

# Power+ Speed drive

## PSD1 Series

**CAREL**



**(ENG)** User manual

**→ LEGGI E CONSERVA  
QUESTE ISTRUZIONI ←**  
**→ READ AND SAVE  
THESE INSTRUCTIONS ←**

**⚠ NO POWER  
& SIGNAL  
CABLES  
TOGETHER**  
**READ CAREFULLY IN THE TEXT!**

H i g h   E f f i c i e n c y   S o l u t i o n s



## WARNINGS



CAREL bases the development of its products on decades of experience in HVAC, on the continuous investments in technological innovations to products, procedures and strict quality processes with in-circuit and functional testing on 100% of its products, and on the most innovative production technology available on the market. CAREL and its subsidiaries nonetheless cannot guarantee that all the aspects of the product and the software included with the product respond to the requirements of the final application, despite the product being developed according to start-of-the-art techniques.

The customer (manufacturer, developer or installer of the final equipment) accepts all liability and risk relating to the configuration of the product in order to reach the expected results in relation to the specific final installation and/or equipment.

CAREL may, based on specific agreements, act as a consultant for the positive commissioning of the final unit/application, however in no case does it accept liability for the correct operation of the final equipment/system.

The CAREL product is a state-of-the-art product, whose operation is specified in the technical documentation supplied with the product or can be downloaded, even prior to purchase, from the website [www.CAREL.com](http://www.CAREL.com).

Each CAREL product, in relation to its advanced level of technology, requires setup / configuration / programming / commissioning to be able to operate in the best possible way for the specific application. The failure to complete such operations, which are required/indicated in the user manual, may cause the final product to malfunction; CAREL accepts no liability in such cases.

Only qualified personnel may install or carry out technical service on the product.

The customer must only use the product in the manner described in the documentation relating to the product.

In addition to observing any further warnings described in this manual, the following warnings must be heeded for all CAREL products:

- Prevent the electronic circuits from getting wet. Rain, humidity and all types of liquids or condensate contain corrosive minerals that may damage the electronic circuits. In any case, the product should be used or stored in environments that comply with the temperature and humidity limits specified in the manual.
- Do not install the device in particularly hot environments. Too high temperatures may reduce the life of electronic devices, damage them and deform or melt the plastic parts. In any case, the product should be used or stored in environments that comply with the temperature and humidity limits specified in the manual.
- Do not attempt to open the device in any way other than described in the manual.
- Do not drop, hit or shake the device, as the internal circuits and mechanisms may be irreparably damaged.
- Do not use corrosive chemicals, solvents or aggressive detergents to clean the device.
- Do not use the product for applications other than those specified in the technical manual.

All of the above suggestions likewise apply to the controllers, serial boards, programming keys or any other accessory in the CAREL product portfolio. CAREL adopts a policy of continual development. Consequently, CAREL reserves the right to make changes and improvements to any product described in this document without prior warning.

The technical specifications shown in the manual may be changed without prior warning.

The liability of CAREL in relation to its products is specified in the CAREL general contract conditions, available on the website [www.CAREL.com](http://www.CAREL.com) and/or by specific agreements with customers; specifically, to the extent where allowed by applicable legislation, in no case will CAREL, its employees or subsidiaries be liable for any lost earnings or sales, losses of data and information, costs of replacement goods or services, damage to things or people, downtime or any direct, indirect, incidental, actual, punitive, exemplary, special or consequential damage of any kind whatsoever, whether contractual, extra-contractual or due to negligence, or any other liabilities deriving from the installation, use or impossibility to use the product, even if CAREL or its subsidiaries are warned of the possibility of such damage.



**WARNING:** separate as much as possible the probe and digital input signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance. Never run power cables (including the electrical panel wiring) and signal cables in the same conduits

## Approval:

the quality and safety of CAREL products are guaranteed by the ISO 9001 certified design and production system, as well as by the and marks.

## DISPOSAL



### INFORMATION FOR USERS ON THE CORRECT HANDLING OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE)

In reference to European Union directive 2002/96/EC issued on 27 January 2003 and the related national legislation, please note that:

- WEEE cannot be disposed of as municipal waste and such waste must be collected and disposed of separately;
- the public or private waste collection systems defined by local legislation must be used. In addition, the equipment can be returned to the distributor at the end of its working life when buying new equipment;
- the equipment may contain hazardous substances: the improper use or incorrect disposal of such may have negative effects on human health and on the environment;
- the symbol (crossed-out wheeled bin) shown on the product or on the packaging and on the instruction sheet indicates that the equipment has been introduced onto the market after 13 August 2005 and that it must be disposed of separately;
- in the event of illegal disposal of electrical and electronic waste, the penalties are specified by local waste disposal legislation.

## SYMBOLS



**Dangerous voltage**



**Caution, hot surface**



**Important:** brings critical subjects regarding use of the product to the user's attention



**Note:** when attention must be given to subjects of relevant importance, in particular regarding practical use of the various product functionality.



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## 1. WARNINGS

### 1.1 General warnings

- The Power+ drive must be fitted by professionally qualified personnel inside of a complete unit or inside of a system as part of a fixed installation, anyway inside a metal enclosure in compliance with prescription 4.3.7 of EN 61800-5-1 Standard.
- The Power+ drive must be installed in TT or TN power supply network and it must be connected permanently downstream of the main distribution board (overvoltage category III).
- This device features dangerous voltages, and consequently failure to observe the instructions contained in this user manual may cause serious harm to people and damage to things.
- The system design, installation, commissioning and maintenance of the drive are operations that are reserved solely for qualified personnel, who understand all of the safety warnings, installation, operating and maintenance instructions contained in this user manual code +0300048EN, available, including prior to purchase, at [www.carel.com](http://www.carel.com), under "Literature".





 Observe all the general and local safety standards concerning installations of high voltage devices, as well as the regulations for the correct use of the personal protective equipment.


 Use this device only for the purposes specified by the manufacturer. Do not make any modifications or replace any components unless recommended by the manufacturer, as these actions may cause fire, electric shock or other damage.


 IP20 drives must be installed in a pollution degree 1 or 2 environment, mounted in a cabinet with IP54 or better.


### 1.2 Fundamental safety rules


Before performing any maintenance work:


-  disconnect Power+ and external control circuits from the power supply, moving the main system switch to "off"; wait at least 5 minutes;
-  always check, using a suitable multimeter, that there is no dangerous voltage across the terminals;
-  always make sure the motor has stopped completely. Motors that are still freely rotating may produce dangerous voltages at the Power+ terminals, even when this is disconnected from the power supply;
-  check the temperature of the heat sink: coming in contact with the heat sink may cause burns.

 When Power+ is connected to the mains, motor terminals U, V, W are live, even if the motor is not running.

 Do not measure insulation resistance or dielectric rigidity directly on Power+, or with Power+ connected.

 The control terminals are isolated from the mains voltage. Nonetheless, the relay outputs may have a dangerous control voltage even when Power+ is not connected to the mains.

 The level of safety provided by the enabling inputs on Power+ (excluding the "Safety Torque Off" input when used in compliance with the standards) is not sufficient in critical applications without adopting further independent safety measures. For all applications where malfunctions may cause serious harm to people and damage to things, the risks must be assessed and additional safety measures adopted

 Ensure correct earthing connections and cable selection as per defined by local legislation or codes. The drive typically have a leakage current of greater than 3.5mA so that a fixed installation to power line is required; furthermore the earth cable must be sufficient to carry the maximum supply fault current which normally will be limited by the fuses or magnetic MCB. Suitably rated fuses or MCB should be fitted in the mains supply to the drive, according to any local legislation or codes.

## 2. INTRODUCTION

Power+ is a drive designed to control compressors with sensorless-brushless permanent magnet (PM) motors (BLDC/BLAC) or asynchronous induction motors. The drives can also be used in some applications with fans and pumps, and consequently the device offers flexible use in the air-conditioning and refrigeration sectors. It is fitted for panel installation or with heat sink outside of the panel. Configuration and programming, as well as the Run/stop controls and speed reference, are managed by a CAREL pCO controller or any controller device via RS485 serial connection using the Modbus® protocol in master mode.

### 2.1 Functions and main features

In summary:

- compact dimensions for assembly in electrical panels;
- operation at ambient temperatures from -20 to 60°C;
- can be installed in residential and industrial environments;
- connection via serial network to Master programmable controller;
- network address can be configured by setting the dipswitches inside to the drive;
- can control various types of compressors;
- safety digital input (Safety Torque Off) when provided;
- dedicated input for PTC thermistor or thermostat to monitor motor overtemperature;
- panel installation or with heat sink outside of the panel installation, to optimize the dissipation of heat inside the electrical panel;
- electrical connections can be made without needing to remove the cover;
- programmable acceleration curve to adapt to the required specifications when starting compressor;
- high switching frequency to limit motor noise;
- detailed information on drive status via numerous read-only variables;
- protection functions for the drive (short-circuit, overcurrent, earth fault, overvoltage and undervoltage on the bus, overtemperature), motor (overtemperature and limitation of current delivered) and system (Safety Torque Off input, communication failure).

### 2.2 Models

The models differ due to power supply and rated output current as well as for type of cooling and for type of installation:

- traditional cooling with air forced finned heatsink.
- coldplate cooling, with plate for coupling to auxiliary cooling circuit devices (not supplied)
- panel installation
- heat sink outside of the panel installation

#### Power supply 200 - 240Vac 50/60Hz single-phase

Code	Rated output current (A)	Cooling mode	Frame size
PSD101021A PSD10102BA PSD10102DA	10	Air forced heatsink; Coldplate; Coldplate w/o cooling adapter;	220x148x168 220x148x93 220x148x87
PSD1012200 PSD10122A0	12	Air forced heatsink; Coldplate;	268x173x168 268x173x98
PSD1016200 PSD10162A0	16	Air forced heatsink; Coldplate;	268x173x168 268x173x98
PSD1D042BA10 PSD1D062BA10 PSD1D102BA10	3,6 6 10	Coldplate	220x198x43

Tab. 2.a

#### Power supply 380 - 280Vac 40/60Hz three-phase

Code	Rated output current (A)	Cooling mode	Frame size
PSD1018400 PSD10184A0	18	Air forced heatsink; Coldplate;	268x173x168 268x173x98
PSD1024400 PSD10244A0	24	Air forced heatsink; Coldplate;	268x173x168 268x173x98
PSD1035420 PSD10354T0 PSD10354C0	35	Panel - air forced heatsink; Outside panel - air forced heatsink ; Coldplate;	354x204x179 354x204x179 354x204x98
PSD1040420 PSD10404T0 PSD10404C0	40	Panel - air forced heatsink; Outside panel - air forced heatsink; Coldplate;	354x204x179 354x204x179 354x204x98

Tab. 2.b

For the dimensions see the related paragraphs "Dimensions"

For Power+ Coldplate models see also the related paragraphs "Power+ Coldplate models"

### 2.3 Accessories

Please, pay attention to the label on the cover of inverter. In the bottom-right, it is possible to read the product review (Rev.):



Fig. 2.a

Depending of the product review, you have to couple the following chokes:

Inverter	Review	Code
PSD10184**	1.112 and previous	PSACH10200
PSD10184**	1.213 and followers	PSACH10100
PSD10244**	any	PSACH10200

Tab. 2.a

### 3. INSTALLATION

**Important:** avoid installing the drive in environments with the following characteristics:

- relative humidity higher than 95% or with condensation;
- strong vibrations or knocks;
- exposure to water sprays;
- exposure to aggressive and polluting atmospheres (e.g.: sulphur and ammonia fumes, saline mist, smoke) to avoid corrosion and/or oxidation;
- strong magnetic and/or radio frequency interference (thus avoid installation near transmitting antennae);
- exposure of the drive to direct sunlight and the elements in general.

#### 3.1 230V 10A Models

##### 3.1.1 Identification

Power+ is identified by a rating plate located on the front of the device, which describes the code, serial number, production date and revision number.

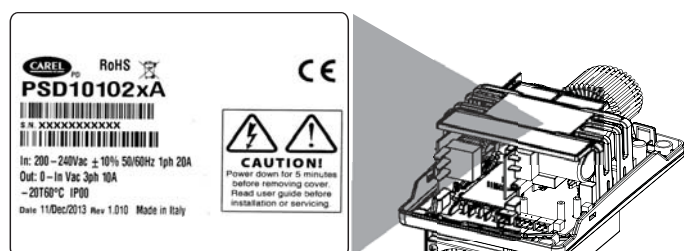


Fig. 3.a

##### 3.1.2 Structure

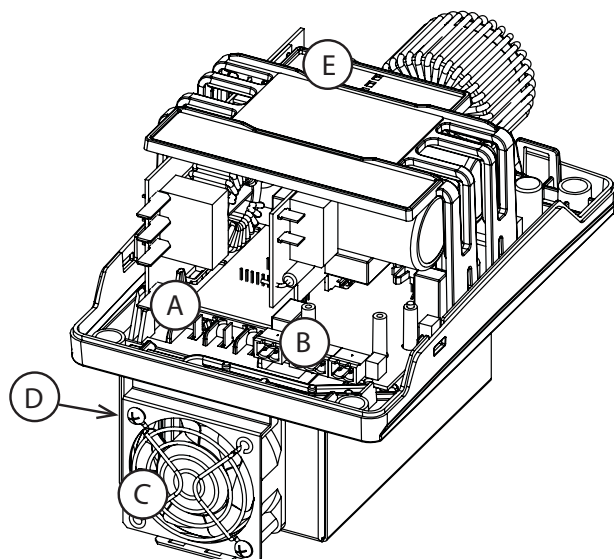


Fig. 3.b

Ref.	Description
A	Male faston for power connections
B	Terminal block for control connections
C	Cooling fan
D	PE
E	Operating status LED

Tab. 3.a

##### 3.1.3 Dimensions

The overall dimensions of the drive vary based on cooling system (size 1 for models with forced air cooled finned heatsink, size 2 for Coldplate models with cooling adapter and size 3 for Coldplate models without cooling adapter) and the type of assembly (panel or with heat sink outside of the panel, see the paragraph on "Drilling and assembly").

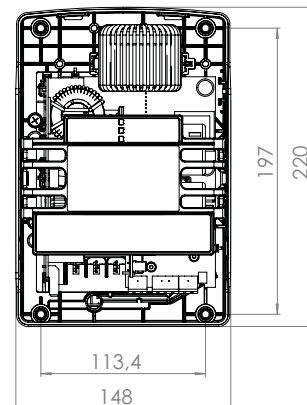
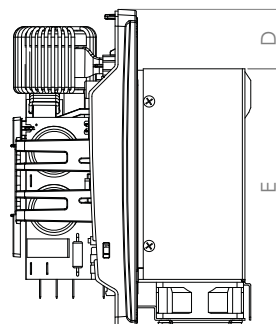
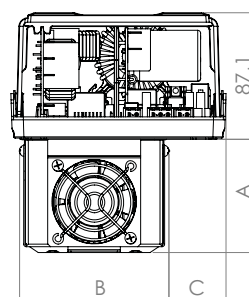


Fig. 3.c

Model	Size	Dimensions (mm)					Weight (kg)
		A	B	C	D	E	
PSD101021A	1	78	102.8	39.3	40.9	177.6	2.7
PSD10102BA	2	6	138	5	6	209.5	1.8
PSD10102DA	3	-	-	-	-	-	1.3
PSD1D042BA10	2	-	-	-	-	-	-
PSD1D062BA10	2	6	138	5	6	209.5	1.8
PSD1D102BA10	2	-	-	-	-	-	-

Tab. 3.b

### 3.1.4 Drilling and assembly

For installation with the heat sink outside of the panel, make a hole with dimensions of the dashed rectangle, where the heat sink will be fitted, and holes for fastening the brackets. These are inserted in the slots located in the plastic base.

For panel installation, refer to the following procedure:

- bend down the tab metal sheet on the bottom of the carter (detail "A");
- use the holes on the upper side of the carter to hang the drive on the panel by using the two screws previously fitted to the panel (detail "B");
- fix the bottom side of the drive to the panel with a screw through the hole on the tab metal sheet previously folded

Installation with heat sink outside of the panel

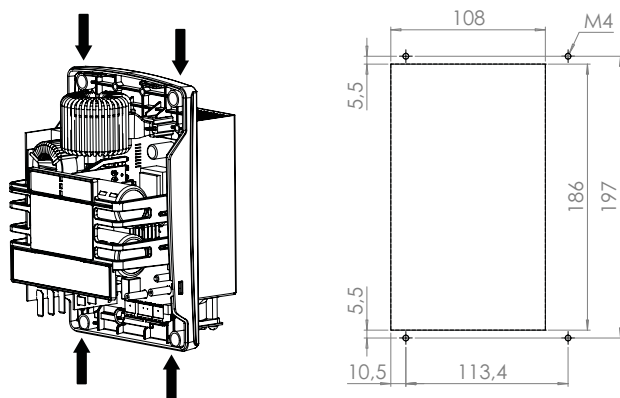


Fig. 3.d

Panel installation

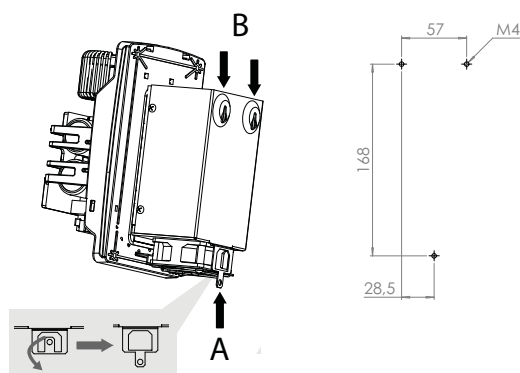


Fig. 3.e

**Important:** During installation do not grab the plastic vertical bracket, but rather the "solid" parts such as the heat sink and the plastic base.

### 3.1.5 Cooling

All the Power+ drives, Coldplate models excluded are fitted with heatsink and cooling fan. There must be sufficient air flow and air change inside the electrical panel. Refer to table 9.1 for maximum heat dissipation values. During installation keep the required minimum distances with respect to other devices or walls of the electrical panelboard.

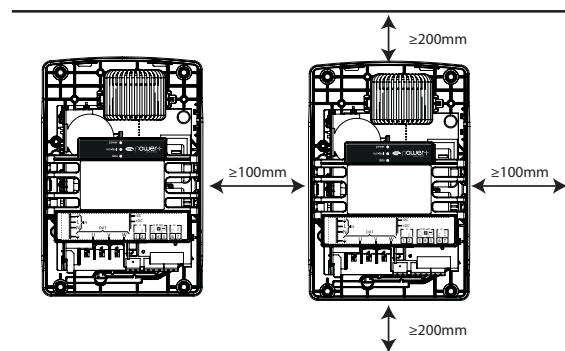


Fig. 3.f

### 3.1.6 Electrical installation

**Important:**

- before carrying out any maintenance work, disconnect the drive and the external control circuits from the power supply by moving the main system switch to "off". Once power has been disconnected from the drive, wait at least 5 minutes before disconnecting the electrical cables;
- always make sure the motor has stopped completely. Motors that are still freely rotating may produce dangerous voltages at the Power+ terminals, even when this is disconnected from the power supply.

Description of the terminals

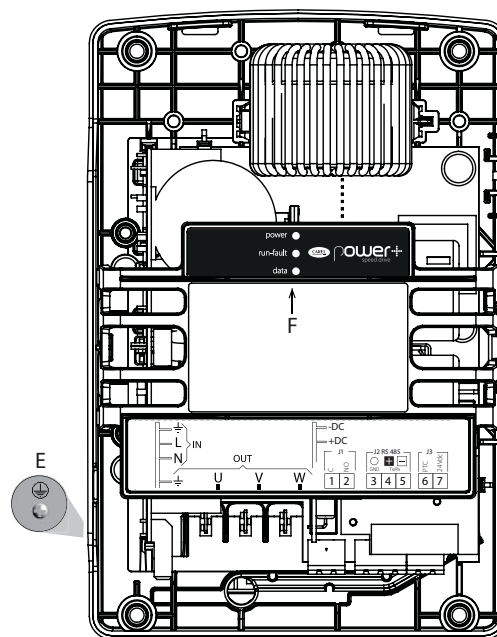


Fig. 3.g

Ref.	Description	
L, N	Single-phase power supply input	
⊕ earth connection (*)		
U, V, W	Motor output	
⊕ earth connection (*)		
-DC	DC bus output	
+DC		
J1-1	C	Relay output
J1-2	NO	(green connector)
J2-3	0V	
J2-4	Tx/Rx+	RS485/ModBus® connection
J2-5	Tx/Rx-	
J3-6	PTC	PTC Input (black connector)
J3-7	24 Vdc	
E	PE ⊕	
F (Led)	POWER (green)	drive powered
	RUN/FAULT (green/red)	drive running / drive alarm
	DATA (yellow)	communication active

Tab. 3.c

(\*) The earth connections inside the drive are electrically connected together and to PE.

**Note:**

the group of terminals for control signals 3...7 and the group of terminals for relay 1,2 have double insulation between each other and with reference to the power terminals.

**Warning:**

the max tightening torque is:

- control terminals: 0,5 Nm.

**Important:**

- in the European Union, all units that incorporate the drive must comply with the Machinery Directive 2006/42/EC. Specifically, the manufacturer of the unit is responsible for the installation of a main switch and the conformity to standard EN 60204-1;
- for fixed installations according to IEC61800-5-1, a disconnect device is required on the circuit between the power supply and the drive;
- only use permanently wired power input connections; the drive must be earthed: the earth wire must be sized for the maximum fault current that is normally limited by the fuses or a circuit breaker.

### 3.1.7 Conformity to EMC standards

Power+ is designed in compliance with the high EMC standards. All models are supplied with an internal EMC filter, designed to reduce the emissions taken towards the power supply line in conformity with harmonised European Standards. It is the installer's responsibility that the device or system within which Power+ is incorporated is in compliance with the Standards in force in the country of use. The Standard in force within the European Union is the EMC 2004/108/EC Directive. Power+ is intended to be incorporated inside fixed installation devices, only installed by specialised staff.

Conformity with the EMC Standard means that the indications given in the "Electric connections" paragraph are respected and, as it also depends on wiring topology, it must be checked on the final machine as envisioned by the Final Product Standard.

### 3.1.8 Electrical connections

For installation proceed as shown below, with reference to the general connection diagrams.

**Important:**

the following warnings must be observed when connecting the drive:

- separate as much as possible the probe and digital input cables (at least 40 cm) from the power cables to avoid possible electromagnetic disturbance. Never lay power cables (including the electrical panel cables) and probe signal cables in the same conduits;
- the cables must be sized according to the table in paragraph 9.1;
- when the fuses are used, these must be chosen according to the data shown in the table in paragraph 9.1, and must comply with the national and local standards in force (in general use type gG fuses for IEC and see Chap. 11 for UL);
- when a magnetic circuit breaker (MCB) is used, it must be of type B, rated according to the data shown in the table in paragraph 9.1;
- avoid installing cables connected to the control terminal block in the immediate vicinity of power devices (contactors, circuit breakers, etc.). Reduce the path of the cables as much as possible, and avoid spiral paths that enclose power devices.

Use cables rated to 90 °C, and if the temperature of the terminals or fastons exceeds 85 °C, use cables rated to 105 °C. Use cable terminals suitable for the terminals and the cables used. Loosen each screw and insert the cable ends, then tighten the screws and lightly tug the cables to check correct tightness. The drive must be earthed: to do this, use either the faston (earth symbol  $\oplus$ ), or the screw (PE symbol  $\oplus$ ) on the side of the heat sink, in accordance with local standards in force. The power supply earth must be connected directly to the earth bar in the electrical panel, without branches to other devices; the earth wire size must be greater than or equal to the phase wires; the earth impedance must be compliant with national and local standards; in compliance with UL requirements, the protective earth connections (PE) must be made using eyelet lugs.

#### Power supply

Connect the power supply cables to fastons L and N; for the size of the cables, type of fastons and fuses, see the table in paragraph 9.1.

To ensure conformity to the EMC directive it is recommended to use a ferrite cable core (e.g. Fair-Rite 2646665702) rounding the earth wire.

**Important:**

- do not connect the power supply to terminals U, V, W;
- make sure the voltage, frequency and number of phases in the power supply match the ratings of the specific model.

#### Earth leakage current

As for all inverter devices, earth leakage current greater than 3,5mA may occur. The drive is designed to produce the minimum possible leakage current. The current depends on the length and the type of motor cable, the effective switching frequency, the type of earth connection used and the type of RFI filter installed.

**Important:**

When earth leakage current is greater than 3,5mA the protective conductor should be at least 10mm<sup>2</sup> if copper or 16mm<sup>2</sup> if aluminium. As an alternative an additional protective conductor could be used.

If a residual-current circuit breaker (RCCB) is to be used, the following conditions apply:

- it must be a type B device (suitable to protect the equipment against leakage current with a DC component);
- Individual RCCBs should be used for each drive.

#### Motor

Connect the motor power cable: use four-wire cable, the impedance of the earth wire must be less than or equal to the impedance of the phase wires. For the size, maximum length of the cable and type of faston, see the table in paragraph 9.1. To ensure conformity to the EMC directive, use shielded cable with tape + braid shields (SN/ST). The cable can also be laid in steel and copper cableways.

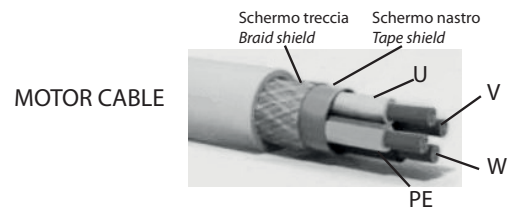


Fig. 3.h

Earth the shield with 360° a metal clamp on both ends of the cable, as close as possible to the terminals. In case of connection of the shield to the drive earth terminal  $\oplus$  (not recommended), the shield has to be twisted. The twisted part must be left as short as possible, and the length must not exceed five times the width. Earth the motor directly using the drive earth faston  $\oplus$ . It is recommended to use a ferrite cable core (e.g. Fair-Rite 2631102002) rounding U, V, W wires only, located between shield earthing and the drive fastons.

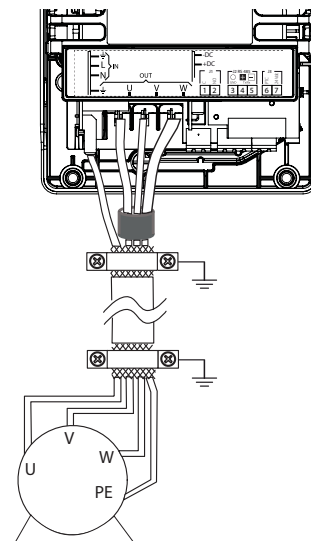


Fig. 3.i

Connect the motor phases so as to ensure the required direction of rotation: to reverse direction, swap over two of U, V, W wires as indicated in the following figures.

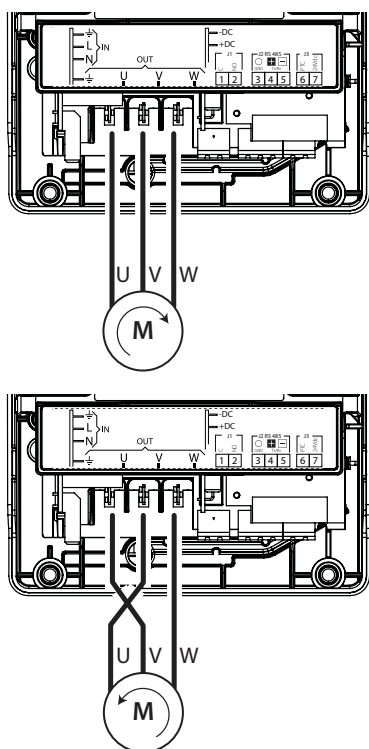


Fig. 3.j



**Note:** Most general purpose asynchronous motors are wound for operation on dual voltage supplies. This is indicated on the nameplate of the motor. This operational voltage is normally selected when installing the motor by selecting either Star or Delta connection. Star always gives the higher of the two voltage ratings. Typical ratings are:

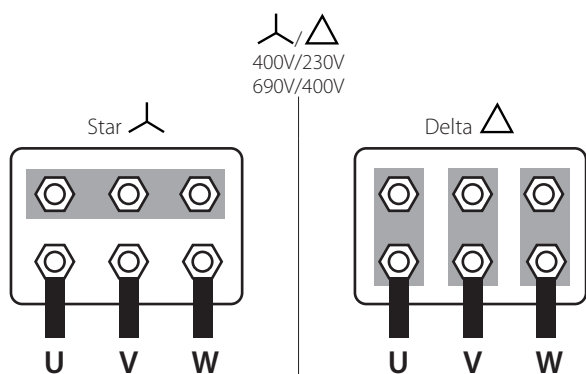


Fig. 3.k

Fig. 3.l



**Important:** do not turn on or OFF a switch between the drive and the motor when the drive is running.

### Motor protector

Connect a PTC thermistor motor protector to terminals 6 and 7: use a cable with a minimum cross-section of 1 mm<sup>2</sup>; alternatively, a Klaxon thermostat can be connected (see the general connection diagram). The PTC thermistor must be selected so that at activation temperature the resistance is > 2600  $\Omega$ .

### Serial network connection

For the serial connection use a three-wire shielded cable. For large networks, install a 120 ohm  $\frac{1}{4}$  W resistor between terminals 4 and 5 on the last drive or device connected, to avoid possible communication problems. To ensure conformity to the EMC directive it is recommended to use a ferrite cable core (e.g. Fair-Rite 2631540002) rounding the three wires only (with one and a half turn), located between shield earthing and the drive earth terminal excluding the shield.

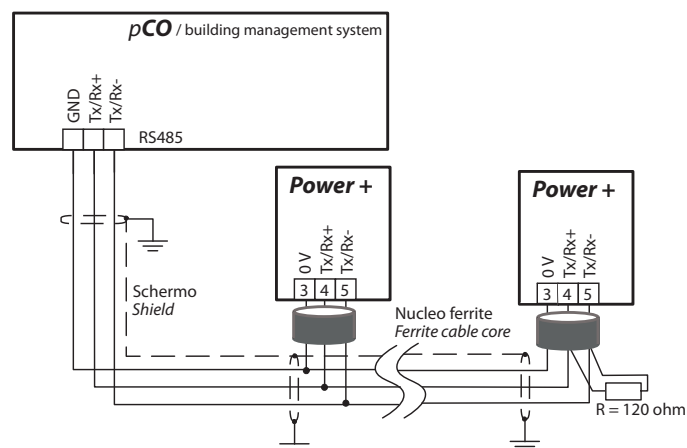


Fig. 3.m

### 3.1.9 Functional layout

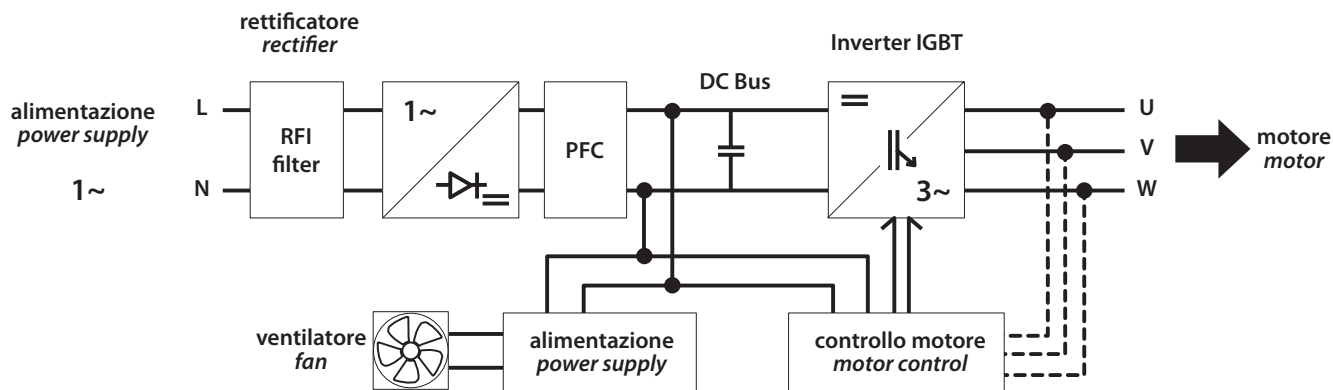


Fig. 3.n

### 3.1.10 General connection diagram

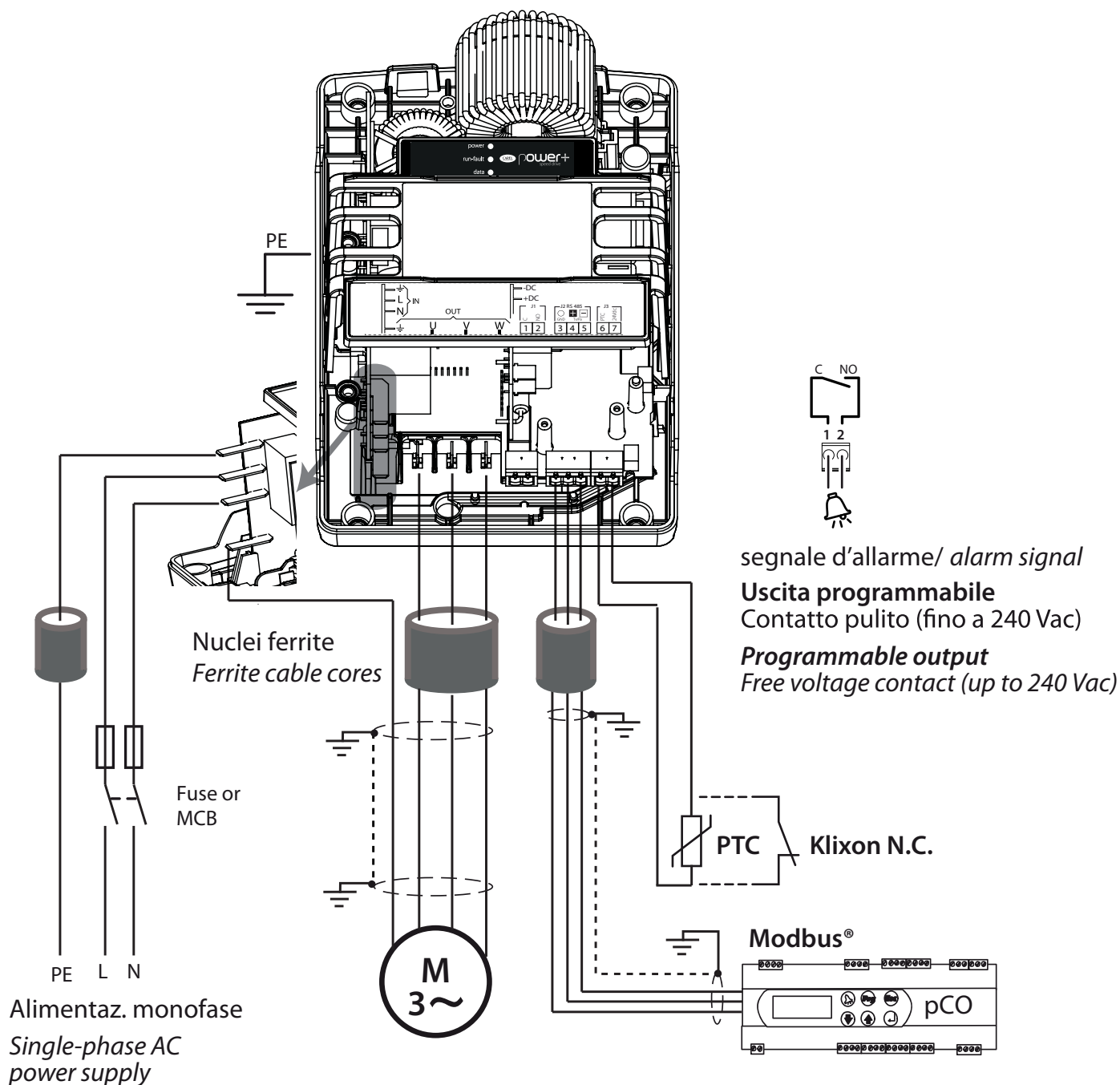


Fig. 3.o

### 3.1.11 Power+ Coldplate models

The Power+ Coldplate models are the same as respective standard Power+ model, with the unique difference that the finned heatsink and fan are replaced by a flat aluminum plate for the Coldplate with cooling adapter model (PSD10102BA, PSD1D042BA10, PSD1D062BA10, PSD1D102BA10), no cooling system for the Coldplate without cooling adapter (PSD10102DA). Both Coldplate versions need to be fitted to an additional device with cooling function (coldplate), typically using liquid refrigerant. The coldplate is the user's responsibility and is not supplied by Carel.

#### Power+ Coldplate with cooling adapter

The Coldplate with cooling adapter version (PSD10102BA, PSD1D042BA10, PSD1D062BA10, PSD1D102BA10) is provided with four threaded holes M5 on the aluminum plate for fixing an additional device with cooling function (coldplate) from the rear side of the drive. This PSD10102BA, PSD1D042BA10, PSD1D062BA10, PSD1D102BA10 model can be also fixed to the coldplate from the front side by using the four holes on the corners of the drive (the same holes used for installation with heatsink outside the panel) by the through holes of the aluminum plate.

#### Dimensions

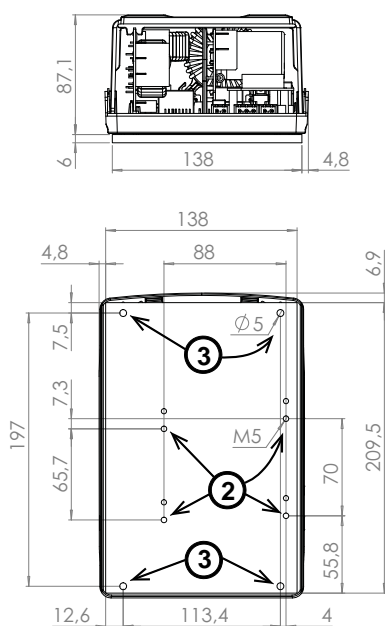


Fig. 3.p

#### Assembly

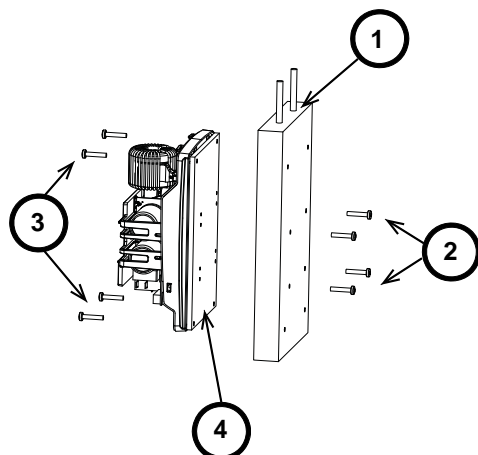


Fig. 3.q

key:	
1	Cooling device - coldplate (example)
2	Holes/screws for cooling device fitting from the rear side of the drive (4 holes M5 maximum depth 14mm)
3	Holes/screws for cooling device fitting from the front side of the drive
4	Power+ plate

#### Coldplate without adapter

The Coldplate without cooling adapter version (PSD10102DA) is provided with four threaded holes M4 for fixing an additional device with cooling function (coldplate) from the rear side of the drive.

#### Dimensions

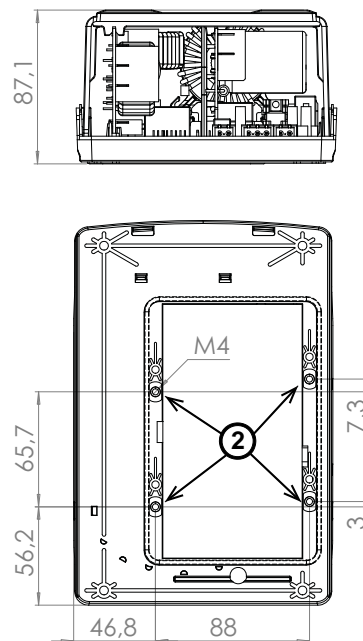


Fig. 3.r

#### Assembly

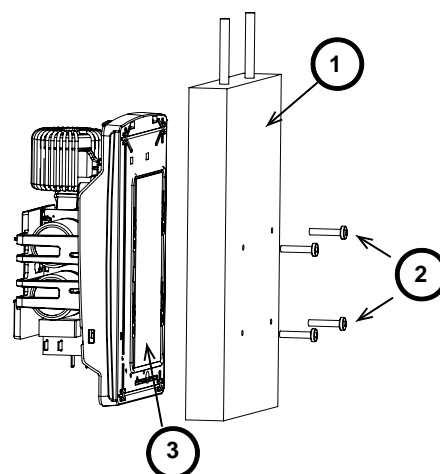


Fig. 3.s

#### key:

1	Cooling device - coldplate (example)
2	Holes/screws for cooling device fitting (4 holes M4 maximum depth 8mm)
3	Power+ plate

#### ⚠ Attention:

- Make sure that the cooling device is dimensioned and fixed to the plate in a way to dissipate the heat while keeping the temperature of the plate below 70°C in the various operating conditions and that the overheating alarm does not intervene.
- Make sure that the cooling device does not cause the formation of condensate on the inner surface of the plate.
- Clean the contact surfaces of the Power+ plate and of the coldplate and ensure they couple perfectly.
- The use of thermal compound or similar product, between the contact surfaces of the Power+ and the coldplate allows better heat coupling.
- It is recommended that cooling device follows prescription as indicated in par. 4.4.5 of the EN 61800-5-1 Standard.



**Warning:** the max tightening torque is 3 Nm.

## 3.2 230V 12/16A and 400V 18/24A Models

### 3.2.1 Identification

Power+ is identified by a rating plate located on the top of the device, which describes the code, serial number, production date and revision number.



Fig. 3.t

### 3.2.2 Structure

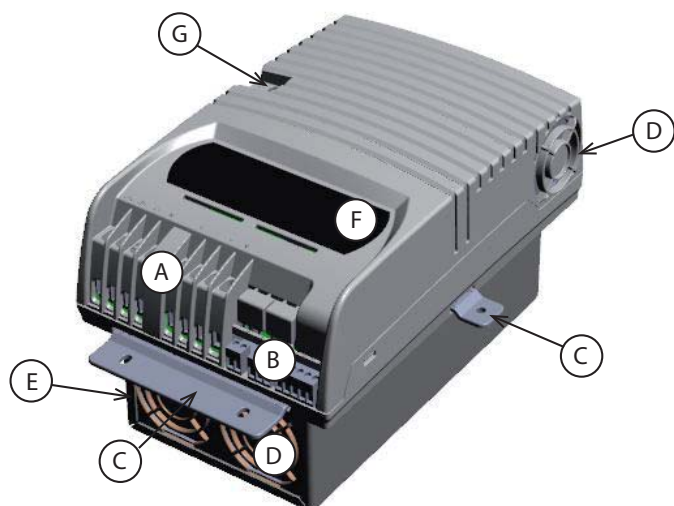


Fig. 3.u

Ref.	Description
A	Terminal block for power connections
B	Terminal block for control connections
C	Fastening brackets
D	Cooling fan
E	PE
F	Operating status LED
G	Terminal block for optional DC Choke in PSD10184** and PSD10244**

Tab. 3.d

### 3.2.3 Dimensions

The overall dimensions of the drive vary based on cooling system (drives with forced air cooled finned heatsink or Coldplate models) and the type of assembly (panel or with heat sink outside of the panel, see the paragraph on "Drilling and assembly"), as the position of the fastening brackets affects the total height. The side brackets are only needed for assembly with the heat sink outside of the panel. The brackets holes have 5.5 mm diameter.

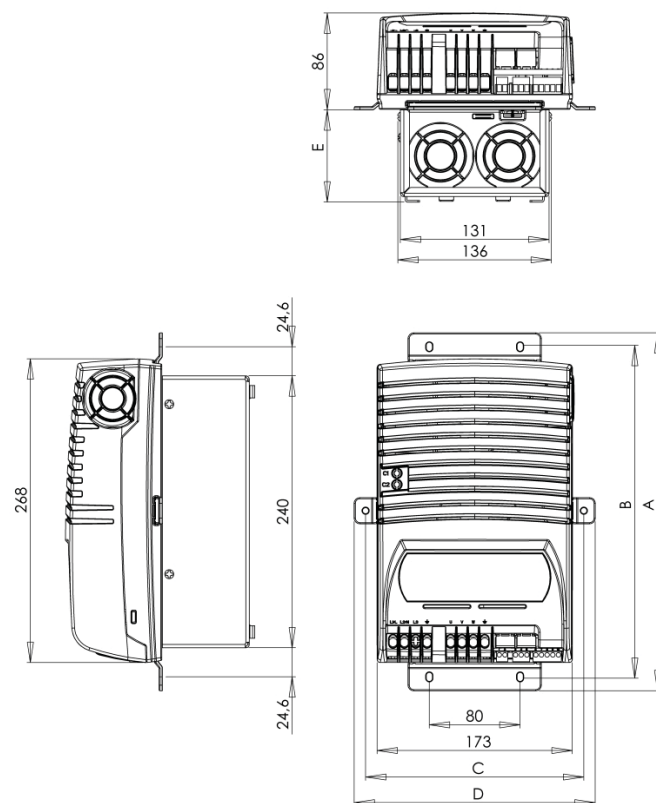


Fig. 3.v

Dimensions (mm)

Model	Size	E	Assembly						Weight	
			Heat sink outside panel	Panel	A	B	C	D	A	B
PSD1012200	268x173x168	82	316	289,2	192,3	213	296	269,3	4,3	
PSD1016200	268x173x168	82	316	289,2	192,3	213	296	269,3	4,4	
PSD10122A0	268x173x98	12	316	289,2	192,3	213	-	-	2,8	
PSD10162A0	268x173x98	12	316	289,2	192,3	213	-	-	2,9	
PSD1018400	268x173x168	82	316	289,2	192,3	213	296	269,3	4,0	
PSD1024400	268x173x168	82	316	289,2	192,3	213	296	269,3	4,1	
PSD10184A0	268x173x98	12	316	289,2	192,3	213	-	-	2,4	
PSD10244A0	268x173x98	12	316	289,2	192,3	213	-	-	2,5	

Tab. 3.e

### 3.2.4 Drilling and assembly

For installation with the heat sink outside of the panel, make a hole with dimensions of the dashed rectangle, where the heat sink will be fitted, and holes for fastening the brackets. These are inserted in the slots located in the plastic base. For panel installation, only use the top and bottom brackets, which are inserted in the slots above and below the heat sink.

#### Installation with heat sink outside of the panel

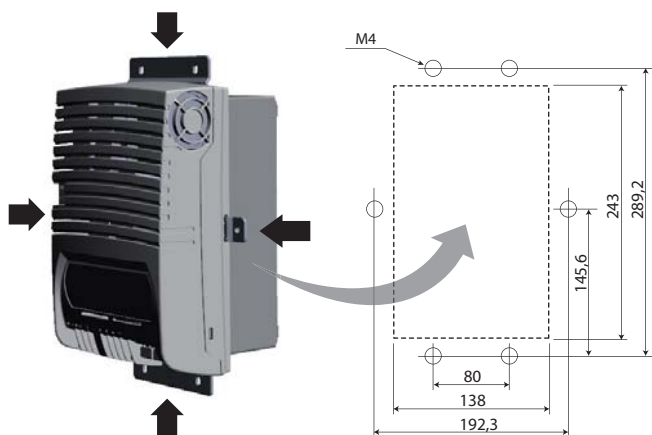


Fig. 3.w

#### Panel installation

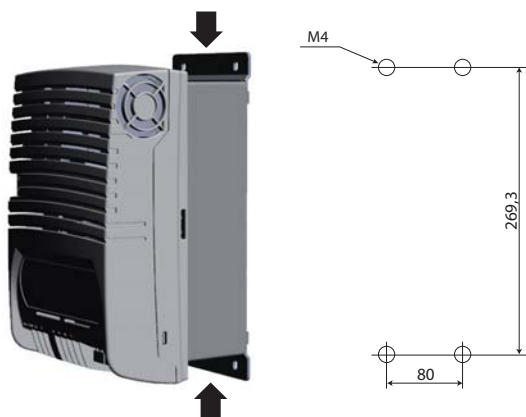


Fig. 3.x

**Important:** in case of dismantling, do not grab the brackets, but rather the "solid" parts such as the heat sink and the plastic cover. Remove the top bracket first, then the bottom one to prevent the drive from falling down.

### 3.2.5 Cooling

All the Power+ drives, Coldplate models excluded, are fitted with heatsink and cooling fans. There must be sufficient air flow and air change inside the electrical panel. Refer to table 9.1 for maximum heat dissipation values. All the Power+ drives are fitted with internal cooling fans on the right side. Avoid hot air inlet to internal fan.

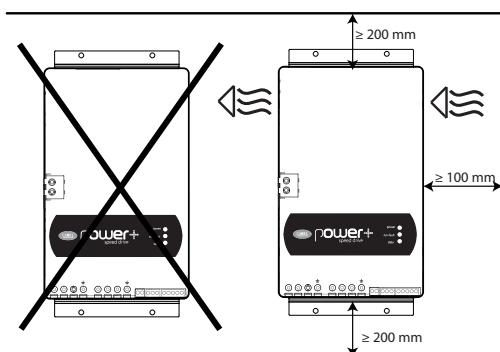


Fig. 3.y

### 3.2.6 Electrical installation

**Important:**

- ⚡ before carrying out any maintenance work, disconnect the drive and the external control circuits from the power supply by moving the main system switch to "off". Once power has been disconnected from the drive, wait at least 5 minutes before disconnecting the electrical cables;
- ⚡ always make sure the motor has stopped completely. Motors that are still freely rotating may produce dangerous voltages at the Power+ terminals, even when this is disconnected from the power supply.

#### Description of the terminals

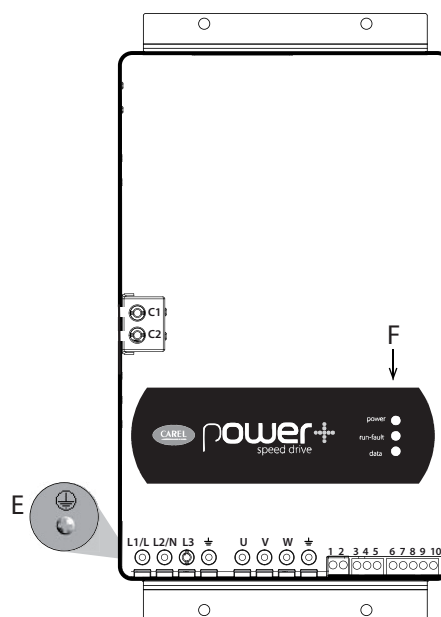


Fig. 3.z

Ref.	Description	
L1/L, L2/N, L3	Three-phase power supply input	
⊕ earth connection (*)		
L1/L, L2/N	Single-phase power supply input	
⊕ earth connection (*)		
U, V, W	Motor output	
⊕ earth connection (*)		
C1, C2	Terminal block not used in PSD10**2**. For optional external DC Choke in PSD10184** e PSD10244**	
1, 2	Relay output	
3	0V	RS485/ModBus® connection
4	RX+/TX+	
5	RX-/TX-	
6	PTC Input	
7	24Vdc	Auxiliary voltage
8	0V	
9	STOa	Safety Torque Off digital input (**)
10	STOb	
E	PE ⊕	
F (Led)	POWER (green)	drive powered
	RUN/FAULT (green/red)	drive running / drive alarm
	DATA (yellow)	communication active

Tab. 3.f

(\*) The earth connections inside the drive are electrically connected together and to PE.

(\*\*) To enable the drive for operation, apply a voltage of 24 Vac/Vdc to the Safety Torque Off digital input. The polarity is indifferent for direct current power supply.

**Note:** the control signals terminal unit 3...10 and the relay terminals unit 1, 2 are double isolated from each other and with respect to the power terminal board.

**! Important:**

- in the European Union, all units that incorporate the drive must comply with the Machinery Directive 2006/42/EC. Specifically, the manufacturer of the unit is responsible for the installation of a main switch and the conformity to standard EN 60204-1;
- for fixed installations according to IEC61800-5-1, a disconnect device is required on the circuit between the power supply and the drive;
- only use permanently wired power input connections; the drive must be earthed: the earth wire must be sized for the maximum fault current that is normally limited by the fuses or a circuit breaker.

### 3.2.7 Conformity to EMC standards

Power+ is designed in compliance with the high EMC standards. All models are supplied with an internal EMC filter, designed to reduce the emissions taken towards the power supply line in conformity with harmonised European Standards. It is the installer's responsibility that the device or system within which Power+ is incorporated is in compliance with the Standards in force in the country of use. The Standard in force within the European Union is the EMC 2004/108/EC Directive. Power+ is intended to be incorporated inside fixed installation devices, only installed by specialised staff.

Conformity with the EMC Standard means that the indications given in the "Electric connections" paragraph are respected and, as it also depends on wiring topology, it must be checked on the final machine as envisioned by the Final Product Standard.

### 3.2.8 Electrical connections

For installation proceed as shown below, with reference to the general connection diagrams.

**! Important:**

the following warnings must be observed when connecting the drive:

- separate as much as possible the probe and digital input cables (at least 40 cm) from the power cables to avoid possible electromagnetic disturbance. Never lay power cables (including the electrical panel cables) and probe signal cables in the same conduits;
- the cables must be sized according to the table in paragraph 9.1;
- when the fuses are used, these must be chosen according to the data shown in the table in paragraph 9.1, and must comply with the national and local standards in force (in general use type gG fuses for IEC and see Chap. 11 for UL);
- when a magnetic circuit breaker (MCB) is used, it must be of type B, rated according to the data shown in the table in paragraph 9.1;
- avoid installing cables connected to the control terminal block in the immediate vicinity of power devices (contactors, circuit breakers, etc.). Reduce the path of the cables as much as possible, and avoid spiral paths that enclose power devices.

Use cables rated to 90 °C, and if the temperature of the terminals exceeds 85 °C, use cables rated to 105 °C. Use cable terminals suitable for the terminals and the cables used. Loosen each screw and insert the cable ends, then tighten the screws and lightly tug the cables to check correct tightness.

**! Important:**

- the max tightening torque is:
- power terminals: 1,5 Nm;
  - control terminals: 0,5 Nm.

The drive must be earthed: to do this, use either the screw terminal (earth symbol  $\oplus$ ), or the screw (PE symbol  $\oplus$ ) on the side of the heat sink, in accordance with local standards in force. To minimise EMC problems, use a shielded power cable with earth wire included, connected to terminal  $\oplus$ . The power supply earth must be connected directly to the earth bar in the electrical panel, without branches to other devices; the earth wire size must be greater than or equal to the phase wires; the earth impedance must be compliant with national and local standards; in compliance with UL requirements, the protective earth connections (PE) must be made using eyelet lugs.

### Power supply

Connect the power supply cables: for PSD10122\*\* and PSD10162\*\* connect the power supply to terminals L1/L and L2/N, for PSD10184\*\* e PSD10244\*\* to terminals L1, L2, L3; for the size of the cables and the type of fuses, see the table in paragraph 9.1.

To ensure conformity to the EMC directive, use shielded cable with tape + braid shields (SN/ST). The cable can also be laid in steel and copper cableways. Earth the shield with 360° a metal clamp on both ends of the cable, as close as possible to the terminals. In case of connection of the shield to the drive earth terminal  $\oplus$  (not recommended), the shield has to be twisted. The twisted part must be left as short as possible, and the length must not exceed five times the width.

For PSD10122\*\* and PSD10162\*\* it is recommended to use a ferrite cable core (e.g. Fair-Rite 2646665702) rounding earth wire only, located just in front of the drive earth terminal  $\oplus$ .

**! Important:**

- do not connect the power supply to terminals U, V, W;
- make sure the voltage, frequency and number of phases in the power supply match the ratings of the specific model.

### Earth leakage current

As for all inverter devices, earth leakage current greater than 3,5mA may occur. The drive is designed to produce the minimum possible leakage current. The current depends on the length and the type of motor cable, the effective switching frequency, the type of earth connection used and the type of RFI filter installed.

**! Important:**

When earth leakage current is greater than 3,5mA the protective conductor should be at least 10mm<sup>2</sup> if copper or 16mm<sup>2</sup> if aluminium. As an alternative an additional protective conductor could be used.

If a residual-current circuit breaker (RCCB) is to be used, the following conditions apply:

- it must be a type B device (suitable to protect the equipment against leakage current with a DC component);
- Individual RCCBs should be used for each drive.

### Motor

Connect the motor power cable: use four-wire cable, the impedance of the earth wire must be less than or equal to the impedance of the phase wires. For the size and maximum length of the cable according to the model, see the table in paragraph 9.1. To ensure conformity to the EMC directive, use shielded cable with tape + braid shields (SN/ST). The cable can also be laid in steel and copper cableways.

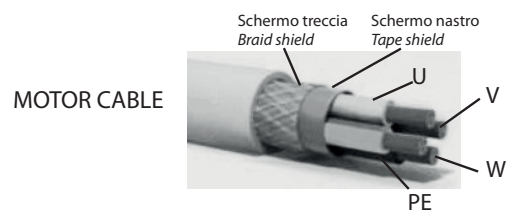


Fig. 3.aa

Earth the shield with 360° a metal clamp on both ends of the cable, as close as possible to the terminals. In case of connection of the shield to the drive earth terminal  $\oplus$  (not recommended), the shield has to be twisted. The twisted part must be left as short as possible, and the length must not exceed five times the width. Earth the motor directly using the drive earth terminal  $\oplus$ . It is recommended to use a ferrite cable core (e.g. Fair-Rite 2631102002) rounding U, V, W wires only, located between shield earthing and the drive terminals.

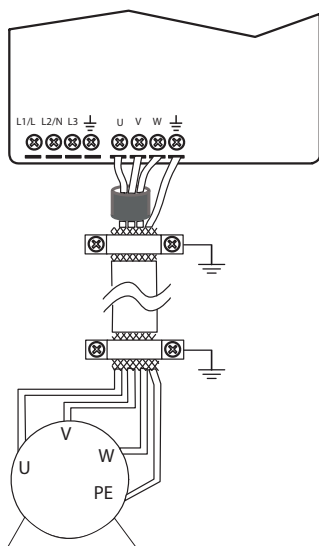


Fig. 3.ab

Connect the motor phases so as to ensure the required direction of rotation: to reverse direction, swap over two of U, V, W wires as indicated in the following figures.

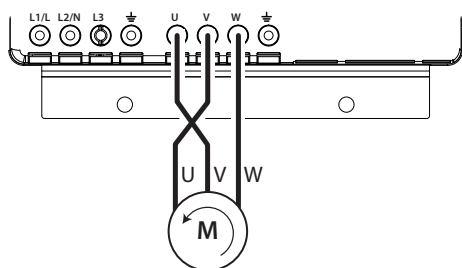
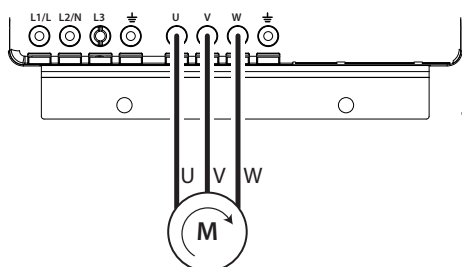


Fig. 3.ac

**Note:** Most general purpose asynchronous motors are wound for operation on dual voltage supplies. This is indicated on the nameplate of the motor. This operational voltage is normally selected when installing the motor by selecting either Star or Delta connection. Star always gives the higher of the two voltage ratings. Typical ratings are:

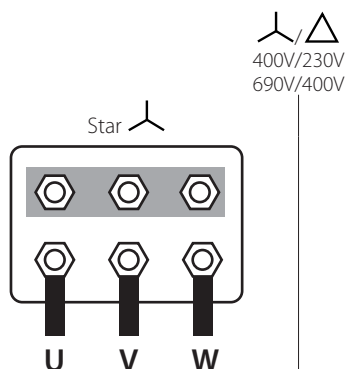


Fig. 3.ad

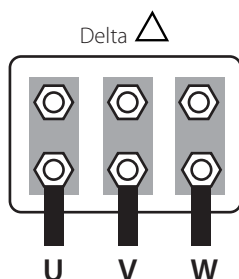


Fig. 3.ae

**Important:** do not turn on or OFF a switch between the drive and the motor when the drive is running.

#### Motor protector

Connect a PTC thermistor motor protector to terminals 6 and 7: use a cable with a minimum cross-section of 1 mm<sup>2</sup>; alternatively, a Klixon thermostat can be connected (see the general connection diagram). The PTC thermistor must be selected so that at activation temperature the resistance is > 2600 Ω.

#### Safety digital input

Connect the "Safety Torque Off" digital input to a safety device (for example, a maximum pressure switch) with normally closed voltage-free contact, in series with an external 24 Vac/24 Vdc voltage source, without needing to observe the polarity for direct current (ref. A). When the contact is open, the drive stops operating, bypassing the software control. If the Safety Torque Off function is not used, the input must be connected to the auxiliary 24 Vdc available on the terminal block, so as to enable correct operation of the drive (ref. B).

#### Dispositivo di sicurezza NC / NC Safety device

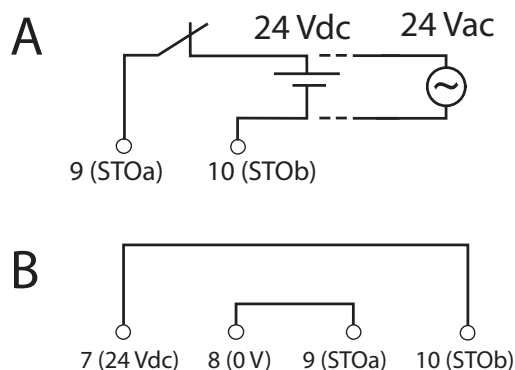


Fig. 3.af

**Note:** IEC61508 standard requires that the power supply applied to the safety input is isolated from the drive.

#### Serial network connection

For the serial connection use a three-wire shielded cable. For large networks, install a 120 ohm ¼. W resistor between terminals 4 and 5 on the last drive or device connected, to avoid possible communication problems.

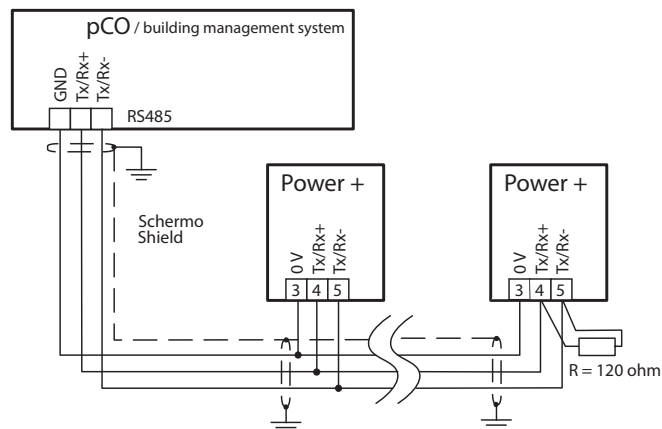


Fig. 3.ag

### 3.2.9 Functional layouts

Codes PSD10122\*\*, PSD10162\*\*

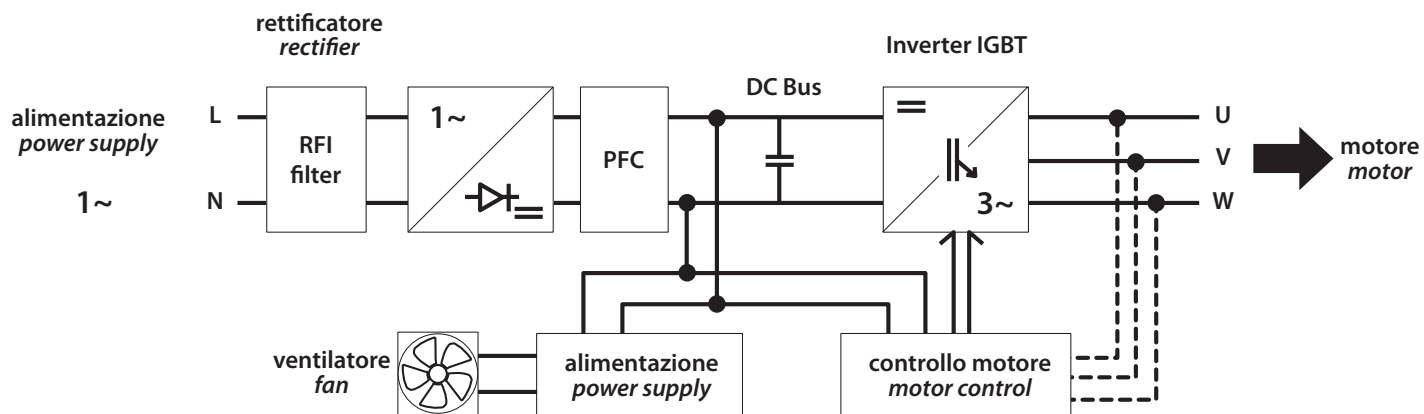


Fig. 3.ah

Codes PSD10184\*\*, PSD10244\*\*

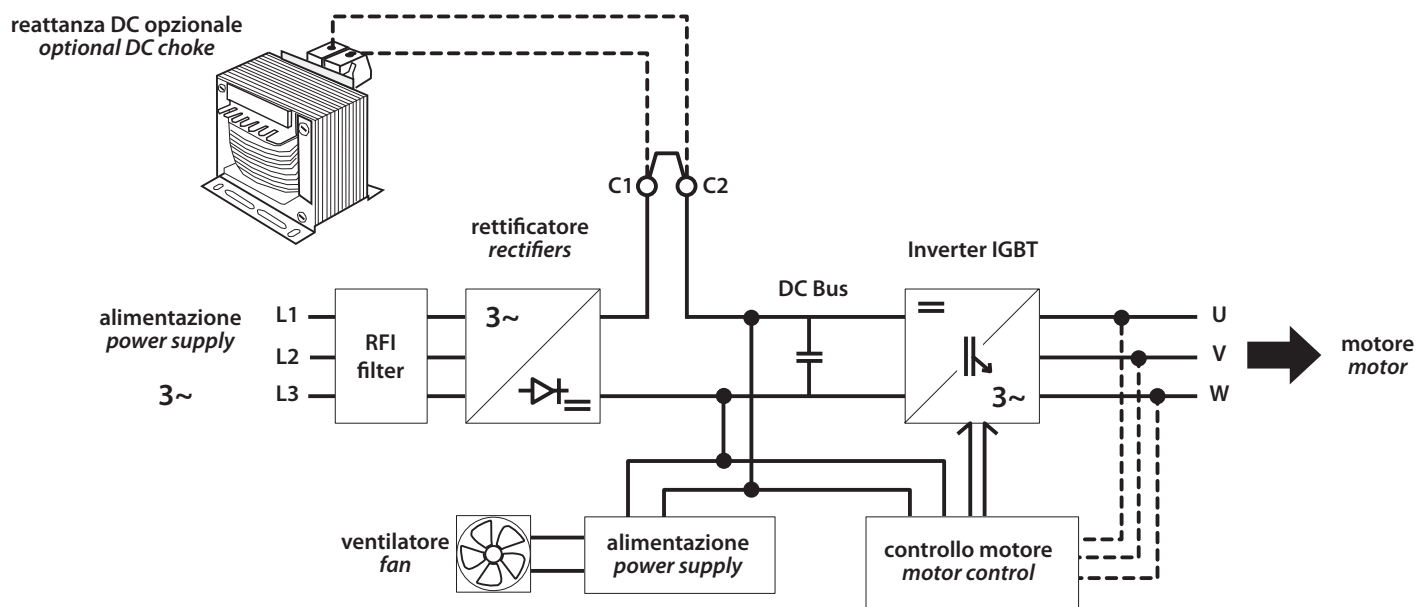


Fig. 3.ai

3.2.10 General connection diagram (PSD10122\*\*, PSD10162\*\*)

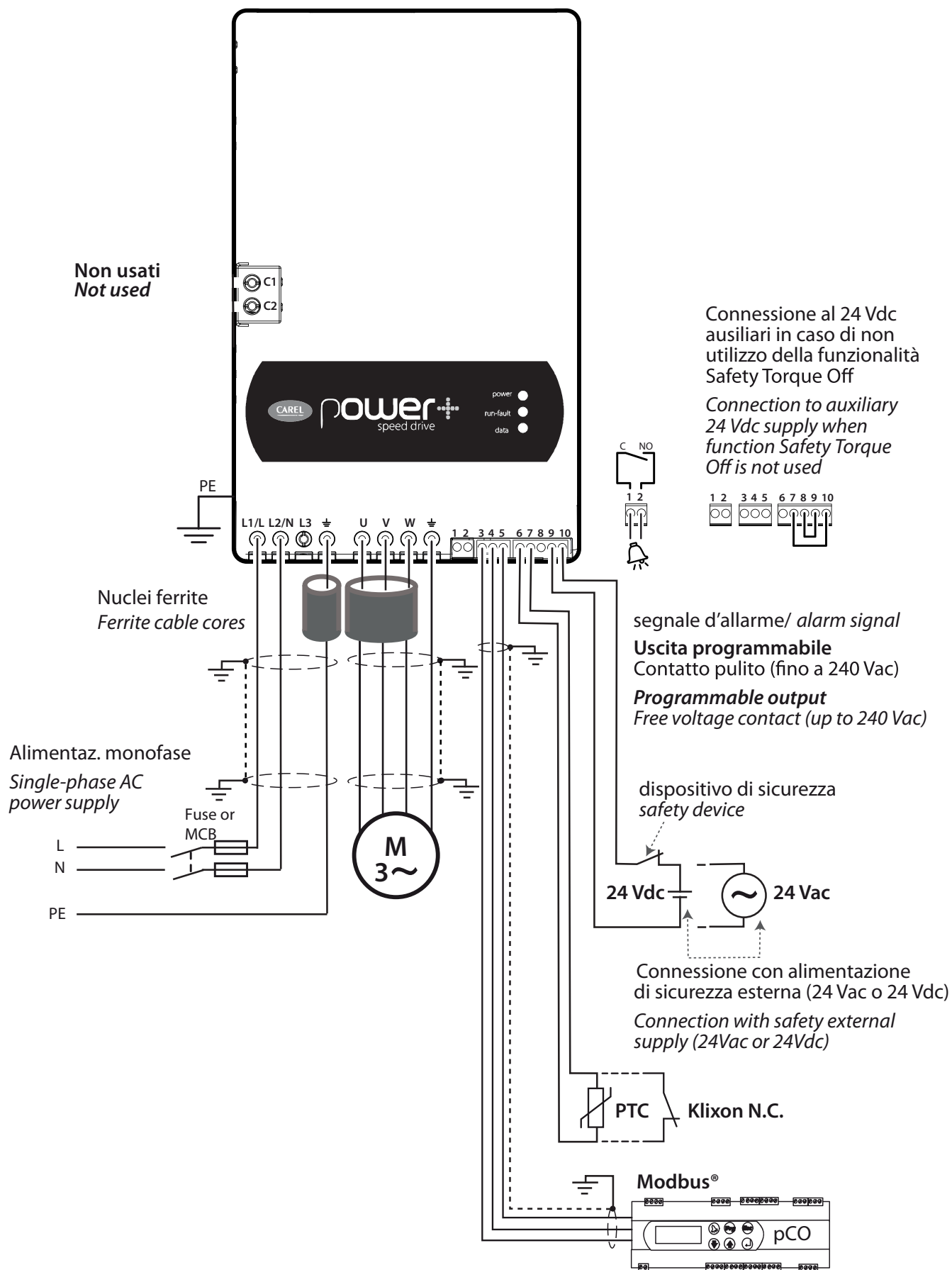


Fig. 3.aj

Connessione al 24 Vdc ausiliari in caso di non utilizzo della funzionalità Safety Torque Off

Connection to auxiliary 24 Vdc supply when function Safety Torque Off is not used

segnale d'allarme/ alarm signal

**Uscita programmabile**  
Contatto pulito (fino a 240 Vac)

**Programmable output**  
Free voltage contact (up to 240 Vac)

dispositivo di sicurezza safety device

Connessione con alimentazione di sicurezza esterna (24 Vac o 24 Vdc)

Connection with safety external supply (24Vac or 24Vdc)

PTC Klixon N.C.

Modbus®

pCO

"Power+" +0300048EN - rel. 3.2 - 02.07.2015

### 3.2.12 Power+ Coldplate models

The Power+ Coldplate (PSD10\*\*\*A0) models are the same as respective standard Power+ models, with the unique difference that the finned heatsink and fan are replaced by a flat aluminium plate. The plate has threaded holes M5 for fixing an additional device with cooling function (coldplate), typically using liquid refrigerant. The coldplate is the user's responsibility and is not supplied by Carel.

#### Dimensions

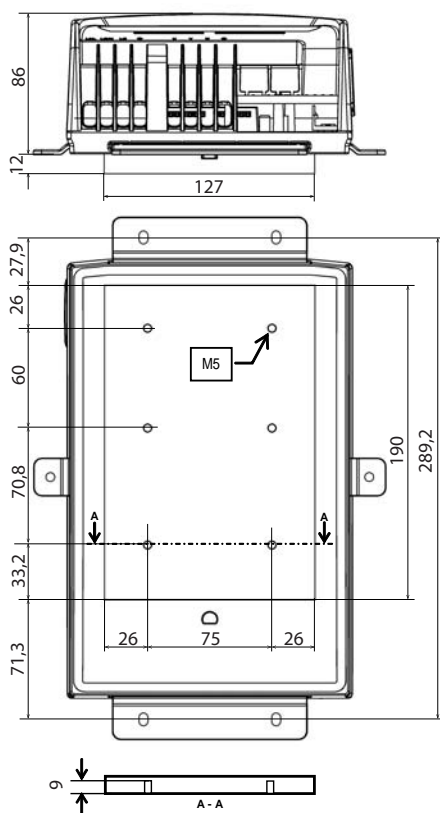


Fig. 3.al

#### Assembly

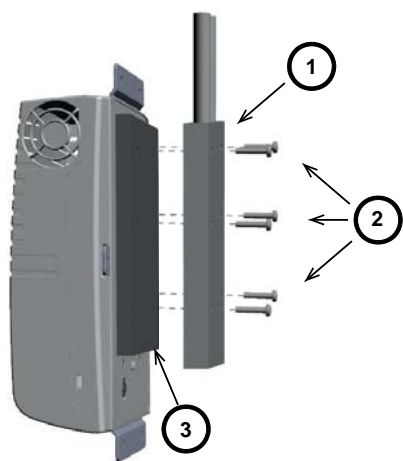


Fig. 3.am

#### key:

- |   |   |
|---|---|
| 1 | Cooling device - coldplate (example)    |
| 2 | Holes/screws for cooling device fitting |
| 3 | Power+ plate                            |

#### ! Attention:

- Make sure that the cooling device is dimensioned and fixed to the plate in a way to dissipate the heat while keeping the temperature of the plate below 70°C in the various operating conditions and that the overheating alarm does not intervene.
- Make sure that the cooling device does not cause the formation of condensate on the inner surface of the plate.
- Clean the contact surfaces of the Power+ plate and of the coldplate and ensure they couple perfectly.

- The use of thermal compound or similar product, between the contact surfaces of the Power+ and the coldplate allows better heat coupling.
- It is recommended that cooling device follows prescription as indicated in par. 4.4.5 of the EN 61800-5-1 Standard.

### 3.2.13 DC Reactance

The DC choke is an optional that can be supplied separately to be used with the Power+ drives with three-phase power supply (PSD10\*\*4\*0) to reduce the harmonic currents to the levels envisioned by EN61000-3-12.

The choke has four holes for fixing to the wall.

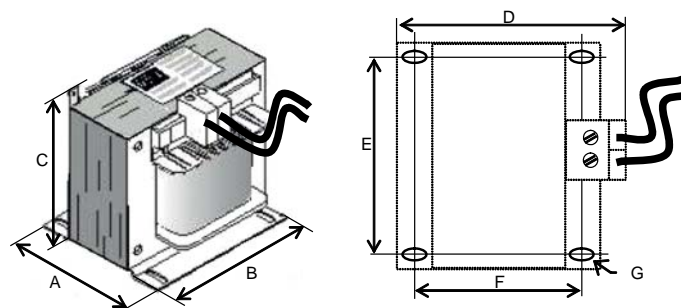


Fig. 3.an

DC choke code	Dimensions (mm)							Weight (kg)
	A	B	C	D	E	F	G (diam)	
PSACH10200	86	96	98	94	84	71	5	3,1
PSACH10100	86	96	98	94	84	71	5	2,7

#### ! Attention:

- Position the choke as near as possible to the drive in a way to minimise connection cable length (max 2m).
- For connection to the drive use cables with section at least equal to the power supply cable.
- Envision the space necessary for connection of the cables to the choke terminals.

### 3.2.14 EMI Filter

The EMI filter is an optional that can be supplied separately to be used with Power+ drives codes PSD10122\*0 and PSD10162\*\* to reduce the emissions to the levels envisioned by EN61800-3 category C1.

The filter must be connected between the power supply and terminals L1/L, L2/N and earth of the drive.

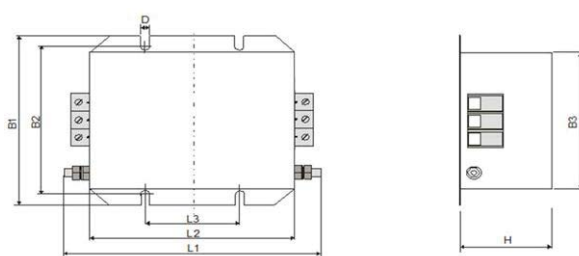


Fig. 3.ao

EMI filter code	Dimensions (mm)								Weight (kg)
	L1	L2	L3	B1	B2	B3	H	D	
PSARF10000 (CNW102.1/30)	180	150	90	98	88	70	70	5	1,3

#### Technical specifications

Current	30A	Leakage current	< 3,5mA
Voltage	250V	Connection by terminal	4mm <sup>2</sup>
Temperature	60°C		

#### ! Attention:

- Connect power supply cable and drive as shown on the label.
- Position the filter as near as possible to the drive in a way to minimise connection cable length.
- Connect the filter metal casing to earth.

### 3.3 400V 35/40A Models

#### 3.3.1 Identification

Power+ is identified by a rating plate located on the right side of the device, which describes the code, serial number, production date and revision number.

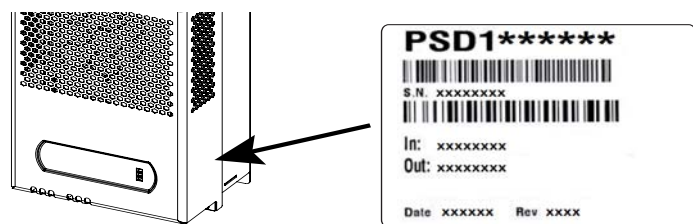


Fig. 3.ap

#### 3.3.2 Structure

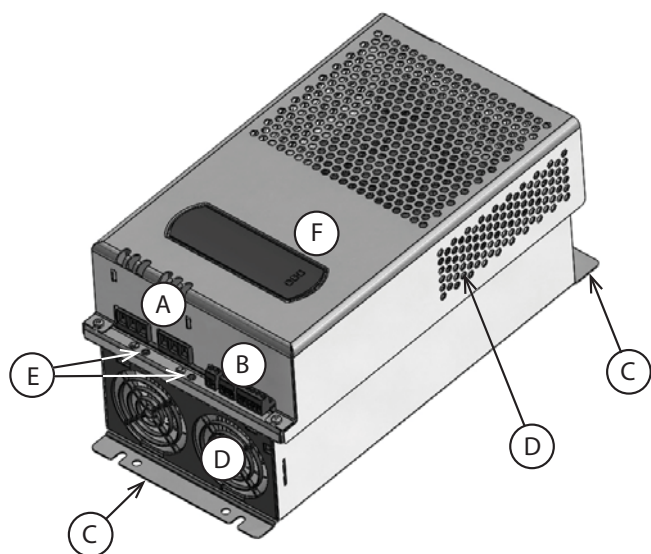


Fig. 3.aq

Ref.	Description
A	Terminal block for power connections
B	Terminal block for control connections
C	Fastening brackets
D	Cooling fans
E	PE protective earth $\oplus$
F	Operating status LED

Tab. 3.g

#### 3.3.3 Dimensions

##### PSD10\*\*42\* (Panel installation)

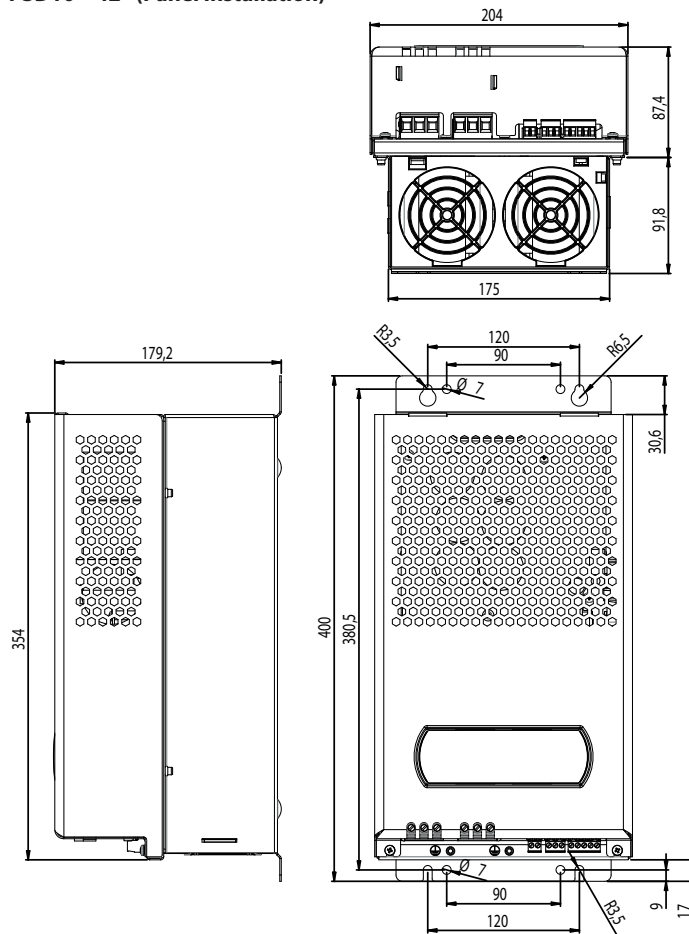


Fig. 3.ar

##### PSD10\*\*4T\* (Installation with heat sink outside of the panel)

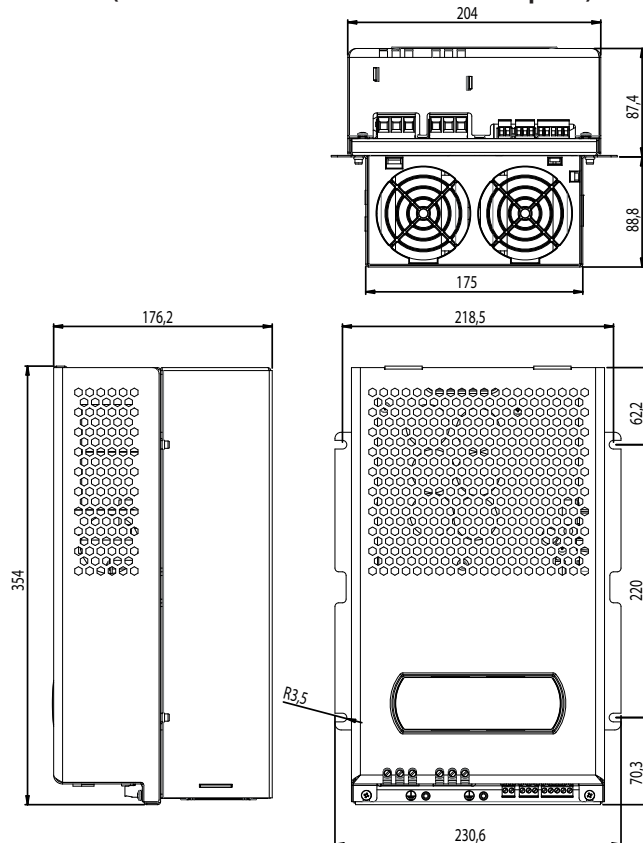


Fig. 3.as

PSD10\*\*4C\* (Coldplate model)

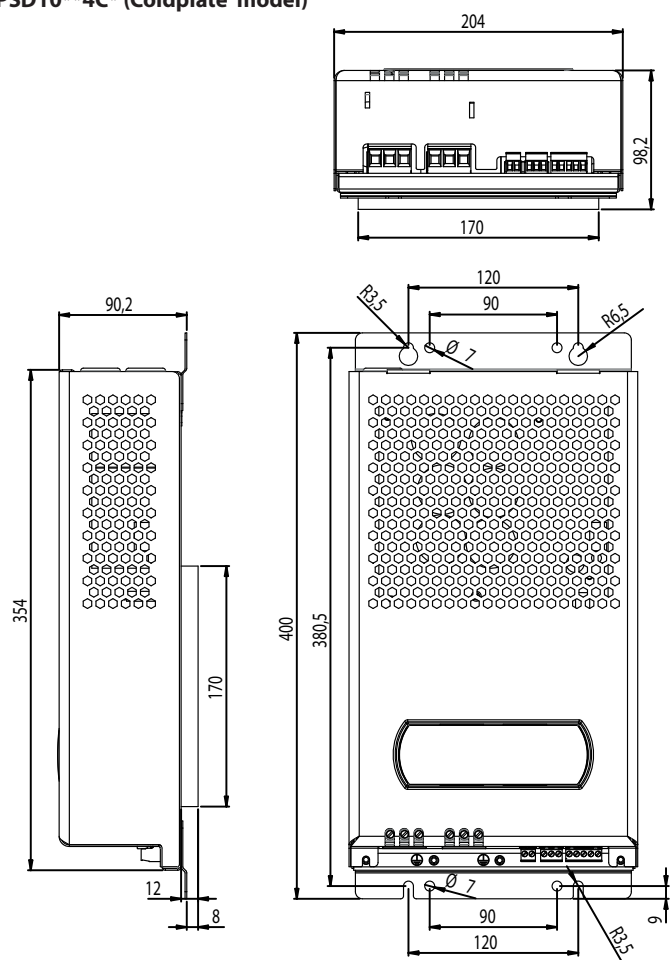


Fig. 3.at

**Important:**

The Power+ Coldplate models are supplied together with two DC-chokes to be externally connected to the Power+. Provide the necessary space for the two DC-chokes and connecting cables.

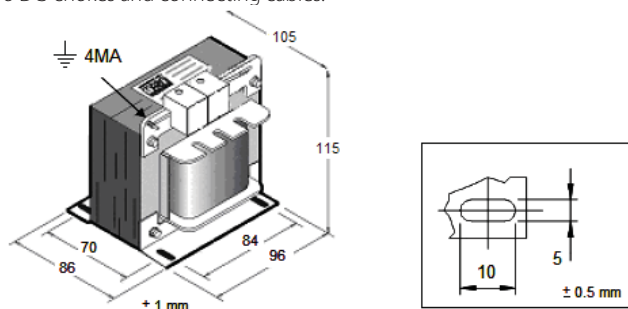


Fig. 3.au

For fastening the cooling device see par. 3.10.

**Weights**

	weight (kg)
PSD1035420	13,5
PSD1035470	13,5
PSD10354C0 (drive only)	5,5
DC-chokes	3,2 x 2
PSD1040420	14
PSD1040470	14
PSD10404C0 (drive only)	5,6
DC-chokes	3,2 x 2

**3.3.4 Drilling and assembly**

**Panel installation (PSD10\*\*42\* and PSD10\*\*4C\* models)**

Make holes for fastening the top and bottom brackets.

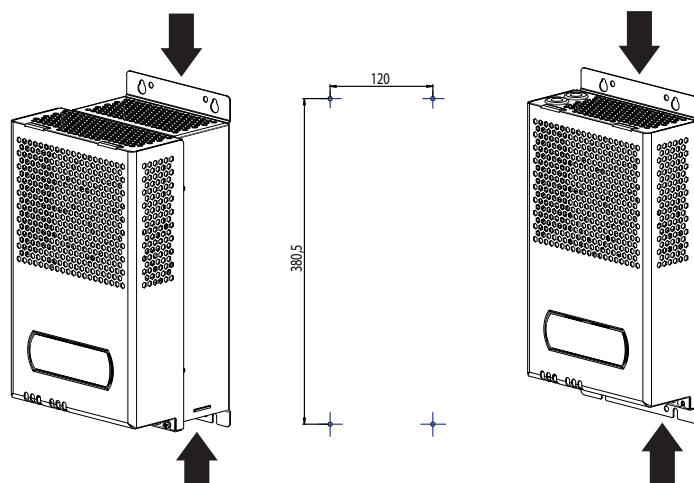


Fig. 3.av

**Installation with heat sink outside of the panel (PSD10\*\*4T\* models)**

Make a hole with dimensions of the dashed area, where the heat sink will be fitted, and holes for fastening the left and right side brackets.

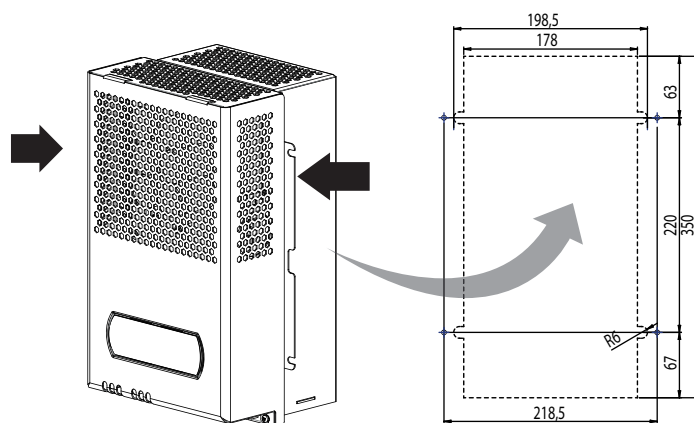


Fig. 3.aw

Use M6 screws for drives installation.

**Important:**

Fasten the top screws before. In case of dismantling remove the bottom screws before.

**3.3.5 Cooling**

The Power+ drives, Coldplate models excluded, are fitted with heatsink and cooling fans. There must be sufficient air flow and air change inside the electrical panel. Refer to table 9.1 for maximum heat dissipation values. The Power+ drives are fitted with internal cooling fans on the right side. Avoid hot air inlet to internal fan.

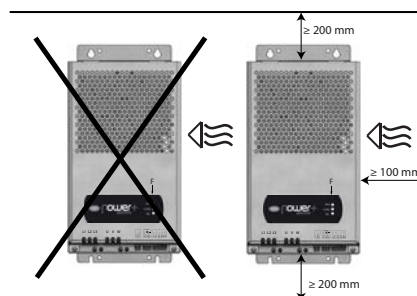


Fig. 3.ax

### 3.3.6 Electrical installation



#### Important:

- before carrying out any maintenance work, disconnect the drive and the external control circuits from the power supply by moving the main system switch to "off". Once power has been disconnected from the drive, wait at least 5 minutes before disconnecting the electrical cables;
- always make sure the motor has stopped completely. Motors that are still freely rotating may produce dangerous voltages at the Power+ terminals, even when this is disconnected from the power supply.

#### Description of the terminals

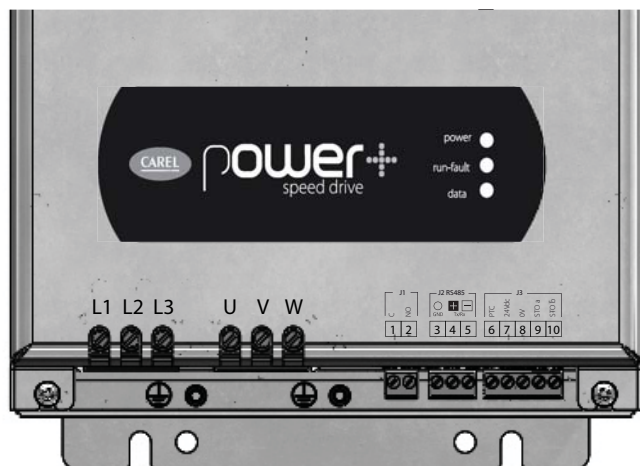


Fig. 3.ay

Ref.	Description	
L1, L2, L3	Three-phase power supply input	
⊕ Earth		
U, V, W	Motor output	
⊕ Earth		
1,2	Relay output	
3	GND	Connessione RS485/ModBus®
4	Tx/Rx+	
5	Tx/Rx-	
6	PTC	PTC input
7	24 Vdc	Auxiliary voltage
8	0V	
9	STOa	Safe Torque Off digital input (*)
10	STOb	
F (Led)	POWER (green)	drive powered
	RUN/FAULT (green/red)	drive running / drive alarm
	DATA (giallo)	communication active

Tab. 3.h

(\*) To enable the drive for operation, apply a voltage of 24 Vac/Vdc to the Safe Torque Off digital input. The polarity is indifferent for direct current power supply.



#### Note:

the group of terminals for control signals 3...10 and the group of terminals for relay 1,2 have double insulation between each other and with reference to the power terminals.



#### Warning: the max tightening torque is:

- power terminals: 1,5 Nm;
- control terminals: 0,5 Nm



#### Important:

- in the European Union, all units that incorporate the drive must comply with the Machinery Directive 2006/42/EC. Specifically, the manufacturer of the unit is responsible for the installation of a main switch and the conformity to standard EN 60204-1;
- for fixed installations according to IEC61800-5-1, a disconnect device is required on the circuit between the power supply and the drive;
- only use permanently wired power input connections; the drive must be earthed: the earth wire must be sized for the maximum fault current that is normally limited by the fuses or a circuit breaker.

### 3.3.7 Conformity to EMC standards

Power+ is designed in compliance with the high EMC standards. All models are supplied with an internal EMC filter, designed to reduce the emissions taken towards the power supply line in conformity with harmonised European Standards. It is the installer's responsibility that the device or system within which Power+ is incorporated is in compliance with the Standards in force in the country of use. The Standard in force within the European Union is the EMC 2004/108/EC Directive. Power+ is intended to be incorporated inside fixed installation devices, only installed by specialised staff.

Conformity with the EMC Standard means that the indications given in the "Electric connections" paragraph are respected and, as it also depends on wiring topology, it must be checked on the final machine as envisioned by the Final Product Standard.

### 3.3.8 Electrical connections

For installation proceed as shown below, with reference to the general connection diagram.



#### Important

the following warnings must be observed when connecting the drive:

- separate as much as possible the probe and digital input cables (at least 40 cm) from the power cables to avoid possible electromagnetic disturbance. Never lay power cables (including the electrical panel cables) and probe signal cables in the same conduits;
- the cables must be sized according to the table in paragraph 9.1;
- when the fuses are used, these must be chosen according to the data shown in the table in paragraph 9.1, and must comply with the national and local standards in force (in general use type gG fuses for IEC and see Chap. 6 for UL);
- when a magnetic circuit breaker (MCB) is used, it must be of type B, rated according to the data shown in the table in paragraph 9.1;
- avoid installing cables connected to the control terminal block in the immediate vicinity of power devices (contactors, circuit breakers, etc.). Reduce the path of the cables as much as possible, and avoid spiral paths that enclose power devices.

Use cables rated to 90 °C, and if the temperature of the terminals exceeds 85 °C, use cables rated to 105 °C. Use cable terminals suitable for the terminals and the cables used. Loosen each screw and insert the cable ends, then tighten the screws and lightly tug the cables to check correct tightness. The drive must be earthed: to do this use the screw (symbol ⊕) close to L1, L2, L3 terminals, in accordance with local standards in force. The earth impedance must be compliant with national and local standards. The earth connections must be made using eyelet lugs.

#### Power supply

Connect the power supply cables to terminals L1, L2, L3; for the size of the cables and the type of fuses, see the table in paragraph 9.1. It is recommended to use a ferrite cable core (e.g. Fair-Rite 2631102002) rounding L1, L2, L3 wires only, located just in front of the drive terminals.



#### Important:

For Coldplate models, the line reactor supplied together the Power+, has to be connected between power supply and terminals L1, L2, L3.

Failure to comply results in equipment malfunction and damage to Power+.



#### Important:

- do not connect the power supply to terminals U, V, W;
- make sure the voltage, frequency and number of phases in the power supply match the ratings of the specific model.

#### Earth leakage current

As for all inverter devices, earth leakage current greater than 3,5mA may occur. The drive is designed to produce the minimum possible leakage current. The current depends on the length and the type of motor cable, the effective switching frequency, the type of earth connection used and the type of RFI filter installed.



#### Important:

When earth leakage current is greater than 3,5mA the protective conductor should be at least 10mm<sup>2</sup> if copper or 16mm<sup>2</sup> if aluminium. As an alternative an additional protective conductor could be used.

If a residual-current circuit breaker (RCCB) is to be used, the following conditions apply:

- it must be a type B device (suitable to protect the equipment against leakage current with a DC component);
- Individual RCCBs should be used for each drive.

## Motor

Connect the motor power cable: use four-wire cable, the impedance of the earth wire must be less than or equal to the impedance of the phase wires. For the size and maximum length of the cable according to the model, see the table in paragraph 9.1. To ensure conformity to the EMC directive, use shielded cable with tape + braid shields (SN/ST). The cable can also be laid in steel and copper cableways.

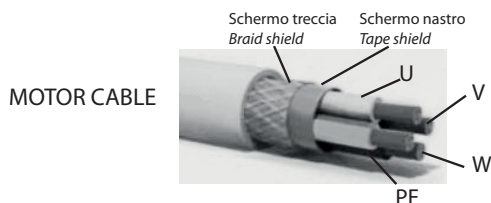


Fig. 3.az

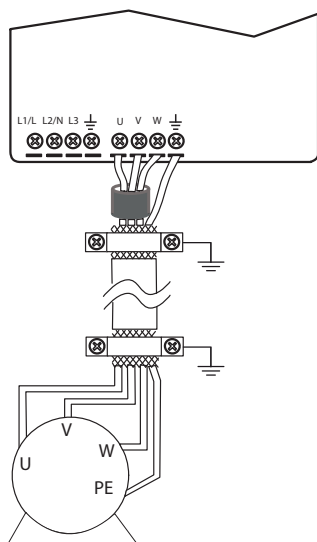


Fig. 3.ba

Earth the shield with 360° a metal clamp on both ends of the cable, as close as possible to the terminals. In case of connection of the shield to the drive screw ⊕ (not recommended), the shield has to be twisted. The twisted part must be left as short as possible, and the length must not exceed five times the width. Earth the motor directly using the drive screw ⊕.

It is recommended to use a ferrite cable core (e.g. Fair-Rite 2631102002) around U, V, W wires only, located between shield earthing and the drive terminals U, V, W.

Connect the motor phases so as to ensure the required direction of rotation: to reverse direction, swap over two of U, V, W wires as indicated in the following figures.

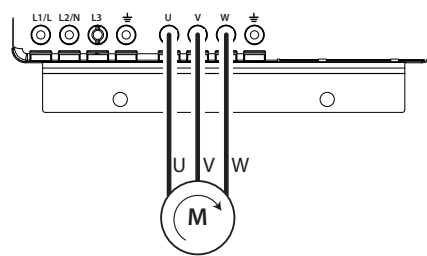
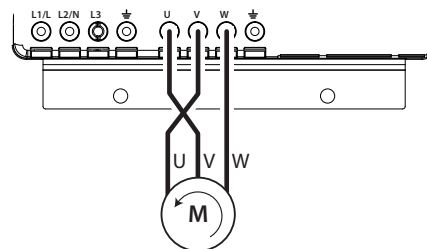


Fig. 3.bb



**Note:** Most general purpose motors are wound for operation on dual voltage supplies. This is indicated on the nameplate of the motor. The operational voltage is normally selected when installing the motor by selecting either Star or Delta connection. Star always gives the higher of the two voltage ratings. Typical ratings are:

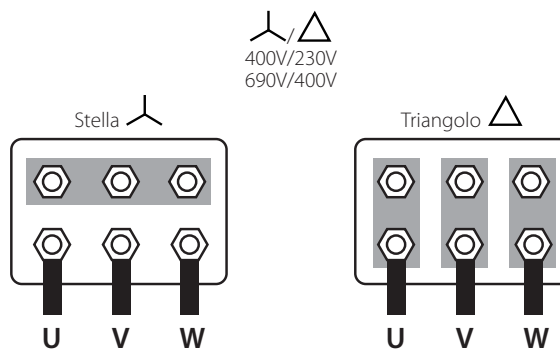


Fig. 3.bc

Fig. 3.bd



**Important:** do not turn on or off a switch between the drive and the motor when the drive is running.

## Motor protector

Connect a PTC thermistor motor protector to terminals 6 and 7: use a cable with a minimum cross-section of 1 mm<sup>2</sup>; alternatively, a Klixon thermostat can be connected (see the general connection diagram). The PTC thermistor must be selected so that at activation temperature the resistance is > 2600 Ω.

## Safety digital input

Connect the "Safety Torque Off" digital input to a safety device (for example, a maximum pressure switch) with normally closed voltage-free contact, in series with an external 24 Vac/24 Vdc voltage source, without needing to observe the polarity for direct current (ref. A). When the contact is open, the drive stops operating, bypassing the software control. If the Safety Torque Off function is not used, the input must be connected to the auxiliary 24 Vdc available on the terminal block, so as to enable correct operation of the drive (ref. B).

Dispositivo di sicurezza NC / NC Safety device

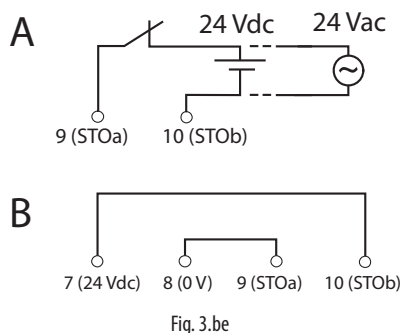


Fig. 3.be



**Note:** IEC61508 standard requires that the power supply applied to the safety input is isolated from the drive.

## Serial network connection

For the serial connection use a three-wire shielded cable. For large networks, install a 120 ohm  $\frac{1}{4}$  W resistor between terminals 4 and 5 on the last drive or device connected, to avoid possible communication problems.

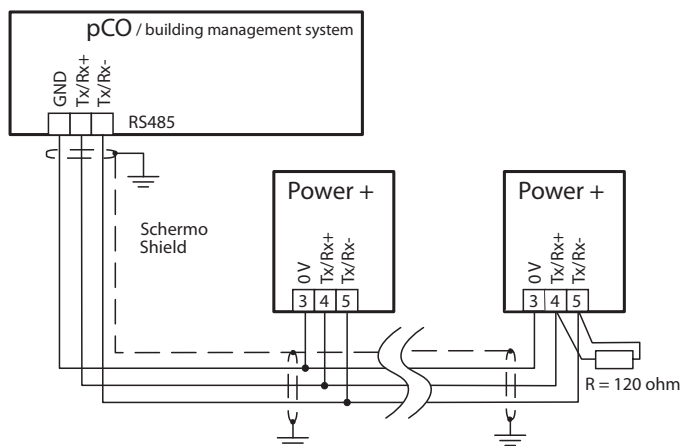


Fig. 3.bf

### 3.3.9 Functional layout

Codes PSD10\*\*42\* and PSD10\*\*4T\*

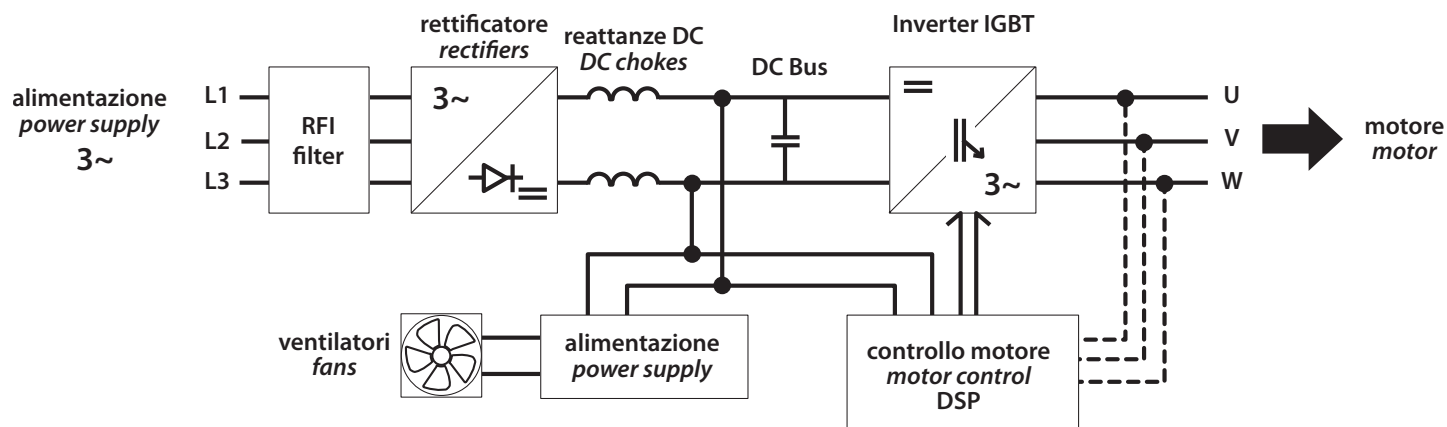


Fig. 3.bg

Codes PSD10\*\*4C\* (Coldplate models)

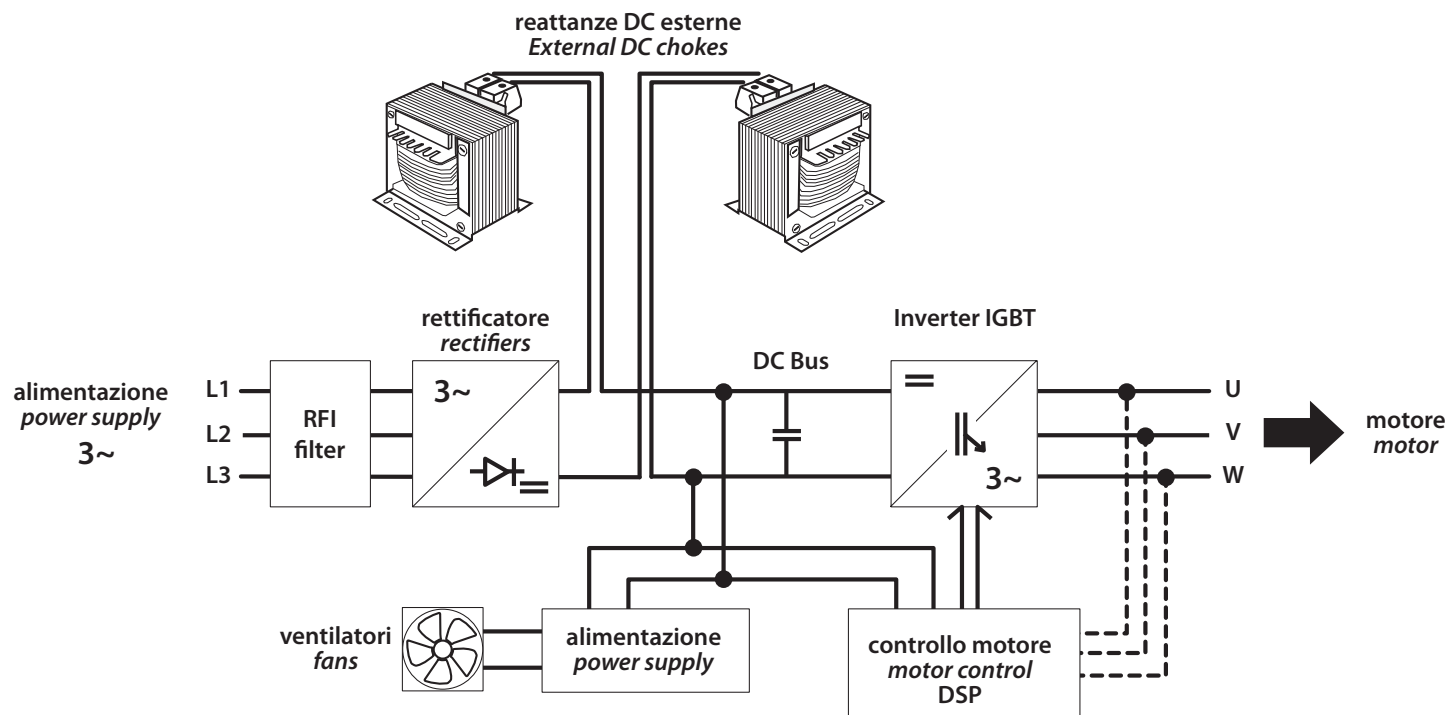


Fig. 3.bh

DC chokes are not inside the Coldplate models. They are to be installed externally to the Power+.

### 3.3.10 General connection diagram

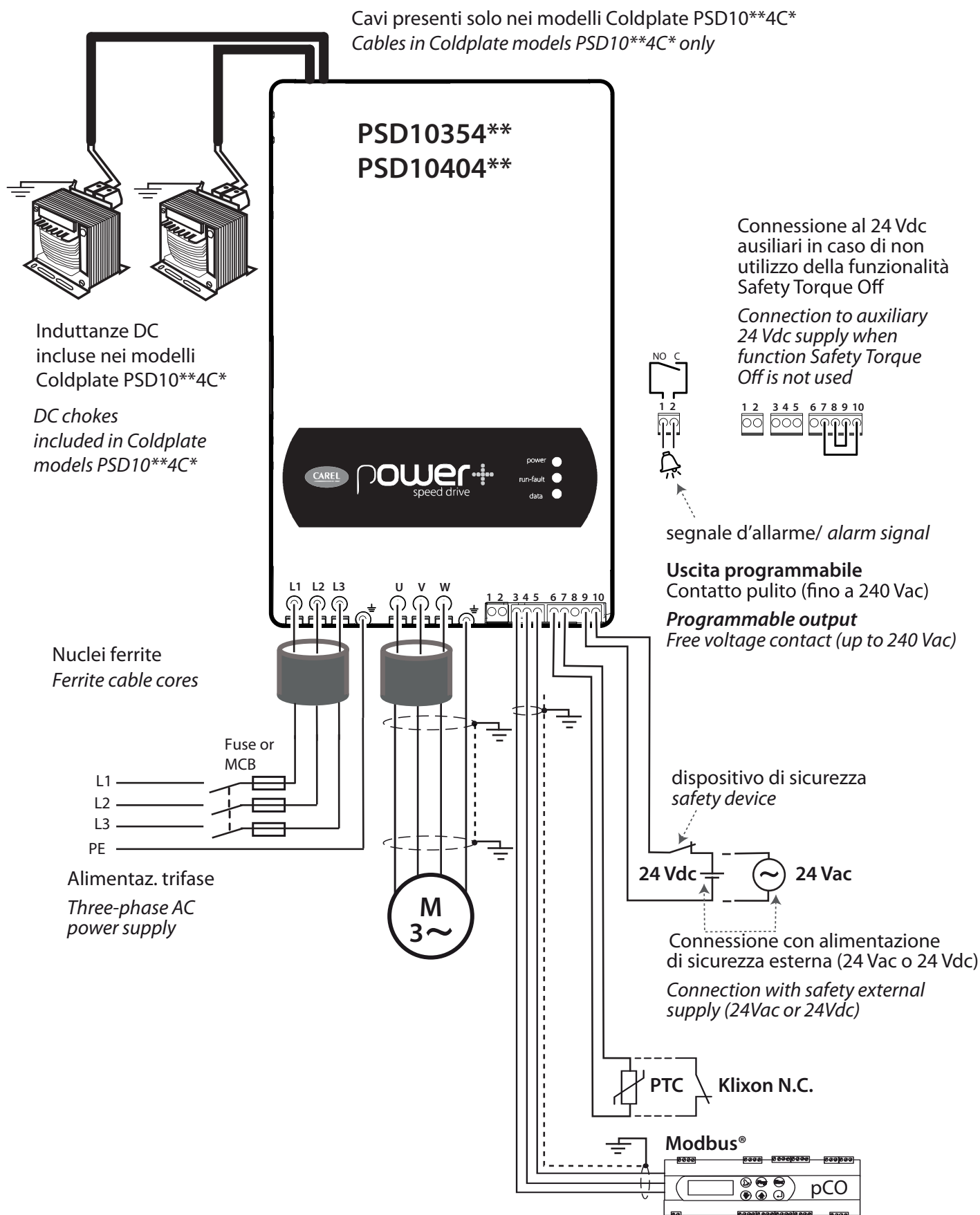


Fig. 3.bi

### 3.3.11 Power+ Coldplate models

The Power+ Coldplate models (PSD10\*\*4C\*) are the same as respective standard Power+ models, with the unique difference that the finned heatsink and fan are replaced by a flat aluminium plate.

The plate has threaded holes M5 for fixing an additional device with cooling function (coldplate), typically using liquid refrigerant. The coldplate is the user's responsibility and is not supplied by Carel.

Plate dimensions (back view)

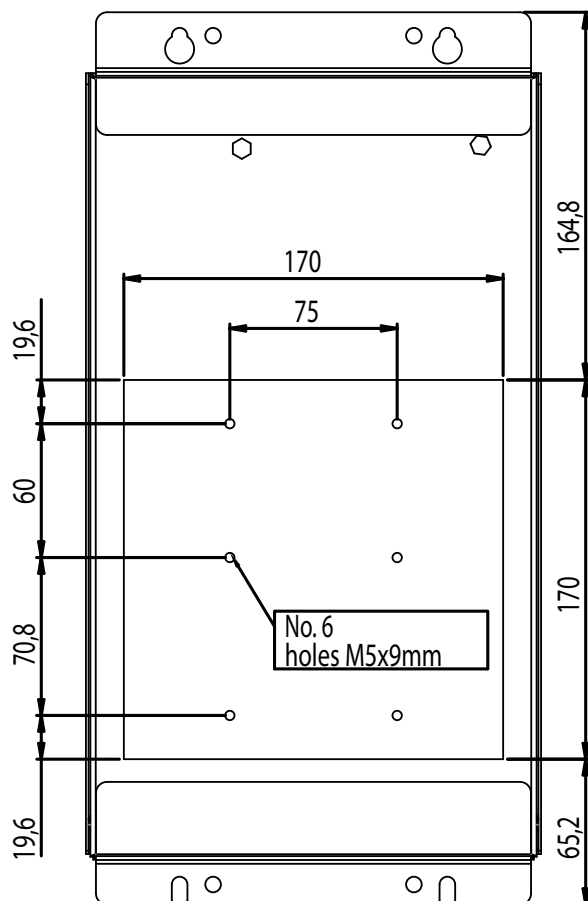


Fig. 3.bj

Assembly

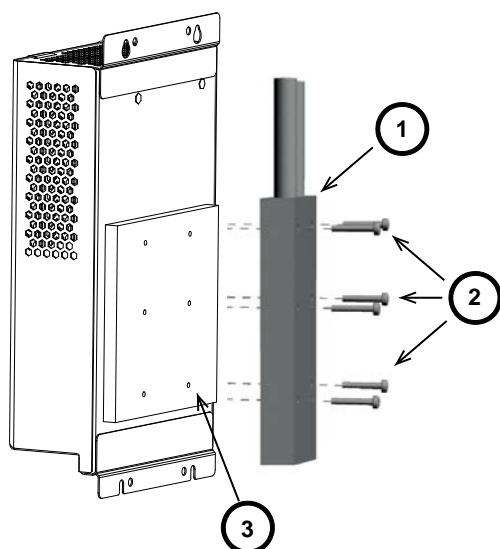


Fig. 3.bk

key:

1	Cooling device - coldplate (example)
2	Holes/screws for cooling device fitting
3	Power+ plate

#### ! Important:

- Make sure that the cooling device is dimensioned and fixed to the plate in a way to dissipate the heat while keeping the temperature of the plate below 70°C in the various operating conditions and that the overheating alarm does not intervene.
- Make sure that the cooling device does not cause the formation of condensate on the inner surface of the plate.
- Clean the contact surfaces of the Power+ plate and of the coldplate and ensure they couple perfectly.
- The use of thermal compound or similar product, between the contact surfaces of the Power+ and the coldplate allows better heat coupling.
- It is recommended that cooling device follows prescription as indicated in par. 4.4.5 of the EN 61800-5-1 Standard.

#### ! Important:

The Power+ Coldplate models (PSD10\*\*4C\*) are supplied together with two DC-chokes to be connected to the two cables coming out from the Power+, as recommended in the figure below. Not removable cables come out from left upper side of the Power+ and they are 30cm long. Install the two DC-chokes close to Power+ so that to connect them to the cables coming out from the Power+. Each cable can be indifferently connected to one of the two Dc-chokes. The polarity is indifferent for of the DC-chokes terminals.

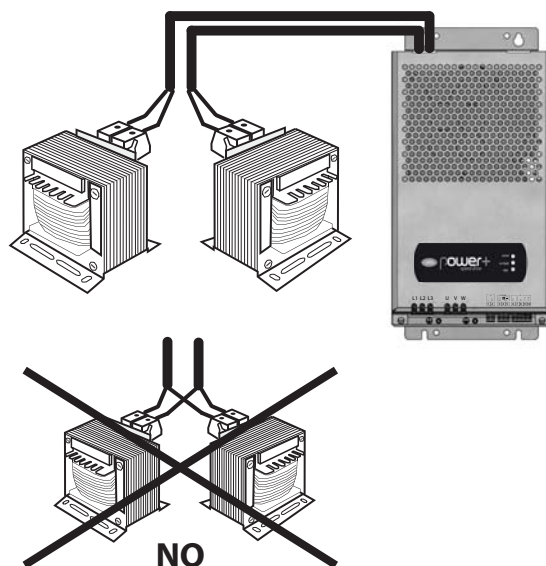


Fig. 3.bl

#### ! Important:

Do not power-on the Power+ Coldplate before to connect the cables coming out from the Power+ to the two DC-chokes terminals. At the ends of the cables are hazardous voltages. Failure to connect as recommended results in equipment malfunction and damage to Power+.

## 4. START-UP

**Important:** Power+ can pilot various types of compressors with permanent magnetic motors (PM) brushless BLDC/BLAC sensorless or asynchronous induction motors. To set the parameters of a particular compressor, consult the values indicated by CAREL in the document "Power+: compressors parameters tables" available upon request.

### 4.1 Configuration

The configuration of the drive consists in setting the various types of parameters that regard:

1. the network communication: network address, data communication baudrate, data communication parity;
2. the selection of the type of motor control;
3. the motor plate data;
4. the motor electric data;
5. motor start-up;
6. the motor control in regenerative functioning mode (load deceleration with high inertia);
7. the proportional and integral regulation (PI) of the speed.

If the motor electric data (e.g., resistances, inductance) are not known or are believed not to reflect the effective data (for example due to the length of the motor cable), the Autotuning function can be used.

**Note:** once the communication parameters are set and the type of motor and control selected, the setting of the parameters referred in the following paragraph depends on the type of motor.

#### 4.1.1 Network communication

##### Network address

The configuration and the programming of the Power+ drive, as well as the run/stop commands and the speed reference are managed by a CAREL pCO control from any BMS (Building Management System) via RS485 serial connection with ModBus® protocol. The ModBus® network address that can be set from 1 to 247. This number is made up from the base address that can be set from the parameter and the address of the 4 dip-switches located inside the drive, which goes from 0 to 15. By changing the base address the entire interval can be covered.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
32	Base address	1	1	233	-	R/W
120	Network address	-	1	247	-	R
121	Dip-switch address	-	0	15	-	R

Tab. 4.a

**Important:** To complete the update of the drive address, both dip-switch and the network, it is necessary a reset command (or after a power off and power on cycle).

	Dip-switch address	Network address
Base address=1	0	1+0=1
	...	
	14	1+14=15
Base address=232	0	232+0=232
	...	
	14	232+14=246

Tab. 4.b

The address of the dip-switches in the drive is set manually as indicated below.

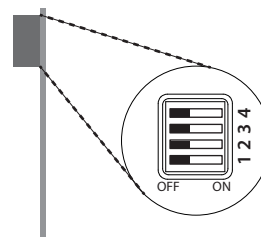


Fig. 4.a

**Important:**

Plastic cover has to be removed to access dip-switches. Before remove cover be sure to turn-off power supply, to wait leds lighting-off and then disconnect wires from terminals. To remove the cover push the two side clips with a tool (i.e. a screwdriver) and rotate up the cover.

Dip-switchAddress				Dip-switch Address
1	2	3	4	
OFF	OFF	OFF	OFF	0
ON	OFF	OFF	OFF	1
OFF	ON	OFF	OFF	2
...	...	...	...	...
ON	ON	ON	ON	15

Tab. 4.c

**Important:**

If the dip-switches address is in the range 0-14, the network address is the sum of base address and dip-switches address, and data communication baudrate and parity depend on related parameters setting.

If the dip-switches address is set to 15, data communication is forced to:

- 19200 bit/s; no parity; 2 stopbit; network address 1 independently to related parameters setting.

#### Communication baudrate, parity and errors monitoring

Mod. add.	Description	Def	Min	Max	U.M.	R/W
30	Data communication baudrate 0 = 9600 bit/s 1 = 19200 bit/s	1	0	1	-	R/W
31	Data communication parity and stop bits 0 = none (2 stopbits), 1 = even (1 stopbits), 2 = odd (1 stopbits),	0	0	2	-	R/W
122	Modbus® communication error	See the paragraph 8.4				R
123	Modbus® error counter					R

Tab. 4.d

**Important:** the modification of the "Communication baudrate" and "Communication parity" parameters only becomes effective on the next switch on or reset command.

The transmission speed can be selected between 9600 and 19200 bit/s. All devices connected in the serial network must have the same communication baudrate and the same data communication parity.

## 4.1.2 Motor control mode setting

Power+ allows to drive compressors with permanent magnetic motors (PM) brushless BLDC/BLAC sensorless or asynchronous induction motors.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
0	Motor control mode 0 = PM brushless motor 1 = not available (acts as 2) 2 = AC asynchronous motor with V/f control	0	0	2	-	R/W

Tab. 4.e

Below find the list of settings to be used according to the type of motor and control. Follow the steps described in paragraphs 4.2 or 4.3 on the basis of the type of motor control selected.

## 4.2 PM motor (brushless)

### 4.2.1 Motor data plate

#### Frequency/voltage/rated current/power factor

The base frequency is the frequency at which the base voltage is applied. Base frequency and base voltage are relative to a generic point in the voltage/frequency curve specified in the motor data sheet. The rated current is the current at full load. The power factor is not used in this motor, but it is recommended to set it at 100 (=1.00) for future compatibility.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
1	Motor base frequency	500 (50.0Hz)	250 (25.0Hz)	5000 (500.0Hz)	0.1Hz	R/W
2	Motor base voltage	230/400	25	250/500	V	R/W
3	Motor rated current	Rated current (*)	(*)	(*)	0.1A	R/W
4	Motor power factor (cosφ)	100 (1.00)	0/50 (0.5)	100 (1.00)	0.01	R/W

Tab. 4.f

(\*) Values are model dependent. See chapter 7 "PARAMETERS TABLE".

**Important:** the base frequency and the base current are used as reference for other parameters. See chapter 7 "PARAMETERS TABLE".

**Note:** see the Appendix for the frequency to the revolution speed conversion formulas, related to the number of motor poles.

#### Maximum motor current

The maximum motor current in the case of the compressor must be set at 1000(=100.0%): as there is no necessity for quick accelerations, no peak currents must be envisioned.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
5	Maximum output current	1000 (100.0%)	0	2000 (200.0%)	0.1% Motor rated current	R/W

Tab. 4.g

### 4.2.2 Motor electric data

The stator resistance is the resistance of the stator windings, measured between phase and phase. In the mathematical model of the motor, Ld and Lq are the inductance used in the reference system (d,q) rotating at rotor speed. It is recommended to use the values indicated by CAREL depending on the motors/compressors available. If the Autotuning is performed, these parameters are set automatically at the end of the procedure on the basis of the measurements detected.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
46	Stator resistance	0	0	30000	0.001ohm	R/W
48	Ld inductance	0	0	6000	0.1mH	R/W
50	Lq inductance	0	0	6000	0.1mH	R/W

Tab. 4.h

## 4.2.3 Motor start-up

These parameters optimise the initial start-up phase of the motor and the relative estimate of the position and the motor speed. It is recommended to use the values indicated by CAREL depending on the motors/compressors available. See paragraph 5.10 for the meaning of the parameters.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
51	Magnetizing time	100	0	30000	ms	R/W
57	Starting current	200 (20.0%)	0	1000 (100.0%)	0.1% Motor rated curr.	R/W
58	Maximum frequency for starting current	0	0	1000 (100.0%)	0.1% Motor rated frequency	R/W

Tab. 4.i

## 4.2.4 PI parameters for speed regulation

In applications with slow acceleration and deceleration times, as with compressors, it is recommended to use default values or the values indicated by CAREL depending on the motors/compressors available. For particular applications, consult CAREL.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
55	Speed loop: Kp	250 (25.0%)	1 (0.1%)	2000 (200.0%)	0.1%	R/W
56	Speed loop: Ti	500 (0.5s)	1 (0.001s)	1000 (1s)	1ms	R/W

Tab. 4.j

## 4.3 AC asynchronous motor with V/f control

### 4.3.1 Motor data plate

#### Frequency/voltage/rated current/power factor

The base frequency is the frequency at which the maximum voltage is applied. The rated voltage is the maximum voltage applied to the motor. If current peaks are necessary, the rated current of the motor must be lower enough that the drive rated current. The Power factor is the rated cosφ of the motor.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
1	Motor base frequency	500 (50.0Hz)	250 (25.0Hz)	5000 (500.0Hz)	0.1Hz	R/W
2	Motor base voltage	230/400	25	250/500	V	R/W
3	Motor rated current	Rated current (*)	(*)	(*)	0.1A	R/W
4	Motor power factor (cosφ)	100 (1.00)	0/50 (0.5)	100 (1.00)	0.01	R/W

Tab. 4.k

(\*) Values are model dependent. See chapter 7 "PARAMETERS TABLE".

**Note:** see the Appendix for the frequency to the revolution speed conversion formulas, related to the number of motor poles.

### Motor electric data

No parameter has to be set. If Autotuning is performed, the "stator resistance" parameter is set automatically at the end of the Autotuning procedure on the basis of the measurements detected, also if its value is not used.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
46	Stator resistance	0	0	30000	mΩ	R/W

Tab. 4.l

### 4.3.2 Motor start-up

These parameters optimise the initial start-up phase of the motor by adapting the V/f feature on the basis of the particular application, in order to improve performance at low speeds.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
35	V/f boost voltage	0	0	250 (25.0%)	0.1% Motor base voltage	R/W
36	V/f frequency adjustment	0	0	1000 (100.0%)	0.1% Motor base frequency	R/W
37	V/f voltage adjustment	0	0	1000 (100.0%)	0.1% Motor base voltage	R/W

Tab. 4.m



**Note:** In the case of asynchronous motor with V/f control, the parameters loose meaning for the PI parameters for the speed control. See paragraph 5.9 for details.

## 4.4 Autotuning

Not currently implemented.

## 4.5 Checks before commissioning

Before commissioning, check that:

- the drive output current is greater than or equal to the rated current or the maximum envisioned for the motor;
- the work voltage range is correct
- the section of the power supply cables is correct;
- the maximum section and length of the motor cables is correct and that they are connected in compliance with the wiring diagrams;
- all of the control inputs are connected correctly;
- drive is not in alarm: in case remove alarm cause (see Chapter 8) and reset the alarm (see paragraph 5.12).

## 4.6 Routine maintenance

The drive should be included within the scheduled maintenance program so that the installation maintains a suitable operating environment, this should include:

- ambient temperature is at or below that set out in the "Environment" section;
- heat sink and internal fans freely rotating and dust free;
- the enclosure in which the drive is installed should be free from dust and condensation; furthermore ventilation fans and air filters should be checked for correct air flow;
- checks on all electrical connections, ensuring screw terminals are correctly torqued and fastons are correctly fitted (PSD1\*102\*\* and PSD1D\*\*2BA10 models);
- checks on power cables that should have no signs of heat damage.



### Important

The internal capacitors must be reformed if the drive has been stored for more than two years.

For information on capacitor reforming, please contact your local Carel representative.

## 5. FUNCTIONS

### 5.1 Inputs and outputs

#### 5.1.1 Inputs

The inputs include:

1. the single or three-phase power supply, depending on the model, which must be connected selecting suitable cables and fuses according to the table in paragraph 9.1;
2. the "Safety Torque Off" safety digital input, to which an alternating or direct voltage source is connected along with a safety device. See the main connection layout;
3. the PTC thermistor for motor overtemperature protection. Must be selected for motor protection and in a way that at the alarm temperature the resistance is  $> 2600 \text{ ohm}$ .

**Important:** in order to use the PTC input, the motor overtemperature alarm must be enabled. See the paragraph 8.5.

#### 5.1.2 Outputs

The drive outputs include:

1. the motor output, to which the cables must be connected, which are dimensioned according to the table in paragraph 9.1;
2. the relay output.

### 5.2 Relay configuration

The relay function can be programmed and can indicate a functioning condition of the drive or an alarm. See the chapter 8 "ALARMS" for the latter case. The relay contact closes if the corresponding event occurs.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
26	Relay configuration 0: drive in alarm 1: external fans running 2: drive overtemperature alarm 3: motor overtemperature alarm 4: motor overload alarm 5: overvoltage alarm 6: undervoltage alarm 7: speed derating in progress 8: motor running	0	0	8	-	R/W

Tab. 5.a

### 5.3 Minimum and maximum output frequency

The parameters allow to set the minimum and maximum limit for the drive output frequency. The frequency set point must also be within the limits fixed by minimum and maximum frequency, otherwise it is not accepted.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
6	Maximum output frequency	0	0	5000	0.1Hz	R/W
7	Minimum output frequency	0	0	5000	0.1Hz	R/W

Tab. 5.b

### 5.4 Direction of rotation inversion

During drive commissioning, in order to change the direction of rotation of the motor, it is possible to swap over two of U, V, W wires. In the event of application with compressors, there is only one motor rotation direction. In other cases it is possible also to enable the reverse direction of rotation with the relative parameter.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
8	Reverse speed enable 0/1 = no/yes	0	0	1	-	R/W

Tab. 5.c

### 5.5 Speed profile

Power+ has been designed with a programmable speed profile for adaptation to the features requested on compressor start-up. Once the speed profile has been selected it is also possible to establish the method of execution. The profile is designed by three frequencies ( $f_1$ ,  $f_2$ ,  $f_3$ ), which must be reached with three linear ramp trends, defined via three accelerations ( $a_1$ ,  $a_2$ ,  $a_3$ ). Once the frequency  $f_i$  ( $i=1, 2, 3$ ) has been reached, the frequency value remains for the time  $t_i$  ( $i=1, 2, 3$ ). Regarding decrease in speed, it is possible to set just one deceleration.

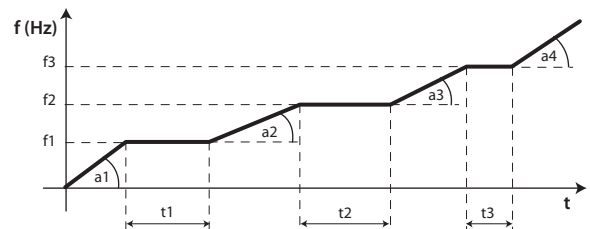


Fig. 5.a

Key

$f_1/f_2/f_3$	Frequency 1/2/3	$f$	Frequency
$a_1/a_2/a_3/a_4$	Acceleration 1/2/3/4	$t$	Time
$t_1/t_2/t_3$	Delay 1/2/3		

Mod. add.	Description	Def	Min	Max	U.M.	R/W
12	Speed profile: frequency 1	0	0	5000	0.1Hz	R/W
13	Speed profile: frequency 2	0	0	5000	0.1Hz	R/W
14	Speed profile: frequency 3	0	0	5000	0.1Hz	R/W
15	Speed profile: acceleration 1	60	0	500	0.1Hz/s	R/W
16	Speed profile: acceleration 2	60	0	500	0.1Hz/s	R/W
17	Speed profile: acceleration 3	60	0	500	0.1Hz/s	R/W
18	Speed profile: acceleration 4	60	0	500	0.1Hz/s	R/W
19	Speed profile: stand-by time 1	0	0	600	s	R/W
20	Speed profile: delay 2	0	0	600	s	R/W
21	Speed profile: delay 3	0	0	600	s	R/W
23	Speed profile: deceleration	60	0	500	0.1Hz/s	R/W

Tab. 5.d



**Note:** it is recommended to use the values indicated by CAREL in relation to the compressor used, as they guarantee the functioning mode specified by the manufacturer. Alternatively it is possible to set a simple profile ( $f_2=f_3=F_{max}$ ;  $t_1=t_2=t_3=0$ ;  $a_2=a_3=a_4=\text{maximum acceleration allowed}$ ) and refer management of the accelerations and delay times to the external control. However, in this case it is necessary to keep the values of  $a_1$  and  $f_1$  indicated by CAREL, as they are critical for the compressor start-up phase.

## 5.6 Speed profile: execution mode

It is possible to define the execution mode of the speed profile with bit0, i.e. if the individual delays must be performed just one time or if they must be carried out every time the frequency set point exceeds one of the f1, f2, f3 frequencies. If the frequency set point is decreased, the deceleration set is respected.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
22	Speed profile: execution mode (2 bit parameter)	3	0	3	-	R/W
	<b>bit</b> <b>meaning</b> <b>0/1</b>					
	0 delay					
	1 force freq. 2					
	execution					
	no/at start-up					

Tab. 5.e

**Note:** if the bit0=1 and the frequency set point is between frequency 2 and frequency 3, the speed profile will be performed respecting delays t1 and t2. If the frequency set point successively decreases to a value below f2, the frequency is reached with the deceleration defined at the relative parameter. If the frequency set point finally increases to a frequency value greater than f3, only delay t3 is respected.

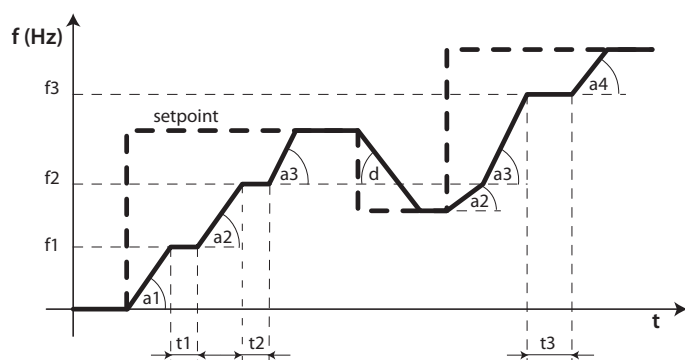


Fig. 5.b

f1/ f2/ f3	Characteristic frequency 1/2/3	f	Frequency
a1/a2/a3/a4	Deceleration/ Acceleration 1/2/3/4	t	Time
t1/ t2/ t3	Delay 1/2/3		

The bit1 is considered only if the frequency set point on start-up is lower than frequency 2 of the profile. If bit1=1, frequency 2 is always reached on start-up respecting delays t1 and t2. The frequency set point is then reached with the deceleration defined by the relative parameter.

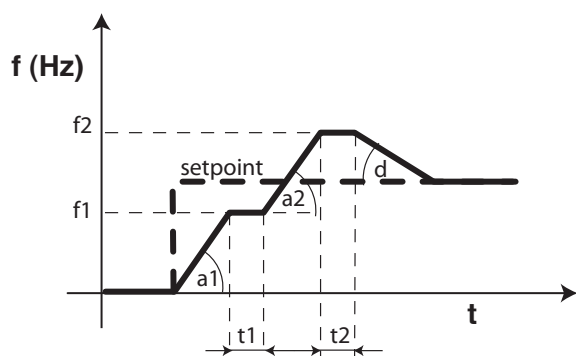


Fig. 5.c

f1/ f2	Frequency 1/2	f	Frequency
a1/a2	Acceleration 1/2	t	Time
t1/ t2	Delay 1/2	d	Deceleration

**Note:** during execution of the acceleration/deceleration ramps, it is possible to display the current frequency of the motor and the intermediate pre-ramp and post-ramp set points.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
108	Motor frequency	-	-	-	0.1Hz	R
125	Pre-ramp frequency set point	-	-	-	0.1Hz	R
126	Post-ramp frequency set point	-	-	-	0.1Hz	R

Tab. 5.f

## 5.7 Switching frequency

The parameter allows to set the switching frequency of the drive. During functioning the switching frequency can decrease to protect the drive from overheating. It can be displayed with the operating switching frequency. See the chapter 6 "PROTECTIONS".

Mod. add.	Description	Def	Min	Max	U.M.	R/W
24	Switching frequency 0 = 4kHz, 1 = 6kHz, 2 = 8kHz	0	0	2	-	R/W
124	Operating switching frequency 0=4kHz, 1=6kHz, 2= 8kHz	-	0	2	-	R

Tab. 5.g

## 5.8 Stop mode

The motor stops after the Stop command has been given (see "Commands" paragraph). In the ramp stop the speed of the motor decreases, according to the fixed deceleration parameter, down to the minimum speed. In coast stop, the motor stops without any control by the drive.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
33	Stop mode 0 = ramp 1 = coast	1	0	1	-	R/W

Tab. 5.h

## 5.9 V/f control for asynchronous motor

In the V/f control, the motor voltage varies linearly with the frequency from 0 Hz to the point where the rated voltage is applied to the motor.

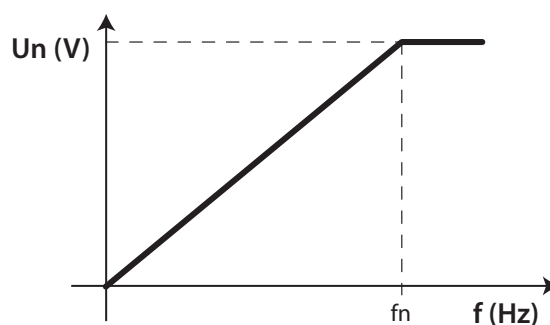


Fig. 5.d

Key			
Un	rated voltage	fn	Rated frequency

The curve can be programmed, by inserting:

- an increase in starting voltage. The boost voltage is applied at frequency 0 for the time set at the "Magnetizing time" parameter, to then drop to zero in correspondence with the frequency adjustment.
- a programmable adjustment point, to adapt the application curve better.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
35	V/f boost voltage	0	0	250 (25.0)	% Motor base voltage	R/W
36	V/f freq. cy adjustment	0	0	1000 (100.0)	% Motor base frequency	R/W
37	V/f voltage adjustment	0	0	1000 (100.0)	% Motor base voltage	R/W

Tab. 5.i

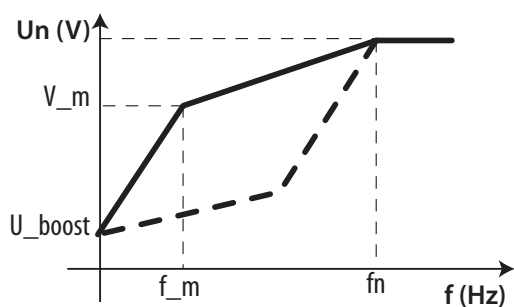


Fig. 5.e

Key				
f <sub>n</sub>	Rated voltage	U <sub>n</sub>	Rated voltage	
f <sub>m</sub>	Intermediate frequency	V <sub>m</sub>	Intermediate voltage	
U <sub>boost</sub>	Voltage boost	f	Frequency	

## 5.10 Motor control on start-up

To increase torque on start-up, Power+ envisions:

- for PM brushless motors a start-up current for the magnetizing time at frequency 0 and then adjusting the amplitude up to the frequency defined at the "Maximum frequency for starting current" parameter. The value of the start-up current is defined by the formulas:  
(Motor rated current)\*(Starting current)

Mod. add.	Description	Def	Min	Max	U.M.	R/W
45	Motor magnetizing current	0	0	Rated output current	0.1A	R/W
51	Magnetizing time	100	0	30000	0.001s	R/W
57	Starting current	200 (20.0%)	0	1000 (100.0%)	0.1%	R/W
58	Max frequency for starting current	0	0	1000 (100.0%)	0.1% Motor base frequency	R/W

Tab. 5.j

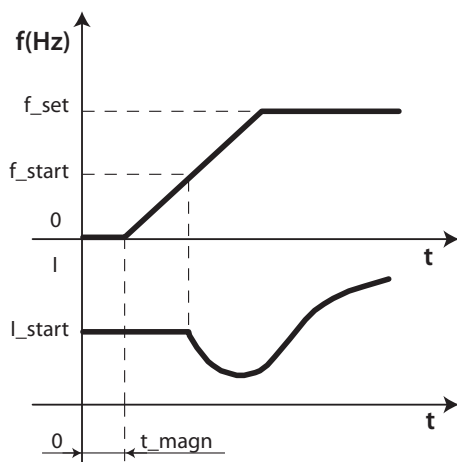


Fig. 5.f

Key			
f <sub>set</sub>	Frequency set point	f <sub>start</sub>	Max frequency for starting current
t <sub>magn</sub>	Magnetizing time	I <sub>start</sub>	Start-up current
t	Time	f	Frequency
I	Current		

- for asynchronous motor with V/f control: see the "V/f control for asynchronous motor" paragraph.

## 5.11 PI parameters

Speed regulation takes place via a PI type control, which in its simplest form is characterised by the following law:

$$u(t) = K_p \left( e(t) + \frac{1}{T} \int e(t) dt \right)$$

Note that the control is calculated as the sum of the two separate contributions, proportional and integral:

- the proportional action varies the control action proportionally to the error. Therefore the greater the value of K<sub>p</sub> (proportional gain) the faster will be the response speed. The proportional action, alone, does not allow the exact set point to be reached.
- the integral action varies the control action proportionally to the integral of the error. The lower the T<sub>i</sub> (integral time) value, the more energetic the control action.

Mod. add.	Description	Def	Min	Max	U.M.
55	Speed loop: K <sub>p</sub>	250 (25.0)	0	2000 (200.0)	0.1%
56	Speed loop: time constant T <sub>i</sub>	500	1	1000	ms

Tab. 5.k

## 5.12 Commands

### 1. Run/stop:

- bit0: run control (Run=1) and stop control (stop=0) of the motor;
- bit1: setting the direction of rotation, clockwise (0) or anti-clockwise (1). In order to have anti-clockwise rotation this must be previously enabled with the "Reverse speed enable" parameter.
- bit2: crank-case heating active (1) or inactive (0). Refer paragr. 5.13

### 2. Reset:

- bit0: allows to cancel the alarms present in the alarms queue and to update the address communication, data communication parity and communication baudrate parameters. For example, the command must be given after modification of the dip-switches in order to set the network address.
- bit1: allows to set the parameters at factory value (default). When the operation has taken place, the "Parameter default" alarm occurs. See the alarms table.
- bit2: reset flag "check drive switch on and switch off" (see speed register, bit2)



**Note:** the resets take place on transition of the respective bit from zero to one and therefore it is necessary to take the bit at zero in order to allow a successive reset action.

- Frequency set point** it is the set point that the motor must reach following the "Run" command; the direction of rotation is given by the bit1 of the Run/Stop command.

- Autotuning:** the command is given after having set the motor plate data, if electric data is not available (resistances, inductance) of the specific motor. When autotuning has ended, the parameter 104 goes automatically back to zero. See the chapter 4 "START-UP".

Mod. add.	Description	Def	Min	Max	U.M.
100	Run/Stop (3 bit parameter)	0	0	7	-
	<b>bit meaning</b>				
	0 0/1= stop/run				
	1 0/1=rotation in clockwise/anticlockwise direction				
	2 0/1= crank-case heating inactive/active; setting to 1 is allowed only if bit0=0				
101	Reset (3 bit parameter)	0	0	7	-
	<b>bit meaning</b>				
	0 1= alarms reset, and updating of communication parameters				
	1 1= parameters reset at default values				
	2 1= reset flag check drive switch on and switch off (see speed regulator, bit2)				
102	Frequency set point	0	Min out freq.	Max out freq.	0.1Hz
103	Autotuning 0/1=not active/start	0	0	1	-

Tab. 5.l

### 5.13 Crank-case heater

In cold environment it may be necessary to keep the compressor warm in order to avoid oil freezing even when compressor is not running. Crank-case heater command forces a programmable current into the compressor windings in order to heat it.

Mod. add.	Description	Def	Min	Max	U.M.
100	Run/Stop (3 bit parameter)	0	0	7	-
	<b>bit meaning</b>				
	0 -				
	1 -				
	2 Crank-case heater: 0= inactive; 1=active setting to 1 is allowed only if bit0=0				
65	Crank-case heater current	0	0	1000	0.1% Motor rated current



**Note:** Run command has priority over crank-case heating.



**Important:**

Crank-case heater current has to be properly set in order to avoid overheating of windings.

### 5.14 Status variables

The status variables are the read-only type and supply information regarding the status of the drive (e.g. Modbus® = 104, drive in start, stop or alarm) or the alarms present in the alarms code or other general information. For example, with the bit of the status regulator it is possible to know whether the drive is in a particular alarm status or protection, the status of the digital safety input (STO) or the relay output.

The speed register signals whether the speed profile has been completed, if the speed automatic decrease function is active and with the relative flag shows whether there has been a voltage black-out.

Other status variables inform regarding the drive temperature, current/voltage/power supplied, the energy supplied in kWh and MWh, the voltage and the voltage ripple on the DC bus, the number of drive switch-on hours and the number of functioning hours with the motor running. Regarding the characteristic data of the drive, the serial number and firmware version are available. For the complete list see paragraph 7.3.

### 5.15 Modbus® Commands

The Power+ drive only uses Registers (16 bit), not boolean variables (coils). The Modbus® functions implemented are:

Function number	Function name
03 (0x03)	Holding register reading
04 (0x04)	Input register reading
06 (0x06)	Single register writing

Tab. 5.m

The Modbus® exceptions supported are:

- exception 1: function not supported;
- exception 2: address not accepted;
- exception 4: value not accepted;
- exception 6: device occupied.

## 6. PROTECTIONS

Protections functions exist that intervene to prevent:

1. mechanical resonances;
2. drive overtemperature.

### 6.1 Skip frequency

It may be necessary to avoid particular frequencies in some systems due to mechanical resonance problems. Using the following parameters it is possible to fix the limits of the frequency area to be avoided for the frequency set point. If the frequency set point assumes a value within the area, the effective set point is blocked at values  $f_c - B/2$  or  $f_c + B/2$ , depending whether the frequency is increasing or decreasing.

Up to three different frequency prohibited areas can be set.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
10	Skip frequency: set 1	0	0	5000 (500.0Hz)	0.1Hz	R/W
11	Skip frequency: band 1					
66	Skip frequency: set 2					
67	Skip frequency: band 2					
68	Skip frequency: set 3					
69	Skip frequency: band 3					

Tab. 6.a

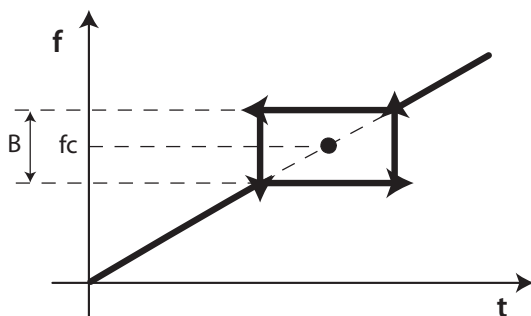


Fig. 6.a

Key			
$f_c$	Skip frequency: set	B	Skip frequency: band
t	Time	f	Frequency

**Note:** if the set point is outside the area defined by the set and the band, traversing the prohibited area takes place with normal acceleration and deceleration.

### 6.2 Automatic reduction of the switching frequency

On increasing switching frequency, motor noise decreases, but the heat to be dissipated increases and therefore, also the temperature of the drive. The switching frequency set is used on start-up and can be gradually decreased automatically if the temperature of the drive reaches high values, in a way to prevent the drive overtemperature alarm. If successively the temperature of the drive is within the typical values, the switching frequency gradually returns to the initial value. Among the reading-only variables, it is possible to display the effective switching frequency.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
24	Switching frequency 0 = 4kHz; 1 = 6kHz; 2 = 8kHz	0	0	2	-	R/W
25	Switching frequency derating 0/1 = no/yes	0	0	1	-	R/W
124	Operating switching frequency 0=4kHz, 1=6Hz, 2=8kHz	0	0	2	-	R

Tab. 6.b

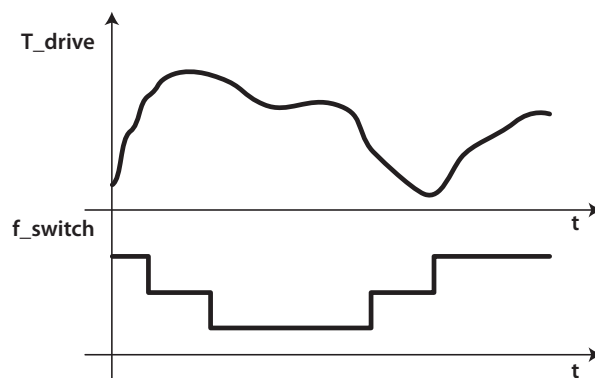


Fig. 6.b

Key

$T_{drive}$	Drive temperature	t	time
$f_{switch}$	switching frequency		

### 6.3 Automatic reduction of motor speed

It is possible to prevent the drive overtemperature alarm also using the automatic motor speed reduction function. Decreasing motor speed corresponds to decreasing the output power of the drive and therefore the heat to be dissipated. See the following figure. To activate the function, set the "Speed reduction mode" parameter at a value  $>0$ , which becomes the differential (DT) in order to determine the temperature threshold ( $T_{th} - DT$ ). When this is exceeded, the speed set point is forced to minimum, corresponding to the "Minimum output frequency" parameter. If after a certain period of time, the temperature of the drive drops below the value  $T_{th} - 2DT$ , the set point gradually returns to the requested value. If the differential is set at zero, the function is disabled.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
9	Speed derating mode 0 = function disabled	0	0	10	°C	R/W

Tab. 6.c

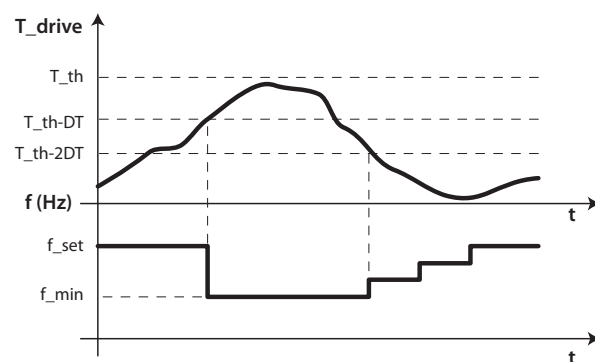


Fig. 6.c

Legenda

t	Time	DT	Differential for automatic speed decrease function
$f_{set}$	Frequency set point	$t_{drive}$	Drive temperature
$T_{th}$	Over-heating alarm threshold	$f_{min}$	Out frequency min

## 6.4 Motor overload

If output current is greater than motor rated current, a I\*T (current\*time) control is started that force the motor overload alarm when current is greater than 150% of motor rated current for 1 minute.

The motor overload counter is

- incremented proportionally to the output current when it is greater than motor rated value; alarm is triggered when counter reach 1000.
- decremented to 0 when current is lower than motor rated value.

Motor overload counter is saved when drive is switched-off. At the next power-on, if enabled via parameter, the counter is restored to previously saved value otherwise it is reset to 0.

Mod. add.	Description	Def	Min	Max	U.M.
3	Motor rated current	(*)	(*)	(*)	0.1A
76	Extended functions (5 bit parameter)	0	0	31	-
	<b>bit meaning</b>				
	0 -				
	1 -				
	2 -				
	3 motor overload at power-on: 0=counter reset 1=counter restored				
	4 -				
153	Motor overload counter	0	0	1000	-

Tab. 6.d

(\*) Values are model dependent. See chapter 7 "PARAMETERS TABLE".

## 6.5 Drive overload

If output current is greater than drive rated current, a I\*T (current\*time) control is started that force the drive overload alarm when current is greater than 110% of drive rated current for 1 minute.

The drive overload counter is

- incremented proportionally to the output current when it is greater than drive rated value; alarm is triggered when counter reach 1000.
- decremented to 0 when current is lower than drive rated value.

The counter is reset to 0 at power-on.

Mod. add.	Description	Def	Min	Max	U.M.
154	Drive overload counter	0	0	1000	-

Tab. 6.e

## 7. PARAMETERS TABLE



### Note:

- the values of some parameters are expressed in tenths, hundredths, thousandths of the unit of measurement. For commodity, in this case the equivalent corresponding value in the standard unit of measurement is indicated at the side in brackets;
- Y/N = YES/NO
- all parameters and commands are accessible in reading and writing (R/W), the status variables are reading only (R). The identification is by address. If register identification is to be used, use the following formula: register = address+1



**Important:** modifying undocumented parameters can seriously compromise the drive and attached devices.

### 7.1 Parameters table

Mod. add.	Parameter	Def	Min	Max	U.M.	R/W	Description	Applicable for		locked if drive is in RUN
								PM motor	AC V/f motor	
0	Motor control mode	0	0	2	-	R/W	Sets the type of motor and control. 0 = PM brushless motor 1 = not used 2 = AC asynchronous motor with V/f control	Y	Y	Y
1	Motor base frequency	500 (50.0Hz)	250 (25.0Hz)	5000 (500.0Hz)	0.1Hz	R/W	Sets the motor base frequency (electric). For AC asynchronous motors the value can normally be found on the motor technical plate. For motors with permanent magnets (PM) it is suggested to set it at values indicated by CAREL.	Y	Y	Y
2	Motor base voltage	230/400	25	250/500	V	R/W	Sets the phase-phase rated voltage (corresponding to the motor base frequency). For AC asynchronous motors the value can normally be found on the motor technical plate (depending on the type of triangle/delta connection). For motors with permanent magnets (PM) it is suggested to set it at values indicated by CAREL. Def. and Max values depends on rated power supply of the models	Y	Y	Y
3	Motor rated current	Drive rated output current	1/10 drive rated output current	Drive rated output current	0.1A	R/W	Sets the motor rated current. It is also the reference for motor overload protection (I*T "current*time" up to 150% of the rated current for 1 minute). For AC asynchronous motors the value can normally be found on the motor technical plate. For motors with permanent magnets (PM) it is suggested to set it at maximum motor current (normally corresponding to maximum electric frequency). For AC asynchronous motors only set the current threshold for overload protection. For PM brushless motors the parameter establishes the maximum supplied current value. If to rotate at a given speed, the motor requires a higher current than that set here, the drive limits the current with consequent speed reduction to a value consistent with the current supplied.	Y	Y	Y
5	maximum output current	1000 (100.0%)	0	2000 (200.0%)	0.1% Motor rated current	R/W	If the control envisions, it is possible to supply the motor with current that can reach double the rated one, considering that the resulting current will be limited by the maximum value that can be supplied by the drive. A larger current than that supplied by the "Motor rated current" parameter can be applied for a limited period of time, after which the "Motor overload" alarm occurs. The threshold beyond which the alarm is activated corresponds to functioning at 150% of the rated current for 1 minute.	Y	N	N
6	Maximum output frequency	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the drive maximum output frequency (electric)	Y	Y	N
7	Minimum output frequency	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the drive minimum output frequency (electric)	Y	Y	N
8	Reverse speed enable	0	0	1	-	R/W	Enables the run command also in anti-clockwise direction: 0 = disabled; 1 = enabled	Y	Y	N
9	Speed derating mode	0	0	10	°C	R/W	The function allows to automatically reduce the speed depending on the temperature of the drive. If enabled, the value 3 is recommended (see par. 6.3). 0 = function disabled	Y	Y	N
10	Skip frequency: set 1	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the prohibited frequencies interval set. See par. 6.1	Y	Y	N
11	Skip frequency: band 1	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the prohibited frequencies interval band. See par. 6.1	Y	Y	N
12	Speed profile: frequency 1	0	0	5000 (500.0Hz)	0.1Hz	R/W	Frequency 1 of the speed profile	Y	Y	N
13	Speed profile: frequency 2	0	0	5000 (500.0Hz)	0.1Hz	R/W	Frequency 2 of the speed profile	Y	Y	N
14	Speed profile: frequency 3	0	0	5000 (500.0Hz)	0.1Hz	R/W	Frequency 3 of the speed profile	Y	Y	N
15	Speed profile: acceleration 1	60 (6.0Hz/s)	0	500 (50.0Hz/s)	0.1Hz/s	R/W	Acceleration 1 of the speed profile	Y	Y	N
16	Speed profile: acceleration 2	60 (6.0Hz/s)	0	500 (50.0Hz/s)	0.1Hz/s	R/W	Acceleration 2 of the speed profile	Y	Y	N

Mod. add.	Parameter	Def	Min	Max	U.M.	R/W	Description	Applicable for		locked if drive is in RUN																		
								PM motor	AC V/f motor																			
17	Speed profile: acceleration 3	60 (6.0Hz/s)	0	500 (50.0Hz/s)	0.1Hz/s	R/W	Acceleration 3 of the speed profile	Y	Y	N																		
18	Speed profile: acceleration 4	60 (6.0Hz/s)	0	500 (50.0Hz/s)	0.1Hz/s	R/W	Acceleration 4 of the speed profile	Y	Y	N																		
19	Speed profile: delay 1	0	0	600	s	R/W	Delay 1 of the speed profile	Y	Y	N																		
20	Speed profile: delay 2	0	0	600	s	R/W	Delay 2 of the speed profile	Y	Y	N																		
21	Speed profile: delay 3	0	0	600	s	R/W	Delay 3 of the speed profile	Y	Y	N																		
22	Speed profile: execution method (2 bit parameter)	3	0	3	-	R/W	See par. 5.6 <table><tr><td>bit</td><td>meaning</td><td>0/1</td></tr><tr><td>0</td><td>delay execution</td><td>always/only once at every start-up</td></tr><tr><td>1</td><td>force frequency 2</td><td>no/at start-up</td></tr></table>	bit	meaning	0/1	0	delay execution	always/only once at every start-up	1	force frequency 2	no/at start-up	Y	Y	N									
bit	meaning	0/1																										
0	delay execution	always/only once at every start-up																										
1	force frequency 2	no/at start-up																										
23	Speed profile: deceleration	60 (6.0Hz/s)	0	500 (50.0Hz/s)	0.1Hz/s	R/W	Set the frequency deceleration	Y	Y	N																		
24	Switching frequency	0	0	2	-	R/W	Sets the switching frequency of the drive. See par. 6.2. 0 = 4kHz; 1 = 6kHz; 2 = 8kHz	Y	Y	N																		
25	Switching frequency derating	0	0	1	-	R/W	The function allows to automatically decrease the PWM switching frequency on the basis of drive temperature: 0 = disabled; 1 = enabled	Y	Y	N																		
26	Relay configuration	0	0	8	-	R/W	Selects the event associated to closure of the relay contact <table><tr><td>0</td><td>drive in alarm</td></tr><tr><td>1</td><td>heatsink fan running</td></tr><tr><td>2</td><td>drive overtemperature alarm</td></tr><tr><td>3</td><td>motor overtemperature alarm</td></tr><tr><td>4</td><td>motor overload alarm</td></tr><tr><td>5</td><td>overvoltage alarm</td></tr><tr><td>6</td><td>undervoltage alarm</td></tr><tr><td>7</td><td>speed derating in progress</td></tr><tr><td>8</td><td>motor running</td></tr></table>	0	drive in alarm	1	heatsink fan running	2	drive overtemperature alarm	3	motor overtemperature alarm	4	motor overload alarm	5	overvoltage alarm	6	undervoltage alarm	7	speed derating in progress	8	motor running	Y	Y	N
0	drive in alarm																											
1	heatsink fan running																											
2	drive overtemperature alarm																											
3	motor overtemperature alarm																											
4	motor overload alarm																											
5	overvoltage alarm																											
6	undervoltage alarm																											
7	speed derating in progress																											
8	motor running																											
27	Motor overtemperature alarm (PTC) enable	0	0	1	-	R/W	Enables the motor overtemperature alarm, which occurs if the PTC input sees a resistance of > 2600 ohm at its ends for the time set at the “Motor overtemperature alarm delay” parameter 0 = disabled; 1 = enabled	Y	Y	N																		
28	Motor overtemperature alarm delay	0	0	600	s	R/W	Sets the time after which the “Motor overtemperature” alarm occurs	Y	Y	N																		
29	Data communication fault timeout	0	0	600	s	R/W	Sets the time after which the “Data communication fault” alarm occurs if the communication with the Master is interrupted (only if the motor is running) 0 = alarm disabled	Y	Y	N																		
30	Data communication baudrate	1	0	1	-	R/W	Sets the Modbus® communication baudrate. The modified value becomes effective only after a reset or successive switch-on of the drive. 0 = 9600 bit/s; 1 = 19200 bit/s	Y	Y	N																		
31	Data communication parity and stopbit	0	0	2	-	R/W	Set the data communication parity and stop bit for communication. The modified value becomes effective only after a reset or successive switch-on of the drive. 0 = none (2 stopbit); 1 = even (1 stopbit); 2 = odd (1 stopbit)	Y	Y	N																		
32	Base address	1	1	233	-	R/W	Sets the drive base address. The drive network address is included in the “Base address”... “Base address” +14 interval, according to the position of the dip-switches. The modified value becomes effective only after a reset or successive switch-on of the drive.	Y	Y	N																		
33	Stop mode	1	0	1	-	R/W	Sets the drive stop mode, following a stop command. 0 = ramp; 1 = coast	Y	Y	N																		
35	V/f boost voltage	0	0	250 (25.0%)	0.1% Motor base voltage	R/W	Sets the voltage applied at frequency 0. See par. 5.10.	N	Y	Y																		
36	V/f frequency adjustment	0	0	1000 (100.0%)	0.1% Motor base frequency	R/W	Sets the frequency adjustment to adapt the V/f curve.	N	Y	Y																		
37	V/f voltage adjustment	0	0	1000 (100.0%)	0.1% Motor base voltage	R/W	Sets the voltage adjustment to adapt the V/f curve.	N	Y	Y																		
46	Stator resistance	0	0	30000 (30.Ω)	mΩ	R/W	Sets the stator resistance	Y	N	N																		
48	Ld inductance	0	0	6000 (600.0 mH)	0.1mH	R/W	Sets the motor inductance component Ld of permanent magnets (PM) motors	Y	N	N																		
50	Lq inductance	0	0	6000 (600.0 mH)	0.1mH	R/W	Sets the motor inductance component Lq of permanent magnets (PM) motors	Y	N	N																		
51	Magnetizing time	100 (0.1s)	0	30000 (30 s)	ms	R/W	Sets the application time of the “Starting current” or of the “Voltage boost”	Y	Y	Y																		
55	Speed loop: Kp	250 (25.0%)	1 (0.1%)	2000 (200.0%)	0.1%	R/W	Sets the proportional gain of speed control loop Expressed in tenths of percentage of the unit gain	Y	N	N																		
56	Speed loop: Ti	500 (0.5s)	1 (0.001s)	1000 (1s)	ms	R/W	Sets the Integral time of speed control loop	Y	N	N																		

Mod. add.	Parameter	Def	Min	Max	U.M.	R/W	Description	Applicable for		locked if drive is in RUN																					
								PM motor	AC V/f motor																						
57	Starting current	200 (20.0%)	0	1000 (100.0%)	0.1% Motor rated current	R/W	Sets the current applied at start-up as percentage of motor rated current	Y	N	N																					
58	Max frequency for starting current	0	0	1000 (100.0%)	0.1% Motor base frequency	R/W	Sets the maximum frequency up to which the current applied at start-up is applied	Y	N	N																					
65	Crank-case heater current	0	0	1000 (100.0%)	0.1% Motor rated current	R/W	Sets the output current when Crank-case heater function is enabled as percentage of motor rated current	Y	Y	N																					
66	STO alarm mode	0	0	2	-	R/W	Sets the STO alarm behavior when STO input is de-energized while in stop status.  <table><tr><td>0</td><td>alarm with manual reset</td></tr><tr><td>1</td><td>alarm with autoreset when STO input is re-energized</td></tr><tr><td>2</td><td>no alarm (drive disabled)</td></tr></table>  When in run status STO alarm is always enabled with manual reset. Refer paragraph 8.8	0	alarm with manual reset	1	alarm with autoreset when STO input is re-energized	2	no alarm (drive disabled)	Y	Y	N															
0	alarm with manual reset																														
1	alarm with autoreset when STO input is re-energized																														
2	no alarm (drive disabled)																														
67	Skip frequency: set 2	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the prohibited frequencies interval set. See par. 6.1	Y	Y	N																					
68	Skip frequency: band 2	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the prohibited frequencies interval band. See par. 6.1	Y	Y	N																					
69	Skip frequency: set 3	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the prohibited frequencies interval set. See par. 6.1	Y	Y	N																					
70	Skip frequency: band 3	0	0	5000 (500.0Hz)	0.1Hz	R/W	Sets the prohibited frequencies interval band. See par. 6.1	Y	Y	N																					
76	Extended functions	0	0	63	-	R/W	<table><tr><th>bit</th><th>meaning</th><th>0/1</th></tr><tr><td>0</td><td>motor phase fault alarm</td><td>enabled/disabled</td></tr><tr><td>1</td><td>reserved</td><td>(*)</td></tr><tr><td>2</td><td>reserved</td><td>(*)</td></tr><tr><td>3</td><td>motor overload at power-on</td><td>counter reset /counter restore</td></tr><tr><td>4</td><td>reserved</td><td>(*)</td></tr><tr><td>5</td><td>reserved</td><td>(*)</td></tr></table> (*) leave at 0	bit	meaning	0/1	0	motor phase fault alarm	enabled/disabled	1	reserved	(*)	2	reserved	(*)	3	motor overload at power-on	counter reset /counter restore	4	reserved	(*)	5	reserved	(*)	Y	Y	N
bit	meaning	0/1																													
0	motor phase fault alarm	enabled/disabled																													
1	reserved	(*)																													
2	reserved	(*)																													
3	motor overload at power-on	counter reset /counter restore																													
4	reserved	(*)																													
5	reserved	(*)																													
77	Inductance saturation factor	0	0	1000	0.1% Reduction	R/W	Inductance saturation reduction (percentage at rated current)	Y	N	N																					

Tab. 7.a

## 7.2 Commands

Mod. add.	Parameter	Def	Min	Max	U.M.	R/W	Description	Applicable for		locked if drive is in RUN										
								PM motor	AC V/f motor											
100	Run/stop (3 bit parameter)	-	0	7	-	R/W	Clockwise and counterclockwise Run and Stop commands, auxiliary functions commands.  <table><tr><th>bit</th><th>meaning</th></tr><tr><td>0</td><td>stop/run</td></tr><tr><td>1</td><td>clockwise/counterclockwise rotation</td></tr><tr><td>2</td><td>crank-case heater off/on (effective only in stop: bit0=0)</td></tr><tr><td>3</td><td>reserved</td></tr></table>	bit	meaning	0	stop/run	1	clockwise/counterclockwise rotation	2	crank-case heater off/on (effective only in stop: bit0=0)	3	reserved	Y	Y	N
bit	meaning																			
0	stop/run																			
1	clockwise/counterclockwise rotation																			
2	crank-case heater off/on (effective only in stop: bit0=0)																			
3	reserved																			
101	Reset (3 bit parameter)	-	0	allowable values: 1, 2, 4	-	R/W	The reset comand is executed when the related bit changes from 0 to 1. After that the bit has to be cleared to 0 again.  <table><tr><th>bit</th><th>meaning</th></tr><tr><td>0</td><td>alarms reset updating of communication parameters reset of communication errors status</td></tr><tr><td>1</td><td>parameters reset at default values</td></tr><tr><td>2</td><td>reset flag check drive switch on and switch off (see speed regulator, bit2)</td></tr></table>	bit	meaning	0	alarms reset updating of communication parameters reset of communication errors status	1	parameters reset at default values	2	reset flag check drive switch on and switch off (see speed regulator, bit2)	Y	Y	Y		
bit	meaning																			
0	alarms reset updating of communication parameters reset of communication errors status																			
1	parameters reset at default values																			
2	reset flag check drive switch on and switch off (see speed regulator, bit2)																			
102	Frequency set point	-	Minimum output frequency	Maximum output frequency	0.1Hz	R/W	Sets the desired output frequency, the direction of rotation is given by bit1 of the "Run/stop" command.	Y	Y	N										
103	Autotuning	-	0	1	-	R/W	The Autotuning procedure allows to estimate different parameters according to the type of motor. See par.4.5. 0 = not active; 1 = start	Y	Y	Y										

Tab. 7.b

## 7.3 Status variables

Mod. add.	Parameter	Def	Min	Max	U.M.	R/W	Description	Applicable for		
								PM	AC V/f	
104	Drive status	-	0	2	-	R	Shows the status of the drive:		Y	Y
105	Alarm code	-	0	29	-	R	See the chapter 8 "ALARMS"		Y	Y
106	Status register (15 bit parameter)	-	0	65535	-	R	Shows the details of the drive status			

Mod. add.	Parameter	Def	Min	Max	U.M.	R/W	Description	Applicable for																
								PM	AC V/f															
107	Speed register (15 bit parameter)	-	0	65535	-	R	Bit 2 on switch-on is forced to 1. With the Reset command (bit2) the flag can be reset at 0. In this way it is possible to control if the drive has been switched off and back on again  <table><tr><th>bit</th><th>meaning</th><th>0/1</th></tr><tr><td>0</td><td>speed profile complet. at least once</td><td>yes/no</td></tr><tr><td>1</td><td>automatic reduction of motor speed</td><td>no/yes</td></tr><tr><td>2</td><td>flag verifies drive switch off and back on</td><td>no/yes</td></tr><tr><td>3..15</td><td>RESERVED</td><td>-</td></tr></table>	bit	meaning	0/1	0	speed profile complet. at least once	yes/no	1	automatic reduction of motor speed	no/yes	2	flag verifies drive switch off and back on	no/yes	3..15	RESERVED	-	Y	Y
bit	meaning	0/1																						
0	speed profile complet. at least once	yes/no																						
1	automatic reduction of motor speed	no/yes																						
2	flag verifies drive switch off and back on	no/yes																						
3..15	RESERVED	-																						
108	Motor frequency	-	-	-	0.1Hz	R	Motor equivalentt frequency. Normally equal to "Post-ramp frequency set point", except in situations with current limitation, in which case it is equal to the estimate value of the "Rotor frequency"	Y	Y															
109	Motor current	-	-	-	0.1A	R	Actual current of the motor	Y	Y															
110	Motor power	-	-	-	0.01kW	R	Current power of the motor	Y	Y															
111	Motor voltage	-	-	-	V	R	Voltage applied to the motor	Y	Y															
113	DC bus voltage	-	-	-	V	R	DC Bus average voltage	Y	Y															
114	Drive temperature	-	-	-	°C	R	Power module temperature	Y	Y															
115	Switch-on time	-	-	-	hour	R	Drive life time	Y	Y															
116	Drive run time	-	-	-	hour	R	Drive switch-on time with motor running	Y	Y															
117	Drive run time from last alarm	-	-	-	hour	R		Y	Y															
118	kWh meter	-	-	-	0.1kWh	R	Total energy supplied to the motor: when it reaches 10,000 (1000kWh), it goes back to zero and the counter is increased in MWh	Y	Y															
119	MWh meter	-	-	-	MWh	R		Y	Y															
120	Network address	-	1	247	-	R	Drive network address	Y	Y															
121	Dip-switch address	-	0	15	-	R	Network address set by the drive dip-switches If set to 15 then communications default configuration is used anyway	Y	Y															
122	Modbus* communication error	-	-	-	-	R	Show additional information regarding communication error Reset to 0 at power-on or on reset command. See par.8.4	Y	Y															
123	Modbus* error counter	-	-	-	-	R	Show number of errors detected in received data from last power-on or reset See par.8.4	Y	Y															
124	Operating switching frequency	-	0	2	-	R	0 = 4kHz, 1 = 6kHz, 2 = 8kHz	Y	Y															
125	Pre-ramp frequency set point	-	-	-	0.1Hz	R	Shows the internal set point for the output frequency before the acceleration/ deceleration ramps	Y	Y															
126	Post-ramp frequency set point	-	-	-	0.1Hz	R	Shows the internal set point for the output frequency after the acceleration/ deceleration ramps	Y	Y															
132	Rotor frequency	-	-	-	0.1Hz	R	Shows the estimated rotor frequency, expressed in equivalent electric frequency for motors with permanent magnetic (PM). Shows the drive output frequency for asynchronous motors with V/f control	Y	Y															
134	DCbus ripple	-	-	-	V	R	Shows the voltage variation (ripple) in the DC bus	Y	Y															
137	Alarm 1	-	-	-	-	R	Shows the last alarm in queue	Y	Y															
138	Alarm 2	-	-	-	-	R	Shows the second to last alarm in queue	Y	Y															
139	Alarm 3	-	-	-	-	R	Shows the third to last alarm in queue	Y	Y															
140	Alarm 4	-	-	-	-	R	Shows the fourth to last alarm in queue	Y	Y															
141	Bootloader release	-	-	-	-	R		Y	Y															
142	Firmware release	-	-	-	-	R		Y	Y															
143	Firmware checksum	-	-	-	-	R		Y	Y															
144	Motor control release	-	-	-	-	R		Y	Y															
145	Serial number 1	-	-	-	-	R		Y	Y															
146	Serial number 2	-	-	-	-	R		Y	Y															
147	Serial number 3	-	-	-	-	R		Y	Y															
148	Serial number 4	-	-	-	-	R		Y	Y															
149	Hardware Identification	-	-	-	-	R	<table><tr><td>2010: PSD10102**, PSD1D**2BA10</td><td></td></tr><tr><td>2012: PSD10122**</td><td>2016: PSD10162**</td></tr><tr><td>4018: PSD10184**</td><td>4024: PSD10244**</td></tr><tr><td>4035: PSD10354**</td><td></td></tr></table>	2010: PSD10102**, PSD1D**2BA10		2012: PSD10122**	2016: PSD10162**	4018: PSD10184**	4024: PSD10244**	4035: PSD10354**		Y	Y							
2010: PSD10102**, PSD1D**2BA10																								
2012: PSD10122**	2016: PSD10162**																							
4018: PSD10184**	4024: PSD10244**																							
4035: PSD10354**																								
153	Motor overload counter	-	0	1000	-	R	0 = no overload	Y	Y															
154	Drive overload counter	-	0	1000	-	R	1÷999 = overload in progress 1000 = alarm triqgering	Y	Y															

Tab. 7.c

## 8. ALARMS

### 8.1 Types of alarm

There are two types of alarm:

- drive malfunctioning alarms;
- motor malfunctioning alarms.

Among the status variables it is possible to check the presence of Modbus® communication alarms.

**! Important: all alarms stop the motor and must be restored using the alarm reset command:**

Pr.101 = 1

followed by the command:

Pr.101 = 0

to resume the initial state.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
101	Reset (3 bit parameter) The particular reset comand is executed when the related bit changes from 0 to 1. After that the bit has to be cleared to 0 again.	0	0	allowable values: 1, 2, 4	-	R/W
	<b>bit meaning</b>					
	0 alarms reset, update of communication parameters and reset of error communication registers					
	1 parameters reset at default values					
	2 reset flag check drive switch on and switch off (see speed register, bit2)					

Tab. 8.a

### 8.2 Alarms log

The most recent 4 alarms are memorised in a FIFO type alarms queue. The last alarm memorised is visible in the Alarm 1 status variable.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
137	Alarm 1	-	-	-	-	R
138	Alarm 2	-	-	-	-	R
139	Alarm 3	-	-	-	-	R
140	Alarm 4	-	-	-	-	R

Tab. 8.b

### 8.3 Alarms table

The alarm code is given in the Alarm 1...4 parameters and in the alarm code parameter (Modbus®=105)

Alarm code	Description	Relay alarm	Reset	Possible cause	Solutions
0	No alarm	-	-	-	-
1	Overcurrent	(*)	reset command	The drive has detected a current supplied that is too high due to: - sudden strong load increase; - acceleration that is too high; - wrong parameters values or inadequate motor.	Check the load, the dimension of the motor and the cables. Decrease acceleration. Check the motor parameters..
2	Motor overload	(*)	reset command	The current supplied has exceeded the motor rated current over the maximum time accepted	Check the load, the dimension of the motor and the cables. Check the motor parameters.
3	Overvoltage	(*)	reset command	The DC voltage of the intermediate circuit has exceeded the limits envisioned due to: - deceleration that is too high; - high over-voltage peaks on the power supply network.	Decrease deceleration.
4	Undervoltage	(*)	reset command	The DC voltage of the intermediate circuit is below the limits envisioned due to: - insufficient power supply voltage; - fault inside the drive.	In the event of temporary cut-off of the power supply, reset the alarm and re-start the drive. Check the power supply voltage.
5	Drive overtemperature	(*)	reset command	The temperature inside the drive has exceeded the maximum level allowed.	Check that the quantity and flow of cooling air are regular. Check that there is not dust in the heat sink. Check the environment temperature. Ensure that the switching frequency is not too high with respect to the environment temperature and the motor load.
6	Drive undertemperature	(*)	reset command	The temperature of the drive is inferior to the minimum level allowed.	Warm up the ambient where the drive is installed.
7	Overcurrent HW	(*)	reset command	The drive has detected an istantaneous current supplied that is too high due to: - sudden strong load increase; - motor cables short circuit; - wrong parameters values or inadequate motor.	Check the load, the dimension of the motor and the cables. Check the motor parameters.
8	Motor overtemperature	(*)	reset command	The temperature detected by the PTC thermistor corresponds to a resistance > 2600 ohm.	Reduce the motor load. Check motor cooling.
9	Reserved (for future use)	(*)	reset command		
10	CPU error	(*)	reset command	Loss of data in memory	Call for assistance
11	Parameter default	(*)	reset command	Execution of reset parameter default command; Parameters user setting corrupted	Set parameters again
12	DCbus ripple	(*)	reset command	Input power supply phase loss	Check the input power supply phases to the drive
13	Data communication fault	(*)	reset command	Data reception failure	Check the serial connection. Switch the drive off and back on again.
14	Drive thermistor fault	(*)	reset command	Internal fault	Call for assistance
15	Autotuning fault	(*)	reset command	Wrong parameter values	Check the parameter values Restart the command again

Alarm code	Description	Relay alarm	Reset	Possible cause	Solutions
16	Drive disabled (STO input open or de-energized)	(*)	reset command (after STO input restored) ref to paragr. 8.8	Cable disconnected Operation of external contactor 24V power supply loss	Check the wiring. Restore external contactor
17	Motor phase fault (**)	(*)	reset command	Motor cable disconnected	Check the connections of the motor cable
18	Reserved (for future use)	(*)	reset command		
19	Speed fault	(*)	reset command	Wrong parameters values or unsuited load	Switch the drive off and back on again and check the parameters are properly set. Check the motor load.
20	PFC module error (PSD10102**, PSD10122**, PSD10162**, PSD1D**2BA10)	(*)	reset command	PFC overcurrent	Call for assistance
21	Power supply overvoltage (PSD10102**, PSD10122**, PSD10162**, PSD1D**2BA10)	(*)	reset command	Too high power supply voltage	Check input power supply and if inductive load generating overvoltage are connected to the line
22	Power supply undervoltage (PSD10102**, PSD10122**, PSD10162**, PSD1D**2BA10)	(*)	reset command	Too low power supply voltage	Check input power supply
23	STO detection error	(*)	reset command	Internal fault	Call for assistance
24	Reserved (for future use)	(*)	reset command		
25	Ground fault	(*)	reset command	The drive has detected a ground current too high	Check ground insulation of the motor and wires .
26	CPU sync error 1	(*)	reset command	Overload CPU	Call for assistance
27	CPU sync error 2	(*)	reset command	Loss of data in memory	Call for assistance
28	Drive overload	(*)	reset command	The current supplied has exceeded the drive rated current over the maximum time accepted	Check the load, the dimension of the motor and the cables. Check the motor parameters.
29	Reserved (for future use)	(*)	reset command		

Tab. 8.c

(\*) Depends on the configuration parameter.

(\*\*) Alarm can be disabled via parameter.

## 8.4 Modbus® communication error

Communication errors number and type, when detected, are monitored to indicate the trend of the communication. These errors are not memorised in the alarms log and do not cause the activation of the alarm relay. In the following status variables are stored the last error type and errors counter.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
122	Modbus® communication error	-	-	-	-	R
123	Modbus® errors counter	-	-	-	-	R

Tab. 8.d

Both variables are reset to 0 at power-on or by the alarm reset comand.

Modbus® communication error	Description	Possible cause
0	No error	-
1	Drive command not valid	Master command not recognised by the drive
2	Address not valid	Attempt to read or write a parameter that is not in the correct address
3	Data not valid	Parameter value out of range Parameter locked or read only
12	Drive operation not valid	- Attempt to reset parameters at the factory value while the drive is in RUN - Drive undervoltage

Tab. 8.e

## 8.5 Motor overtemperature

The intervention of the motor overtemperature alarm depends on the setting of the enabling and delay parameters. It is possible to connect a PTC thermistor or a thermostat to the digital input set-up. See the "Electrical installation" paragraph.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
27	Motor overtemperature alarm (PTC) enable 0/1=no/yes	0	0	1	-	R/W
28	Motor overtemperature alarm delay	0	0	600	s	R/W

Tab. 8.f

## 8.6 Serial communication interruption

The interrupted communication alarm is enabled by setting the "Data communication fault Timeout" at a value >0.

Mod. add.	Description	Def	Min	Max	U.M.	R/W
29	Data communication fault Timeout 0 = alarm disabled	0	0	600	s	R/W

Tab. 8.g



**Important:** the alarm is only active if the drive is in the Run status.

It is recommended to enable this alarm otherwise, if the data communication fault occurs with the drive/motor running, stop can no longer be commanded.

## 8.7 Alarms signal with relay

The relay can be used by configuring it in a way that signals the status of the drive in alarm or a specific alarm. See paragraph 5.2.

## 8.8 STO alarm mode

When STO input is de-energized, drive outputs U,V and W are disabled by safety hardware circuitry. If it happen while drive is in Run status, motor will stop by coasting and a STO alarm will be forced. If it happen while drive is in Stop status (motor already standstill) instead, it is possible to set STO alarm behavior as follows:

Mod. add.	Description	Def	Min	Max	U.M.	R/W
66	STO alarm mode (while drive in Stop)	0	0	2	-	R/W

Tab. 8.h

STO alarm mode	Description
0	alarm with manual reset
1	alarm with autoreset when STO input is re-energized
2	no alarm (drive disabled)

Tab. 8.i



**Important:** If a run command is received while STO input is de-energized, a STO alarm is forced anyway and it will be restored only by the alarm reset command.

## 9. TECHNICAL SPECIFICATIONS

Environmental conditions	Storage temperature		-40T60°C
	Operating temperature		-20T60°C
			-20T55°C (PSD10404** only)
	Humidity		<95% rH non-condensing
	Altitude		Maximum allowed: 4000 m above sea level Up to 1000 m a.s.l. without derating Maximum output current derating: 1% /100 m
	Pollution degree		Max 2
Power supply	Input voltage		200 - 240Vac ± 10%, 50/60 Hz, 1~ (Cod. PSD1***2**) 380 - 480Vac ± 10%, 50/60 Hz, 3~ (Cod. PSD10**4*0)
Motor output	Output voltage		0 - Input voltage
	Output frequency		0 - 500 Hz
	Maximum length		See par. 9.1
	Switching frequency		4, 6, 8 kHz
Functions	Protection functions		Drive: short-circuit, overcurrent, ground fault, overvoltage and undervoltage, overtemperature Motor: overtemperature and overload (150% rated current for 1 minute) System: Safety Torque Off input (if available), communication failure
	Frequency resolution		0,1 Hz
	Control unit		
Inputs	1 motor protector input		PTC temp. probe or voltage-free contact max source current 10 mA, max. length 25 m
	1 "Safety Torque Off "digital input		1 contact at 24 Vac/Vdc ± 20%: typical input current 5 mA, maximum length 25 m - PSD10102**, PSD1D**2BA10 models excluded
Outputs	1 relay		Programmable output, voltage-free contact: 240 Vac, 1 A
Interface	24Vdc auxiliary power supply		Double insulation, precision 10%, 50 mA max - PSD10102**, PSD1D**2BA10 models excluded
	Serial data connection		RS485, Modbus® protocol, maximum transmission speed 19200 bit/s. Receiver input resistance 96kΩ typical (1/8 unit-load, that is 1/256 of total bus load)
	Maximum length		100 m – shielded cable
Casing index of protection			IP00 - PSD10102**, PSD1D**2BA10 models only IP20 (front panel, open type equipment) IP44 for heat sink (installation with heat sink outside of panel) - PSD10354*0 models excluded
Conformity to standards	CE conformity	Low voltage directive	2006/95/EC EN 61800-5-1: Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy.
		Electromagnetic compatibility directive	2004/108/EC EN 61800-3, ed.2.0.: Adjustable speed electrical power drive systems. EMC requirements and specific test methods. EN61000-3-2: Electromagnetic compatibility (EMC) Part 3-2: Limits - Limits for harmonic currents emissions (equipment input current < 16 A per phase) - PSD10102**, PSD1D**2BA10 models only. EN61000-3-12: Electromagnetic compatibility (EMC) Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and <= 75 A per phase.
			Maximum short-circuit current allowed at the drive terminals (IEC60439-1): 100kA
		UL conformity	UL 508C (Refer to Chap. 11 "UL notes for installation instructions")

Tab. 9.a

### 9.1 Rated values

The table below shows the rated input and output values, as well as the specifications for sizing the cables (cross-section, maximum length) and the fuses. The values refer to an operating temperature of 60 °C and a switching frequency of 8 kHz, unless otherwise specified.

Model	Rated input current <sup>(1)</sup> (A)	Fuse or type B circuit breaker <sup>(1)</sup> (A)	Power cable cross-section (mm <sup>2</sup> )	Rated output current (A)	Rated output power <sup>(2)</sup> (kW)	Max. total dissipation <sup>(1)</sup> (W)	Max. heatsink dissipation <sup>(1)</sup> (W)	Minimum motor cable cross-section (mm <sup>2</sup> )	Maximum motor cable length (m)
PSD10102**	17	25	4 <sup>(3)</sup>	10	3,8	270	150	2,5 <sup>(4)</sup>	5
PSD1D042BA10	7	25	2,5	3,6	1,4	100	55	2,5	5
PSD1D062BA10	11		4	6	2,3	160	90		
PSD1D102BA10	17		4	10	3,8	270	150		
PSD10122*0	22	32	4	12	4,5	330	190	2,5	5
PSD10162*0	28	40	6	16	6,0	450	250	2,5	5
PSD10184*0	23	32	4	18	10,5	320	250	4	5
PSD10244*0	30	40	6	24	14	485	380	4	5
PSD10354*0	35	40	6	35	21	600	500	6	5
PSD10404*0 <sup>(5)</sup>	40	50	6	40	24	710	600	6	5

Tab. 9.b

(1) Referred to input voltage of 230 Vac for single-phase power supply drives (Cod. PSD10\*\*2\*\*, PSD1D\*\*2BA10) and to 400 Vac for three-phase power supply ones (Cod. PSD10\*\*4\*\*). If voltage is lower than nominal, input current in drive Cod. PSD10122\*\* and PSD10162\*\* can increase up to 32 A.

(2) Rated output power is referred to following conditions:

- output voltage: 230 Vac for single-phase drives, 400 Vac for three-phase ones
- rated output current
- cos $\phi$  0.94 for single-phase drives and cos $\phi$  0.88 for three-phase ones

(3) Example of faston to be used for input power supply cables (wire 12-10 AWG): MOLEX 190050016.

(4) Example of faston to be used for output power motor cables (wire 12-10 AWG): MOLEX 190050016 or MOLEX 190070082.

(5) Operating temperature: 55°C max

Switching frequency: 6kHz max in case of output current > 35A at operating temperature > 50°C.

## 10. APPENDIX

### 10.1 Conversion formulas

$RPS = F / (P / 2)$	$RPS = RPM / 60$
$RPM = (F \times 60) / (P / 2)$	$RPM = RPS \times 60$
$F = RPS \times (P / 2)$	$F = (RPM \times (P / 2)) / 60$

**Key:**

F	frequency (Hz) of the voltage and current applied to motor
RPS	revolution per second of motor shaft (rotor)
RPM	revolution per minute of motor shaft (rotor)
P	number of poles of motor (always an even number)
P/2	number of polar couples of motor



**Nota:** In AC motors (asynchronous induction motor) RPS and RPM derived from previous formulas are not the actual value because of the intrinsic rotor "slip". The actual values is always lower than calculated RPS and RPM values, and the difference increase with the load. The RPM actual value is motor dependent and it is usually specified by manufacturer at nominal load.

### 10.2 Conversion table

F (Hz)	2 poles		4 poles		6 poles		8 poles		10 poles	
	RPS	RPM	RPS	RPM	RPS	RPM	RPS	RPM	RPS	RPM
10	10	600	5	300	3,3	200	2,5	150	2	120
20	20	1200	10	600	6,7	400	5	300	4	240
30	30	1800	15	900	10	600	7,5	450	6	360
40	40	2400	20	1200	13,3	800	10	600	8	480
50	50	3000	25	1500	16,7	1000	12,5	750	10	600
60	60	3600	30	1800	20	1200	15	900	12	720
70	70	4200	35	2100	23,3	1400	17,5	1050	14	840
80	80	4800	40	2400	26,7	1600	20	1200	16	960
90	90	5400	45	2700	30	1800	22,5	1350	18	1080
100	100	6000	50	3000	33,3	2000	25	1500	20	1200
110	110	6600	55	3300	36,7	2200	27,5	1650	22	1320
120	120	7200	60	3600	40	2400	30	1800	24	1440
130	130	7800	65	3900	43,3	2600	32,5	1950	26	1560
140	140	8400	70	4200	46,7	2800	35	2100	28	1680
150	150	9000	75	4500	50	3000	37,5	2250	30	1800
160	160	9600	80	4800	53,3	3200	40	2400	32	1920
170	170	10200	85	5100	56,7	3400	42,5	2550	34	2040
180	180	10800	90	5400	60	3600	45	2700	36	2160
190	190	11400	95	5700	63,3	3800	47,5	2850	38	2280
200	200	12000	100	6000	66,7	4000	50	3000	40	2400
210	210	12600	105	6300	70	4200	52,5	3150	42	2520
220	220	13200	110	6600	73,3	4400	55	3300	44	2640
230	230	13800	115	6900	76,7	4600	57,5	3450	46	2760
240	240	14400	120	7200	80	4800	60	3600	48	2880
250	250	15000	125	7500	83,3	5000	62,5	3750	50	3000
260	260	15600	130	7800	86,7	5200	65	3900	52	3120
270	270	16200	135	8100	90	5400	67,5	4050	54	3240
280	280	16800	140	8400	93,3	5600	70	4200	56	3360
290	290	17400	145	8700	96,7	5800	72,5	4350	58	3480
300	300	18000	150	9000	100	6000	75	4500	60	3600
310	310	18600	155	9300	103,3	6200	77,5	4650	62	3720
320	320	19200	160	9600	106,7	6400	80	4800	64	3840
330	330	19800	165	9900	110	6600	82,5	4950	66	3960
340	340	20400	170	10200	113,3	6800	85	5100	68	4080
350	350	21000	175	10500	116,7	7000	87,5	5250	70	4200
360	360	21600	180	10800	120	7200	90	5400	72	4320
370	370	22200	185	11100	123,3	7400	92,5	5550	74	4440
380	380	22800	190	11400	126,7	7600	95	5700	76	4560
390	390	23400	195	11700	130	7800	97,5	5850	78	4680
400	400	24000	200	12000	133,3	8000	100	6000	80	4800

Tab. 10.a

## 11. UL NOTES FOR INSTALLATION INSTRUCTIONS

The PSD1 models, that conform to the UL Standard and CSA Standard have the UL/CSA mark on the nameplate.

- Transient Voltage Surge Protection

The drive is equipped with internal type 2 Surge Protection Device according to the United States Standard UL508C.

For Canadian end-use applications, an external Surge Protection Device is recommended in according to the Canadian Standard CSA C22.2-No.14-13.

See table below:

Drive model No.	Manufacturer	UL file	Model	Vnom.	Vclamp.	Mov type	Surge Current	Isc
PSD10102** PSD1D042BA10 PSD1D062BA10 PSD1D102BA10 PSD10162*0 PSD10122*0 PSD10244*0	ERICO INTERNATIONAL CORPORATION	E325047	TDS1501SR240	240V	900V	2	20 kA	5000 A
PSD10184*0 PSD10354*0 PSD10404*0	ERICO INTERNATIONAL CORPORATION	E325047	TDS350TNC277	480V	1800V	2	20 kA	5000 A

Tab. 11.a



**Note:**

Others equivalent UL listed components with same ratings may be used.

- The PSD1\*\*\*2\*\* drives are suitable for use on a circuit capable of delivering not more than 5000 Amperes rms symmetrical, 240 Vac +10% maximum.
- The PSD1\*\*\*4\*\* drives are suitable for use on a circuit capable of delivering not more than 5000 Amperes rms symmetrical, 480 Vac +10% maximum.

Protection fuses must be provided according to the following table:

Drive model No.	Manufacturer	UL file	Model	Rated current Arms	Vnom. (Vac)
PSD10102**	Siemens	E167357	3NE1815-0	25	690
PSD1D**2BA10	Siemens	E167357	3NE1815-0	25	690
PSD10122*0	Siemens	E167357	3NE4101	32	1000
PSD10162*0	Siemens	E167357	3NE4102	40	1000
PSD10184*0	Siemens	E167357	3NE4101	32	1000
PSD10244*0	Siemens	E167357	3NE4101	32	1000
PSD10354*0	Siemens	E167357	3NE4102	40	1000
PSD10404*0	Siemens	E167357	3NE4117	50	1000

Tab. 11.b



**Note:**

Other equivalent UL Listed or UL Recognized External Semiconductor Fuses with the same ratings and in particular with "Peak-let-trough-current  $I_p$ " and "Clearing  $I_{2t}$ " equal or lower than the ones of fuse models indicated in Tab. 11.b.

- The PSD1 series is classified as Opentype
- The PSD1 series is designed for a maximum surrounding air temperature of 60°C for all the models with the exception of PSD10404\*0 models that is 55°C.
- The PSD1 series must be placed in a pollution degree 2 Environment.
- The Field Wiring Power Terminals must be used with the tightening torque of 13 lib-in (1,5 Nm)
- Any Auxiliary Wiring Terminal Blocks must be used with the tightening torque of 4,4 lib-in (0,5 Nm)
- Any field connection, either power or auxiliary, must be used within the ratings specified by the manufacturer. See Chap. 9 for details.
- The auxiliary field wiring connection must be made with the female connectors supplied with the drive.
- The metal-sheet case grounding connection must be made with an eyelet tube terminal insulated wire.

[illegible]



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