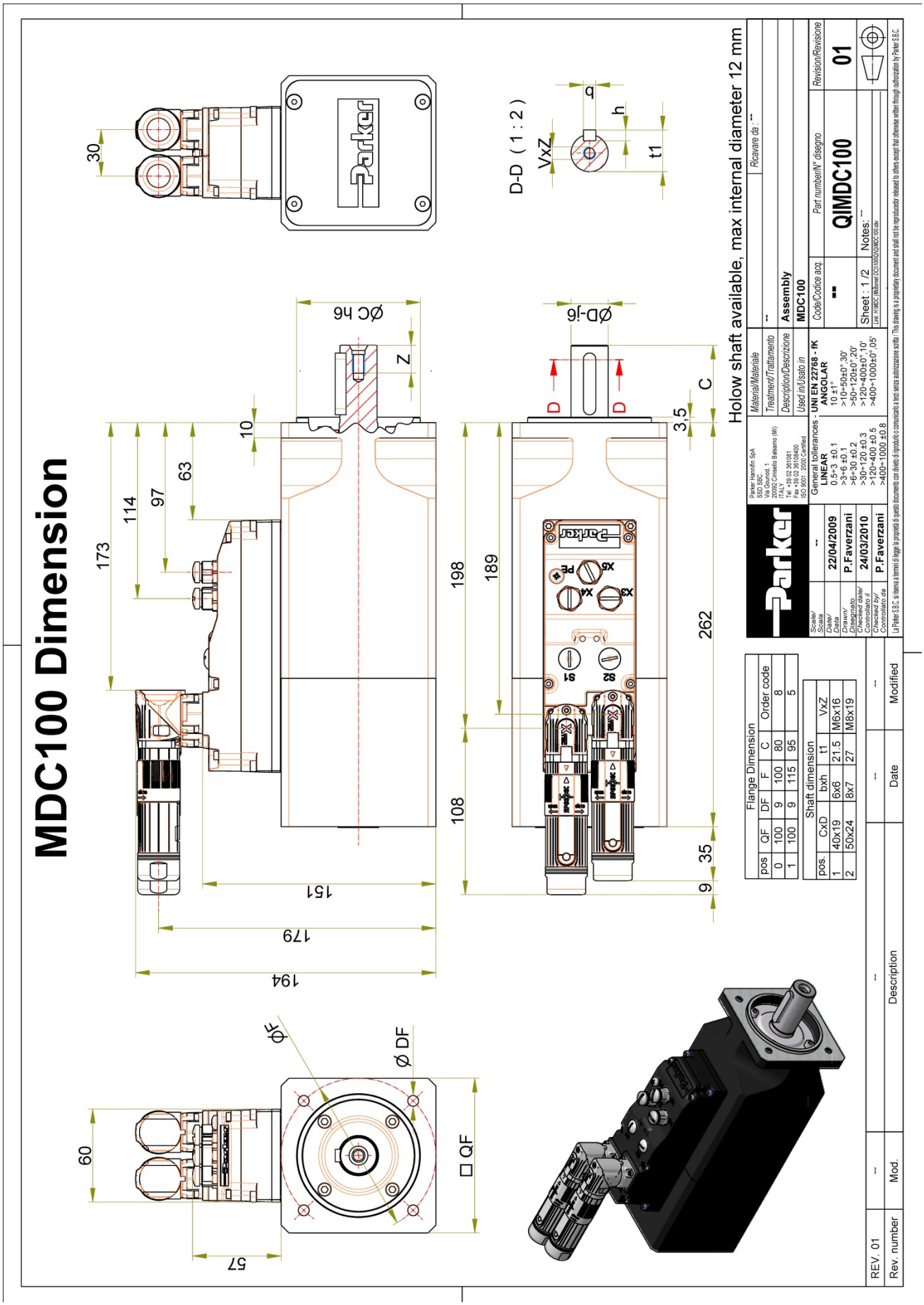

MDC70
Parker
79,2
70□
30
70□
A-A (1 : 1)
Shaft dimension table
pos. CxD bxh t1 VxZ
0 23x11 4x4 12.5 M4x10
1 30x14 5x5 16 M5x12.5
2 40x19 6x6 21.5 M6x16
Ø60 h6 (+0 -0,019)
137,9
120,9
86,9
8,5
2,5
285,5
35,1
44
121
164
220,4
109,1
9
Ø75
Ø6
Parker Hannifin SpA
SBC
Via Gounod, 1
20092 Cinisello Balsamo (MI)
ITALY
Tel. +39 02 361081
Fax +39 02 36108400
ISO 9001 2000 Certified
Material/Materiale
Treatment/Trattamento
Description/Descrizione
Used in/Usato in
Ricavare da :
Code/Codice acq.
Part number/N°disegno
Revision/Revisione
MDC7090/0-N800
Sheet : 1 /1
Notes:
Scale/ Scala
Date/ Data
Drawn/ Disegnato
Checked date/ Controllato il
Checked by/ Controllato da
21/12/2010
F.Molaro
11/06/2007
F.Molaro
General tollerances - UNI EN 22768 - fK
LINEAR
0.5÷3 ±0.1
>3÷6 ±0.1
>6÷30 ±0.2
>30÷120 ±0.3
>120÷400 ±0.5
>400÷1000 ±0.8
ANGOLAR
10 ±1°
>10÷50±0°30'
>50÷120±0°20'
>120÷400±0°10'
>400÷1000±0°05'
REV.
Rev. number
Mod.
Description
Date
Modified


MDC100 Dimension
Holow shaft available, max internal diameter 12 mm
Parker
Assembly
MDC100
QIMDC100
01
Sheet : 1 / 2
Notes: --
Flange Dimension
pos QF DF F C Order code
0 100 9 100 80 8
1 100 9 115 95 5
Shaft dimension
pos. CxD bxh t1 VxZ
1 40x19 6x6 21.5 M6x16
2 50x24 8x7 27 M8x19
D-D (1 : 2)
ØC h6
ØD-j6
ØF
Ø DF
□ QF
173
114
97
63
10
151
179
194
198
189
108
262
35
9
3,5
C
Z
D
30
60
57

4.2 Mounting instructions

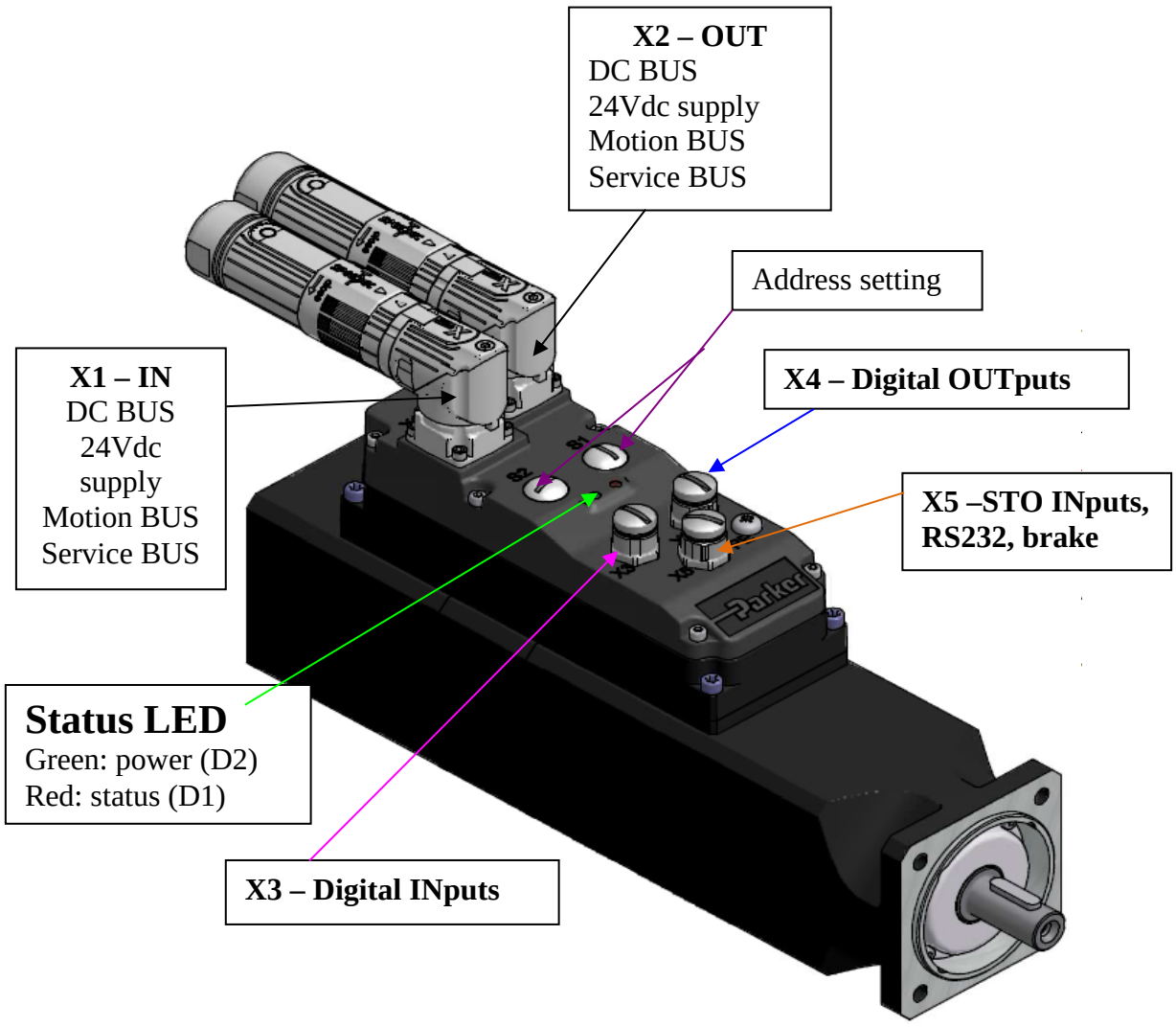
IMPORTANT

- Do not install in hazardous environments.

IMPORTANT

- To ensure drive cooling, leave a free space above, below and in front of at least 100 mm. The hot air cooling must be done in an external environment, to avoid damage caused by the formation of condensation.

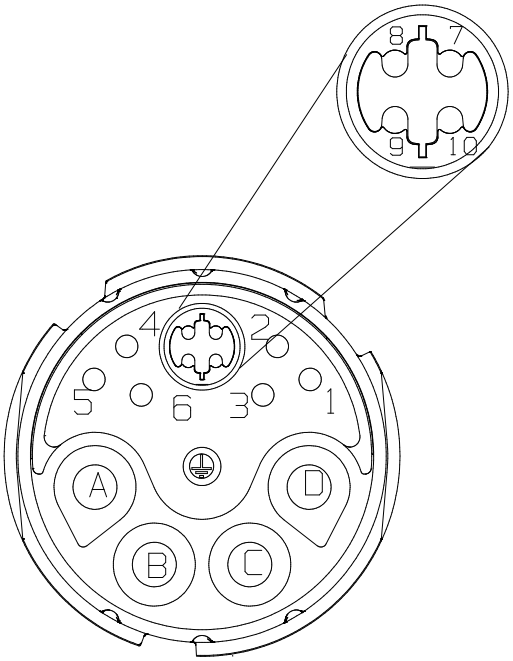
4.3 Connectors layout



* the connectors of I/O cables are not included

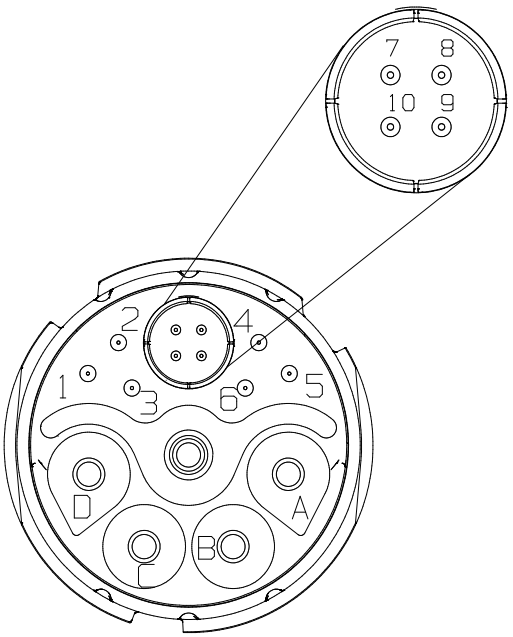
4.4 Signal connectors

X1 – Connector male IN (motor side)



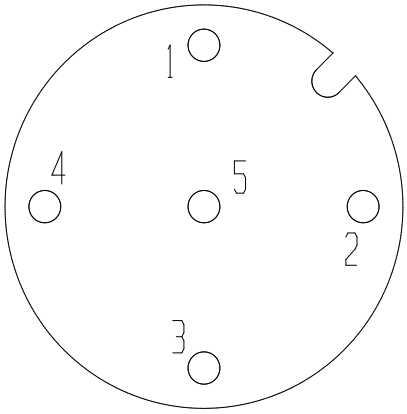
X1 – IN - motor side	
A	Vdc AUX
B	+ DCBUS
C	- DCBUS
D	0V AUX
PE	Ground
1	+ serv_bus
2	- serv_bus
3	0V_serv_bus
4	STO1
5	STO_0V
6	STO2
7	+ TX
8	- TX
9	+ RX
10	- RX

X2 – Connector female OUT (motor side)



X2 – OUT - motor side	
A	Vdc AUX
B	+ DCBUS
C	- DCBUS
D	0V AUX
PE	Ground
1	+ serv_bus
2	- serv_bus
3	0V_serv_bus
4	STO1
5	STO_0V
6	STO2
7	+ TX
8	- TX
9	+ RX
10	- RX

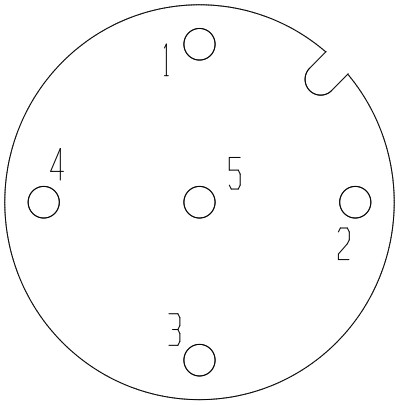
X3 – Connector female digital Inputs (motor side)



X3 – INputs - motor side *	
1	24V inputs
2	IN1
3	0V
4	IN2
5	PE

* the connectors of I/O cables are not included

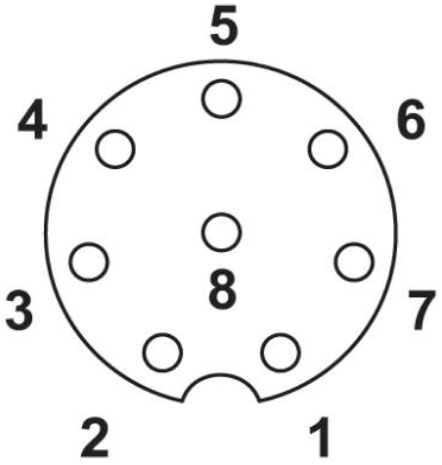
X4 – Connector female digital Outputs (motor side)



X4 – OUTputs - motor side *	
1	24V outputs
2	OUT1
3	0V
4	OUT2
5	PE

* the connectors of I/O cables are not included

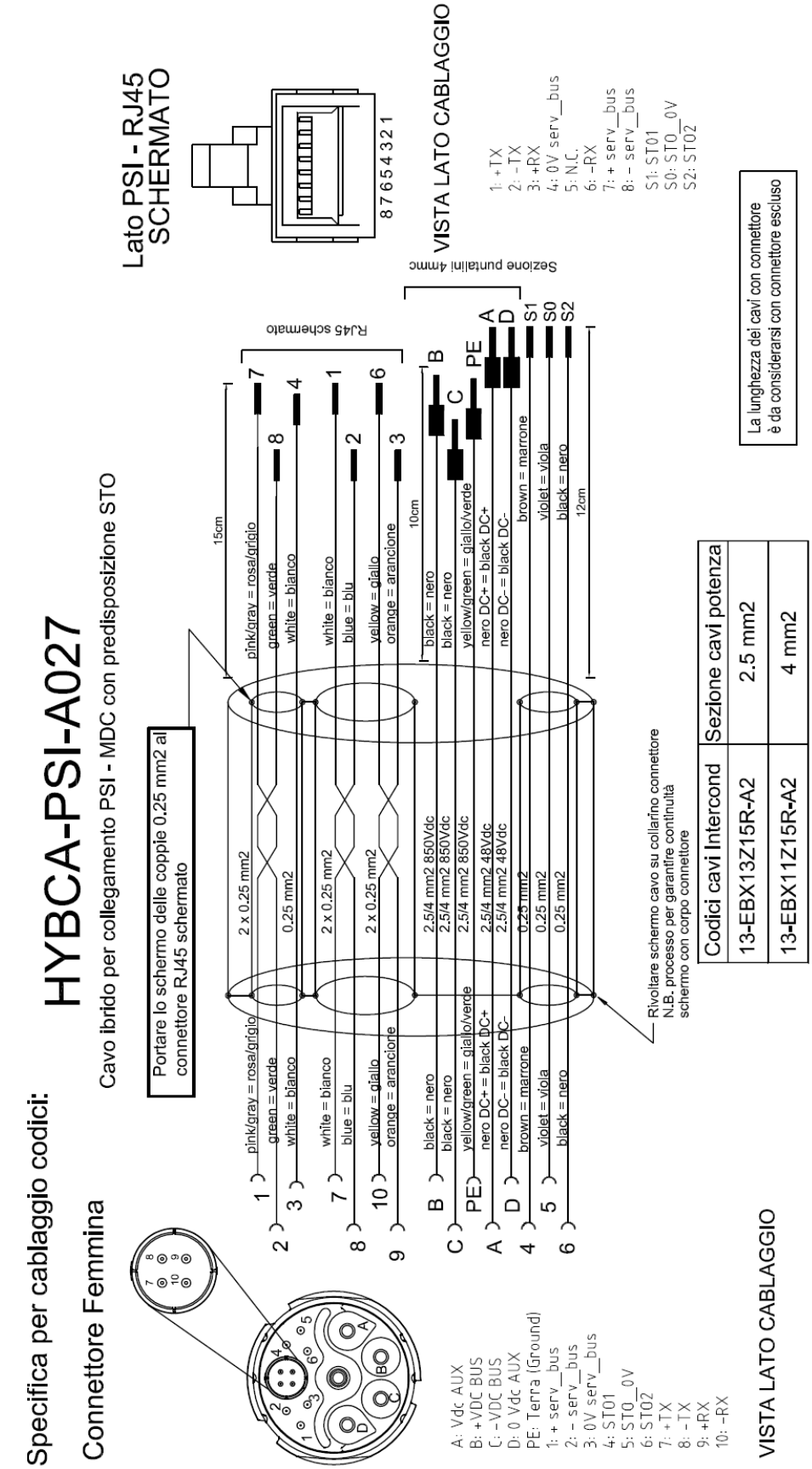
X5 – Connector female STO (motor side)



X5 – STO - motor side *	
1	BOOT
2	HW_BRAKE
3	RS232_TXD
4	/STO1_AUX
5	STO_0V
6	/STO2_AUX
7	RS232_RXD
8	RS232_GND

* the connectors of STO cables are not included

4.5 Hybrid cable – Connection PSI-MDC



Codici cavi Intercond	Sezione cavi potenza
13-EBX13Z15R-A2	2.5 mm2
13-EBX11Z15R-A2	4 mm2

4.6 LEDs status

LED	(red) D1 Error Status	Off	No error	The EtherCAT communication of the device is in working condition.
		Flickering	Booting error	Booting error was detected. INIT state reached, but parameter "Change" in the AL status register is set to 0x01: change/error.
		Blinking	Invalid configuration	General Configuration Error.
		Single Flash	Unsolicited state change	Slave device application has changed the EtherCAT state autonomously: parameter "Change" in the AL status register is set to 0x01: change/error.
		Double flash	Application watchdog timeout	An application watchdog timeout has occurred.
		On	PDI watchdog timeout	A PDI watchdog timeout has occurred
	(green) D2 Run Status	Off	Init	The device is in state INIT
		Blinking	Pre operational	The device is in state PRE-OPERATIONAL
		Single Flash	Safe operational	The device is in state SAFE-OPERATIONAL
		On	Operational	The device is in state OPERATIONAL
		Flickering	Initialization or bootstrap	The device is booting and has not yet entered the INIT state, or the device is in state BOOTSTRAP. Firmware download operation in progress

4.7 Address setting

Address setting		
Selectors	S1	Address selector "alias". Digit less significant
	S2	Address selector "alias". Digit more significant

4.8 Hybrid Cable: lengths and cross sections

Hybrid cable: Power Motor line and Signal (Ethernet Cat. 6)

Model		**HYBCA – PSI**		**Max. Voltage**	**Max. Current**
DC bus	Section	4mm^2 (x2) (12AWG)	2,5mm^2 (x2) (8AWG)	750VDC	20A (4mm^2) 12A (2,5mm^2)
PE	Section	4mm^2 (x1) (12AWG)	2,5mm^2 (x1) (8AWG)	-	-
AUX. supply	Section	4mm^2 (x2) (12AWG)	2,5mm^2 (x2) (8AWG)	48VDC	20A (4mm^2) 12A (2,5mm^2)
Total Maximum length		100 m			
Communication BUS	Section	0.2mm^2 (x2x4) (24AWG)			
Conductor resistance		4.95 Ω/km			
Conductor resistance		91 Ω/km			
Cable capacitance		50nF/km			

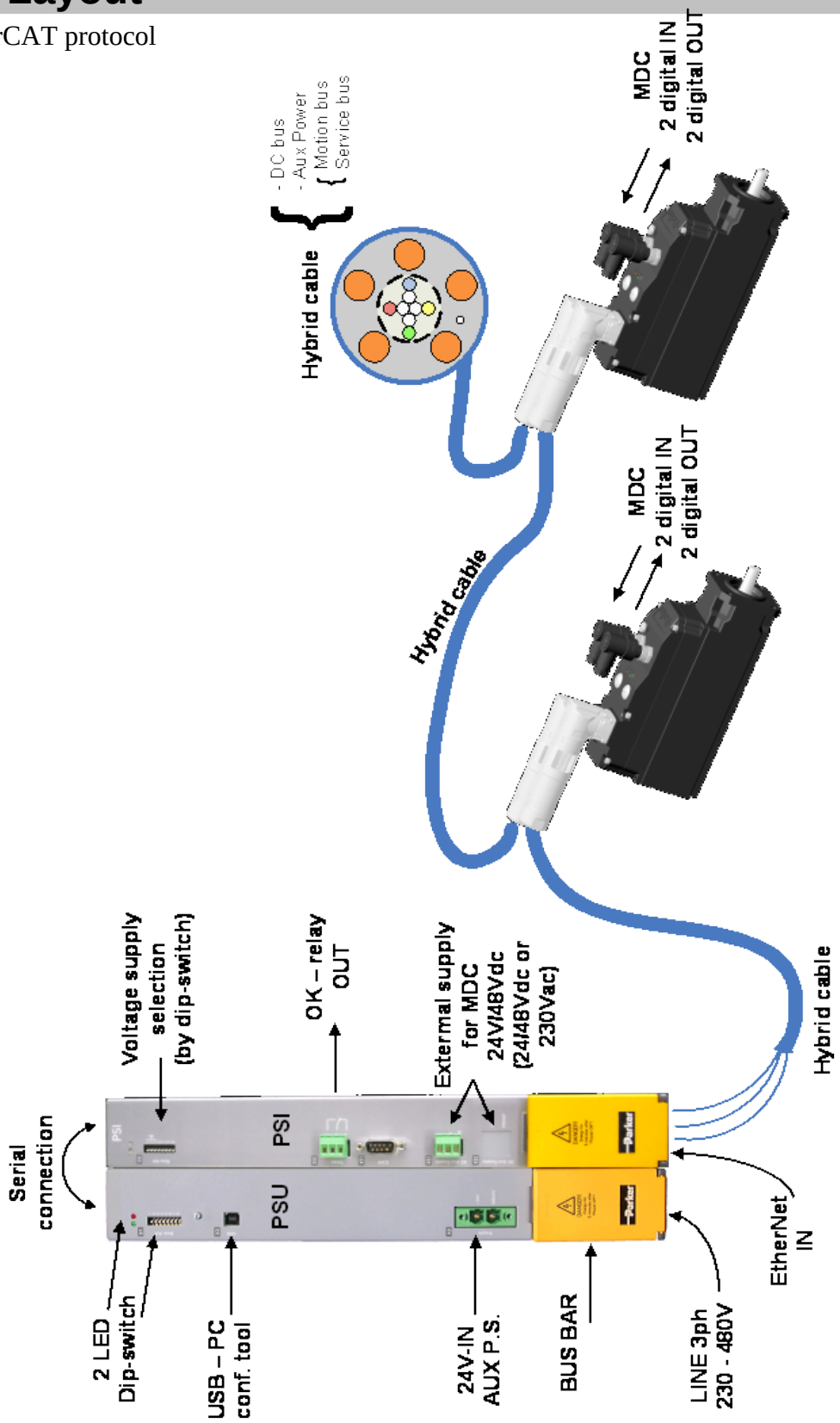
Minimum bending radius: 5 x diameter, fixed laying (PF → 5x16=80mm);
10 x diameter, dynamic laying (PM→ 10x16=160mm).

4.9 Limits Hybrid cable with Intercontec connector

Power Motor		
DC BUS	Vdc	750
Max current	A	20A (4mm^2) – 12A (2,5mm^2)
Main Power supply (@ 400Vac)	-	10kW on DC bus up to 28 MDC60 @ nominal power up to 14 MDC70 @ nominal power up to 6 MDC100 @ nominal power
Main Power supply (@ 230Vac)	-	6kW on DC bus up to 16 MDC60 @ nominal power up to 8 MDC70 @ nominal power up to 3 MDC100 @ nominal power
Control Supply		
Auxiliary supply	Vdc A	48 20A (4mm^2) – 12A (2,5mm^2)

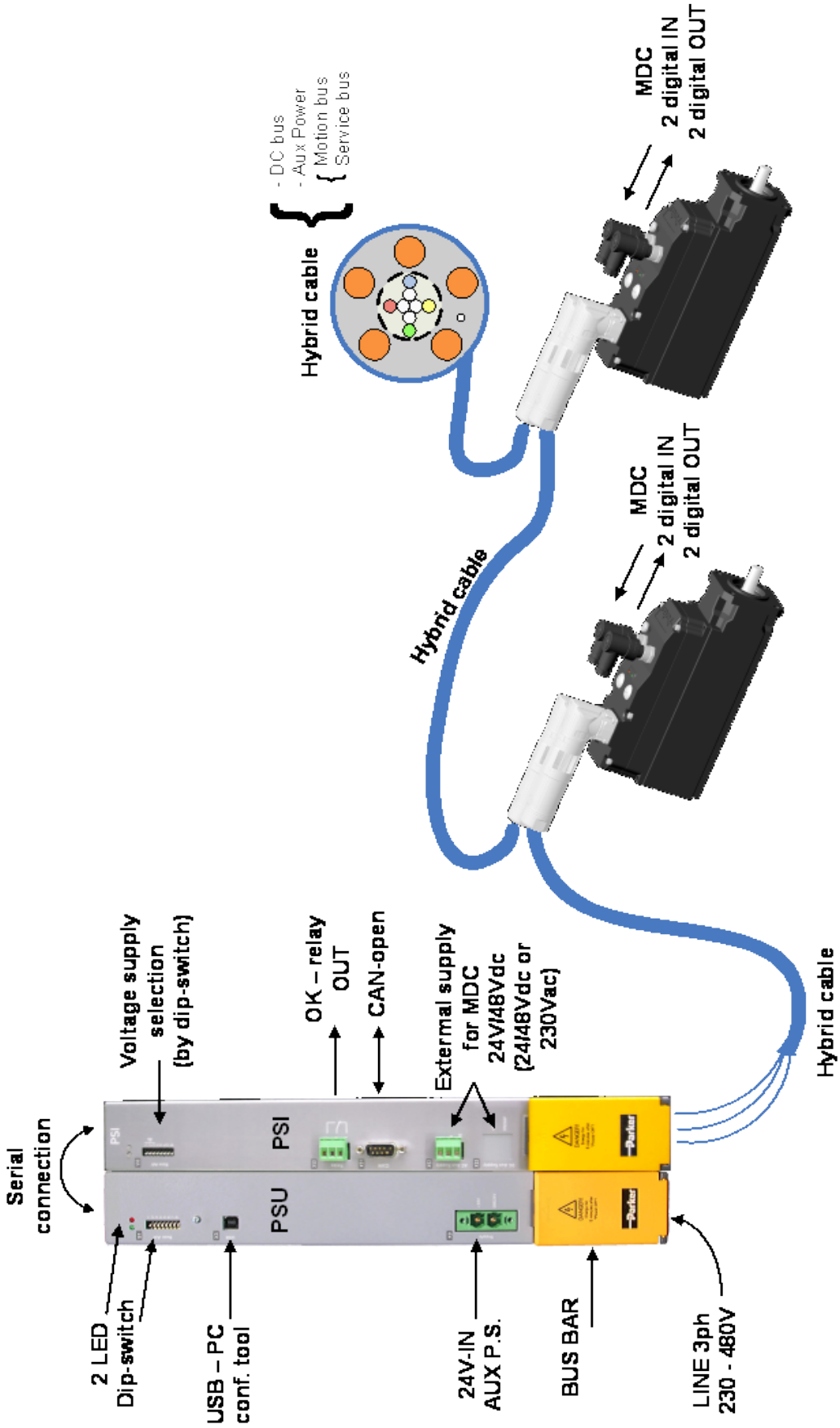
4.10 Layout

EtherCAT protocol



* the connectors of I/O cables are not included

CANopen DSP402 protocol



* the connectors of I/O cables are not included

4.11 How to determinate the power supply

To simplify, it's possible follow this example:
N. 30 MDC 70 30, cable length: 50m

object	N	Single unit		Current required		Power required
		24V	48V	24V	48V	
MDC	30	0.5A 12W	0.25A 12W	0.5*30= 15A	0.25*30= 7.5A	12*30=360W

object	N	Single unit		Current required		Power required
		MDC60	MDC82	MDC60	MDC82	
Brake	0	0.5A 11W	0.5A 11W	0A	0A	0W

object	N	Section		Resistance		Voltage required			
		2.5mm^2	4mm^2	2.5mm^2	4mm^2	24V		48V	
		Ω/km	Ω/km			2.5mm^2	4mm^2	2.5mm^2	4mm^2
Cable length	50m	-	4.95	0A	4.95*0.05 =0.25Ω	-	0.25*15 =3.7V	-	0.25*7.5 =1.9V

Valuation using 4mm^2 cable:

- Supplier at 48Vdc, current >7,5A and power > 360W:
  - option "E" for the PSI;
  - directly from PSU not usable;
  - option "P" not usable, because the max power is 120W.
- Supplier at 24Vdc, current >15A and power > 360W:
  - option E for the PSI at 28Vdc;
  - directly from PSU not usable, the minimum voltage for MDC is 24Vdc, but are necessary 28Vdc for to have 24Vdc on the last MDC, but PSU range voltage is 21÷27Vdc, so the voltage required is over the range of PSU;
  - option "P" not usable.

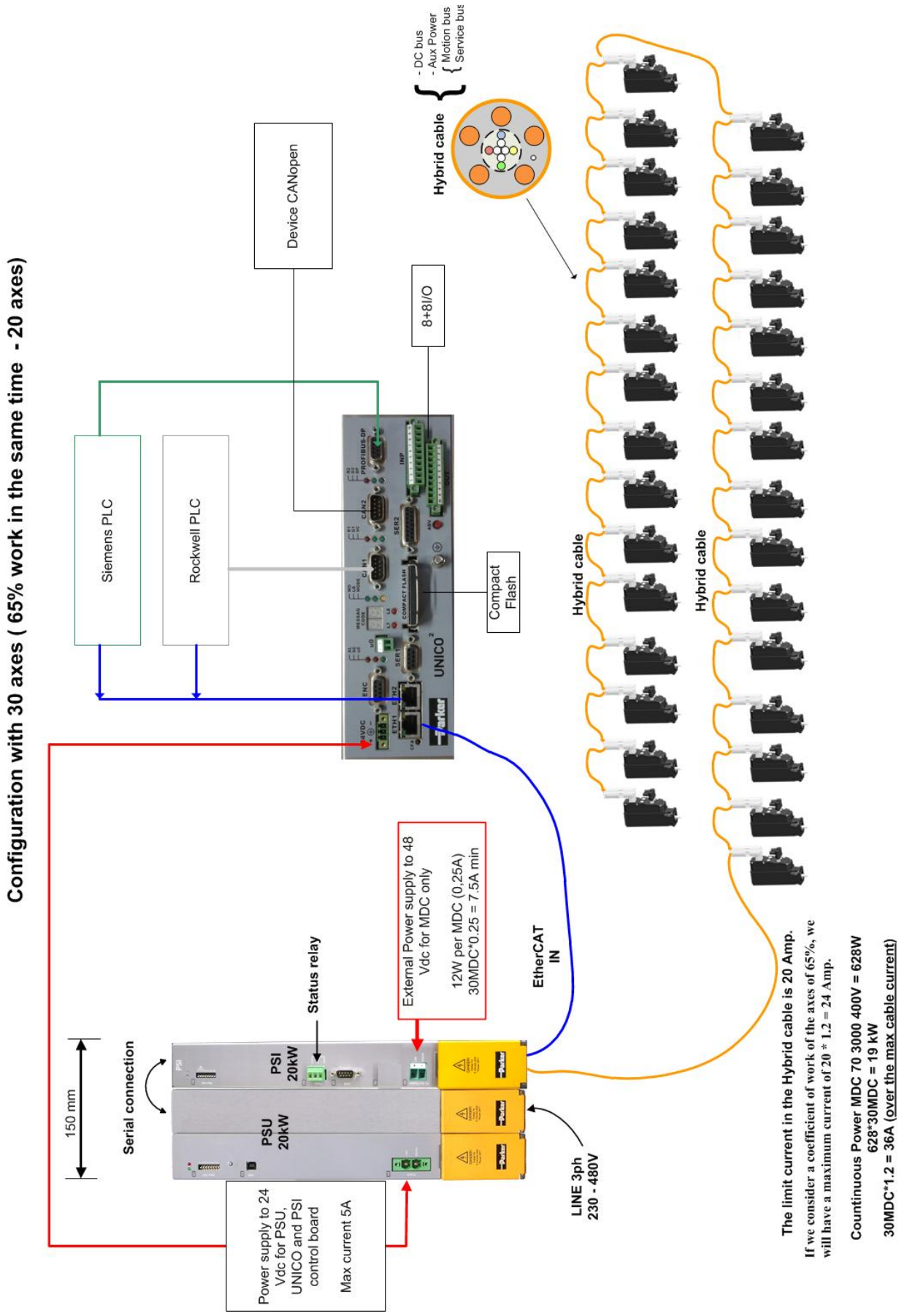
Motor power
In case of the duty cycle contemporaneity:

$P_{continuous} = (\sum_1^N Torque\ nominal[Nm] \times nominal\ speed\ [rad]) \times coeff.contemp.$

$$P_{continuous} < P_{PSU\_PSI}$$

$$Curren\ t_{total} = (\sum_1^N motor\ nom.current) \times coeff.contemp. < 20A\ (cable\ sect.4mm^2)$$

Coeff. Contemporaneity = 65%


Configuration with 30 axes (65% work in the same time - 20 axes)
Device CANopen
Hybrid cable
- DC bus
- Aux Power
- Motion bus
- Service bus
8+8I/O
Siemens PLC
Rockwell PLC
Compact Flash
UNICO²
Hybrid cable
Hybrid cable
External Power supply to 48 Vdc for MDC only
12W per MDC (0.25A)
30MDC*0.25 = 7.5A min
Status relay
EtherCAT IN
PSI 20kW
PSU 20kW
Serial connection
150 mm
Power supply to 24 Vdc for PSU, UNICO and PSI control board
Max current 5A
LINE 3ph 230 - 480V
The limit current in the Hybrid cable is 20 Amp.
If we consider a coefficient of work of the axes of 65%, we will have a maximum current of 20 * 1.2 = 24 Amp.
Countinuous Power MDC 70 3000 400V = 628W
628*30MDC = 19 kW
30MDC*1.2 = 36A (over the max cable current)

5 Decimal parameters

Description field: **R**: read; **W**: write; **M**: memory; **K**: key parameter

Par.	Description	Field	Range	Def.	Res.
Pr0	**Motor speed**: a read-only parameter expressed in rpm; the Pr0 message is not ever displayed on the screen. Instead, the message indicating the status of the converter is displayed.	R	± 15.000 [rpm]	0	1 rpm
Pr7	**Main reference (read-only):** If b40.2=0 is used, Pr7 is the reference for the speed regulator. In some operating modes Pr7 can be used as a reference for other values (torque/acceleration) and in these cases Pr7 will be expressed in the most suitable unit of measurement.	R	±9000 [rpm]		1 rpm
Pr13	**Overspeed limit.** If the absolute value of the motor speed exceeds the value set in Pr13, b41.0 will be =1, Otherwise, it will be = 0.	R/W	0÷13000 [rpm]	3500	1 rpm
Pr14	**High speed limit.** If b40.7=0 and if the difference of the speed of the motor and the reference is less than Pr14 and greater than Pr15, b41.1 will be = 1. Otherwise, it will be 0. If b40.7 = 1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 will be =1. Otherwise, it will be =0.	R/W	±13000 [rpm]	20	1 rpm
Pr15	**Low speed limit.** If b40.7=0 and if the difference of the speed of the motor and the reference is less than Pr14 and greater than Pr15, b41.1 will be =1. Otherwise, it will be =0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 will be =1. Otherwise, it will be =0.	R/W	±13000 [rpm]	-20	1 rpm
Pr16	**Integral gain of the speed regulator.**	R/W	0÷32767	120	1
Pr17	**Damping of the speed regulator.** If Pr16=0, Pr17 is the proportional gain of the speed regulator.	R/W	0÷32767	2000	1
Pr18	**Band width limiter.** Pr18 is used to set the time constant of a first order filter placed on the digital signal of the torque request. The frequency of the filter cut will be: 1240/Pr18 Hertz.	R/W	1÷1000 [1=128 µsec]	3	1
Pr19	**Peak torque.** This is the maximum torque that the converter can supply to the motor. It is expressed as a percentage of the peak current of the motor multiplies to motor constant torque.	R/W	0÷100.0 [$\%T_{max}$] of Obj Mot_Torque max	100.0	0.1% Tmax
Pr20	**DC bus voltage (read-only).** Displays the value of the voltage present on the DC bus.	R	0÷850 [Volt]		1

Par.	Description	Field	Range	Def.	Res.
Pr28	**Motor shaft position.** Indicates the absolute position of the resolver. (requires b42.15=1)	R	0÷4095 [count]		1
Pr29	**Number of motor poles.**	R/W K,M	2÷64	0	1
Pr31	**Operating mode (n.a.).** Used to select the active operating mode.	R/W	202-203	-	1
Pr32	**Rated speed.** This is the rated speed of the motor. The speed that has been set is used to limit the speed request. Therefore, it should be set to about 10% greater than the maximum operational speed.	R/W K,M	0÷9000 [rpm]	0	1
Pr33	**Rated current of the motor.** The rated current of the motor must be set.	R/W K,M	0.1÷In [A]	0	0.1
Pr34	**Number of poles on the resolver.**	R/W K,M	2÷4÷8	0	1
Pr35	**Torque monitor.** Unit = % of the torque at peak current, resolution 0.1%. Indicates the percentage of the torque (motor peak current * K_t) that the motor is supplying.	R	0÷100.0 of Obj Mot_Torque max [%]		0.1%
Pr36	**Thermal image winding (read-only).** Unit = % of the rated temperature. Indicates the estimate of the heat in the innermost coils of the motor. If this reaches the value of 100.0 % equal to the nominal value, b41.11 will become 1 and therefore the current will be limited to the nominal value. Description: if the drive generate the max current, starting from 0 current, after 2s, Pr36=100% and b41.11=1 result: the drive limits the current at the rated current. This situation remains until the drive generates "0" current and after 35s Pr36 is "0" again	R	0÷100.0 [%Temp]		0.1%
Pr46	**Motor resistance.** The phase-phase resistance of the motor.	K,M	0.1÷ 300.0 [Ohm]	0	0.1
Pr47	**Motor inductance.** The phase-phase inductance of the motor.	K,M	0.1÷ 500.0 [mH]	0	0.1
Pr49	**CANopen Address.** (set by dip-switch)		1÷127		1
Pr51	**Position error.**	R/W	-32768÷ +32767 [count]	0	1
Pr55	**Window for servo-error 1**. If the position error as an absolute value exceeds the value set in Pr55, b70.4 is set to 1. Otherwise, b70.4 = 0.	R/W	[count]	1000	1

Par.	Description	Field	Range	Def.	Res.
Pr56	**Window for servo-error 2**. If the position error as an absolute value exceeds the value set in Pr56, b70.5 is set to 1. Otherwise, b70.5 = 0.	R/W	[count]	1000	1
Pr71	**Constant value = -1.** Double word.	R/W	-32768÷ +32767	-1	1
Pr72	**Constant value = 0.** Double word.	R/W	-32768÷ +32767	0	1
Pr73	**Constant value = 1.** Double word.	R/W	-32768÷ +32767	1	1
Pr74	**Constant value = 2.** Double word.	R/W	-32768÷ +32767	2	1
Pr75	**Constant value = 10.** Double word.	R/W	-32768÷ +32767	10	1
Pr76	**Constant value = 100.** Double word.	R/W	-32768÷ +32767	100	1
Pr77	**Constant value = 1000.** Double word.	R/W	-32768÷ +32767	1000	1
Pr78	**Constant value = 1024.** Double word.	R/W	-32768÷ +32767	1024	1
Pr79	**Constant value = 4096.** Double word.	R/W	-32768÷ +32767	4096	1
Pr80	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr81	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr82	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr83	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr84	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr85	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr86	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr87	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr88	**Free parameter.** A parameter that can be stored by the user (word).	R/W	-32768÷ +32767	0	1
Pr92	**First timer of the PLC.** Every 6.144 ms, if Pr92 is not 0, it is decremented. If it is equal to 0, b99.0 is set to 1.	W	0		
Pr93	**Second time of the PLC.** Every 6.144 ms, if Pr93 is not 0, it is decremented. If it is equal to 0, b99.1 is set to 1.	W	0		
Pr106	**Feed forward scale**. The range is: from 0 to 2000, but if Pr106=1000 the feed forward doesn't use the scale.		0 ÷ 2000	0	1

Par.	Description	Field	Range	Def.	Res.
Pr203	**Motor temperature pre-alarm.** The user can fix the motor temperature to set pre-alarm flag (b232.12).	[°C]	120	R/W	
Pr204	**Motor temperature alarm.** The user can fix the motor temperature to rise alarm event.	[°C]	130	R/W	
Pr205	**Motor temperature.** Motor temperature estimate.	[°C]	-	R	

5.1 Binary parameters

The binary parameter Pb40 can be read and set and then stored. The binary parameter Pb41 provides indications about the status of the system. The parameters Pb42 and Pb99 be read and set and then stored.

Par.	Description	Field	Def.
b39.3	**IN 0 Front edge of caught quota.** (0) positive edge. (1) negative edge.	R/W	0
b39.4	**IN 1 Front edge of caught quota.** (0) positive edge. (1) negative edge.	R/W	0
b39.6	**Caught quota.** (1) always enabled. (0) enable caught after the reset of the bit	R/W	0
b39.10	**Parameters conversion.** (1) Parameters interface enabled, relative at these parameters: Pr16, Pr17, Pr18, Pr19, Pr29, Pr32, Pr33, Pr34, Pr46, Pr47, Pr57.	R/W	0
b40.7	**Selection of the absolute/relative speed window.** If = 0, the speed window Pr14 Pr15 b41.1 will function in relative mode. Otherwise, if = 1, it will function in absolute mode.	R/W M	0
b41.0	**Overspeed.** When the absolute value of the motor speed exceeds the value set in Pr13, b41.0 = 1. Otherwise, b41.0 = 0.	R	
b41.1	**In speed:** If b40.7 = 0 and if the difference in speed between the motor and the reference is less than Pr14 and greater than Pr15, b41.1 = 1. Otherwise, = 0. If b40.7=1 and if the motor speed is less than Pr14 and greater than Pr15, b41.1 =1. Otherwise, = 0.	R	
b41.2	**Zero speed.** If the motor speed (Pr0) = 0, b41.2=1. Otherwise, b41.2 = 0.	R	
b41.3	**Forward.** If the motor speed (Pr0) is positive, b41.3 = 0. Otherwise, b41.3 = 1.	R	
b41.4	**Converter O.K.** If = 1, there is no alarm. Otherwise, = 0.	R	
b41.6	**PSI & PSU O.K.** If = 1, there is no alarm the motor can be enabled.	R	
b41.11	**I^2T active.** Indicates that Pr36 has reached the 100.0 % value and therefore the converter is limiting the current to the nominal value.	R	
b41.12	**Drive enablede.**	R	
b42.15	**Signal synchronization.** (1) To enable the synchronization MDC to the external bus, PLL synchronized. In this condition the motor position, status of the digital inputs, value capture function are enabled.	R	0
b70.2	**Feedback direction.** If = 1, the rotation of the motor is inverted. Only with feedback done by the resolver.	R/W M	0
b70.4	**Servo error**. b70.4 will be set to 1 if the position error as an absolute value exceeds the value set in Pr55.	R	0
b70.5	**Servo error**. b70.5 will be set to 1 if the position error as an absolute value exceeds the value set in Pr56.	R	0

Par.	Description	Field	Def.
b70.14	**Value master captured**. If set to 1, this means that the value master has been captured. The user must set the bit to 1 (requires b42.15=1).	R/W M	0
b70.15	**Value motor captured**. If set to 1, this means that the value motor has been captured. The user must set the bit to 1 (requires b42.15=1).	R/W M	0
b90.0	**Digital input 0.** (requires b42.15=1)	R	0
b90.1	**Digital input 1.** (requires b42.15=1)	R	0
b90.X	**Status of digital input X**. If X is greater than 1, this is a bit that can be stored by the user.	W	0
b91.0	**Digital output 0.** It's necessary to set the management by b231.8=1 and b 231.9=1.	W	
b91.1	**Digital output 1.** It's necessary to set the management by b231.8=1 and b 231.9=1.	W	
b91.Y	**Status of digital output Y.** If Y is greater than 1 this is a bit that can be stored by the user. Parameter Pb91 is not saved and is set to 0 when the unit is powered on.	W	0
b94.0	**Force a double word formatted operation.** When the unit is powered on, this is 0. If it is set to 1, the first mathematical operation executed by the pico-PLC is done by using three double word type operands. After the execution of the operation b94.0 is automatically set to 0. If Pr60..Pr68 Pr110...Pr148 are used, the double word formatting is implicit.	W	0
b99.0	**Status of the first timer.** Equal to 1 if Pr92 = 0.	W	0
b99.1	**Status of the second timer.** Equal to 1 if Pr93 = 0.	W	0
b99.2	Equal to 1 if the result of the last PLC operation is negative.	W	0
b99.3	Equal to 1 if the result of the last PLC operation is 0.	W	0
b99.12	**Default values.** This command sets all parameters to the default values: motor data, type of feedback, gains and peak current.	R/W	0
b99.13	**PLC status**. If set to 1, the PLC program is executed. If 0, the program is not executed, but the PLC instructions can be modified.	W	1
b99.15	**Storing of parameters.** This command stores all parameters and pico-PLC.	W	0
b230.12	**STO1mon.**	R	0
b230.13	**STO2mon.**	R	0
b230.14	**PSU/PSI OK.** (1) the drive enabling is possible after the status ok of the PSU/PSI, b41.6=1.	W	0
b231.12	**KTY motor pre-alarm (1).** This pre-alarm allows to stop the machine before (around 125°C – 257°F) reaching the alarm limit (around 135°C – 275°F).	0	R
b390.6	**Drive reset.** Software reset, switch off / switch on of the drive control board.	W	0

6 Function

6.1 Setting the default parameters

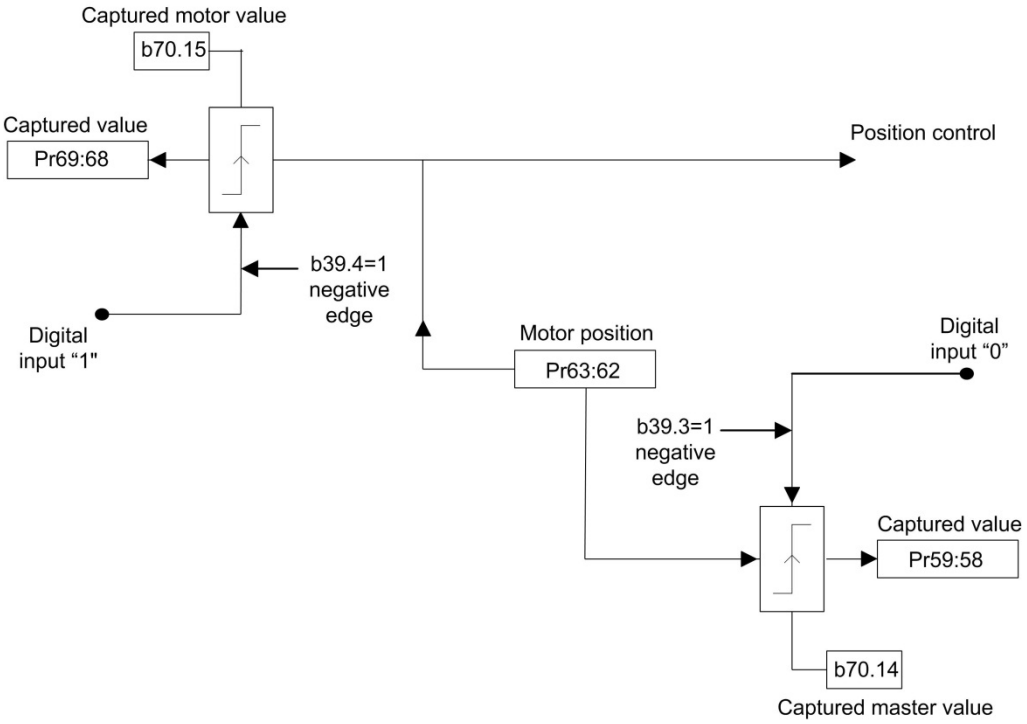
If you want to set the default values of the converter as it was supplied by the manufacturer, follow these instructions:

- power off the converter using the hardware
- connect only 24Vdc
- power on the drive
- set b99.13 to 0
- issue the command b99.12
- save the set up using command b99.15.

6.2 Value capture

At every positive, or negative (b39.4=1), front of digital input 1, the value of Pr63:62 is captured and stored in Pr68:69 and b70.15 is set to 1 to signal the event. b70.15 is not reset automatically.
Analogous situation, at every positive, or negative (b39.3=1), front of digital input 0, the value of Pr63:62 is captured and stored in Pr58:59 and b70.14 is set to 1 to signal the event. b70.14 is not reset automatically.

The function is always enabled if the bit b39.6 is equal to 1. Otherwise when the bit b39.6 is set to 0, the value capture function needs the reset of the signal event bit: b70.14 and b70.15.



N.B. this function requires b42.15=1.

7 Field bus interface: CAN or EtherCAT

A CAN bus interface based on the physical layer ISO/DIS11898 is included on the converter. The Data link layer is the full CAN version 2.0 part A (ID 11 bit).

7.1 CANopen dsp402 (D/E5 version)

The CANbus node must be set through Pr49 with values from 1 to 127.
Transmission speed is 250 kbps.

In the CANopen implementation of drive an SDO channel is available (standard cob-id). Both standard guarding protocols are available , Node guarding and heartbeat (the two cannot exist in the same time) Heartbeat is activated when a producer heartbeat time is set different from 0.Three PDO channels PDO 1,2,4 from the predefined standard connection set are available PDO 1 and 2 are serviced by a cyclic routine executed every 2.048 msec and they are remappable (elements of 2 or 4 bytes can be mapped) the RTR is allowed event time and inhibit time are active they can handle synchronous requests serviced every 2.048 msec or they can be handled as event driven.
PDO 4 is the PDO channel used for strictly realtime operation as controlling motor trajectory or position loop (the PDO is synchronous type 1) no RTR is allowed and a restricted set of parameters can be mapped , in particular (ID: to the second axis apply as offset 0x0800, while to the third axis the offset is 0x1000; PDO: to the second axis apply as offset 0x0040, while to the third axis the offset is 0x0080):

PDO 4 rx : [0x6040] control word
[0x60c1][1] position reference in counts
[0x60c1][2] velocity reference in counts/sec
[0x60c1][3] velocity reference in rpm

PDO 4 tx : [0x6041] status word
[0x6063] position feedback in counts
[0x6064] position feedback in counts

Life guarding protocol is implemented and can be activated writing life time factor and guard time besides a missing guarding event ,life guarding protocol can be triggered by a missing sync or a bus-off condition.

Note NMT commands are handled every 1.024 msec, so subsequent commands should be sent to the drive not closer than 1.204 msec including broadcast NMT commands.

7.1.1 Dictionary object summary of ds301

[0x1000] : device type
[0x1018] : Identity object
//pdo
[0x1600] : PDO 1 rx mapping parameters
[0x1601] : PDO 2 rx mapping parameters
[0x1603] : PDO 4 rx mapping parameters
[0x1a00] : PDO 1 tx mapping parameters
[0x1a01] : PDO 2 tx mapping parameters
[0x1a03] : PDO 4 tx mapping parameters
//manufacturer
[0x2000](*) : parameters' array 0..254 read write access
[0x2001] : parameters' array 254..NR_PAR read write access
[0x2002] : parameters' array 0..254 set bit access
[0x2003] : parameters' array 254..NR_PAR set bit access
[0x2004] : parameters' array 0..254 reset bit access
[0x2005] : parameters' array 254..NR_PAR reset bit access
[0x2006] : pico-plc area first 254 instructions
[0x2007] : pico-plc area last 2 instructions

[0x2011] (*) : application parameters [object 0x2000 MDC CANopen]
- [0x2011] [1] : Master frequency
- [0x2011] [2] : enable ICS calibration
- [0x2011] [3] : enable ICS filter
- [0x2011] [4] : enable ICS motor offset table

[0x2030] : blocks' array 0..254 read write access in double word. The parameters in double word can be read and written in "blocks" of two parameters: the block number is half of parameter even: Pr101:100 is 50^{th} block and Pr103:102 is 51^{st} block.
[0x2063] : counter auxiliary encoder
[0x2069] : Current reference filter parameters

(*) object CANopen 0x2000 is moved to object 0x2011.

7.1.2 Dictionary object summary of dsp402

[0x6007] 'Abort connection option code': with the following available values
0: No action
1: Alarm (alarm MISSING_SYNC_TRIP (Er16) if sync is missing when b271.8=1 the sync signal interval exceeds the 120% of the nominal sync cycle lasting time of index 0x1006 communication cycle period the regularity of sync signal is checked with a resolution of 2.048 msec.

(If the node does not receive the guarding message before its lifetime an ABORT_CONN_TRIP (Er13)) is generated.

2: disable voltage
3: quick stop

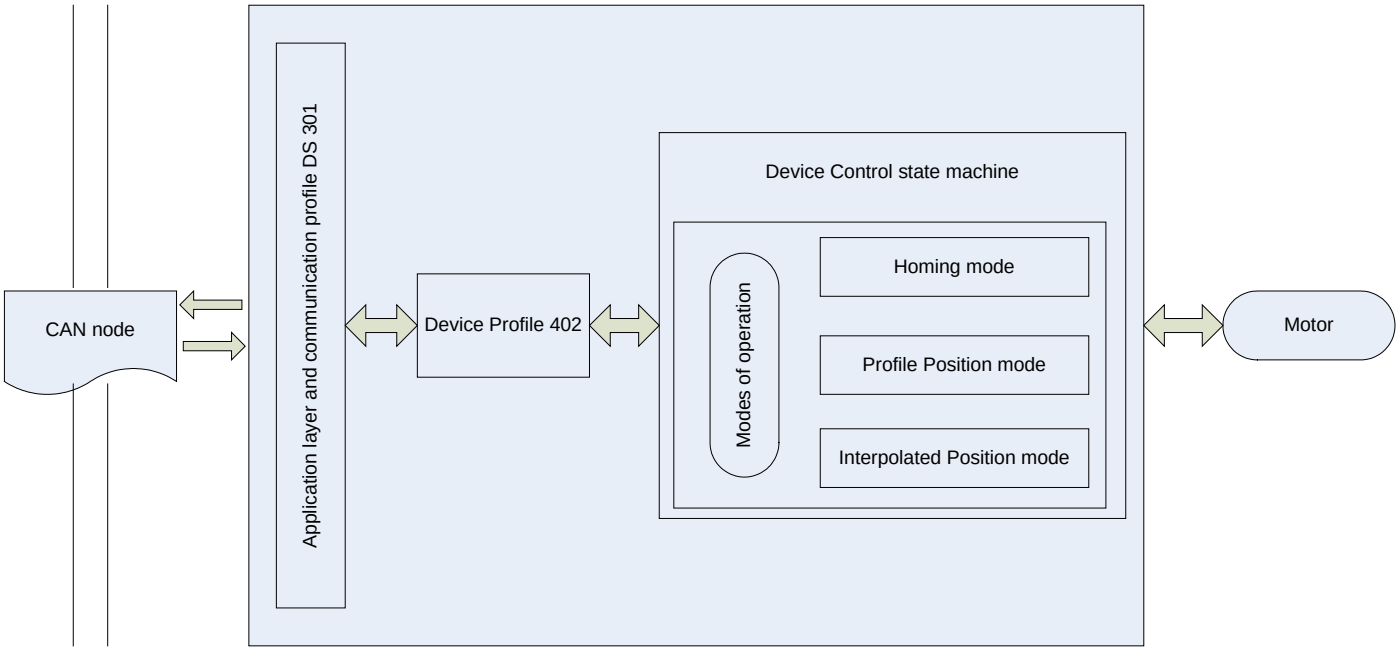
[0x6040] 'Control word':
[0x6041] 'Status word':
[0x605a] 'Quick stop option code': valid values 0, 2, 3, 6, 7
[0x605e] 'Fault reaction option code': valid values 0, 2, 3.
[0x6060] 'Mode of operation': valid values 7 (opm202), 8 (opm203)
[0x6061] 'Modes of operation display': see the previous.
[0x6063] 'position actual value (counts)': If read by mean of SDO or mapped on PDO 1 or 2 returns the value of position feedback in counts from pr[63:62] if mapped on PDO 4 returns the value of the position feedback at the sync signal.
[0x6064] 'position actual value (counts)': If read by mean of SDO or mapped on PDO 1 or 2 returns the value of position feedback in counts from pr[63:62] if mapped on PDO 4 returns the value of the position feedback at the sync signal.
[0x6065] 'Following error window': it is converted in counts by mean of position factor then set in SERVO1 (pr[55]) the parameters is used to test following error. The parameters of SERVO1 are changed by the firmware only if in remote mode. In DS402 the bit target reached depends from this object.
[0x6066] 'Following error timeout': resolution of 1.024 msec per unit. In DS402 the bit target reached depends from this object.
[0x6067] 'Position window': in user units converted by mean of position factor and compared with the motor position to check if target reached in profile position and interpolated position modes.
[0x6068] 'Position window time': resolution of 1.024 msec per unit
[0x607a] 'Target position': in user units converted by mean of position factor and used in profile position mode.
[0x6085] 'quick stop deceleration': deceleration in quick stop action
[0x60c0] 'Interpolation sub mode selection': valid values 0(linear interpolation),-1(cubic interpolation with position and velocity)
[0x60c1][1] 'Interpolation data record': INTEGER32 interpolator position reference
[0x60c1][2] 'Interpolation data record': INTEGER32 interpolator velocity reference in counts/sec
[0x60c1][3] 'Interpolation data record': INTEGER32 interpolator velocity reference in RPM
[0x6502] 'Supported drive modes': see (see 0x6060)

Following modes of operation of DSP402 are implemented beside the device control state machine:

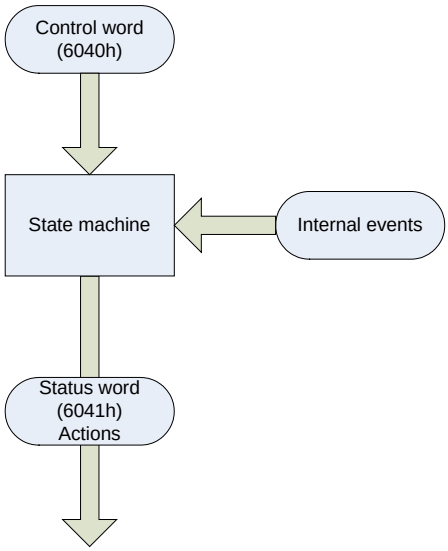
Interpolated position mode

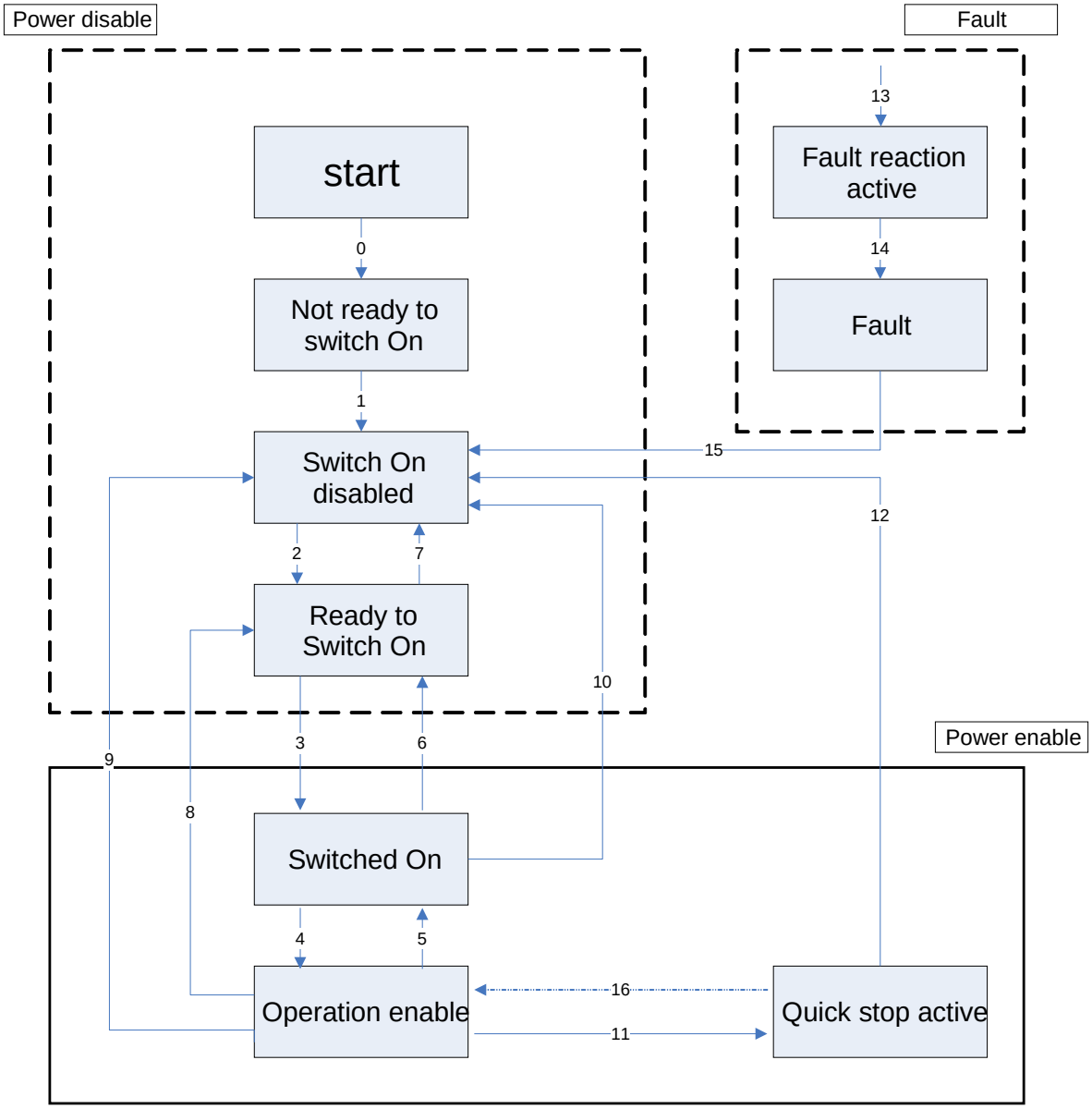
Cyclic synchronous position (only for EtherCAT)

The field Error Code will contain a specific code based on the different drive alarm (see the MDC CANopen manual).



Here by the schematic of device control with controlword e statusword





If I^2t current clamping is active bit 11 of the statusword rises.

7.1.2.1 Object 6040h: Controlword

The *controlword* consist of bits for:
• the controlling of the state,
• the controlling of operating modes and
• manufacturer specific options.

OBJECT DESCRIPTION

INDEX	6040h
Name	Controlword
Object Code	VAR
Data Type	UNSIGNED16
Category	Mandatory

ENTRY DESCRIPTION

Access	rw
PDO Mapping	Possible
Value Range	UNSIGNED16
Default Value	No

DATA DESCRIPTION The bits of the *controlword* are defined as follows:

15 11	10 9	8	7	6 4	3	2	1	0
Manufacturer specific	**Reserved**	**Halt**	**Fault reset**	**Operation mode specific**	**Enable operation**	**Quick stop**	**Enable voltage**	**Switch on**
O	O	O	M	O	M	M	M	M
MSB			LSB					

0 -Optional
M –Mandatory

BITS 0 – 3 AND 7:
Device control commands are triggered by the following bit patterns in the *controlword*:

Command	**Bit of the *controlword***					**Transitions**
	Fault reset	**Enable operation**	**Quick stop**	**Enable voltage**	**Switch on**	
Shutdown	0	X	1	1	0	2,6,8
Switch on	0	0	1	1	1	3*
Switch on	0	1	1	1	1	3**
Disable voltage	0	X	X	0	X	7,9,10,12
Quick stop	0	X	0	1	X	7,10,11
Disable operation	0	0	1	1	1	5
Enable operation	0	1	1	1	1	4,16
Fault reset		X	X	X	X	15

Table 4: Device control commands **(bits marked X are irrelevant, * ... In the state SWITCHED ON the drive executes the functionality of this state., ** ... It exists no functionality in the state SWITCHED ON. The drive does not do any in this state.)**

BITS 4, 5, 6 AND 8:
These bits are operation mode specific. The description is situated in the chapter of the special mode. The following table gives an overview:

Bit	Operation mode		
	Velocity mode	**Profile velocity mode**	**Profile torque mode**
4	rfg enable	reserved	reserved
5	rfg unlock	reserved	reserved
6	rfg use ref	reserved	reserved
8	Halt	Halt	Halt

Table 5: Mode specific bits in the *controlword*

BITS 9, 10:
These bits are reserved for further use. They are inactive by setting to zero. If they have no special function, they must be set to zero.

BITS 11, 12, 13, 14 AND 15:
These bits are manufacturer specific.

7.1.2.2 Object 6041h: Statusword

The *statusword* indicates the current state of the drive. No bits are latched. The *statusword* consist of bits for:
• the current state of the drive,
• the operating state of the mode and
• manufacturer specific options.

OBJECT DESCRIPTION

INDEX	6041h
Name	Statusword
Object Code	VAR
Data Type	UNSIGNED16
Category	Mandatory

ENTRY DESCRIPTION

Access	ro
PDO Mapping	Possible
Value Range	UNSIGNED16
Default Value	No

Bit	Description	M /O
0	Ready to switch on	M
1	Switched on	M
2	Operation enabled	M
3	Fault	M
4	Voltage enabled	M
5	Quick stop	M
6	Switch on disabled	M
7	Warning	O
8	Manufacturer specific	O
9	Remote	M
10	Target reached	M
11	Internal limit active	M
12 - 13	Operation mode specific	O
14 - 15	Manufacturer specific	O

BITS 0 – 3, 5 AND 6:
The following bits indicate the status of the device:

Value (binary)	State
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

Table 7: Device state bits (x ... irrelevant for this state)

BIT 4: VOLTAGE ENABLED
High voltage is applied to the drive when this bit is set to 1.

BIT 5: QUICK STOP

When reset, this bit indicates that the drive is reacting on a quick stop request. Bits 0, 1 and 2 of the *statusword* must be set to 1 to indicate that the drive is capable to regenerate. The setting of the other bits indicates the status of the drive (e.g. the drive is performing a quick stop as result of a reaction to a non-fatal fault. The fault bit is set as well as bits 0, 1 and 2).

BIT 7: WARNING

A drive warning is present if bit 7 is set. The cause means no error but a state that has to be mentioned, e.g. temperature limit, job refused. The status of the drive does not change. The cause of this warning may be found by reading the fault code parameter. The bit is set and reset by the device.

BIT 8:
This bit may be used by a drive manufacturer to implement any manufacturer specific functionality.

BIT 9: REMOTE
If bit 9 is set, then parameters may be modified via the CAN-network, and the drive executes the content of a command message. If the bit remote is reset, then the drive is in local mode and will not execute the command message. The drive may transmit messages containing valid actual values like a *position actual value*, depending on the actual drive configuration. The drive will accept accesses via SDO in local mode.

BIT 10: TARGET REACHED
If bit 10 is set by the drive, then a set-point has been reached. The set-point is dependent on the operating mode. The description is situated in the chapter of the special mode. The change of a target value by software alters this bit.
If *quick stop option code* is 5, 6, 7 or 8, this bit must be set, when the quick stop operation is finished and the drive is halted.
If halt occurred and the drive has halted then this bit is set too.

BIT 11: INTERNAL LIMIT ACTIVE
This bit set by the drive indicates, that an internal limitation is active: I^2t current clamping is active.

BIT 12 AND 13:
These bits are operation mode specific. The description is situated in the chapter of the special mode The following table gives an overview:

Bit	Operation mode					
	vl	**pp**	**pv**	**tq**	**hm**	**ip**
12	reserved	Set-point acknowledge	Speed	reserved	Homing attained	ip mode active
13	reserved	Following error	Max slippage error	reserved	Homing error	reserved

Table 8: Mode specific bits in the *statusword*

BIT 14 AND 15:
These bits may be used by a drive manufacturer to implement any manufacturer specific functionality.

7.1.2.3 Object 605B$_h$: Shutdown option code

The parameter *shutdown option code* determines what action should be taken if there is a transition OPERATION ENABLE ⇒ READY TO SWITCH ON.

OBJECT DESCRIPTION

INDEX	605Bh
Name	Shutdown option code
Object Code	VAR
Data Type	INTEGER16
Category	Optional

ENTRY DESCRIPTION

Access	rw
PDO Mapping	No
Value Range	INTEGER16
Default Value	0

DATA DESCRIPTION

Value	**Description**
-32768 ... –1	manufacturer specific
0	Disable drive function
1	Slow down with slow down ramp; disable of the drive function
2 ... 32767	reserved

7.1.2.4 Object 605Ch: Disable operation option code

The parameter *disable operation option code* determines what action should be taken if there is a transition OPERATION ENABLE ⇒ SWITCHED ON.

INDEX	605Ch
Name	Disable operation option code
Object Code	VAR
Data Type	INTEGER16
Category	Optional

ENTRY DESCRIPTION

Access	rw
PDO Mapping	No
Value Range	INTEGER16
Default Value	1

DATA DESCRIPTION

Value	**Description**
-32768 ... -1	manufacturer specific
0	Disable drive function
1	Slow down with slow down ramp and then disabling of the drive function
2 ... 32767	reserved

7.1.2.5 Object 605Ah: Quick stop option code

The parameter *quick stop option code* determines what action should be taken if the Quick Stop Function is executed.
OBJECT DESCRIPTION ENTRY DESCRIPTION

INDEX	605Ah
Name	Quick stop option code
Object Code	VAR
Data Type	INTEGER16
Category	Optional

Access	rw
PDO Mapping	No
Value Range	INTEGER16
Default Value	2

DATA DESCRIPTION

Value	**Description**
0	disable drive function
1	slow down on slow down ramp
2	slow down on quick stop ramp
5	slow down on slow down ramp and stay in QUICK STOP
6	slow down on quick stop ramp and stay in QUICK STOP

7.1.2.6 Object 605Eh: Fault reaction option code

The parameter *Fault reaction option code* determines what action should be taken if a fault occurs.
OBJECT DESCRIPTION

INDEX	605Eh
Name	Fault reaction option code
Object Code	VAR
Data Type	INTEGER16
Category	Optional

ENTRY DESCRIPTION

Access	rw
PDO Mapping	No
Value Range	INTEGER16
Default Value	2

DATA DESCRIPTION

Value	**Description**
-32768 ... -1	manufacturer Specific
0	disable drive, motor is free to rotate
1	slow down on slow down ramp
2	slow down on quick stop ramp

7.1.2.7 Object 6060h: Modes of operation

The parameter *modes of operation* switches the actually choosen operation mode.
OBJECT DESCRIPTION

INDEX	6060h
Name	Modes of operation
Object Code	VAR
Data Type	INTEGER8
Category	Mandatory

ENTRY DESCRIPTION

Access	rw
PDO Mapping	Possible
Value Range	INTEGER8
Default Value	No

DATA DESCRIPTION

Value	**Description**
1	Profile Position Mode
6	Homing Mode
7	Interpolated Position Mode

NOTE A read of *modes of operation* shows only the value of *modes of operation*. The actual mode of the drive is reflected in the object *modes of operation display*. It may be changed by writing to *modes of operation.*

7.1.2.8 Object 6061h: Modes of operation display

The *modes of operation display* shows the current mode of operation. The meaning of the returned value corresponds to that of the *modes of operation* option code (index 6060h).

OBJECT DESCRIPTION

INDEX	6061h
Name	Modes of operation display
Object Code	VAR
Data Type	INTEGER8
Category	Mandatory

ENTRY DESCRIPTION

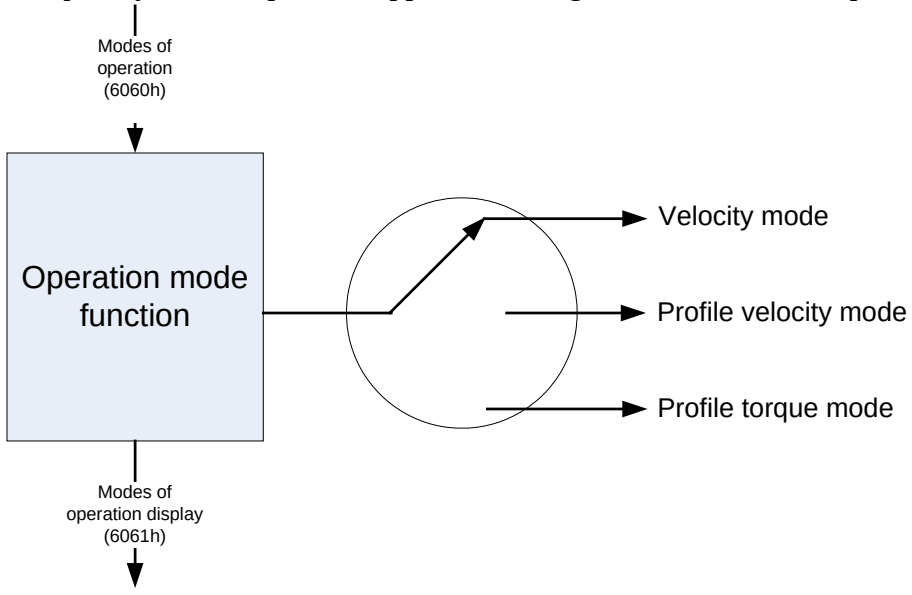
Access	ro
PDO Mapping	Possible
Value Range	INTEGER8
Default Value	No

DATA DESCRIPTION Same as for object 6060_h *modes of operation*.
NOTE The actual mode is reflected in the *modes of operation display* (index 6061_h), and not in the m*odes of operation* (index 6060_h).

7.1.3 Functional description

7.1.3.1 Modes of operation function

The device behaviour depends on the activated modes of operation.
It is possible to implement different device modes. Since it is not possible to operate the modes in parallel, the user is able to activate the required function by selecting a mode of operation. An example of exclusive functions are those for position and torque control, which can only control one variable at any one time. The variables can perform at most a limited function. Such hybrids are regarded as the particular characteristics of a mode of operation. Position control operation and encoder profile support can be active at the same time, for example. Consequently encoder profile support is not regarded as a mode of operation.



7.1.4 Interpolated Position Mode (operative mode 202)

In Interpolated Position Mode (Pr31=202) the cycle time is set in the object 0x1006 'communication cycle period' and depending on the value set in this object different ways of regulation are possible.
If the value is less than 2500 µsec the position loop is executed at the moment the sync signal is received the position reference received on the PDO is directly processed as target of the position loop. If the value is more or equal than 2500 µsec the position reference received is interpolated according the interpolation sub mode index 0x60c0 , the interpolation may be cubic or linear.
If object 0x60c0 is 0 the interpolation algorithm is linear otherwise if –1 is cubic with both position and velocity reference, if –2 is cubic with position reference only.
If on the synchronous PDO 4 rx it is not mapped the position reference the position loop is not executed but the velocity reference received is set, the velocity reference may be supplied in counts/sec or RPM respectively mapping object 0x60c1.2 or 0x60c1.3, in this case the external controller executes position loop.
Note: In interpolated position mode factor group conversion are not active. If the cycle time is less than 2500 µsec the feedforward of velocity may be computed by the drive from the delta of position reference in the cycle time (gain of feedforward component should be set accordingly with the cycle time). Otherwise feedforward of velocity may be sent with PDO4 rx mapping in RPM units the object 0x60c1.3.
Depending on the different algorithms of interpolation there is a different delay between the moment the target position is received on the PDO and validated by the sync and the moment when the target position is active in the trajectory setpoint of the motor.
In case of cycle time less than 2500 µsec the position loop trajectory setpoint is immediately upgraded with the last received position setpoint as soon as the sync signal is received.
In case of cycle time longer than 2500 µsec, both with linear interpolation and cubic interpolation with position and velocity, the point specified in the target position received on the PDO will be activated as trajectory setpoint at the end of the cycle time started with the sync signal that validated the target position, so with a cycle time delay.
As last, in case of cycle time longer than 2500 µsec and cubic interpolation with position reference only, the point specified in the target position received on the PDO will be activated as trajectory setpoint at the end of the next cycle time started with the sync signal that validated the target position, so with two cycle time delay.

Index	Object	Name	Type	Attr.	M/O
60C0h	VAR	Interpolation sub mode select	INTEGER16	rw	O
60C1h	ARRAY	Interpolation data record	INTEGER32	rw	O

Index	Object	Name	Type	Chapter
6040h	VAR	Controlword	UNSIGNED16	dc
6041h	VAR	Statusword	UNSIGNED16	dc
605Ah	VAR	Quick stop option mode	INTEGER16	dc
6060h	VAR	Modes of operation	INTEGER8	dc
6061h	VAR	Modes of operation display	INTEGER8	dc
6063h	VAR	Position actual value*	INTEGER32	pc

Note: the position loop resolution can be selected through parameter Pr169, that would be considered in this range: 4096 to 32768, as power of 2.

7.1.4.1 Object 60C0h: Interpolation sub mode select

For the interpolated position mode a manufacturer may offer different interpolation algorithms. This object reflects or changes the actually chosen interpolation mode.
OBJECT DESCRIPTION

INDEX	60C0h
Name	Interpolation sub mode select
Object Code	VAR
Data Type	INTEGER16
Category	Optional

ENTRY DESCRIPTION

Access	rw
PDO Mapping	Possible
Value Range	0..-2
Default Value	0

DATA DESCRIPTION

Value	**Description**
-2	Cubic interpolation only position
-1	Cubic interpolation speed+position
0	Linear interpolation
+1..+32767	reserved

7.1.4.2 Object 60C1h: Interpolation data record

The *interpolation data record* are the data words which are necessary to perform the interpolation algorithm. The number N of data words in the record is defined by *interpolation data configuration*. The interpretation of the data words in *interpolation data record* may vary with the different possible interpolation modes as set by the *interpolation sub mode select*.
For the linear interpolation mode each interpolation data record simply can be regarded as a new position set-point. To describe a cubic spline interpolation e.g., four or more data words are needed for the spline coefficients, and further interpolation parameters.
After the last item of an *interpolation data record* is written to the devices input buffer, the pointer of the buffer is automatically incremented to the next buffer position.
OBJECT DESCRIPTION

INDEX	60C1h
Name	Interpolation data record
Object Code	ARRAY
Data Type	INTEGER32
Category	Optional

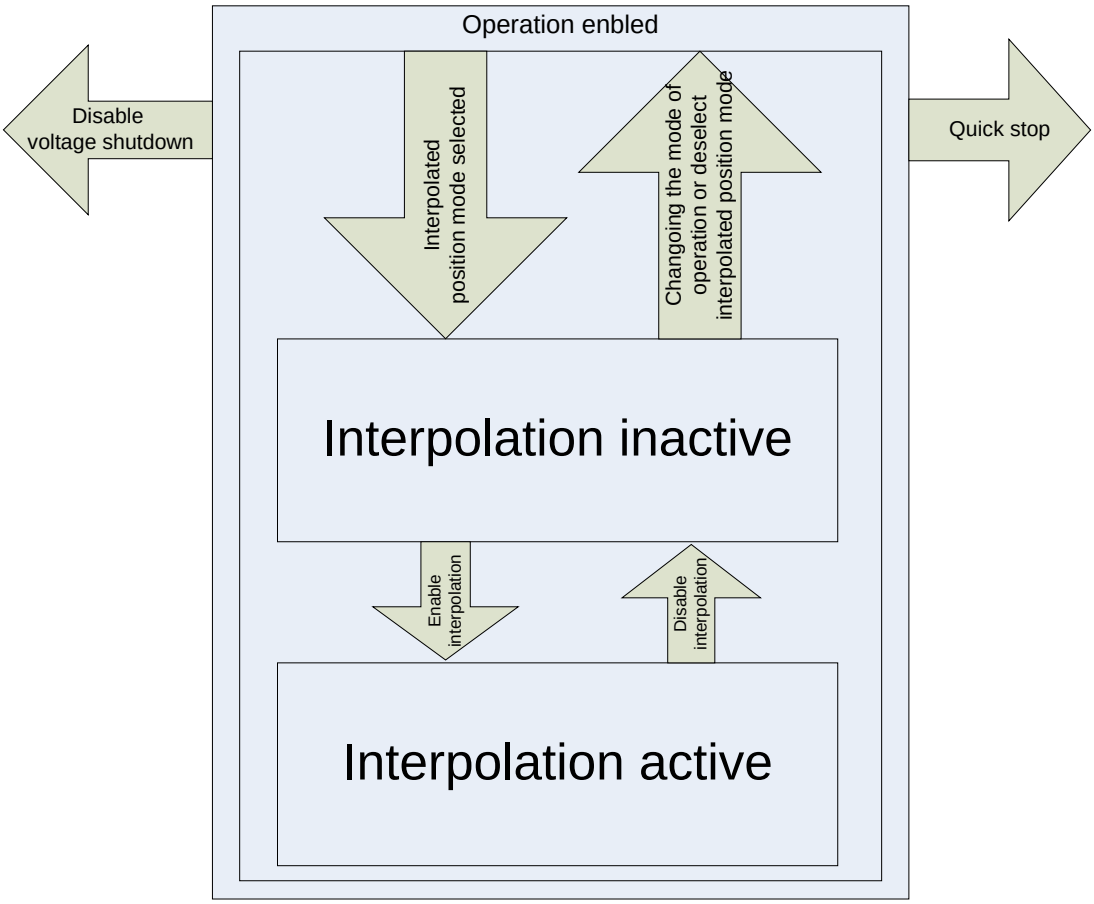
ENTRY DESCRIPTION

Sub-Index	0
Description	number of entries 3
Entry Category	Mandatory
Access	ro
PDO Mapping	No
Value Range	3
Default Value	No

Sub-Index	1
Description	Position setpoint in counts
	the first parameter of ip function fip(x1, .. xN)
Entry Category	Mandatory
Access	rw
PDO Mapping	Possible
Value Range	INTEGER32
Default Value	No

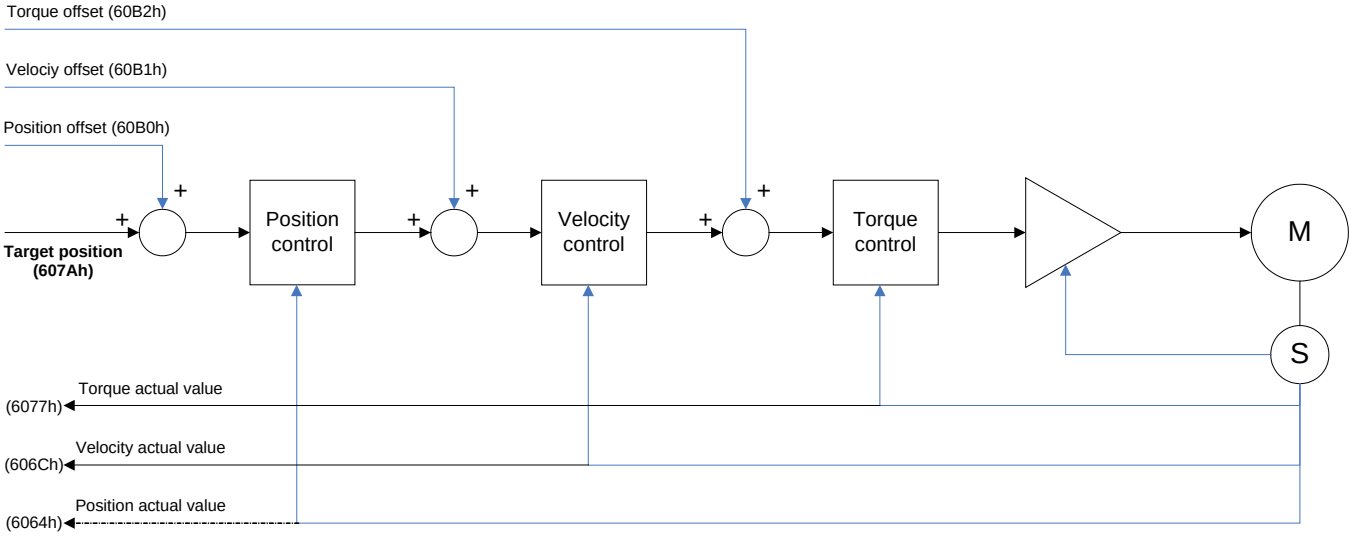
Sub-Index	2
Description	Velocity setpoint in counts/sec
	the second parameter of ip function fip(x1, .. xN)
Entry Category	Optional
Access	rw
PDO Mapping	Possible
Value Range	INTEGER32
Default Value	No

Sub-Index	3
Description	Velocity setpoint in rpm
	the 3-rd parameter of ip function fip(x1, .. xN)
Entry Category	Optional
Access	rw
PDO Mapping	Possible
Value Range	INTEGER32
Default Value	No


Operation enbled
Disable
voltage shutdown
Interpolated
position mode selected
Changoing the mode of
operation or deselect
interpolated position mode
Quick stop
Interpolation inactive
Enable
interpolation
Disable
interpolation
Interpolation active

7.1.5 Mode Cyclic synchronous position (operative mode 203)

The overall structure for this mode Cyclic synchronous position (Pr31 = 203 – only for EtherCAT protocol) is shown in Figure:



With this mode, the trajectory generator is located in the control device, not in the drive device. In cyclic synchronous manner, it provides a target position to the drive device, which performs position control, velocity control and torque control. Optionally, additive velocity and torque values can be provided by the control system in order to allow for velocity and/or torque feedforward. Measured by sensors, the drive device may provide actual values for position, velocity and torque to the control device.

The behaviour of the control function is influenced by control parameters like limit functions, which are externally applicable. The drive internal control function is not specified more precisely in this part of profile specification as it is highly manufacturer-specific, but the format and content of the control parameters are provided.

Index	Object	Name	Type	Attr.	M /O
60B0h	VAR	Position offset	INTEGER32	rw	O
60B1h	VAR	Velocity offset	INTEGER 32	rw	O
60B2h	VAR	Torque offset	INTEGER 16	rw	O

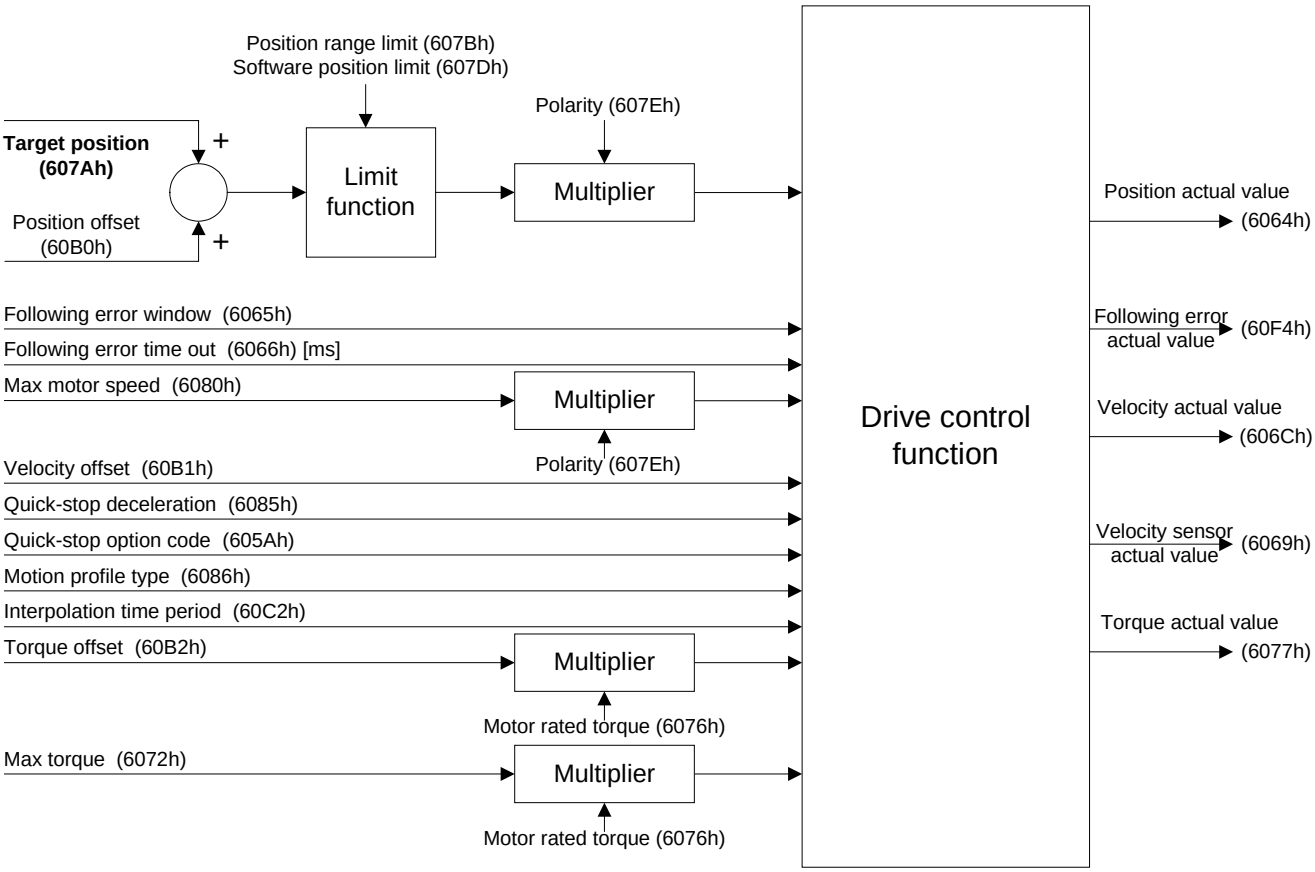
Index	Object	Name	Type	Chap.
6040h	VAR	Controlword	VALORE ASSOLUTO16	dc
6041h	VAR	Statusword	VALORE ASSOLUTO16	dc
605Ah	VAR	Quick stop option mode	INTERO 16	dc

Note: the position loop resolution can be selected through parameter Pr169, that would be considered in this range: 4096 to 32768, as power of 2.

7.1.5.1 Functional description

Figure below shows the inputs and outputs of the drive control function. The input values (from the control function point of view) are the target position and optionally a position offset (to be added to the target position to allow two instances to set up the position) as well as an optional velocity offset and an optional torque offset used for feedforward control. Especially in cascaded control structures, where a position control is followed by a velocity or torque control, the output of the position control loop is used as an input for a further calculation in the drive device. Limit functions may be used to restrict the range of values to avoid unintended positions.
The interpolation time period defines the time period between two updates of the target position and/or additive position and shall be used for intercycle interpolation.
The target position shall be interpreted as absolute value.

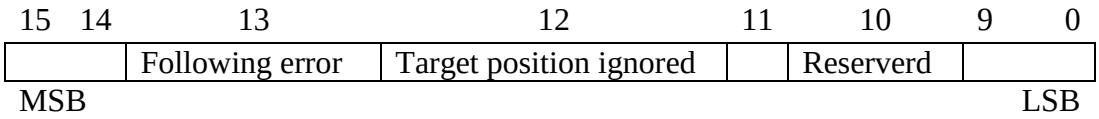
The position actual value is used as mandatory output to the control device. Further outputs may be the velocity actual value, torque actual value and the velocity sensor actual value. The following error actual value may be used as an additional parameter.



All values are transformed – if necessary – from user-defined units to normalized units such as increments with the relative functions.
A target position value or position offset outside the allowed range of the following error window around a position demand value for longer than the following error time out shall result in setting bit 13 (following error) in the statusword to 1.

7.1.5.2 Use of controlword and statusword

The cyclic synchronous position mode uses no mode specific bits of the controlword and three bits of the statusword for mode-specific purposes. Figure 64 shows the structure of the statusword. Table 236 defines the values for bit 10, 12, and 13 of the statusword.



Name	Value	Description
Bit 10	0	Reserved
	1	Reserved
Bit 11	0	Target position ignored
	1	Target position shall be used as input to position control loop
Bit 12	0	No following error
	1	Following error

Definition of bit 10, bit 12, and bit 13

7.1.5.3 Detailed object definitions

7.1.5.3.1 Object 60B0h: Position offset

This object shall provide the offset of the target position. The offset shall be given in user-defined position units.

NOTE The value itself is absolute and thus independent of how often it is transmitted over the communication system, for example, transmitted twice does not mean double value. Since the additive position value represents an offset to the target position it can be also used to control the drive with relative values with regard to the target position.

Object description

INDEX	60B0h
Name	Position offset
Object code	VAR
Data type	INTEGER 32
Category	Optional

Entry description

Sub-index	00h
Access	rw
PDO mapping	See /CiA402-3/
Range value	Integer 32
Default value	0

7.1.5.3.2 Object 60B1h: Velocity offset

This object shall provide the offset for the velocity value. The offset shall be given in user-defined velocity units. In cyclic synchronous position mode, this object contains the input value for velocity feed forward.

NOTE The value itself is absolute and thus independent of how often it is transmitted over the communication system, for example transmitted twice does not mean double value. Since the additive velocity value represents an offset to the target velocity, it can be also used to control the drive with relative values with regard to the target velocity.

Object description

INDEX	60B1h
Name	Velocity offset
Object code	VAR
Data type	Integer 32
Category	Optional

Entry description

Sub-index	00h
Access	rw
PDO mapping	See /CiA402-3/
Range value	Integer 32
Default value	0

7.1.5.3.3 Object 60B2h: Torque offset

This object shall provide the offset for the torque value. The offset shall be given in per thousand rated torque. In cyclic synchronous position mode, this object contains the input value for torque feed forward.

NOTE The value itself is absolute and thus independent of how often it is transmitted over the communication system, for example transmitted twice does not mean double value.

Object description

INDEX	60B2h
Name	Torque offset
Object code	VAR
Data type	Integer 16
Category	Optional

Entry description

Sub-index	00h
Access	rw
PDO mapping	See /CiA402-3/
Range value	Integer 16
Default value	0

7.1.6 Drive parameters

Some debug commands and parameters are added concerning CANopen

Par.	Description	Field	Range	Def.	Ris.
Pr273	**CANOPEN_CTRL_WORD.** Control of drive status.	R	-32768÷+32767	0	1
Pr274	**CANOPEN_STATUS_WORD.** Status of the drive.	R	-32768÷+32767	0	1
Pr275	**ETHERCAT_STATUS_WORD.** Status of the drive.	R	-32768÷+32767	0	1
Pr169	**Position loop resolution selection.** The position loop resolution can be selected by parameter Pr169. Ranging from 4096 to 32768 counts. The parameter change is effective the next time the drive is powered up.	W	4096÷32768	4096	$2^{12\div15}$
Pr227:226	**EtherCAT msk error init (alarm).**	R	-	-	-
Pr229:228	**EtherCAT msk error live (alarm).**	R	-	-	-

8 Alarms

The Parameter Pr23 shows the error message generate from the Parker UNICO external control.

9 Revision history of the User Manual

- Rev 0 – 2011
  First edition
- Rev 0.1 – 2012
  CANopen DS402 opm202
- Rev 0.2 – 2013 February
  CANopen

For other informations log into website www.parker-eme.com. *Arranges to the manual data can be made by the manufacturer without advance notice. The data shown in the manual correspond to the specifications relating to the revision date*

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Ed. 2011-03-03

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