PDC MAIN POWER SUPPLY UNITS
NCT ELECTRONICS UNITS

INSTALLATION DOCUMENTATION

TABLE OF CONTENTS

VERSION HISTORY

Version number	Name	Description
100	BT	Preliminary version
101	BS	Power supply unit specification

INTRODUCTION

This installation manual gives information about mechanical and electrical data of the compact main power supply units of the NCT servo system, electrical connections required for operation, and recommendations to their use.

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NCT Ipari Elektronikai Kft.

1 IDENTIFICATION

Type name: PDC-3-40-25(-R)

Cooler: Típus

Egyéb info.

Other information:

Type marking of the NCT EtherCAT servo amplifiers

P_C-3-40-25-R

- NCT EtherCAT servo amplifier

  PDC *– main power supply unit*

  with resistive braking

  PRC *– main power supply unit*

  with regenerative function

- Three-phase mains supply
- Rated mains voltage
- Rated DC bus output current

  25 *– 25* A_{RMS}

  80 *– 80* A_{RMS}

- EtherCAT head unit

  RJ45 UTP + LVDS

* *Not yet available*

2 CONSTRUCTION

2.1 Structure of the NCT drive system

There is no rectifier block in the servo amplifiers of the NCT drive system however the same separate power supply unit provides all the servo amplifiers with the energy. A DC bus carrying the rectified current connects the power supply unit to the servo amplifier units. The depth of the modules is the same and all electrical connections are located on or near the front panel, so they can be installed in a row and produce an aesthetic, clear, easy-to-cable system. The order of the modules is arbitrary; they can be arranged in several rows. The direct mains supply and modular structure characterising the NCT drive systems simplify electrical design, creating the mains supply input and any subsequent supplement or replacement of modules.

2.2 PxC … power supply units

The most important function of the main power supply units is to supply power to the servo amplifiers. Servo amplifiers require a DC voltage at their input, which can vary only slightly depending on the load. The rectified voltage of the three-phase mains is displayed directly at the output of the DC bus of the power supplies; the ripple rectified voltage is almost completely smoothed out by the capacitors on the DC bus. The value of the voltage on the DC bus is basically determined by the line voltage of the mains and the voltage across the mains choke. The function of the mains choke is to reduce the harmonic content of the current drawn from the mains. The power supply units have a soft start system that switches on and off depending on the DC bus voltage. The on and off voltage is different. If the bus voltage is less than half the nominal value, the soft start is switched on, if the bus voltage value rises above 80% of the nominal value, the soft start is switched off. Without a soft start, the overcurrent protection in front of the power supply at the moment of power-up would trip immediately.

Every drive system has an operating condition (brake mode) in which power flows from the motor to the main power supply unit. The PDC … power supply units, through resistors, can convert this power into heat. Since there is no built-in brake resistor in the PDC ... power supply units, external brake resistor has to be connected to it. The PRC … power supply units recuperate the excess power generated to the mains through a choke coil which is an essential element of the recuperation.

There is a design of the power supply units that provides servo amplifiers of the drive system with supply voltage of 24 V_{DC} and industrial communication channel (EtherCat) through a flexible flat cable. In the case of this design, there are two RJ45 connectors (X1 and X2) on the front panel, and a flexible flat cable connector (X4) at the top of the box. At the end of the type name, there is a letter R (PDC ... -R) referring to this design.

2.3 Compact mechanical design

The drive boxes can be placed side by side directly; it is not necessary to keep a distance between the units. It is a space-saving, easy-to-assemble and cost effective solution.

For mounting, the mounting tab can be placed in two different ways – for slotted mounting plate technique and normal assembly technology.

2.4 Cooling from outside

More intensive cooling and higher available power. Separated electronics, minimal dirt, longer life and maintenance-free operation. Temperature dependent fan control, energy-saving solution, there is no overcooling, longer life. Heat is produced outside the cabinet, no heat in the electric cabinet, energy-saving solution.

2.5 Chainable auxiliary supply voltage and EtherCAT LVDS

In order to decrease cabling and costs, the EtherCAT connection to the NCT control can also be realized by settling the industrial Ethernet connector (RJ45) only on the power supply unit, and by stringing the drives into an LVDS channel using flexible flat cable.

Furthermore, the auxiliary supply voltage is linked using the same cable. Thus, the auxiliary supply voltage has to be input in a compact drive group at one place only, or, if the main power supply unit provides auxiliary supply voltage due to its construction, such cable design will not be necessary at all. The drives get the supply voltage for their operation through the chaining cable.

2.6 Hidden bus design

A pair of buses sunk into the front panel is used to provide high-voltage power supply for the drive modules. After simple removing the plastic shock-proof protection front panel, any of the units can be taken out from the drive row by swinging out the bus elements without dismantling them.

3 TECHNICAL DATA

3.1 Rated values of the PDC-3-40-25(-R) power supply unit

Description	Value
Input voltage (in case of the PDC-3-23-25)	3×400 V_{AC} (3×230 V_{AC})
Input current	3×20 A_{eff}
Output voltage	540 V_{DC}
Loadability	25 A_{DC}
Ambient temperature	0 ~ 45 °C
Protection class	IP20
Heat production	60 W
Weight	5.7 kg
Current consumption of the auxiliary power supply unit (PDC 3-40-25)	350 mA
Current consumption of the auxiliary power supply unit (PDC 3-40-25-R)	400 mA
Maximum rated loadability of the input of the auxiliary power supply unit with connected LVDS units	2.6 A
Recommended external braking resistor	FZG 400×65-22

3.2 Maximum absolute ratings of the PDC-3-40-25 power supply unit

Description	Minimum	Maximum
Limit values of the DC high voltage	10 V_{DC}	750 V_{DC}
Short-time (20ms) current consumption of the DC high-voltage input	1 A_{DC}	50 A_{DC}
DC auxiliary supply voltage	15 V_{DC}	30 V_{DC}
Short-time (20ms) current consumption of the input of the auxiliary power supply unit with connected LVDS units	0.35 A_{DC}	5 A_{DC}
Ambient temperature	–5 °C	55 °C
Relative humidity		60%

3.3 Safety precautions

Only person who knows general rules for electric safety and is properly trained is allowed to carry out commissioning, inspection, repair and maintenance of the servo drives marketed by the NCT Kft. In addition, this person has to know all the dangers of the given equipment and all the rules of avoidance of accident. The person working on the electric equipment is not only responsible for his/her own physical integrity, but he/she has to prevent other person for being exposed to danger.

3.3.1 Protection against shock hazard

Commissioning, repair and maintenance of the servo drives marketed by the NCT Kft. has to always be carried out in accordance with the standard MSZ HD 60364-4-41:2007.

The metal case of the PDC … power supply units have to always be connected to the protective conductor by the use of a wire of specified thickness. Applying a voltage higher than the extra-low voltage to the PDC … power supply units is allowed only in the case if they are properly connected to the protective conductor. Only wires with undamaged insulation, undamaged connecting counterparts without cracks and core end sleeves with insulating shrouds have to be used during commissioning the PDC … power supply units. When the PDC … power supply units are purchased, their DC bus terminals can be touched freely; however, after installation of the servo amplifiers, inaccessibility of these terminals has to be ensured. While the DC bus terminals can be touched freely, it is forbidden to apply voltage to the drive system. High-capacity capacitors connected to the DC bus retain the charge stored on them for a long time even after disconnection from the mains. If, for any reason, it is needed to handle PDC … power supply units, always make sure that the voltage of the DC bus has already decreased to zero.

3.3.2 Hot surfaces

The PDC … power supply units produce heat during operation, and this heat warms them and their surroundings as well. During operation, the PDC … power supply units can heat up to such a high temperature that they can cause burns by touching them; especially the heat-transferring surfaces can become extremely hot. Always make sure whether the temperature of the surface to be touched can cause burn.

3.3.3 Avoidance of overheating

During operation, the PDC … power supply units produce heat, which heats themselves and their surroundings. If the heat produced cannot escape from the device with sufficient intensity, the device will overheat. One of the most important aspects of installation is to avoid this case. Installation steps are described in section 4.5.

3.3.4 Prevention of accidents

On the PDC … power supply units, there are live points that might be touched. For this reason, such installation place has to be selected where it is not possible to access to the PDC … power supply units under normal circumstances. The most commonly used solution is building them in the switching cabinet.

The PDC … power supply units themselves are protected in accordance with the IP00 class, and they will have the IP20 class protection only after mounting protective cover over the DC buses.

3.3.5 Protection against hazardous agents

The PDC … power supply units – like other electronic devices – are sensitive to various contaminating agents and moisture. Certainly, it is necessary to avoid entering water and several stable and liquid materials into the power supply units. Similarly, it is necessary to prevent air contaminated with coolant, oil spray, graphite dust and sawdust etc., or humid air from entering the inner space of the device.

If the PDC … power supply units are operated in a room where the air is not clean properly, protection of the devices has to be ensured. When you provide properly clean environment, do not forget heat generated a part of which has to be delivered away by the air surrounding the drive. Nowadays, the switching cabinet with heat exchanger or the cabinet air-conditioned and sealed seems to be the best solution.

3.4 Requirements on the high-current AC input

Rated loadability of the input is 3×400 V_{DC} and 20 A_{RMS}. To ensure this, 3×4 mm^2 cross-section wiring must be used. This size can also be connected to the input connector.

A short-term (1 second) loss of the mains supply or a short phase loss of it does not necessarily lead to a loss of readiness.

3.5 Requirements on furnishing with auxiliary supply voltage

During normal operation of the power supply with rated voltage of 24 V_{DC}, the voltage must not fall below the level of 18 V_{DC} even for a short time. This can lead to unsteady operation of the power supply unit and occasional drive units (with PxC …- R EtherCat head unit) strung together with the LVDS flexible flat cable. And, the voltage must not exceed the level of 28 V_{DC} continuously. Short-term overvoltage protection is built into the system.

3.6 Life time

4 MECHANICAL INSTALLATION

4.1 EtherCAT communication by the use of RJ45 UTP cable

Connection to the power supply headcard modules by the use of industrial UTP cable is realized in the well-proven way, as we are used to do on older drive types. The upper connector is OUT and the lower connector is IN.

4.2 Chaining by the use of LVDS flexible flat cable

If the drives are connected to each other by the use of flexible flat cable, this can be done using 20-core flexible flat cable in the following way: a longer flexible flat cable is required between the power supply headcard and the first drive, and a shorter one between two drives. The flexible flat cables have to be pushed into a 20-pin flexible flat cable connector so that the positioning extensions of both connectors face in the same direction, and then they have to be folded back by the use of a crinkle preventer.

Not only the EtherCAT communication, but also the 24 V auxiliary supply voltage of all units is connected to one another on the flexible flat cable. That is why it is enough to connect the 24 V_{DC} auxiliary supply voltage to only one unit of the block on a chained block.

Figure 1 The LVDS flexible flat cable chaining

The following cable length has to be cut for connection:

- Long cable: 115 mm
- Short cable: 87 mm

The connection can be realized int he manner illustrated in Figure 2. The power supply unit has to be placed at the left end of the row so that the order is proper in the EtherCAT.

4.3 High-current bus chaining

Chaining can be realized by the use of plastic element and copper parts made especially for this purpose. Two drives can be chained to one another by the use of handle-shaped copper forms length of which is identical for each drive size. The bus element is adjusted to the width of the drive.

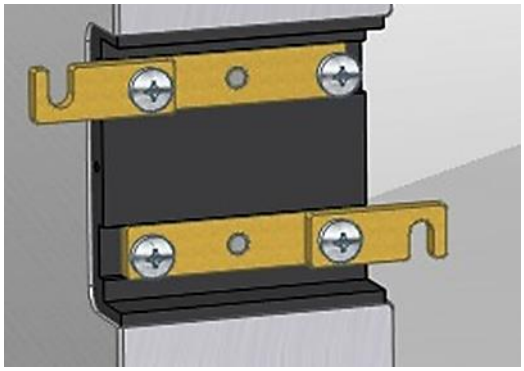


Figure 2 DC bus clenches

The clenches have to be placed onto the DC bus element as shown in the picture. In this arrangement, when the screws are being tightened, the clenches turn onto the screws. In the case of other arrangements, the clenches may slide off the scews. It is recommended to assemble the buses by the use of the specified screws. In the case, when such screws are not available, the assembly can be carried out by the use of M5×15 D cross recessed head screws, but it is absolutely necessary to use a plain washer and a spring washer. However, the washers may hinder the clenches from turning.

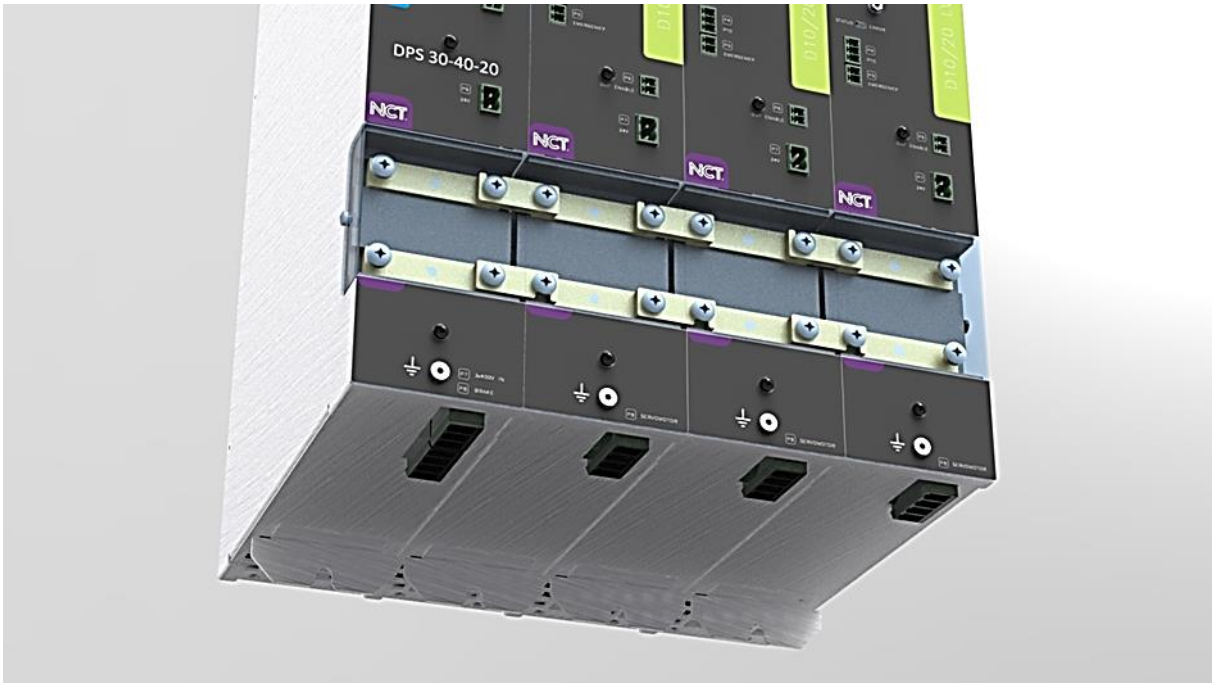


Figure 3 High-current outlets

4.4 Mounting

The PDC … power supply units have to be mounted on a steel plate at least 3 mm thick using two M5 screws. The mounting holes have to be located as shown in the following figure (for other connected servo amplifiers, this may be different).

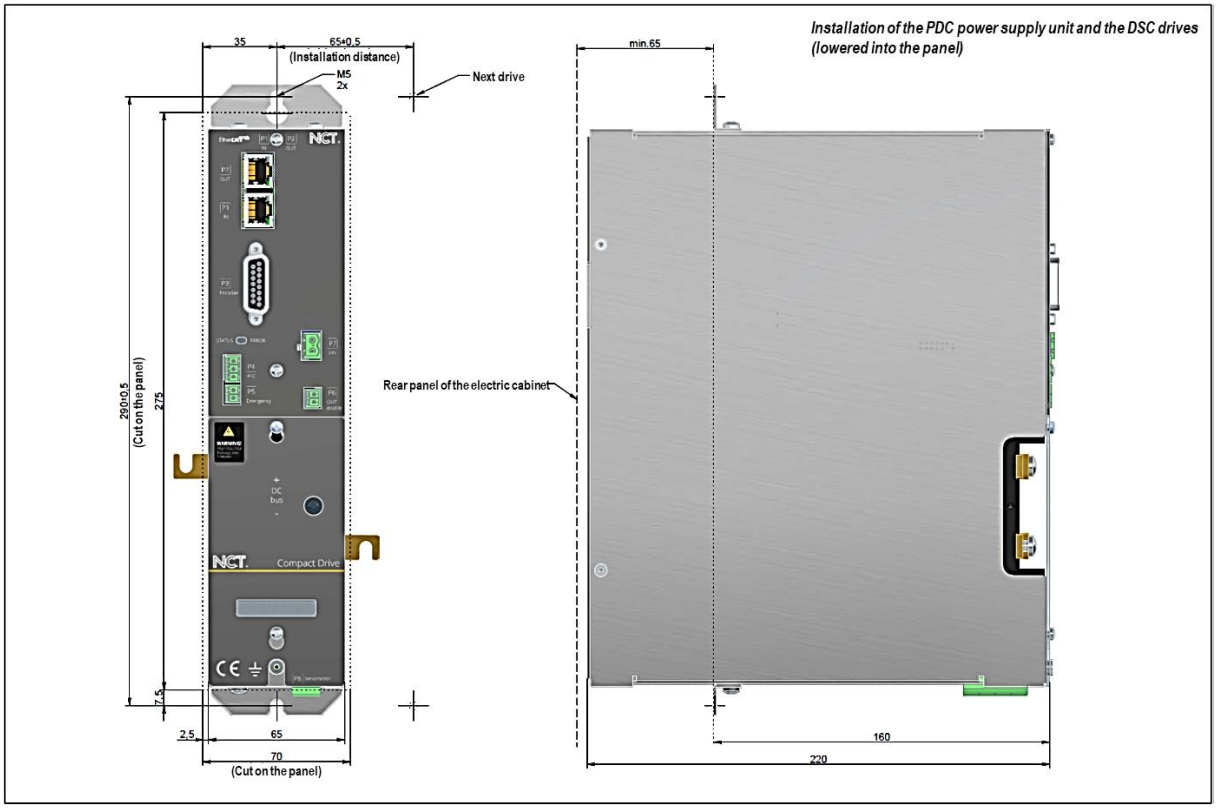


Figure 4 Mounting dimensions of the PDC power supply units

Mounting tabs have to be used for clamping the power supply unit. The lower and the upper mounting tabs are different. The upper mounting tabs have a keyhole design for M5 pan head screw (it is recommended to use torx pan head screw). The power supply units are delivered together with one upper tab (article number is 00-65028676-30), with one lower tab (article number is 00-65028677-30) and four M4×8 screws with reduced shaft (article number is 00-65035113-10). Before mounting, the lower and upper tabs have to be clamped to the unit.

The mounting tabs can be mounted on the side of the drive in two different manners.

If the intension is to install the power supply units in a cabinet in a standard manner, the tabs have to be mounted at the very rear position.

If the intension is to install the power supply units by the use of slotted mounting plate technique in order to exclude heat of the power cascades from the closed interior of the cabinet, the tabs have to be mounted in front of the perforated cooling grill.

4.5 Heat removal

If the design of the control cabinet allows, these units shall be installed in a closed electric cabinet so that the part of the power supply containing the electronic components is in contact

with the clean air of the electric cabinet and the cooling rib transmitting the greater part of the heat generated is located outside the electric cabinet.

The heat energy derived from dissipation of high-power rectifier module and the IGBT brake unit module as semiconductors and from the choke coil is confined in a heat channel at the rear part of the box. By relocating the mounting tabs and building in the slotted mounting plate, this heat channel goes into the heat removal channel being outside the cabinet. The intermediate room is a semi-enclosed chamber equipped with an air filter and usually a fan, and separated from the workshop space. In the case of this mounting mode, the tabs have to be clamped in the intermediate position, and, in accordance with the drawings, a hole has to be cut on the rear panel of the electric cabinet; the unit has to be got through this hole. The advantage of this solution is that only a small proportion of the heat produced by the power supply unit warms up the interior of the electric cabinet; the considerable proportion of the heat generated is kept out, and using air-conditioner or heat exchanger is not required provided that it is not required by any other unit built in the electric cabinet.

It is only the air flowing freely that carries out cooling in the rear space of the drive box until threshold temperature is reached; when the threshold temperature is reached, the cooling fan turns on. The flow rate of the fan can be adjusted in several stages depending on the temperature; thus, life time of the fan and consequently the drive extends. In addition, the fan blows the air to the cooling rib only; therefore the possible impurity included in the air does not enter the electronics where it can cause failure. Contamination can cause the drive to indicate overheat error, which can be corrected by a simple cleaning or replacement of the air filter.

If this mounting method is not feasible, the tabs have to be attached to the rear position and thus the units have to be clamped to the mounting plate.

Other equipment has to also be protected from the heat generated by the power supply units. It is not recommended to install heat-sensitive electronic equipment (NC control, other drive, etc.) above the power supply units.

It is very important to clean or replace the filters on the cabinet at specified intervals.

When using a heat exchanger, the characteristics of the given type of heat exchanger and its location in the cabinet have to be taken into account, and the various heat generating units in the cabinet have to be placed on this basis.

5 ELECTRICAL INSTALLATION

During electrical installation, safety instructions have to always be observed, and they have to be taken into account during design.

5.1 High-current connections

5.1.1 Grounding lug

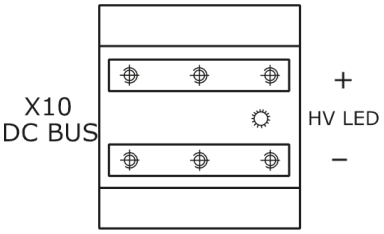
The housing of the power supply units has to be connected to the guard wire; for this, on the metal cover of each device, there is a connecting point marked with generally accepted grounding symbol. The cross-section of the guard wire and the cross-section of the mains wire of the power supply unit have to be the same.

At the bottom of the front panel, there is the connection point, where the lugged cable can be connected to using an M5x10 screw. The cable cross-section has to be at least 4 mm^2.

5.1.2 DC bus

The power supply unit and servo amplifier units are connected to one another by the DC bus carrying the rectified current. The connection can be made properly if the mounting holes of the power supply unit and servo amplifiers are positioned as specified in subchapter 4.4.

Connection has to be made in the following way:



On the power supply unit and servo amplifiers next to it, the screws fixing the front plate of the DC bus (with the label DC bus) have to be loosed and then the plate has to be removed. This gives access to the DC bus connection. For each delivered unit, two movable copper rails are screwed to the DC bus connection. Screws fixing them have to be loosened (T25 Torx screwdriver is needed), then the rails have to be turned to the next unit and hooked under the screw there; it has to be done for each adjacent units and then the fixing screws have to be retighten. Finally, the DC bus front plates have to be put back in their place and fixed. (For units on the edges, typically such a power supply unit, a movable copper rail becomes redundant.) There are two side blocking elements with the article number 00-65028543-00 in the package delivered; they have to be attached to the DC bus connection of the units on the edge to completely prevent access to the DC bus. See Figure 2 DC bus clenches and Figure 3 High-current outlets.

If it is not possible to place the units in a line, for example, if the drives to be supplied are arranged in several rows, copper cable with ring terminal crimping lug can also be used. The cross-section of the copper cable must be at least the same as the cross-section of mains wire of the power supply unit. With such a connection, the cables must not approach signal wires closer than 10 cm. For longer connections, a high-current shielded cable with grounded shielding at both ends is recommended.

There is a dangerous voltage on the DC bus, even for a few minutes after the power supply unit has been disconnected from the mains. The presence of dangerous voltage is indicated by the LED light behind the DC bus front panel above the “CHARGE” label. Due to the hazardous voltage, the units may only be connected to the mains if all the front panels and side blocking elements of the DC bus are properly fixed.

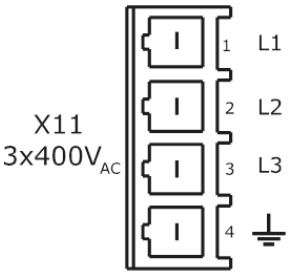
5.1.3 Three-phase input

Connector marking: X11

Manufacturer of the connector: Phoenix Contact

Type by the manufacturer: PC 4/4-G-7.62

Type of the counterpart: PC 4/4-ST-7.62



The PDC … power supply unit has to be installed after the overcurrent protection device. The cross-section of the phase conductors of the mains cable has to be specified in accordance with the standard MSZ EN 60204-1:2010. The cross-section of the protective conductor must match the cross-section of the phase conductors. A wire of up to 4 mm^2 can be connected to the counterpart.

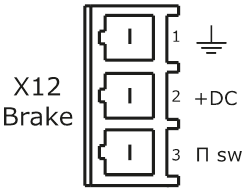
5.1.4 Brake resistor output

Connector marking: X12

Manufacturer of the connector: PHOENIX CONTACT

Type by the manufacturer: PC 4/3-G-7.62

Type of the counterpart: PC 4/3-ST-7.62



A wire of up to 4 mm^2 can be connected to the counterpart.

The cross-section of the wire of the external brake resistor has to be specified in accordance with the standard MSZ EN 60204-1:2010, based on the consumed current.

In order to decrease emitted electromagnetic interference, the wires have to be shielded; the shield has to be connected to the protective grounding potential galvanically at both ends.

5.2 Low-current connections

Low current connections generally mean 24 V inputs and outputs.

5.2.1 Auxiliary supply voltage input

Connector marking: X31

Auxiliary supply voltage: 24 V_{DC} (+20%, –10%)

It is connected by the use of a 2-pole 5.08 mm pitch connector.

Manufacturer of the connector: Phoenix Contact

Type of the connector: MSTBA 2.5/2-G-5.08

Type of the counterpart: MSTB 2.5/2-ST-5.08

Maximum loadability of the input is 28 V_{DC} and 2.5 A_{DC}, at continuous average load.

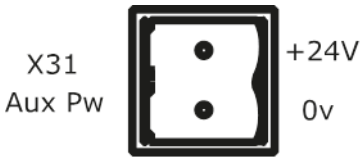


Figure 5 Auxiliary supply voltage input

The PxC … power supply units require an external power source to operate their internal units. In addition, the power supply units also have a design which transmits the 24 V_{DC} supply voltage to the servo amplifiers of the drive system (this design is indicated by the letter R at the end of the type designation). With this design, also the drives chained to the power supply unit using flexible flat cable can be supplied with 24 V_{DC} through the auxiliary supply connector of the PxC … power supply unit. When determining the number of servo amplifiers that can be chained after the PxC ...- R power supply, the following condition must be met: the sum of the current consumed by the power supply unit and the combined current consumption of the chained drives must not exceed the maximum current consumption allowed for the auxiliary supply unit of of the power supply unit.

(An example: There are one PDC 3-40-25-R and five DSC 20/40-LE units. The current consumption through the 24 V_{DC} auxiliary supply unit connector is as follows: 0.4 A+5·0.44 A=2.6 A. Thus, this is a proper configuration).

5.2.2 Contactor enable input

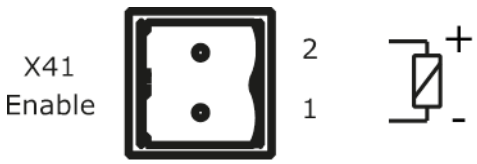
Connectable voltage: 24 V_{DC} (+20%, –10%) (point 1: 0 V, point 2: +24 V)

Manufacturer of the connector: Phoenix Contact

Type of the connector: MSTBA 2.5/2-G-5.08

Type of the counterpart: MSTB 2.5/2-ST-5.08

The input is a voltage operating the coil of a non-polarity sensitive relay. The value of the voltage is 18 ~ 28 V_{DC}, the power consumption is 200 mW.



In the PDC power supply units, there is an electronic switch between the mains connector and the DC bus. Until this electronic switch pulls, no voltage appears on the DC bus. (However, following the release of the electronic switch, there will be voltage on the DC bus yet for a few minutes.) In the operating circuit, contacts of two relays are connected in series. One of the relays is controlled by the software of PDC … power supply unit, the other relay can be switched on and off through the Contactor Enable connection. So, actually, the operating coil of a 24 V_{DC} relay connects to the Contactor Enable connection. When 24 V_{DC} voltage is applied here, the relay will pull. And, when no voltage is applied here, the relay will not pull, so the electronic switch will not be able to pull either, thus no voltage can appear on the DC bus. Therefore, it is not necessary to install a magnetic switch in front of the power supply units but they can be connected directly (more precisely, through an overcurrent protection device) to the mains.

5.2.3 Availability output

Connector marking: X42

Maximum current flowing through the contact poles: 0.5 A_{AC} (250 V_{AC}) and 1 A_{DC} (30 V_{DC})

Maximum voltage allowed at the contact poles: 30 V_{DC} vagy 250 V_{AC}

Manufacturer of the connector: Phoenix Contact

Type of the connector: MSTBA 2.5/2-G-5.08

Type of the counterpart: MSTB 2.5/2-ST-5.08

The output is a non-polarity sensitive relay contact.

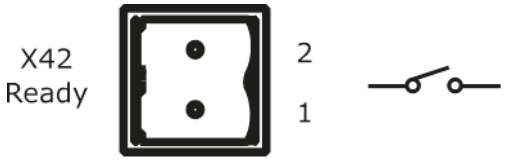


Figure 6 Availability output

The main power supply availability signal means a single contact controlled electrically. If the power supply unit is able to function properly, this contact is closed (0 ohm), so the unit is ready to operate. If, for some reason, the device cannot work properly or the soft start works, this contact is open (break), so the unit is not operational. The power supply unit cannot be loaded until it is ready to operate.

5.3 Headcard communication unit

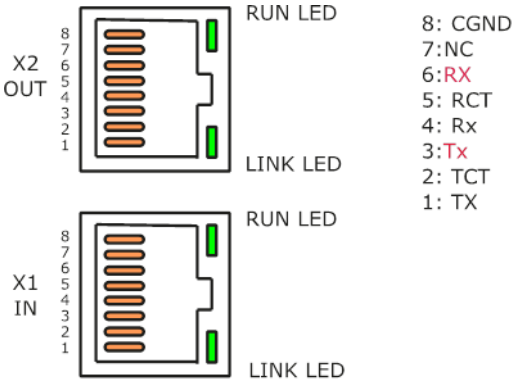
5.3.1 RJ45 UTP connection

Manufacturer of the connector: Amphenol

Type of the connector: LMJ2018813130DL3T1

Type of the counterpart: Harting

Manufacturer of the counterpart: 09 45 151 1100



Connector markings: X1 (lower) IN, X2 (upper) OUT

The two RJ45 connectors are not an integral part of the PxC …- R power supply units, they are not necessary for operation of the units; only the cabling of the entire drive system is simplified with this solution. The RJ45 connection must be used if you want to connect servo amplifiers chained with flexible flat cable after the PxC …- R power supply, to the EtherCat network.

In this case, it can be seen on the EtherCAT setting interface as (drive head) servo headunit.

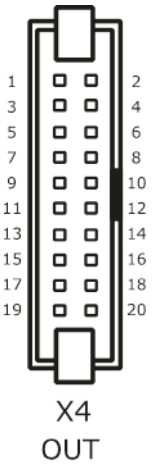
5.3.2 EtherCAT LVDS flexible flat cable

Manufacturer of the connector: E-tec

Type of the connector: PSL20W

Type of the counterpart: IDS-020-S100-01/P

Connector marking: X4 OUT



It also is not an integral part of the PxC …- R power supply units, they are not necessary for operation of the units; only the cabling of the entire drive system is simplified with this solution. In the delivered package of the PxC … power supply unit, there is one PxC to DxC LVDS flexible flat cable (article number is 30-00000229-00) for connecting the PxC …- R power supply unit to the subsequent DxC … servo amplifier. (And similarly, additional DxC … servo amplifiers also can be chained using 'DxC to DxC LVDS flexible flat cable' (article number is 30-00000230-00). Through these flexible flat cables, the power supply unit provides the DxC … servo amplifiers with 24 V_{DC} supply voltage and LVDS signals of the EtherCAT industrial communication channel.

The units can be chained only in the way that the PxC … main power supply unit is at the far left side of the flexible flat cable and the drive units chained to the right next to it in descending order of power.

5.4 Indicating the status and the error of the main power supply units

There is a 7-segment display on the PxC …power supply units giving information about the status of the unit even if the unit is operating properly and even if it is in a fault condition. When the unit receives the 24 V_{DC} supply voltage, the decimal point of the 7-segment display will flash continuously at the current character, in any operating mode.

The operational states are indicated continuously by illuminating codes, with the slight exception of the indication during braking, because it is actually discontinuous, as it is only visible during the operation of the brake resistor. Each error indication code flashes at the same rate as the decimal point.

5.4.1 Codes of status indication

- Illuminating dot: It indicates operation and availability of the power supply unit. If the dot stops flashing, the power supply unit is inoperable.
- Code L: If the Contactor enable input on the power supply unit is activated, but the 3×400V_{AC} (or 3×230V_{AC}) voltage is not applied at the high-voltage input, this status code will indicate that the soft start operation has not yet begun.
- Code C: If the Contactor enable input on the power supply unit is activated, and the high voltage is also applied at the input, the soft start operation will begin. This code can be seen throughout the operation.
- Code 1 or 2: When the soft start terminates, the operational readiness and the normal operation will be indicated by the code 1 or 2. The code 1 indicates the voltage 3×400 V_{AC} at the input (it is software-dependent), the code 2 indicates the voltage 3×230 V_{AC}.
- Code 8 or B: Both codes seem to be the same on the display. (Brake) This code illuminates intermittently throughout the braking.

5.4.2 Codes of error status indication

- Code P: IGBT transistor error
- Code H: Cooling rib overheating error
- Code F: DC bus overvoltage error
- Code ≡ or || line: Soft start error

6 FUNCTIONING OF AND ACTUATING THE POWER SUPPLY UNIT

6.1 Normal operation with the PDC 3-40-25 power supply unit

When 24 V_{DC} voltage is applied to the auxiliary power supply connector of a properly operating PDC …power supply unit, its internal control processor begins to work after the 24 V auxiliary supply voltage has arrived. It tests its internal hardware environment and, if it finds everything fine, waits in default position. A flashing decimal point can be seen on the 7-segment display. The 3×400 V_{AC} voltage can already be there at the high-current and high-voltage input of the main power supply unit. If the 24 V_{DC} voltage is applied to the Contactor enable input too, on the 7-segment display a letter C will appear indicating that the process of the soft start has begun. (During the process of the soft start, the PDC … power supply unit is not ready to operate yet.) If, through the mains connector, the PDC … power supply unit is connected to the three-phase mains, the process of the soft start will pass off in some seconds. The capacitors on the high-voltage DC bus will be charged; some of the capacitors are in the power supply unit, the others are in the drive units. During the process of the soft start, load must not be on the DC bus, i.e. all the drive units must be in disabled state. If the power supply unit detects overload, it interrupts the process of the soft start, returns to the initial state with an error indication and switches off the high-voltage from the DC bus. If the soft start has finished successfully, i.e. the rectified voltage of the three-phase mains appears between the poles of the DC bus, the letter C on the 7-segment display changes to the character indicating the operational readiness status, and the unit becomes ready to operate; the operational readiness output (Ready) of the power supply unit, which is a contact, changes to be of closed status. In case of any error and in default position, this contact is of open status. The servo amplifiers connected to the DC bus can now load the PDC … power supply unit.

The characters indicating operational readiness status of the PDC … power supply unit are the following:

- 1 – in the case of 3×400 V mains;
- 2 – in the case of 3×230 V mains.

If, through the signal of operational readiness (Ready), the PDC … power supply unit enables the consumption, it will attempt to maintain the readiness status until a fault occurs or the DC bus voltage drops below 50% of the rated value. In the event of a short-term mains failure, the power supply unit will not lose its operational readiness. When the DC bus voltage drops below 50% of the rated value, the 7-segment display returns to indicate either the letter C (if there is still voltage at the Contactor Enable connector) or only the flashing decimal point (if the voltage has been removed from the Contactor Enable connector) or a character associated with an error message (if the unit has lost operational readiness due to a malfunction).

The PDC … power supply unit monitors the DC bus voltage continuously, and when the voltage reaches the value of 680 V, it connects the external brake resistor to the DC bus. When the resistance brake operates, all the segments of the 7-segment display flash (usually for a very short time; this may not be noticeable).

6.2 Managing the errors

6.2.1 P – IGBT error

In the PDC … power supply units, discrete IGBT switches the DC bus voltage to the external brake resistor. The discrete IGBT is short-circuit protected. We speak of an IGBT fault when this short-circuit protection is activated. This fault causes immediate loss of operational readiness. If an IGBT error occurs, the power supply unit is most likely damaged.

6.2.2 H – Cooling rib overheating error

When the cooling rib of the PDC … power supply unit approaches the temperature that causes failure, an error will be generated. In this case, the power supply unit immediately ceases the operational readiness. If the cooling rib overheating fault occurs several times, it is highly likely that one of the components is not properly designed.

6.2.3 F – DC bus overvoltage error

Units connected to the DC bus may be damaged when its voltage exceeds the value of 800 V. For this reason, a voltage monitoring system is built in, which generates an error when the DC bus voltage exceeds the value of 780 V. This fault causes immediate loss of operational readiness. If the DC bus overvoltage fault occurs several times, the unit may be suspected of malfunction or incorrect design.

6.2.4 Soft start error

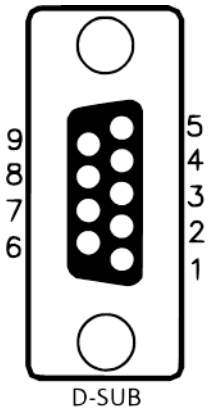
During soft start, the DC bus capacitor block is charged through resistors. To protect these resistors, two types of fault monitoring have been built in. One comes into action when it detects a load current through the DC bus during soft start, then immediately interrupts the soft start process and lights all the vertical segments of the 7-segment display. The other comes into action when it detects a short circuit on the DC bus, then immediately interrupts the soft start process and lights all the horizontal segments of the 7-segment display. (If the voltage is removed from the Contactor Enable input, the software of the unit will re-enable beginning the soft start process after 30 seconds.) This phenomenon is most often caused by an illegal enable of one of the servo amplifiers. Rarely, a real electrical short is there on the DC bus.

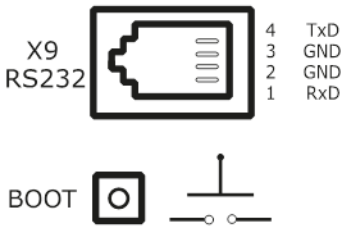
6.3 Upgrading the software

For PDC … power supply units that are already installed, updating the software controlling them may be needed. To update the software, a file with a .hex extension provided by the manufacturer of the PDC … power supply unit is required.

For upgrading, a personal computer and an RS232C interface cable composed of a 9-pin patch cable, a female D-Sub connector and an RJ10 connector (Molex 90075-0027) are required.

Connection is illustrated in the figure below.





9-pin female D-Sub connector	RJ10 connector
2: Transmitter Output (TXD)	1: Receiver Input (RXD)
3: Receiver Input (RXD)	4: Transmitter Output (TXD)
5: Ground (GND)	2,3: Ground (GND)

The current version of the CodeSkin Chip Programmer has to be installed on the personal computer.

The software update procedure is as follows:

In order to make an RJ10 and a pushbutton visible, the upper front panel has to be removed. The personal computer has to be connected to the PDC … power supply unit using the RS232C interface cable (if there is no serial port already, a USB to serial converter cable can be used). It has to be checked that the 24 VDC supply voltage is received by the unit. The counterpart of the auxiliary supply connection has to be disconnected, and then plugged back in while the pushbutton is pressed continuously. In 20 minutes, the pushbutton has to be released.

At this point, all the segments of the 7-segment display are dark except one that gives light faintly.

On the personal computer, the program named CodeSkin Chip Programmer has to be started (usually using the file C2Prog.exe)

On the Target tab, the type of the processor to be programmed has to be selected. To do this, it has to be known that the PDC … power supply units are currently controlled by a TPS320F28027-type processor manufactured by the Texas Instruments. (If this changes, this information will be included with the software to be loaded.) For the CodeSkin Chip Programmer v1.7, the appropriate setting is 28027,23,21.

Then, communication on the RS232 channel has to be selected. It can be done on the Options tab, where the SCI option from the drop-down menu has to be selected; in this case, the Serial will be active automatically.

Pressing the Configure Ports … button, a small window will pop up, in which pressing the Scan Ports, the program will search for the active serial ports

(Serial port: COM1,COM2…).The serial port to which the RS232C interface cable is connected has to be selected. Pressing the OK button, the window disappears.

Pressing the Select File … button, a window will pop up, in which the program to be loaded can be selected. Doing this in the usual way, the CodeSkin Chip Programmer is ready for programming.

The programming process can be started by pressing the Program button. At this moment, a small window will pop up and will start the loading. It is necessary to wait until the OK button becomes active. When it happens, all the windows has to be closed, the RS232C interface cable has to be removed, the upper front panel has to be replaced, and the unit has to be restarted.