

# Altivar 610

## Variable Speed Drives

### Installation Manual

07/2015



---

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

No part of this document may be reproduced in any form or by any means, electronic or mechanical, including photocopying, without express written permission of Schneider Electric.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

© 2015 Schneider Electric. All rights reserved.

---

# Table of Contents

---



	<b>Safety Information</b> .....	<b>5</b>
	<b>About the Book</b> .....	<b>9</b>
<b>Chapter 1</b>	<b>Introduction</b> .....	<b>11</b>
	Drive Overview .....	<b>12</b>
	Accessories and Options .....	<b>14</b>
	Steps for setting up the drive .....	<b>15</b>
	Preliminary Instructions .....	<b>16</b>
<b>Chapter 2</b>	<b>Technical Data</b> .....	<b>17</b>
2.1	Environment Data .....	<b>18</b>
	Temperature Conditions .....	<b>19</b>
	Altitude Conditions .....	<b>19</b>
2.2	Mechanical Data .....	<b>20</b>
	Dimensions and Weights .....	<b>21</b>
	Characteristics of the Power Part Terminals .....	<b>28</b>
	Arrangement and Characteristics of Control Block Terminals and Communication and I/O Ports .....	<b>30</b>
2.3	Electrical Data .....	<b>31</b>
	Drive Ratings in Normal Duty .....	<b>32</b>
	Drive Ratings in Heavy Duty .....	<b>33</b>
	Derating Curves .....	<b>34</b>
	Control Terminals Electrical Data .....	<b>37</b>
	Sink / Source Switch Configuration .....	<b>39</b>
<b>Chapter 3</b>	<b>Drive Mounting</b> .....	<b>41</b>
	Mounting Conditions .....	<b>42</b>
	Mounting Procedures .....	<b>46</b>
<b>Chapter 4</b>	<b>Drive wiring</b> .....	<b>49</b>
	Wiring Instructions .....	<b>50</b>
	Cable Length Instructions .....	<b>52</b>
	Wiring Diagrams .....	<b>54</b>
	Wiring the Power Part .....	<b>56</b>
	Electromagnetic Compatibility .....	<b>60</b>
	Operation on an IT or Corner Grounded System .....	<b>62</b>
	Wiring The Control Part .....	<b>65</b>
<b>Chapter 5</b>	<b>Checking Installation</b> .....	<b>67</b>
	Check List Before Switching On .....	<b>67</b>
<b>Chapter 6</b>	<b>Maintenance</b> .....	<b>69</b>
	Scheduled servicing .....	<b>69</b>



# Safety Information



## Important Information

### NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

### **DANGER**

**DANGER** indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

### **WARNING**

**WARNING** indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

### **CAUTION**

**CAUTION** indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

### **NOTICE**

**NOTICE** is used to address practices not related to physical injury.

### PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

### Qualification Of Personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product. In addition, these persons must have received safety training to recognize and avoid hazards involved. These persons must have sufficient technical training, knowledge and experience and be able to foresee and detect potential hazards that may be caused by using the product, by changing the settings and by the mechanical, electrical and electronic equipment of the entire system in which the product is used. All persons working on and with the product must be fully familiar with all applicable standards, directives, and accident prevention regulations when performing such work.

## Intended Use

This product is a drive for three-phase synchronous and asynchronous motors and intended for industrial use according to this manual. The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements and the technical data. Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety measures must be implemented. Since the product is used as a component in an entire system, you must ensure the safety of persons by means of the design of this entire system (for example, machine design). Any use other than the use explicitly permitted is prohibited and can result in hazards. Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.

## Product Related Information

**Read and understand these instructions before performing any procedure with this drive.**

### **DANGER**

#### **HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

- Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation and who have received safety training to recognize and avoid hazards involved are authorized to work on and with this drive system. Installation, adjustment, repair and maintenance must be performed by qualified personnel.
- The system integrator is responsible for compliance with all local and national electrical code requirements as well as all other applicable regulations with respect to grounding of all equipment.
- Many components of the product, including the printed circuit boards, operate with mains voltage. Do not touch. Use only electrically insulated tools.
- Do not touch unshielded components or terminals with voltage present.
- Motors can generate voltage when the shaft is rotated. Prior to performing any type of work on the drive system, block the motor shaft to prevent rotation.
- AC voltage can couple voltage to unused conductors in the motor cable. Insulate both ends of unused conductors of the motor cable.
- Do not short across the DC bus terminals or the DC bus capacitors or the braking resistor terminals.
- Before performing work on the drive system:
  - Disconnect all power, including external control power that may be present.
  - Place a **Do Not Turn On** label on all power switches.
  - Lock all power switches in the open position.
  - Wait 15 minutes to allow the DC bus capacitors to discharge. The DC bus LED is not an indicator of the absence of DC bus voltage that can exceed 800 Vdc. Measure the voltage on the DC bus between the DC bus terminals (PA/+, PC/-) using a properly rated voltmeter to verify that the voltage is <42 Vdc
  - If the DC bus capacitors do not discharge properly, contact your local Schneider Electric representative. Do not repair or operate the product.
- Install and close all covers before applying voltage.

**Failure to follow these instructions will result in death or serious injury.**

### **WARNING**

#### **UNEXPECTED MOVEMENT**

Drive systems may perform unexpected movements because of incorrect wiring, incorrect settings, incorrect data or other errors.

- Carefully install the wiring in accordance with the EMC requirements.
- Do not operate the product with unknown or unsuitable settings or data.
- Perform a comprehensive commissioning test.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

Damaged products or accessories may cause electric shock or unanticipated equipment operation.

## **DANGER**

### **ELECTRIC SHOCK OR UNANTICIPATED EQUIPMENT OPERATION**

Do not use damaged products or accessories.

**Failure to follow these instructions will result in death or serious injury.**

Contact your local Schneider Electric sales office if you detect any damage whatsoever.

## **WARNING**

### **LOSS OF CONTROL**

- The designer of any control scheme must consider the potential failure modes of control paths and, for critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop, overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines (1).
- Each implementation of the product must be individually and thoroughly tested for proper operation before being placed into service.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

(1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control and to NEMA ICS 7.1 (latest edition), Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.

## **NOTICE**

### **DESTRUCTION DUE TO INCORRECT MAINS VOLTAGE**

Before switching on and configuring the product, verify that it is approved for the mains voltage

**Failure to follow these instructions can result in equipment damage.**

The metal surfaces of the product may exceed 100 °C (212 °F) during operation.

## **WARNING**

### **HOT SURFACES**

- Ensure that any contact with hot surfaces is avoided.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of hot surfaces.
- Verify that the heat dissipation is sufficient by performing a test run under maximum load conditions.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**





# About the Book



## At a Glance

### Document Scope

The purpose of this document is:

- to give you mechanical and electrical information related to the drive,
- to show you how to install and wire this drive.

### Validity Note

**NOTE:** The products listed in the document are not all available at the time of publication of this document online. The data, illustrations and product specifications listed in the guide will be completed and updated as the product availabilities evolve. Updates to the guide will be available for download once products are released on the market.

This documentation is valid for the Altivar 610 drive.

The technical characteristics of the devices described in this document also appear online. To access this information online:

Step	Action
1	Go to the Schneider Electric home page <a href="http://www.schneider-electric.com">www.schneider-electric.com</a> .
2	In the <b>Search</b> box type the reference of a product or the name of a product range. <ul style="list-style-type: none"><li>• Do not include blank spaces in the reference or product range.</li><li>• To get information on grouping similar modules, use asterisks (*).</li></ul>
3	If you entered a reference, go to the <b>Product Datasheets</b> search results and click on the reference that interests you. If you entered the name of a product range, go to the <b>Product Ranges</b> search results and click on the product range that interests you.
4	If more than one reference appears in the <b>Products</b> search results, click on the reference that interests you.
5	Depending on the size of your screen, you may need to scroll down to see the data sheet.
6	To save or print a data sheet as a .pdf file, click <b>Download XXX product datasheet</b> .

The characteristics that are presented in this manual should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the manual and online information, use the online information as your reference.

## Related Documents

Use your tablet or your PC to quickly access detailed and comprehensive information on all our products on [www.schneider-electric.com](http://www.schneider-electric.com)

The internet site provides the information you need for products and solutions

- The whole catalog for detailed characteristics and selection guides
- The CAD files to help design your installation, available in over 20 different file formats
- All software and firmware to maintain your installation up to date
- A large quantity of White Papers, Environment documents, Application solutions, Specifications... to gain a better understanding of our electrical systems and equipment or automation
- And finally all the User Guides related to your drive, listed below:

Title of Documentation	Reference Number
Altivar 610 Quick Start	EAV64374 (English), EAV64379 (Chinese)
Altivar 610 Installation Manual	EAV64381 (English), EAV64386 (Chinese)
Altivar 610 Programming Manual	EAV64387 (English), EAV64393 (Chinese)
Altivar 610 Communication Parameters File	EAV64394 (English)
Altivar 610 Modbus Manual	EAV64395 (English)
Altivar 610 PROFIBUS DP manual	EAV64396 (English)

You can download these technical publications and other technical information from our website at <http://download.schneider-electric.com>

## Terminology

The technical terms, terminology, and the corresponding descriptions in this manual normally use the terms or definitions in the relevant standards.

In the area of drive systems this includes, but is not limited to, terms such as **error, error message, failure, fault, fault reset, protection, safe state, safety function, warning, warning message**, and so on.

Among others, these standards include:

- IEC 61800 series: Adjustable speed electrical power drive systems
- IEC 61508 Ed.2 series: Functional safety of electrical/electronic/programmable electronic safety-related
- EN 954-1 Safety of machinery - Safety related parts of control systems
- EN ISO 13849-1 & 2 Safety of machinery - Safety related parts of control systems.
- IEC 61158 series: Industrial communication networks - Fieldbus specifications
- IEC 61784 series: Industrial communication networks - Profiles
- IEC 60204-1: Safety of machinery - Electrical equipment of machines – Part 1: General requirements

In addition, the term **zone of operation** is used in conjunction with the description of specific hazards, and is defined as it is for a **hazard zone** or **danger zone** in the EC Machinery Directive (2006/42/EC) and in ISO 12100-1.

---

# Chapter 1

## Introduction

---

### What Is in This Chapter?



This chapter contains the following topics:



Topic	Page
Drive Overview	12
Accessories and Options	14
Steps for setting up the drive	15
Preliminary Instructions	16

## Drive Overview

### Frame Sizes

The family of Altivar 610 includes 6 frame sizes for a wide range of applications and power requirements

Frame Size 1	Frame Size 2
3-phase 380...415 V, 0.75...7.5 kW, 1...10 HP	3-phase 380...415 V, 11 and 15 kW, 15 and 20 HP
	
ATV610U07N4...U75N4	ATV610D11N4 and D15N4

Frame Size 3	Frame Size 4
3-phase 380...415 V, 18.5 and 22 kW, 25 and 30 HP	3-phase 380...415 V, 30...45 kW, 40...60 HP
	
ATV610D18N4 and D22N4	ATV610D30N4...D45N4

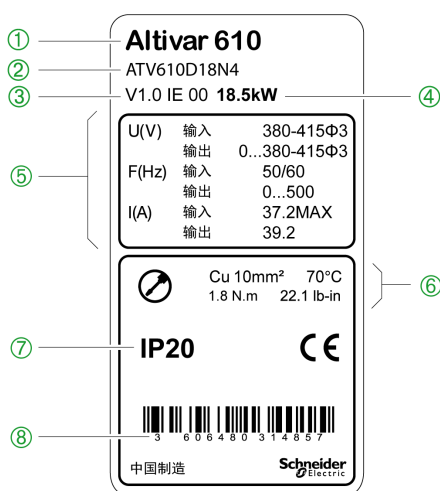
Frame Size 5	Frame Size 6
3-phase 380...415 V, 55...90 kW, 75... 125 HP	3-phase 380...415 V, 110...160 kW 150...250 HP
	
ATV610D55N4...D90N4	ATV610C11N4...C16N4,

Catalog Number Description

	ATV	610	D	75	N4
<b>Product Range</b> ATV Altivar					
<b>Product Type</b> 610 610: Standard product					
<b>Factor for power rating</b> U power x 0.1 D power x 1 C power x 10					
<b>Power rating</b> 11 - 13 - 15 - 55 - 75					
<b>Power part supply</b> N4 380 Vac (380...415 Vac) 3 phase N4Z 380 Vac (380...415 Vac) 3 phase, product without Plain Text Display Terminal					

## Nameplate example

The nameplate contains the following data:



- ① Product type ② Catalog number ③ Firmware version ④ Power rating ⑤ Power part information  
⑥ Power part cable information ⑦ Degree of protection ⑧ Serial number

## Accessories and Options

### Introduction

Altivar Easy 610 drives are designed to take numerous accessories and options to increase their functionality. For a detailed description and catalog numbers, refer to the Catalog on [schneider-electric.com](http://schneider-electric.com)

All accessories and options come with an instruction sheet to help installation and commissioning. Therefore you will only find here a short product description.

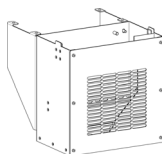
### Accessories

#### Drive

- EMC plate

#### IP upgrade

- Metal conduit box for size 6 product for IP21 degree of protection on bottom side



#### Plain text display terminal

- Remote mounting kit for mounting on enclosure door

### Filters

#### dv/dt filters

### Options

#### I/O extension modules

- Digital and analog I/O module
- Relay output module

#### Communication modules

- PROFIBUS DP V1

## Steps for setting up the drive

### Procedure

## **INSTALLATION**

### **① Receive and inspect the drive controller**

- ❑ Check that the catalog number printed on the label is the same as that on the purchase order
- ❑ Remove the drive from its packaging and check that it has not been damaged

### **② Verify the supply mains**

- ❑ Verify that the supply mains is compatible with the power part supply range of the drive.

### **③ Mount the drive**

- ❑ Mount the drive in accordance with the instructions in this document
- ❑ Install the transformer(s), if any
- ❑ Install any internal and external options

### **④ Wire the drive**

- ❑ Connect the motor, ensuring that its connections correspond to the voltage
- ❑ Connect the supply mains, after making sure that the power is off
- ❑ Connect the control

*Steps 1 to 4 must be performed with the power off.*



## **⑤ PROGRAMMING**

Refer to the Programming Manual

## Preliminary Instructions

### Handling and Storage

#### **WARNING**

##### **DANGEROUS HANDLING**

- Do not handle a damaged packaging.
- Follow the handling instructions.
- Open and handle the packaging with care.

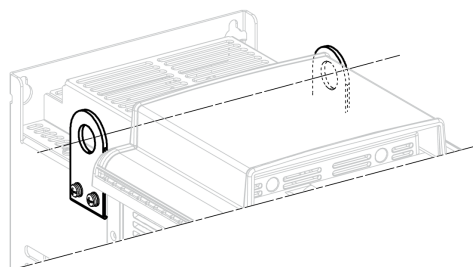
**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

To help protect the drive before installation, handle and store the device in its packaging. Ensure that the ambient conditions are acceptable.

### Handling the Wall Mounting Drives

ATV610 of frame sizes 1 up to 3 can be removed from their packaging and installed without a handling device.

Higher drive frame sizes require a handling device; for this reason, these drives all have lifting lugs.



### Check the Delivery of the Drive

Damaged products or accessories may cause electric shock or unanticipated equipment operation.

#### **DANGER**

##### **ELECTRIC SHOCK OR UNANTICIPATED EQUIPMENT OPERATION**

Do not use damaged products or accessories.

**Failure to follow these instructions will result in death or serious injury.**

Contact your local Schneider Electric sales office if you detect any damage whatsoever.

Step	Action
1	Remove the drive from the packaging and verify that it has not been damaged
2	Verify that the catalog number printed on the nameplate ( <a href="#">see page 14</a> ) corresponds to the purchase order.



---

## Chapter 2

### Technical Data

---

#### What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
2.1	Environment Data	18
2.2	Mechanical Data	20
2.3	Electrical Data	31

---

## Section 2.1

### Environment Data

---

#### What Is in This Section?

This section contains the following topics:

Topic	Page
Temperature Conditions	19
Altitude Conditions	19

## Temperature Conditions

### Climatic Environmental Conditions for Transportation and Storage

The environment during transportation and storage must be dry and free from dust.

Storage	Temperature	°C	-40...70
		°F	-40...158
Transportation	Temperature	°C	-40...70
		°F	-40...158
Relative humidity		%	5...95

### Climatic Environmental Conditions for Operation

The maximum permissible ambient temperature during operation depends on the mounting distances between the devices and on the required power. Observe the pertinent instructions in the chapter Drive Mounting ([see page 41](#)).

Frame sizes 1...6 ATV610..... products	Temperature without derating	°C	-15...45
		°F	5...113
	Temperature with derating of output power (1)	°C	Up to 60
		°F	Up to 140
	Temperature with derating of output power (1) and control without Graphic display terminal	°C	Up to 70
		°F	-40...158
All products	Relative humidity without condensing	%	5...95

(1) Refer to Derating Curves section ([see page 34](#)).

## Altitude Conditions

### Operating Altitude

Operating possibilities according to the altitude

Altitude	Supply voltage	Supply Electrical Network			Derating
		TT/TN	IT	Corner-Grounded	
Up to 1000 m (3300 ft)	380..415 V	✓	✓	✓	o
1000...2000 m (3300...6600 ft)	380..415 V	✓	✓	✓	✓
2000...3800 m (6600...12400 ft)	380..415 V	✓	✓	—	✓
3800...4800 m (12400...15700 ft)	380..415 V	✓	—	—	✓
<b>Legend:</b> ✓: Derate the nominal current of the drive by 1% for each additional 100 m. o: Without derating —: Not applicable					

---

## Section 2.2

### Mechanical Data

---

#### What Is in This Section?

This section contains the following topics:

Topic	Page
Dimensions and Weights	21
Characteristics of the Power Part Terminals	28
Arrangement and Characteristics of Control Block Terminals and Communication and I/O Ports	30

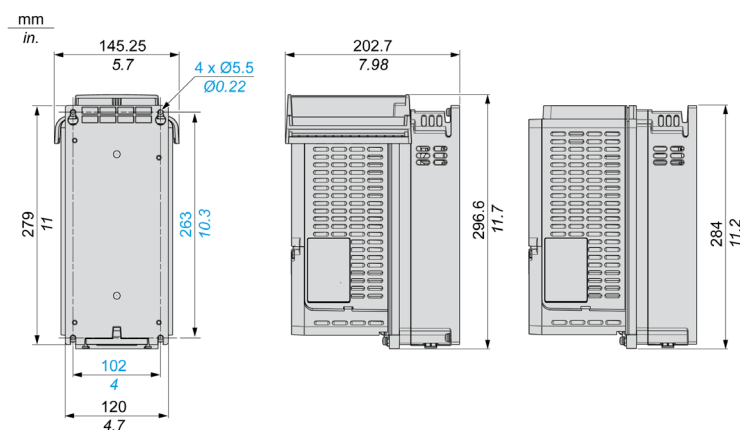
## Dimensions and Weights

### About the drawings

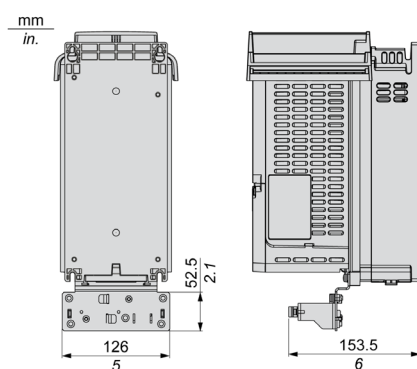
All drawings CAD files can be downloaded from [www.schneider-electric.com](http://www.schneider-electric.com)

### Frame Size 1

#### IP20 Drives - Rear and Side View With Top Cover - Side View Without Top Cover



#### IP20 Drives - Rear and Side View With EMC Plate

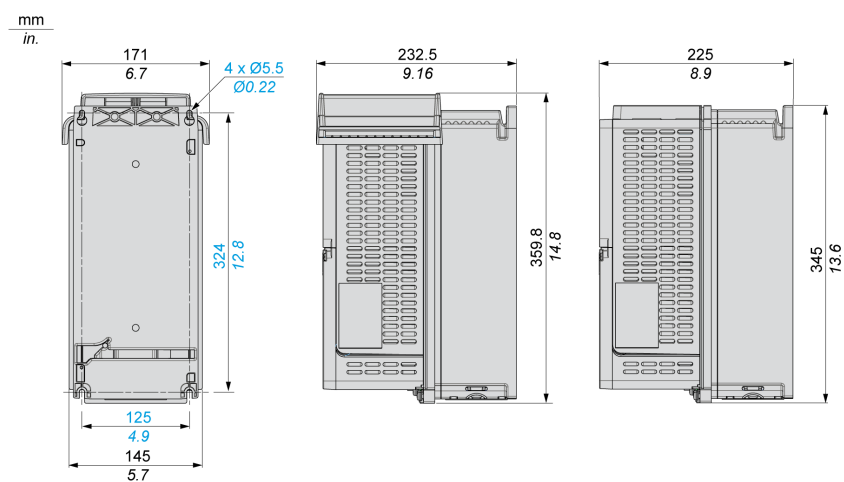


### Weights

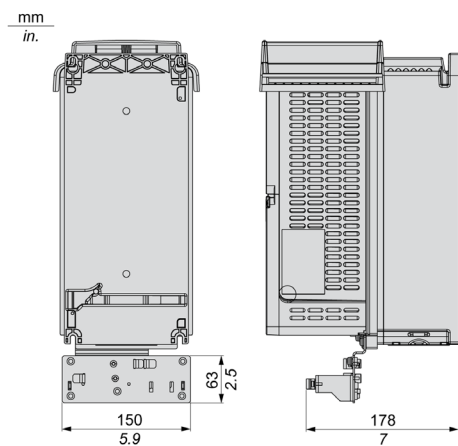
Catalog Number	Weight in kg (lb)
ATV610U07N4...U30N4	2.4 (5.3)
ATV610U40N4	4.0 (8.8)
ATV610U55N4, ATV610U75N4	4.1 (9)

## Frame size 2

### IP20 Drives - Rear and Side View With Top Cover - Side View Without Top Cover



### IP20 Drives - Rear and Side View With EMC Plate

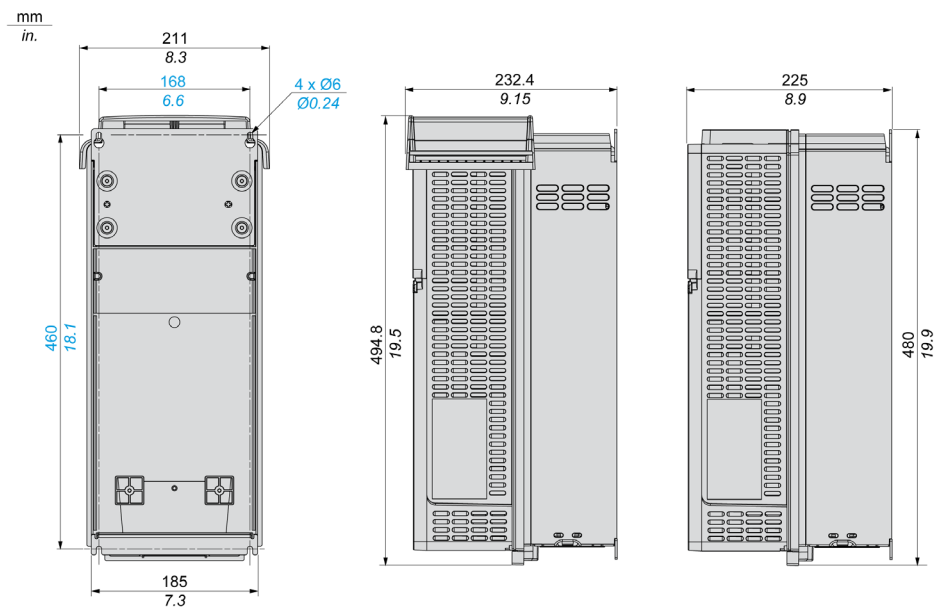


### Weights

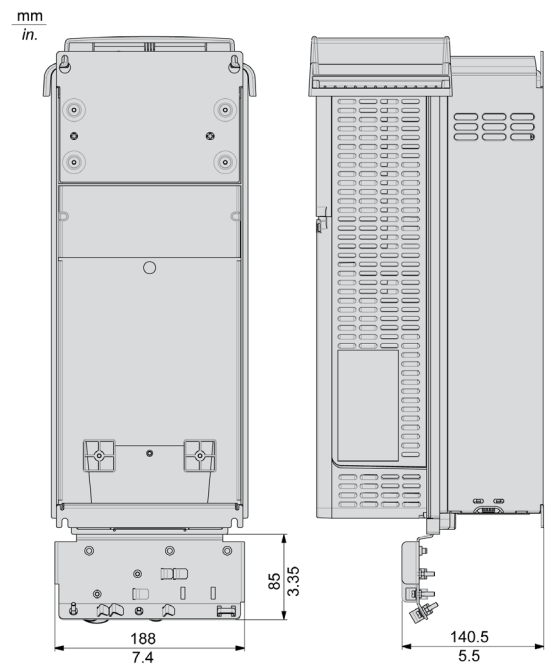
Catalog Number	Weight in kg (lb)
ATV610D11N4 and ATV610D15N4	7.2 (15.9)

Frame size 3

IP20 Drives - Rear and Side View With Top Cover - Side View Without Top Cover



IP20 Drives - Side and Rear View with EMC plate

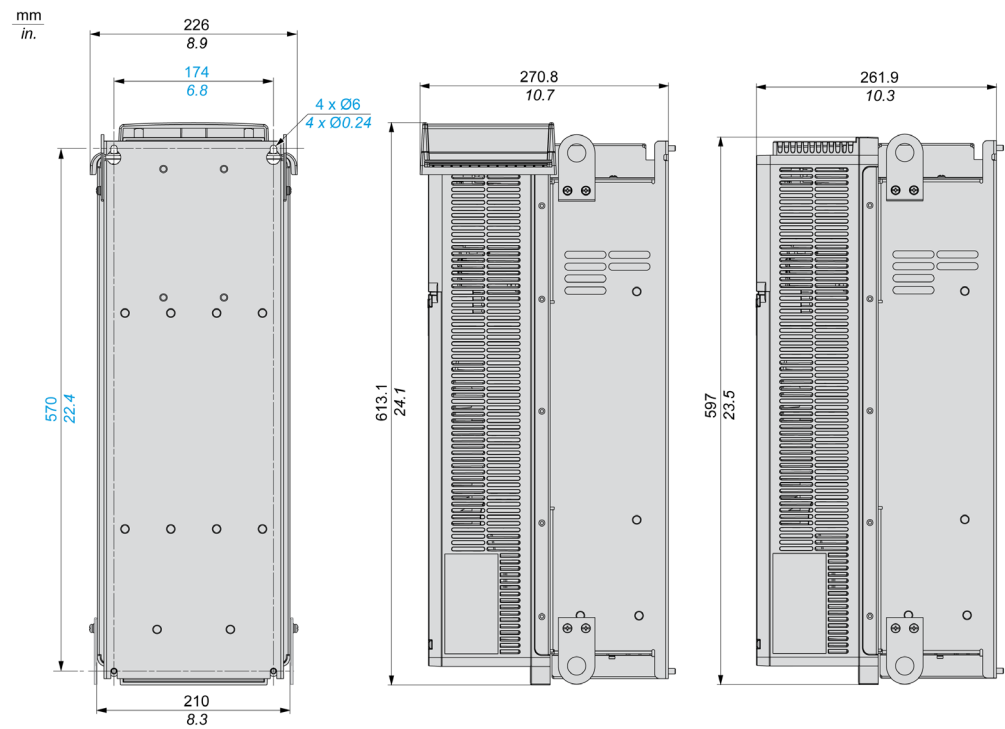


Weights

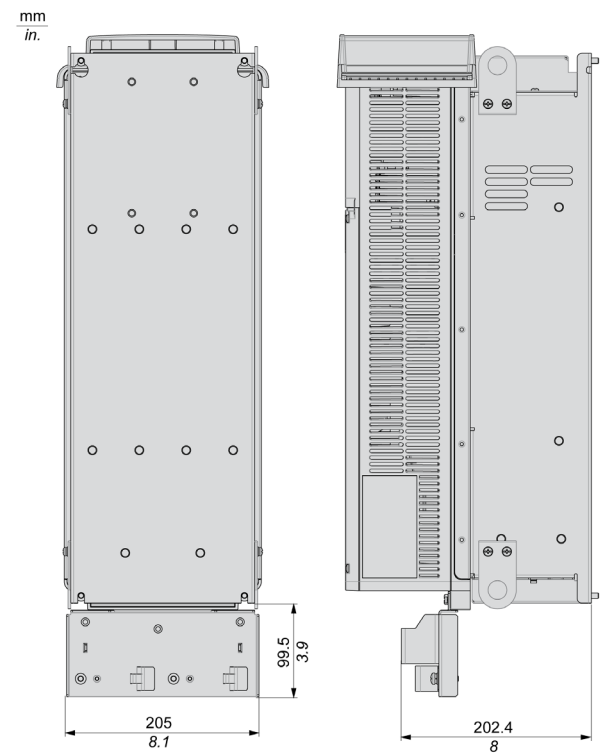
Catalog Number	Weight in kg (lb)
ATV610D18N4 and ATV610D22N4	14 (30.9)

Frame size 4

IP20 Drives - Rear and Side View With Top Cover - Side View Without Top Cover



IP20 Drives - Side and Rear View with EMC plate



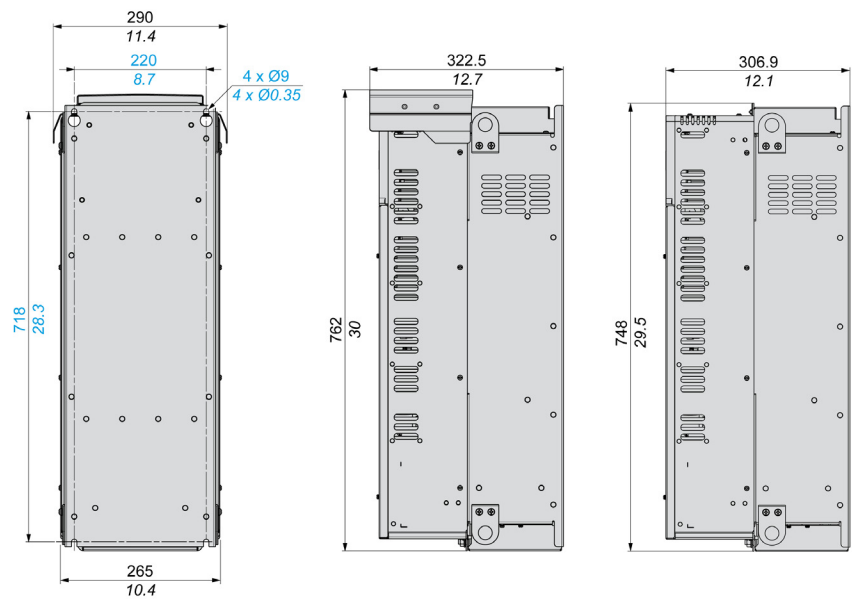
Weights

Catalog Number	Weight in kg (lb)
ATV610D30N4...ATV610D45N4	28 (61.7)

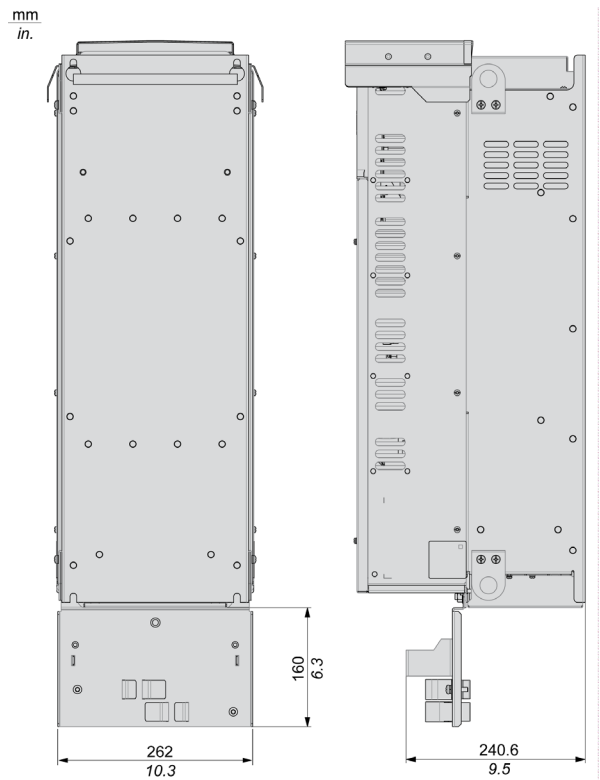


Frame size 5

IP20 Drives - Rear and Side View With Top Cover - Side View Without Top Cover



IP20 Drives - Rear and Side View With Top Cover

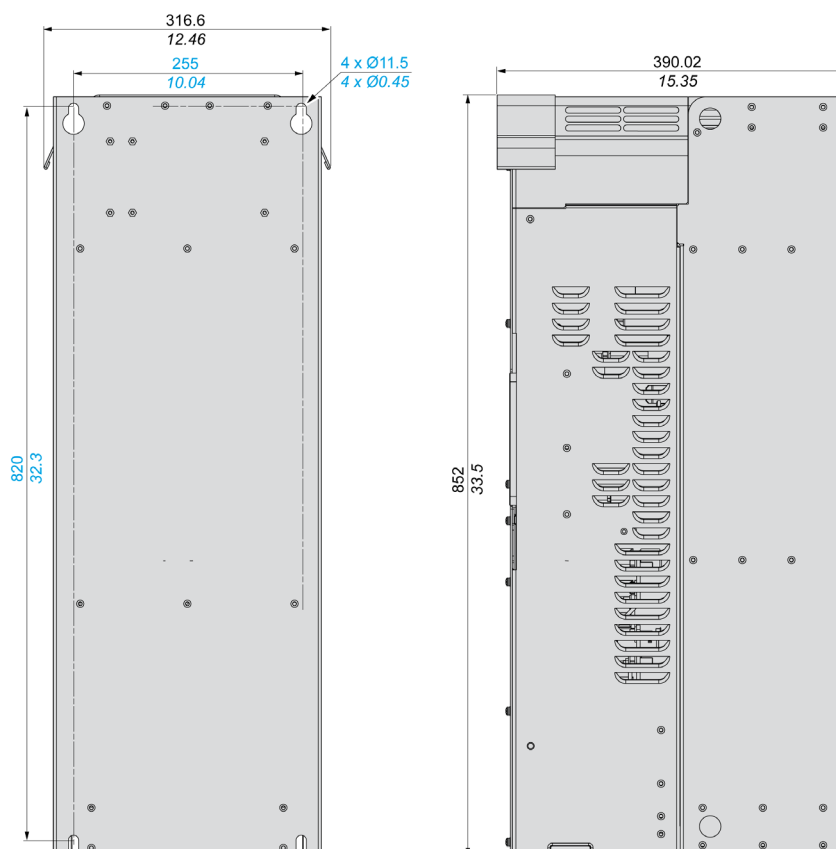


Weights

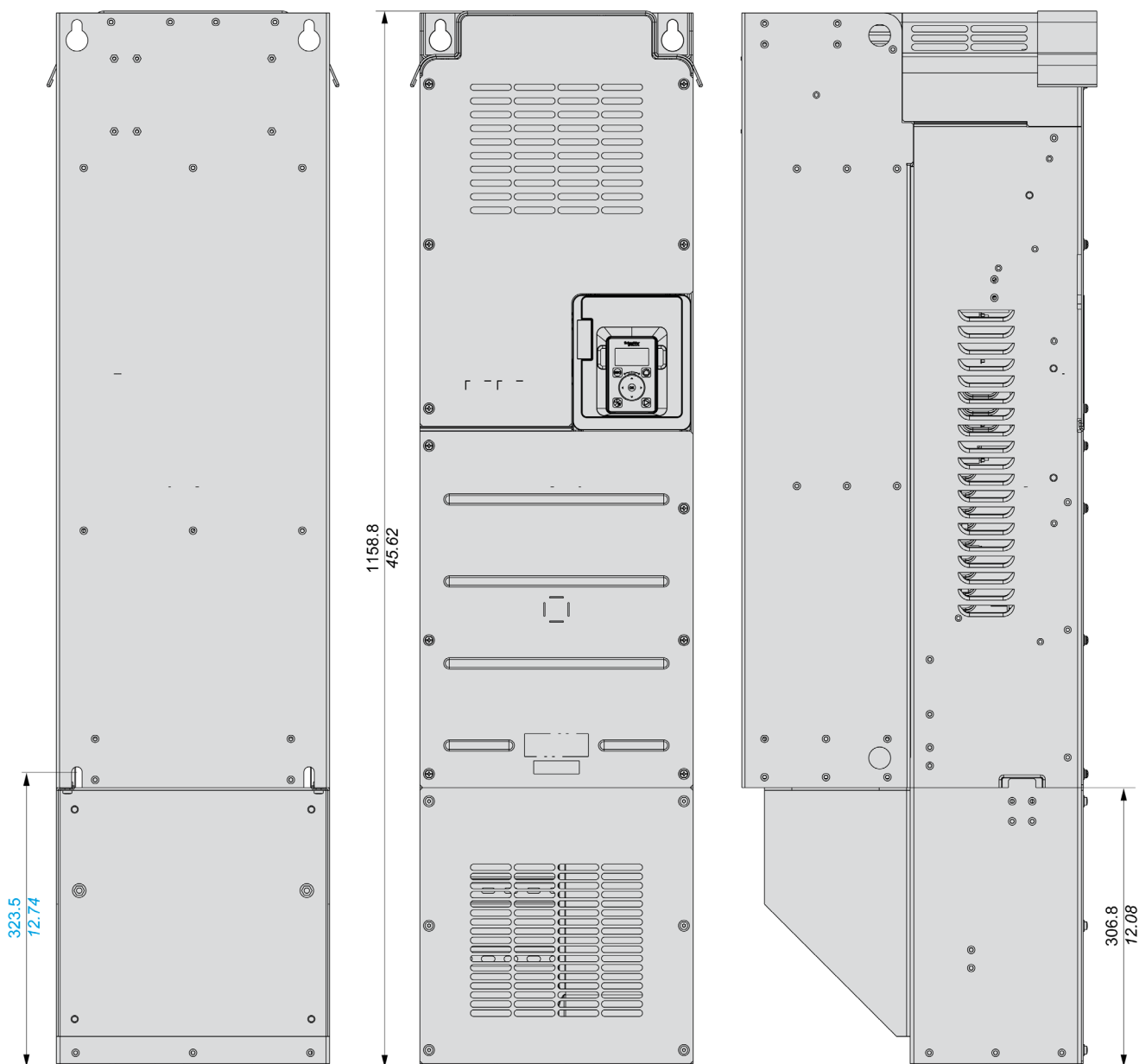
Catalog Number	Weight in kg (lb)
ATV610D55N4...ATV610D90N4	53.7 (118.4)

## Frame size 6

### IP20 Drives - Rear and Side View With Top Cover



## IP20 Drives - Rear, Front and Side View With Top Cover and Conduit Box



## Weights

Catalog Number	Weight in kg (lb)
ATV610C11N4...ATV610C16N4	82 (181)

## Characteristics of the Power Part Terminals

### Ground Cables

Ground cable cross sections of input and output ground cables are the same as those given for the input and output cables. Minimum cross section of protective ground cable is 10 mm<sup>2</sup> (AWG 8).

### Frame Size 1

ATV610	Supply Terminals (L1, L2, L3)			Output Terminals (U, V, W)		
	Wire Cross Section		Tightening Torque	Wire Cross Section		Tightening Torque
	Minimum	Maximum (*)	Rated	Minimum	Maximum (*)	Rated
	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)
U07N4 to U55N4	1.5 (16)	6 (10)	1.3 (11.5)	1.5 (16)	6 (10)	1.3 (11.5)
U75N4	2.5 (14)	6 (10)	1.3 (11.5)	2.5 (14)	6 (10)	1.3 (11.5)
(*) maximum permissible cross section of the terminal						

### Frame Size 2

ATV610	Supply Terminals (L1, L2, L3)			Output Terminals (U, V, W)		
	Wire Cross Section		Tightening Torque	Wire Cross Section		Tightening Torque
	Minimum	Maximum (*)	Rated	Minimum	Maximum (*)	Rated
	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)
D11N4	4 (12)	10 (8)	1.5 (13.3)	4 (12)	10 (8)	1.5 (13.3)
D15N4	6 (10)	10 (8)	1.5 (13.3)	6 (10)	10 (8)	1.5 (13.3)
(*) maximum permissible cross section of the terminal						

### Frame Size 3

ATV610	Supply Terminals (L1, L2, L3)			Output Terminals (U, V, W)		
	Wire Cross Section		Tightening Torque	Wire Cross Section		Tightening Torque
	Minimum	Maximum (*)	Rated	Minimum	Maximum (*)	Rated
	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)
D18N4, D22N4	10 (8)	16 (6)	2.5 (22.1)	10 (8)	16 (6)	2.5 (22.1)
(*) maximum permissible cross section of the terminal						

### Frame Size 4

ATV610	Supply Terminals (L1, L2, L3)			Output Terminals (U, V, W)		
	Wire Cross Section		Tightening Torque	Wire Cross Section		Tightening Torque
	Minimum	Maximum (*)	Rated (**)	Minimum	Maximum (*)	Rated (**)
	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)
D30N4	16 (6)	50 (1-1/0)	5 (44.3)	16 (6)	50 (1-1/0)	5 (44.3)
D37N4	25 (4)	50 (1-1/0)	5 (44.3)	25 (4)	50 (1-1/0)	5 (44.3)
D45N4	35 (2)	50 (1-1/0)	5 (44.3)	35 (2)	50 (1-1/0)	5 (44.3)
(*) maximum permissible cross section of the terminal						
(**) tightening torques according to wire cross section:						
<ul style="list-style-type: none"> <li>16 mm<sup>2</sup>...35 mm<sup>2</sup>, tightening torque: 5 N·m (44.3 lb.in)</li> <li>50 mm<sup>2</sup>, tightening torque: 10 N·m (88.5 lb.in)</li> </ul>						

## Frame Size 5

ATV610	Supply Terminals (L1, L2, L3)			Output Terminals (U, V, W)		
	Wire Cross Section		Tightening Torque	Wire Cross Section		Tightening Torque
	Minimum	Maximum (*)	Rated (**)	Minimum	Maximum (*)	Rated (**)
	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N·m (lb.in)
D55N4	50 (1-1/0)	120 (4/0)	10 (88.5)	50 (1-1/0)	120 (4/0)	10 (88.5)
D75N4	70 (2/0)	120 (4/0)	10 (88.5)	70 (2/0)	120 (4/0)	10 (88.5)
D90N4	95 (3/0)	120 (4/0)	18 (159.3)	95 (3/0)	120 (4/0)	18 (159.3)
(*) maximum permissible cross section of the terminal (**) tightening torques according to wire cross section: • 50 mm <sup>2</sup> ...70 mm <sup>2</sup> , tightening torque: 10 N·m (88.5 lb.in) • 95 mm <sup>2</sup> ...120 mm <sup>2</sup> , tightening torque: 18 N·m (159.3 lb.in)						

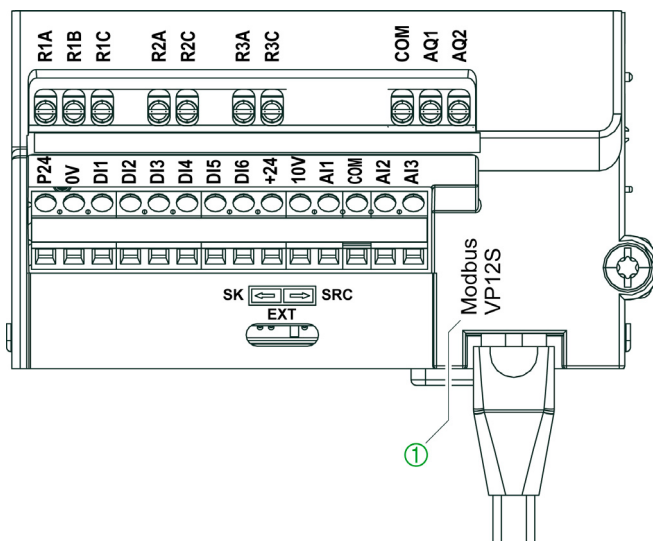
## Frame Size 6

ATV610	Supply Terminals (L1, L2, L3)			Output Terminals (U, V, W)		
	Wire Cross Section		Tightening Torque	Wire Cross Section		Tightening Torque
	Minimum	Maximum (*)	Rated	Minimum	Maximum (*)	Rated
	mm <sup>2</sup>	mm <sup>2</sup>	N·m	mm <sup>2</sup>	mm <sup>2</sup>	N·m
C11N4	2 x 50	3 x 120	27	2 x 50	3 x 120	27
C13N4	2 x 70	3 x 120	27	2 x 70	3 x 120	27
C16N4	2 x 95	3 x 120	27	2 x 95	3 x 120	27
(*) maximum permissible cross section of the terminal						

## Arrangement and Characteristics of Control Block Terminals and Communication and I/O Ports

### Terminal Arrangement

The control block terminals are the same for all drive frame sizes.



① Modbus VP12S: This is the standard Modbus serial link marking. VP•S means connector with power supply, where 12 stands for the 12 Vdc supply voltage.

### Wiring Characteristics

Wire cross sections and tightening torques

Control Terminals	Relay Output Wire Cross Section		Other Wire Cross Section		Tightening Torque
	Minimum (1)	Maximum	Minimum (1)	Maximum	
	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	mm <sup>2</sup> (AWG)	N•m (lb.in)
All terminals	0.75 (18)	1.5 (16)	0.5 (20)	1.5 (16)	0.5 (4.4)

(1) The value corresponds to the minimum permissible cross section of the terminal.

**NOTE:** Control Terminal Electrical data. ([see page 37](#))

### RJ45 Communication port

It is used to connect a:

- Remote graphic display terminal, using a Modbus serial line
- Modbus network
- Configuration loader tool...

**NOTE:** Check that RJ45 cable is not damaged prior to connect it to the product otherwise the power supply of the control could be lost.

---

## Section 2.3

### Electrical Data

---

#### What Is in This Section?

This section contains the following topics:

Topic	Page
Drive Ratings in Normal Duty	32
Drive Ratings in Heavy Duty	33
Derating Curves	34
Control Terminals Electrical Data	37
Sink / Source Switch Configuration	39

## Drive Ratings in Normal Duty

### IP20 Products 3-Phase Power Part Supply Voltage 380...415 V 50/60 Hz

Catalog Number and Size (S•)		Nominal Power (1)		Power Part Supply				Drive (output)	
				Max. Input Current		Apparent Power	Max. Inrush Current (2)	Nominal Current (1)	Max. Transient current (1) (3)
				at 380 Vac	at 415 Vac				
		kW	HP	A	A	kVA	A	A	A
ATV610U07N4	S1	0.75	1	3.1	2.9	2.1	8	2.2	2.4
ATV610U15N4	S1	1.5	2	5.7	5.3	3.8	8	4	4.4
ATV610U22N4	S1	2.2	3	7.8	7.1	5.1	8	5.6	6.2
ATV610U30N4	S1	3	-	10.1	9.2	6.6	34	7.2	7.9
ATV610U40N4	S1	4	5	8.8	8.5	6.1	33	9.3	10.2
ATV610U55N4	S1	5.5	7 1/2	11.6	11	7.9	34	12.7	14
ATV610U75N4	S1	7.5	10	14.7	13.7	9.9	34	15.8	17.4
ATV610D11N4	S2	11	15	22	20.7	14.9	40	23.5	25.9
ATV610D15N4	S2	15	20	29.4	27.7	19.9	40	31.7	34.9
ATV610D18N4	S3	18.5	25	37.2	35.2	25.3	76	39.2	43.1
ATV610D22N4	S3	22	30	41.9	39.0	28	76	46.3	50.9
ATV610D30N4	S4	30	40	62.5	59.7	42.9	91	61.5	67.7
ATV610D37N4	S4	37	50	76.6	72.9	52.4	101	74.5	82
ATV610D45N4	S4	45	60	92.9	88.3	63.5	124	88	96.8
ATV610D55N4	S5	55	75	111.5	105.6	75.9	167	106	116.6
ATV610D75N4	S5	75	100	147.9	139.0	99.9	186	145	159.5
ATV610D90N4	S5	90	125	177.8	168.5	121.1	240	173	190.3
ATV610C11N4	S6	110	150	201	165.0	118.6	325	211	232
ATV610C13N4	S6	132	200	237	213.0	153.1	325	250	275
ATV610C16N4	S6	160	250	284	261.0	187.6	325	302	332
<p><b>(1)</b> The switching frequency is adjustable:</p> <ul style="list-style-type: none"> <li>○ From 2...12 kHz for drive frame sizes 1 to 4, rated value: 4 kHz</li> <li>○ From 1...8 kHz for drive frame sizes 5 and 6, rated value: 2.5 kHz</li> </ul> <p>For operation at switching frequencies higher than the rated value. Derating must be applied to the drive (output) current (<a href="#">see page 34</a>).</p> <p>In this case, switching frequency can be reduced if an excessive temperature rise occurs.</p> <p><b>(2)</b> Peak current when power is switched On, for the maximum supply mains voltage.</p> <p><b>(3)</b> The drive is designed to run up to 60 s at 110% of nominal current.</p>									



## Drive Ratings in Heavy Duty

### IP20 Products 3-Phase Power Part Supply Voltage 380...415 V 50/60 Hz

Catalog Number and Size (S•)		Nominal Power (1)		Power Part Supply				Drive (output)	
				Max. Input Current		Apparent Power	Max. Inrush Current(2)	Nominal Current (1)	Max. Transient current (1) (3)
				at 380 Vac	at 415 Vac				
		kW	HP	A	A	kVA	A	A	A
ATV610U07N4	S1	0.37	1/2	1.7	1.5	1.1	8	1.5	2.3
ATV610U15N4	S1	0.75	1	3.1	2.8	2	8	2.2	3.3
ATV610U22N4	S1	1.5	2	5.6	5.1	3.7	8	4	6
ATV610U30N4	S1	2.2	3	7.6	7	5	34	5.6	8.4
ATV610U40N4	S1	3	-	7.2	6.7	4.8	33	7.2	10.8
ATV610U55N4	S1	4	5	8.9	8.6	6.2	34	9.3	14
ATV610U75N4	S1	5.5	7 1/2	11.3	10.7	7.7	34	12.7	19.1
ATV610D11N4	S2	7.5	10	16.4	15.7	11.3	40	16.5	24.8
ATV610D15N4	S2	11	15	23	21.9	15.7	40	23.5	35.3
ATV610D18N4	S3	15	20	31.6	30.3	21.8	76	31.7	47.6
ATV610D22N4	S3	18.5	25	36	33.8	24.3	76	39.2	58.8
ATV610D30N4	S4	22	30	49.7	46.3	33.3	91	46.3	69.5
ATV610D37N4	S4	30	40	65.8	61.8	44.4	101	59.6	89.4
ATV610D45N4	S4	37	50	80.5	75.8	54.5	124	74.5	112
ATV610D55N4	S5	45	60	95.9	91.2	65.6	167	88	132
ATV610D75N4	S5	55	75	115.8	109.1	79.1	186	106	159
ATV610D90N4	S5	75	100	155.8	149.1	107.2	240	145	217.5
ATV610C11N4	S6	90	125	170	160	115	325	173	259.5
ATV610C13N4	S6	110	150	201	188	135.1	325	211	317
ATV610C16N4	S6	132	200	237	224	161	325	250	375
<p><b>(1)</b> The switching frequency is adjustable:</p> <ul style="list-style-type: none"> <li>○ From 2...12 kHz for drive frame sizes 1 to 4, rated value: 4 kHz</li> <li>○ From 1...8 kHz for drive frame sizes 5 and 6, rated value: 2.5 kHz</li> </ul> <p>For operation at switching frequencies higher than the rated value. Derating must be applied to the drive (output) current (<a href="#">see page 34</a>).</p> <p>In this case, switching frequency can be reduced if an excessive temperature rise occurs.</p> <p><b>(2)</b> Peak current when power is switched On, for the maximum supply mains voltage.</p> <p><b>(3)</b> The drive is designed to run up to 60 s at 110% of nominal current.</p>									

## Derating Curves

### Description

Derating curves for the nominal drive current ( $I_n$ ) as a function of temperature and switching frequency. Refer to the Mounting Conditions chapter ([see page 43](#)) for the mounting types description.

### Possible Mountings

Mounting A: Standalone IP21

Mounting B: Side by side IP20, without top cover

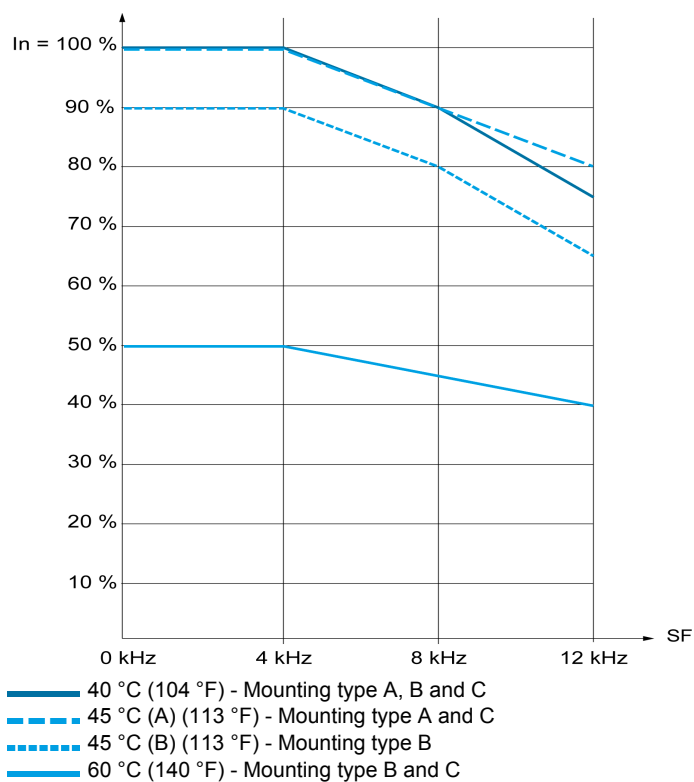
Mounting C: Standalone IP20, without top cover

### Permissible Temperatures According to Mounting Type

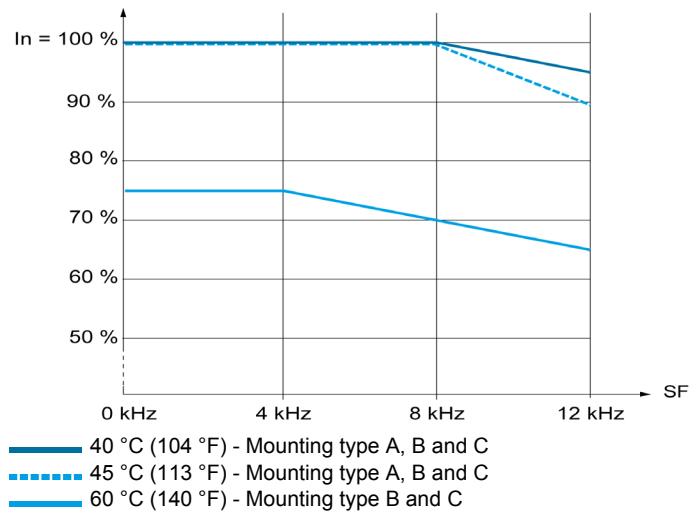
The possible mounting type are described in the Mounting Types section ([see page 43](#)).

Temperature in °C (°F)	Mounting Type
40 (104)	A, B, C
45 (113)	A, B, C
45 (113) (A)	A, C
45 (113) (B)	B
60 (140)	B, C

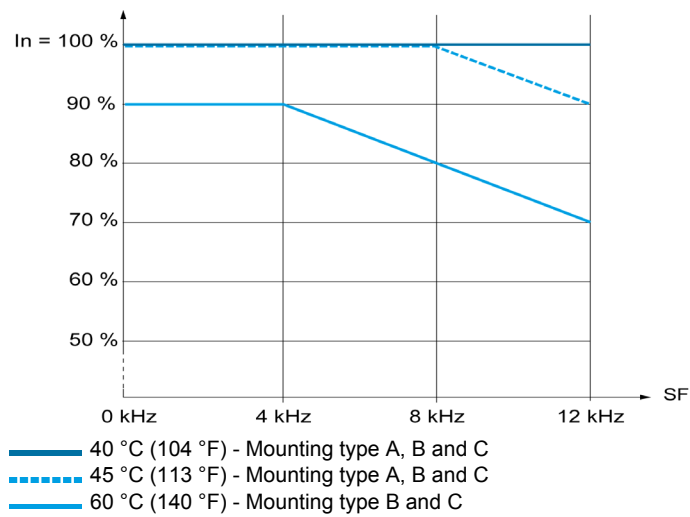
### Frame Size 1



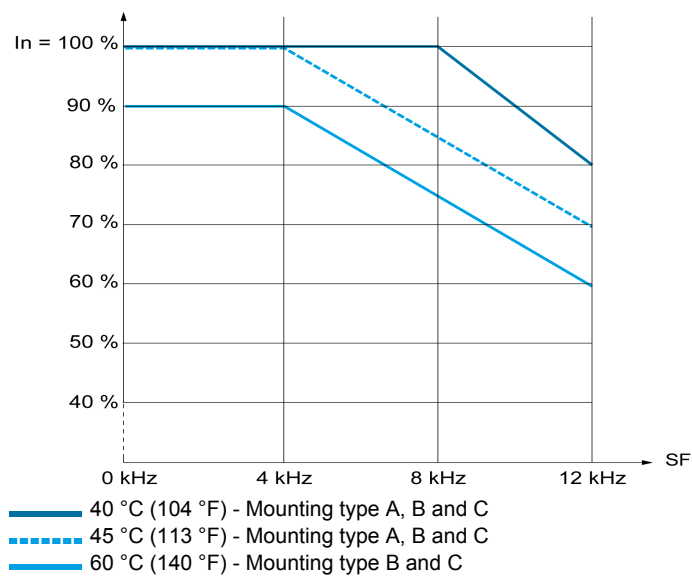
## Frame Size 2



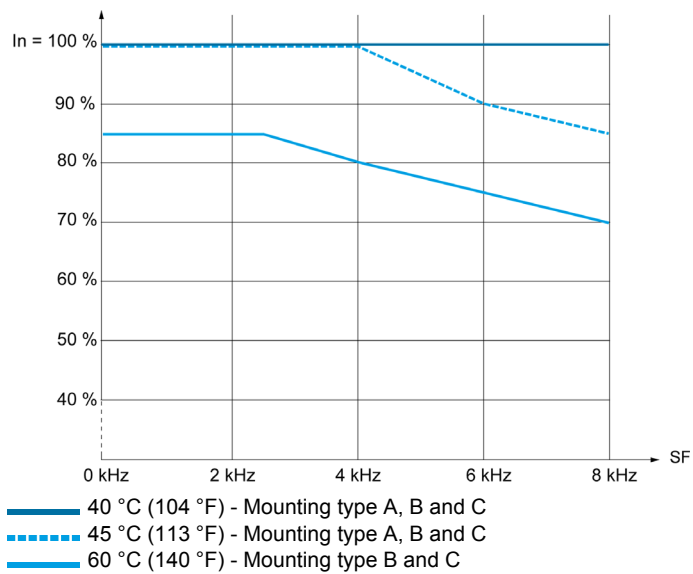
## Frame Size 3 - 380...480 V



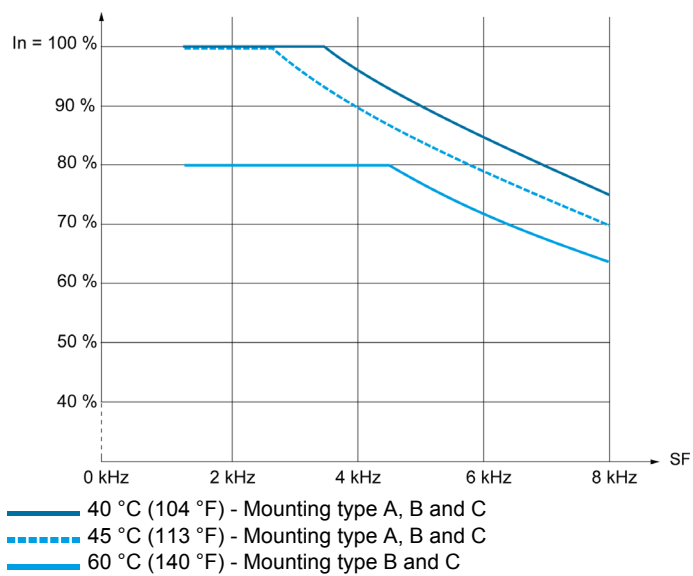
## Frame Size 4



## Frame Size 5



## Frame Size 6



## Control Terminals Electrical Data

### Characteristics of Terminals

**NOTE:**

- For a description of the terminal arrangement, refer to Arrangement and Characteristics of Control Terminals and Communication And I/O Ports ([see page 30](#))
- For factory setting I/O assignment, refer to the Programming Manual.

Terminal	Description	I/O Type	Electrical characteristics
R1A	NO contact of relay R1	O	<b>Output Relay 1</b> <ul style="list-style-type: none"> <li>Minimum switching capacity: 5 mA for 24 Vdc</li> <li>Maximum switching current on resistive load: (<math>\cos \phi = 1</math>): 3 A for 250 Vac and 30 Vdc</li> <li>Maximum switching current on inductive load: (<math>\cos \phi = 0.4</math> and <math>L/R = 7</math> ms): 2 A for 250 Vac and 30 Vdc</li> <li>Refresh time: 5 ms <math>\pm</math> 0.5 ms</li> <li>Service life: 100,000 operations at maximum switching current</li> </ul>
R1B	NC contact of relay R1	O	
R1C	Common point contact of relay R1	O	
R2A	NO contact of relay R2	O	<b>Output Relay 2</b> <ul style="list-style-type: none"> <li>Minimum switching capacity: 5 mA for 24 Vdc</li> <li>Maximum switching current on resistive load: (<math>\cos \phi = 1</math>): 3 A for 250 Vac and 30 Vdc</li> <li>Maximum switching current on inductive load: (<math>\cos \phi = 0.4</math> and <math>L/R = 7</math> ms): 2 A for 250 Vac and 30 Vdc</li> <li>Refresh time: 5 ms <math>\pm</math> 0.5 ms</li> <li>Service life: 100,000 operations at maximum switching power</li> </ul>
R2C	Common point contact of relay R2	O	
R3A	NO contact of relay R3	O	<b>Output Relay 3</b> <ul style="list-style-type: none"> <li>Minimum switching capacity: 5 mA for 24 Vdc</li> <li>Maximum switching current on resistive load: (<math>\cos \phi = 1</math>): 3 A for 250 Vac and 30 Vdc</li> <li>Maximum switching current on inductive load: (<math>\cos \phi = 0.4</math> and <math>L/R = 7</math> ms): 2 A for 250 Vac and 30 Vdc</li> <li>Refresh time: 5 ms <math>\pm</math> 0.5 ms</li> <li>Service life: 100,000 operations at maximum switching power</li> </ul>
R3C	Common point contact of relay R3	O	
24V	Output supply for digital inputs	O	<ul style="list-style-type: none"> <li>+24 Vdc</li> <li>Tolerance: minimum 20.4 Vdc, maximum 27 Vdc</li> <li>Current: maximum 200 mA for both 24 Vdc terminals</li> <li>Terminal protected against overload and short-circuit</li> <li>In Sink Ext position, this supply is powered by external PLC supply</li> </ul>
COM	Analog I/O common	I/O	0 V for Analog outputs
AQ1	Analog output	O	AQ: Analog output software-configurable for voltage or current <ul style="list-style-type: none"> <li>Voltage analog output 0...10 Vdc, minimum. Minimum load impedance 470 <math>\Omega</math>,</li> <li>Current analog output X-Y mA by programming X and Y from 0...20 mA, maximum load impedance 500 <math>\Omega</math></li> <li>Maximum sampling time: 10 ms <math>\pm</math> 1 ms</li> <li>Resolution 10 bits</li> <li>Accuracy: <math>\pm</math> 1% for a temperature variation of 60°C (140°F)</li> <li>Linearity <math>\pm</math> 0.2%</li> </ul>
AQ2	Analog output	O	
P24	External input supply	I	External input supply +24 Vdc <ul style="list-style-type: none"> <li>Tolerance: minimum 19 Vdc, maximum 30 Vdc</li> <li>Current: maximum 0.8 A</li> </ul>
0V	0 V	I/O	0 V for P24

Terminal	Description	I/O Type	Electrical characteristics
DI1-DI6	Digital inputs	I	<p>6 programmable logic inputs 24 Vdc, comply with IEC/EN 61131-2 logic type 1</p> <ul style="list-style-type: none"> <li>Positive logic (Source): State 0 if <math>\leq 5</math> Vdc or logic input not wired, state 1 if <math>\geq 11</math> Vdc</li> <li>Negative logic (Sink): State 0 if <math>\geq 16</math> Vdc or logic input not wired, state 1 if <math>\leq 10</math> Vdc</li> <li>Impedance 3.5 k<math>\Omega</math></li> <li>Maximum voltage: 30 Vdc</li> <li>Maximum sampling time: 2 ms <math>\pm</math> 0.5 ms</li> </ul> <p>Multiple assignment makes it possible to configure several functions on one input (example: DI1 assigned to forward and preset speed 2, DI3 assigned to reverse and preset speed 3).</p>
DI5-DI6	Pulse inputs	I	<p>Programmable Pulse input</p> <ul style="list-style-type: none"> <li>Comply with level 1 PLC, IEC 65A-68 standard</li> <li>State 0 if &lt; 0.6 Vdc, state 1 if &gt; 2.5 Vdc</li> <li>Pulse counter 0...30 kHz</li> <li>Frequency range: 0...30 kHz</li> <li>Cyclic ratio: 50 % <math>\pm</math> 10 %</li> <li>Maximum input voltage 30 Vdc, &lt; 10 mA</li> <li>Maximum sampling time: 5 ms <math>\pm</math> 1 ms</li> </ul>
10V	Output supply for Analog input	O	<p>Internal supply for the analog inputs</p> <ul style="list-style-type: none"> <li>10.5 Vdc</li> <li>Tolerance <math>\pm</math> 5%</li> <li>Current: maximum 10 mA</li> <li>Short circuit protected</li> </ul>
AI1-AI2-AI3	Analog inputs	I	<p>Software-configurable V/A : voltage or current analog input</p> <ul style="list-style-type: none"> <li>Voltage analog input 0...10 Vdc, impedance 30 k<math>\Omega</math>,</li> <li>Current analog input X-Y mA by programming X and Y from 0...20 mA, with impedance 250 <math>\Omega</math></li> <li>Maximum sampling time: 5 ms <math>\pm</math> 1 ms</li> <li>Resolution 12 bits</li> <li>Accuracy: <math>\pm</math> 0.6% for a temperature variation of 60°C (140°F)</li> <li>Linearity <math>\pm</math> 0.15% of maximum value</li> </ul>
COM	Analog I/O common	I/O	0 V for Analog inputs
AI2-AI3	Sensor inputs	I	<p>Software-configurable PT100/PT1000 or KTY84 or PTC or Water level sensor</p> <ul style="list-style-type: none"> <li><b>PT100</b> <ul style="list-style-type: none"> <li>1 or 3 thermal sensors mounted in series (configurable by software)</li> <li>Sensor current: 5 mA</li> <li>Range -20...200°C (-4...392°F)</li> <li>Accuracy <math>\pm</math> 4°C (39°F) for a temperature variation of 60°C (140°F)</li> </ul> </li> <li><b>PT1000</b> <ul style="list-style-type: none"> <li>1 or 3 thermal sensors mounted in series (configurable by software)</li> <li>Thermal sensor current: 1 mA</li> <li>Range -20...200°C (-4...392°F)</li> <li>Accuracy <math>\pm</math> 4°C (39°F) for a temperature variation of 60°C (140°F)</li> </ul> </li> <li><b>PTC</b> <ul style="list-style-type: none"> <li>6 sensors maximum mounted in series</li> <li>Sensor current: 1 mA</li> <li>Nominal value: &lt; 1.5 k<math>\Omega</math></li> <li>Overheat trigger threshold: 2.9 k<math>\Omega</math> <math>\pm</math> 0.2 k<math>\Omega</math></li> <li>Overheat reset threshold: 1.575 k<math>\Omega</math> <math>\pm</math> 0.75 k<math>\Omega</math></li> <li>Threshold for low impedance detection: 50 k<math>\Omega</math> -10 <math>\Omega</math> / +20 <math>\Omega</math></li> <li>Protected for low impedance &lt; 1000 <math>\Omega</math></li> </ul> </li> <li><b>KTY84</b> <ul style="list-style-type: none"> <li>1 thermal sensor</li> <li>Thermal sensor current: 1 mA</li> <li>Range -20...200°C (-4...392°F)</li> <li>Accuracy <math>\pm</math> 4°C (39°F) for a temperature variation of 60°C (140°F)</li> </ul> </li> <li><b>Water Level Sensor</b> <ul style="list-style-type: none"> <li>Sensitivity: 0...1 M<math>\Omega</math>, adjustable by software</li> <li>Water level sensor current: 0.3 mA...1 mA maximum</li> <li>Adjustable delay: 0...10 s</li> </ul> </li> </ul>

## Sink / Source Switch Configuration

### **! WARNING**

#### UNANTICIPATED EQUIPMENT OPERATION

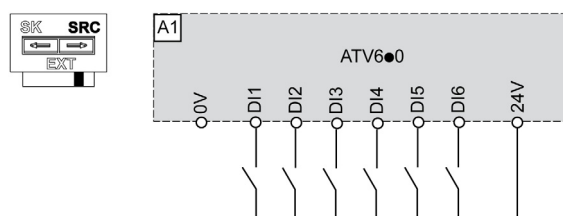
- If the drive is set to **Sink Int** or **Sink Ext**, do not connect the **0 V** terminal to ground or to protective ground.
- Verify that accidental grounding of digital inputs configured for sink logic, caused, for example, by damage to the signal cables, cannot occur.
- Follow all applicable standards and directives such as NFPA 79 and EN 60204 for proper control circuit grounding practices.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

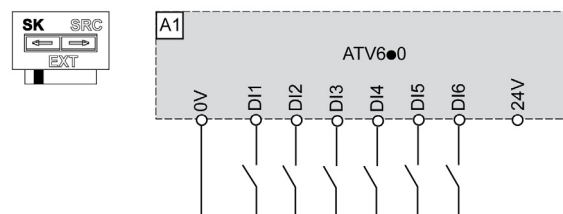
The switch is used to adapt the operation of the logic inputs to the technology of the programmable controller outputs. To access the switch, follow the Access to control Terminals procedure ([see page 65](#)). The switch is located below the control terminals ([see page 30](#)).

- Set the switch to Source (factory setting) if using PLC outputs with PNP transistors.
- Set the switch to Ext if using PLC outputs with NPN transistors.

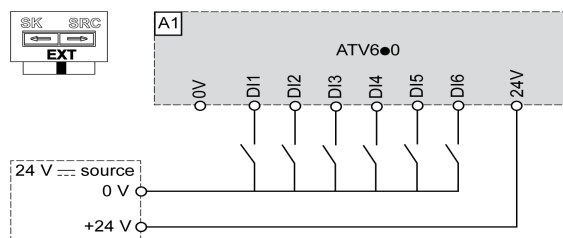
### Switch Set to SRC (Source) Position Using the Output Power Supply for the Digital Inputs



### Switch Set to SK (Sink) Position Using the Output Power Supply for the Digital Inputs



### Switch Set to EXT Position Using an External Power Supply for the DIs







---

## Chapter 3

### Drive Mounting

---

#### What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Mounting Conditions	42
Mounting Procedures	46

## Mounting Conditions

### Before You Begin

#### **DANGER**

##### **ELECTRIC SHOCK CAUSED BY FOREIGN OBJECTS OR DAMAGE**

Conductive foreign objects in the product or damage may cause parasitic voltage.

- Do not use damaged products.
- Keep foreign objects such as chips, screws or wire clippings from getting into the product.

**Failure to follow these instructions will result in death or serious injury.**

The metal surfaces of the product may exceed 100 °C (212 °F) during operation.

#### **WARNING**


##### **HOT SURFACES**

- Ensure that any contact with hot surfaces is avoided.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of hot surfaces.
- Verify that the heat dissipation is sufficient by performing a test run under maximum load conditions.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

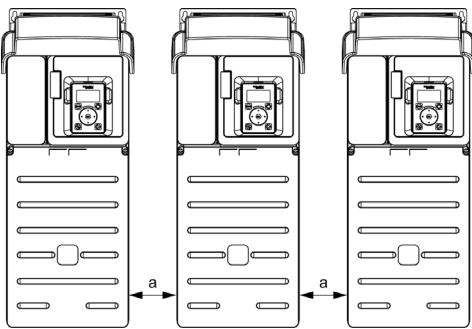
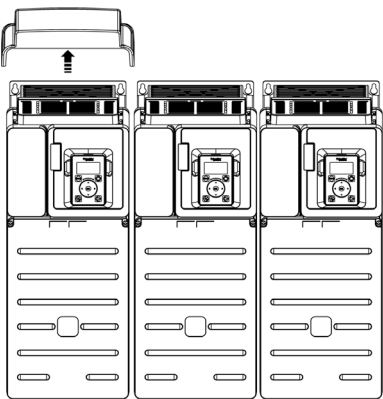
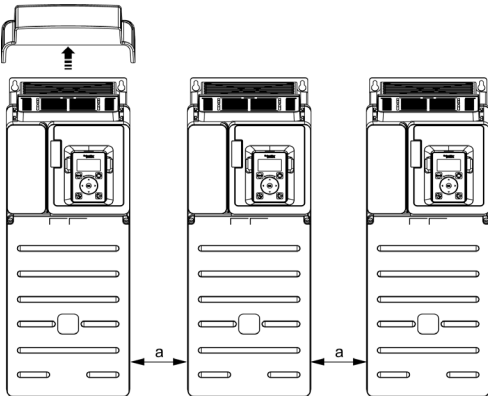
### Attaching A Label With Safety Instructions

A label kit is provided with the drive.

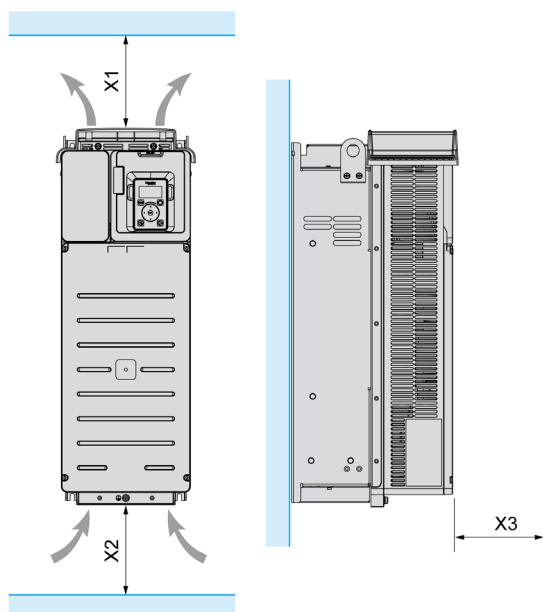
Step	Action
1	Observe the safety regulations in the target country
2	Select the label suitable for the target country
3	Attach the label to the front of the device so that it is clearly visible. Below is the English version 

## Mounting Types

This table shows the possible mounting types and the resulting IP degree of protection.

Mounting		Figure
No	Type / IP	
A	Individual IP20	 <p>Frame sizes 1, 2 and 3: <math>a \geq 100 \text{ mm (3.9 in.)}</math>            Frame sizes 4, 5 and 6: <math>a \geq 110 \text{ mm (4.33 in.)}</math></p>
B	Side by side IP20	 <p>Frame sizes 1, 2 and 3: possible            Frame sizes 4 and 5: possible, 2 drives only            Frame size 6: only at ambient temperature lower than 40 °C (104 °F)</p>
C	Individual IP20	 <p>Frame sizes 1, 2 and 3: no restriction of clearance            Frame sizes 4, 5 and 6: <math>a \geq 110 \text{ mm (4.33 in.)}</math></p>

## Clearances and Mounting Position - Wall Mounting



Minimum clearance regarding the drive frame size

Frame Size	X1	X2	X3
1...5	≥ 100 mm (3.94 in.)	≥ 100 mm (3.94 in.)	≥ 10 mm (0.39 in.)
6	≥ 250 mm (10 in.)	≥ 250 mm (10 in.)	≥ 100 mm (3.94 in.)

X1: free space in top of the drive

X2: free space in bottom of the drive

X3: free space in front of the drive

## General Mounting Instructions

- Mount the device in a vertical position. This is required for cooling the device.
- Attach it on the mounting surface in compliance with standards, using 4 screws with captive washer according to the table given in Mounting Procedures ([see page 46](#)).
- The use of washers is required with all mounting screws.
- Tighten the fixation screws.
- Do not mount the device close to heat sources.
- Avoid environmental effects like high temperatures and high humidity as well as dust, dirt and conductive gases.
- Adhere to the minimum installation distances for required cooling.
- Do not mount the device on flammable materials.

## Power Dissipated For Enclosed Drives and Required Air Flow

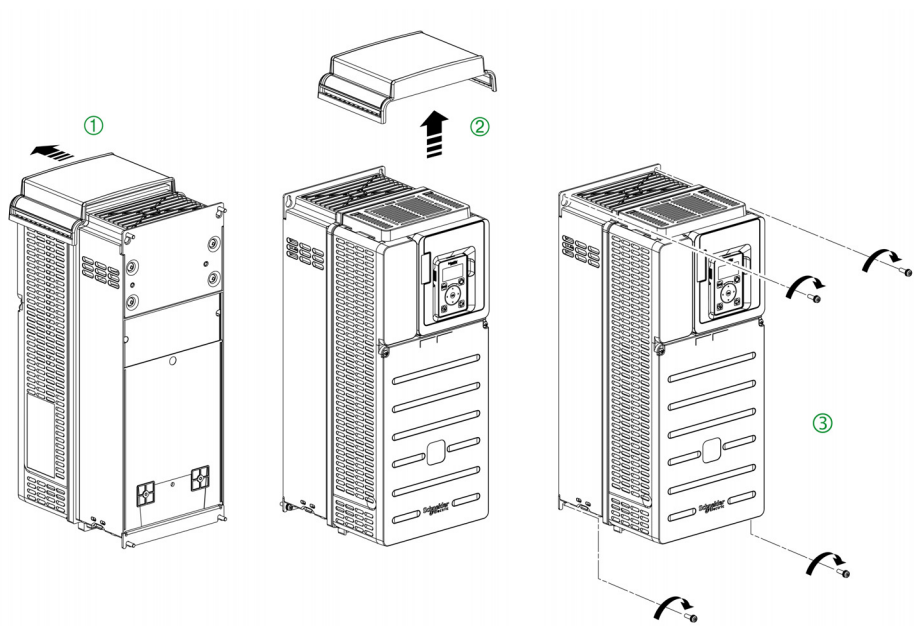
Catalog Number	Frame Size	Power Dissipated (1)			Minimum air flow rate required per hour	
		Forced Cooled Area	Natural Cooled Area	Total		
		(W)	(W)	(W)	(m <sup>3</sup> )	(yd <sup>3</sup> )
ATV610U07N4	1	19	23	42	38	50
ATV610U15N4	1	40	25	65	38	50
ATV610U22N4	1	54	27	81	38	50
ATV610U30N4	1	74	29	103	38	50
ATV610U40N4	1	128	32	160	38	50
ATV610U55N4	1	171	35	205	38	50
ATV610U75N4	2	216	42	258	103	135
ATV610D11N4	2	310	54	364	103	135
ATV610D15N4	3	408	62	469	215	281
ATV610D18N4	3	410	64	474	215	281
ATV610D22N4	3	492	72	564	215	281
ATV610D30N4	4	649	91	740	240	314
ATV610D37N4	4	842	109	950	240	314
ATV610D45N4	4	1000	121	1121	240	314
ATV610D55N4	5	969	131	1100	295	386
ATV610D75N4	5	1460	177	1637	295	386
ATV610D90N4	5	1745	199	1943	295	386
ATV610C11N4	6	2060	230	2290	600	785
ATV610C13N4	6	2620	260	2880	600	785
ATV610C16N4	6	3410	300	3710	600	785
(1) First value is the power dissipated at nominal current in the forced cooled area of the drive. The second value is the power dissipated at nominal current in the natural cooled area. If the drive is installed in a standard cabinet, the sum of both values is to be taken into account.						

## Mounting Procedures

### Mounting Screws

Frame Size	Screw diameter	Hole diameter
1	5 mm (0.2 in)	6 mm (0.24 in)
2	5 mm (0.2 in)	6 mm (0.24 in)
3	5 mm (0.2 in)	6 mm (0.24 in)
4	5 mm (0.2 in)	6 mm (0.24 in)
5	8 mm (0.31 in)	9 mm (0.35 in)
6	10 mm (0.4 in)	11.5 mm (0.45 in)

### Mounting Procedure For Frame Sizes 1 to 4



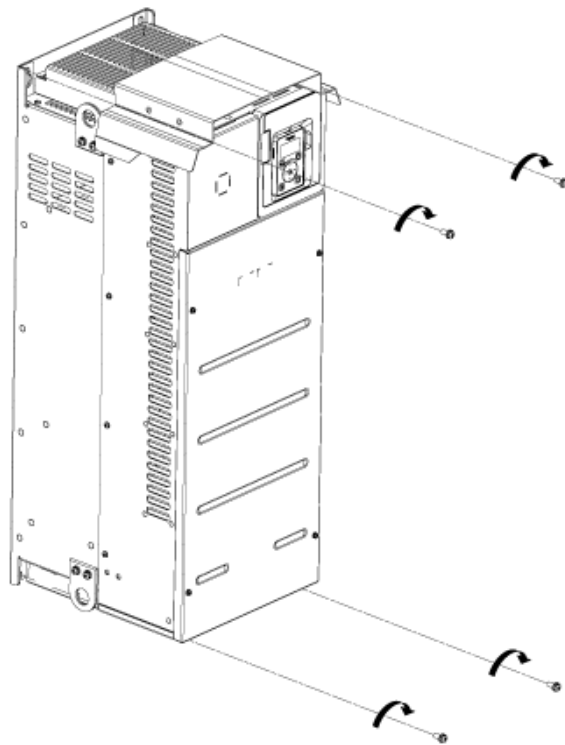
Perform the following instructions

Step	Action
1	Slide the top cover from back to front
2	Remove the top cover
3	Attach the drive to the mounting surface using the M5 screws with captive washer.
4	Refit the top cover to help prevent metal parts to fall into the drive during wiring operation or if IP20 degree of protection is requested.

---

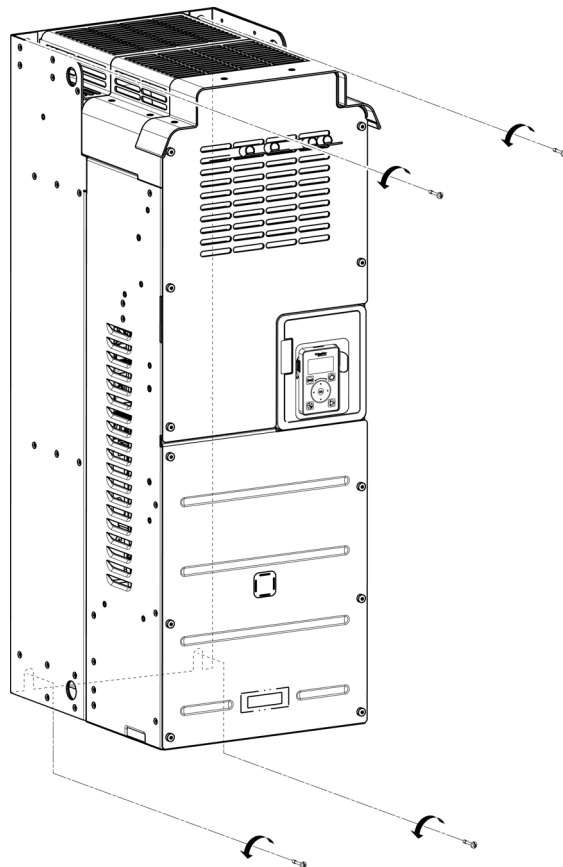
### Mounting Frame Size 5 Drives

Mounting of the drive does not require any preliminary procedure. Just Screw the drive on the mounting surface using the M8 screws with captive washer.



### Mounting Procedure For Frame Size 6

Mounting the drive does not require preliminary dismantling operation. Just screw the drive on the mounting surface using the M10 screws with captive washer.







---

# Chapter 4

## Drive wiring

---

### What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Wiring Instructions	50
Cable Length Instructions	52
Wiring Diagrams	54
Wiring the Power Part	56
Electromagnetic Compatibility	60
Operation on an IT or Corner Grounded System	62
Wiring The Control Part	65

## Wiring Instructions

### General Instructions

#### **DANGER**

##### **HAZARD OF FIRE OR ELECTRIC SHOCK**

- Wire cross sections and tightening torques must comply with the specifications provided in this document
- Do not use multi-conductor cables without cable lugs for any connection with a voltage higher than 25 Vac.

**Failure to follow these instructions will result in death or serious injury.**

#### **NOTICE**

##### **RISK OF REDUCE SERVICE LIFE AND INSUFFICIENT EMC**

- Do not connect the drive to a low impedance mains.
- An additional mains reactor must be used if the SCCR exceeds the value given in the catalog.

**Failure to follow these instructions can result in equipment damage.**

### Cable Characteristics

If you are using cables longer than 150 m (492 ft) between the drive and the motor, add output filters (for more details refer to the catalog).

Use a shielded cable to meet the requirements of Category C2 or C3 according to the standard IEC 61800-3, except when using a sinus filter. In this case, the use of a non-shielded motor cable is possible.

To limit the currents in common mode, use common mode output filters (ferrite) in order to reduce the circulating currents in the motor windings.

Standard linear capacity cables can be used with the drive. Use of cables with lower linear capacity could increase cable length performances.

The overvoltage limitation function **[Motor surge limit.] 5 L** enables you to increase the cable length while decreasing the torque performances (refer to Programming manual EAV64318).

### Power and Circuit Protection

Where local and national codes require upstream protection with a residual current device, use a type A device for three-phase drives used on single-phase mains and a type B device for three-phase drives as defined in the IEC standard 60755.

Choose a suitable model integrating:

- High frequency current filtering,
- A time delay that helps to prevent a triggering of the upstream device caused by the load from stray capacitance on power-on. The time delay is not available for 30 mA devices; in this case, choose devices with immunity against nuisance triggering.

If the installation includes several drives, provide one "residual current device" per drive.

### Control

- Keep the control circuits away from the power cables. For digital and analog inputs/outputs, use shielded twisted cables with a pitch of 25...50 mm (1 in. and 2 in.), connecting the shielding to ground at each end.
- It is recommended to use cable ends, available on [www.schneider-electric.com](http://www.schneider-electric.com).

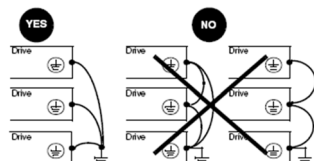
### **⚡ ⚠ DANGER**

#### **ELECTRIC SHOCK CAUSED BY INSUFFICIENT GROUNDING**

Insufficient grounding causes the hazard of electric shocks

- Ground the drive system before applying voltage.
- Do not use conduits as protective ground conductors; use a protective ground conductor inside the conduit.
- The cross section of the protective ground conductor must comply with the applicable standards.
- Do not consider cable shields to be protective ground conductors.

**Failure to follow these instructions will result in death or serious injury.**



### **⚡ ⚠ DANGER**

#### **ELECTRIC SHOCK CAUSED BY INSUFFICIENT GROUNDING**

This product has an increased leakage current  $>3.5$  mA.

- Use a protective ground conductor with at least  $10 \text{ mm}^2$  (AWG 6) or two protective ground conductors with the cross section of the conductors supplying the power terminals.
- Verify compliance with all local and national electrical code requirements as well as all other applicable regulations with respect to grounding of all equipment.

**Failure to follow these instructions will result in death or serious injury.**

Tighten the grounding screws according to the instructions given in the Ground Cables section ([see page 28](#)).

### **⚠ WARNING**

#### **INSUFFICIENT PROTECTION AGAINST OVERCURRENTS**

- Properly rated overcurrent protective devices must be used.
- Use the fuses specified in the catalog.
- Do not connect the product to a supply mains whose short-circuit current rating (SCCR) exceeds the permissible value specified in the catalog.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

### **NOTICE**

#### **DESTRUCTION DUE TO INCORRECT WIRING**

- Before switching on and configuring the product, verify that it is properly wired.

**Failure to follow these instructions can result in equipment damage.**

- Ensure that the resistance to ground is 1 Ohm or less.
- When grounding several drives, you must connect each one directly, as shown in the above figure.
- Do not loop ground cables or connect them in series.

## Cable Length Instructions

### Long Cable Lengths Consequences

When drives are used with motors, a combination of fast switching transistors and long motor cables can even cause peak voltages up to twice the DC link voltage. This high peak voltage can cause premature aging of motor winding insulation which leads to motor breakdown.

The overvoltage limitation function will enable to increase the cable length while decreasing the torque performances.

### Length Of Motor Cables

Because of the permitted mains disturbances, the allowed overvoltages at the motor, the occurring bearing currents and the permitted heat losses the distance between inverter and motor(s) is limited.

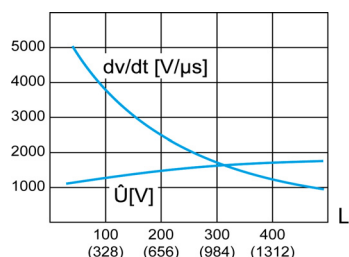
The maximum distance heavily depends on the used motors (insulation material), the type of motor cable used (shielded/unshielded), the cable laying (cable channel, underground installation...) as well as from the used options.

### Dynamic Voltage Load Of The Motor

Overvoltages at the motor terminals result from reflection in the motor cable. Basically the motors are stressed with measurable higher voltage peaks from a motor cable length of 10 m. With the length of the motor cable also the value of overvoltage increases.

The steep edges of the switching impulses at the output side of the frequency inverter lead to a further load of the motors. The slew rate of the voltage is typically over 5 kV/μs but it decreases with the length of the motor cable

Load of the motor with overvoltage and slew rate when using conventional drive



L Length of motor cables in meters (feet)

### Corrective Actions Overview

A number of simple measures can be taken to help enhance the motor life time:

- Specification of a motor designed for speed drive applications (IEC60034-25 B or NEMA 400 should be prescribed).
- Reduce to a minimum the distance between motor and drive.
- Use unshielded cables.
- Reduce the drive switching frequency (a reduction to 2.5 kHz is recommended.)

### Preventive Measures Suitable for Wall Mounting Drives According to IEC60034-25

The preventive measures will depend on motor characteristics and cable length.

Motor cable length (unshielded cable)	Motor conforming to IEC60034-25	Motor NOT-conforming to IEC60034-25
1 m (3 ft) < L < 50 m (164 ft)	Filter not required	dV/dt filter
50 m (164 ft) < L < 100 m (328 ft)	Filter not required	Sinus filter
100 m (328 ft) < L < 300 m (984 ft)	Filter not required	Sinus filter
300 m (984 ft) < L < 500 m (1640 ft)	dV/dt filter	Sinus filter
500 m (1640 ft) < L < 1000 m (3281 ft)	Sinus filter	Sinus filter

**NOTE:** When calculating cable lengths for the purpose of guarding against these overvoltage situations, a shielded cable should count as twice the length of an unshielded cable. For example, if a shielded cable is 100 m (328 ft) in actual length, it should be considered to be equal to a 200 m (656 ft) length standard cable in the calculation.

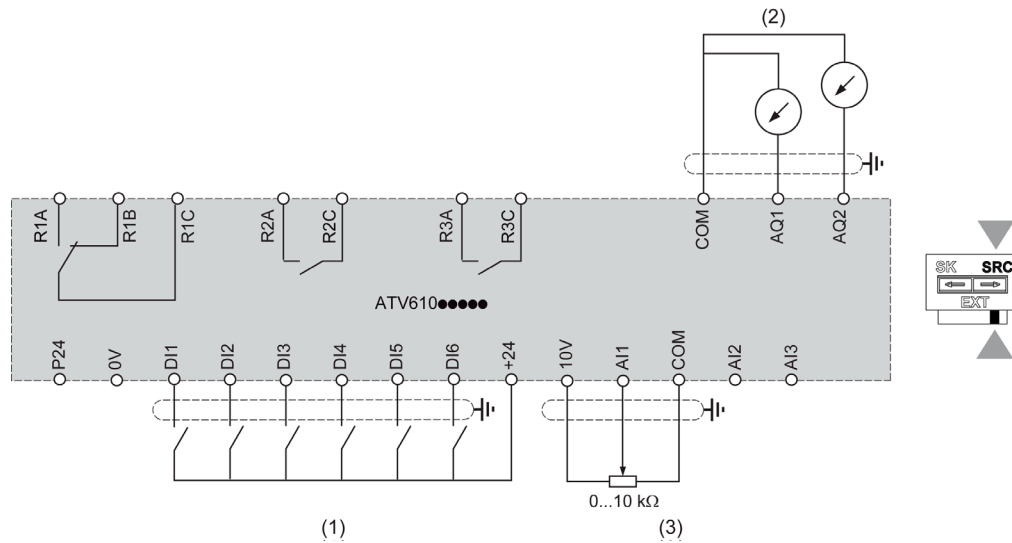
---

### Additional Information

Further detailed technical information is available in the following white paper *An Improved Approach for Connecting VSD and Electric Motors* available on [www.schneider-electric.com](http://www.schneider-electric.com).

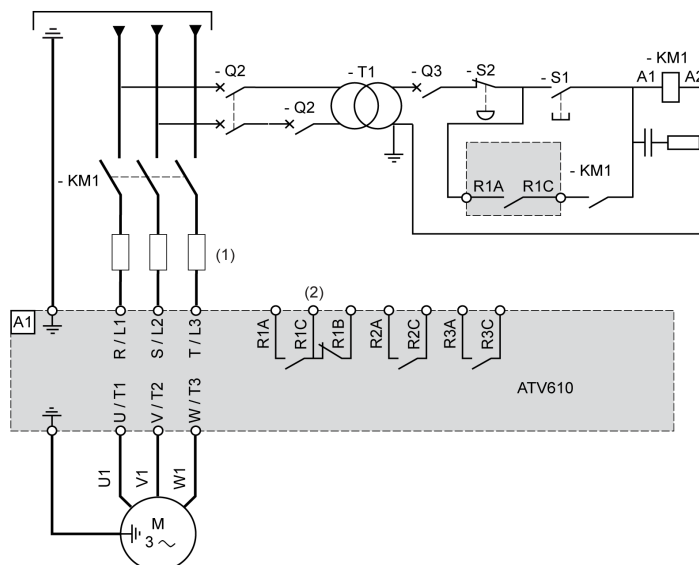
## Wiring Diagrams

## Control Block Wiring Diagram



- (1) Digital Input - Shielding instructions are given in the Electromagnetic Compatibility section (see page 60).
- (2) Analog Output
- (3) Analog Input

## Single or Three-phase Power Supply - Diagram With Line Contactor



- (1) Line choke (if used).
- (2) Use relay output R1 set to operating state Fault to switch Off the product once an error is detected.

### Single or Three-phase Power Supply - Diagram With Downstream Contactor

If a Run command is executed while the downstream contactor between the drive and the motor is still open, there may be residual voltage at the output of the drive. This can cause an incorrect estimation of the motor speed when the contacts of the downstream contactor are closed. This incorrect estimation of the motor speed can lead to unanticipated equipment operation or to equipment damage.

In addition, there may be overvoltage at the output of the drive if the power stage is still enabled when the downstream contactor between the drive and the motor opens.

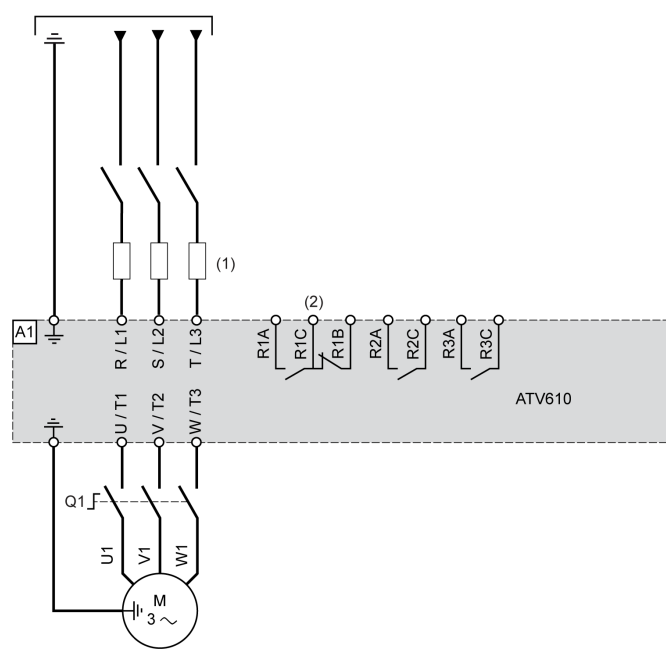
## WARNING

## UNANTICIPATED EQUIPMENT OPERATION OR EQUIPMENT DAMAGE

If a downstream contactor is used between the drive and the motor, verify the following:

- The contacts between the motor and the drive must be closed before a Run command is executed.
- The power stage must not be enabled when the contacts between the motor and the drive open.

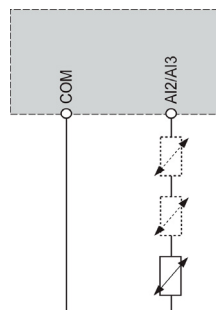
**Failure to follow these instructions can result in death, serious injury, or equipment damage.**



- (1) Line choke (if used)
- (2) Use relay output R1 set to operating state Fault to switch Off the product once an error is detected.

## Sensor Connection

It is possible to connect either 1 or 3 sensors on terminals AI2 or AI3.



## Wiring the Power Part

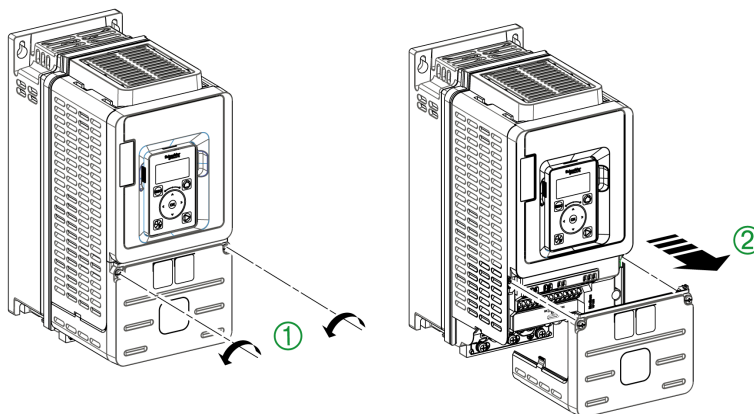
### Access To The Terminals For Frame Size 1...3

#### **DANGER**

##### **HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**

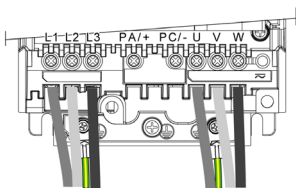


Apply the following instructions to access the terminals on **frame size 3** drives

Step	Action
1	Unscrew the 2 screws attaching the housing
2	Remove the front cover

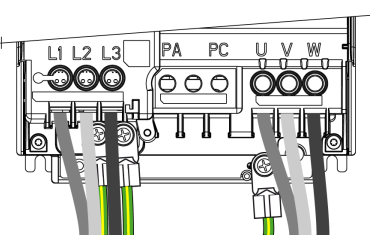
### Frame Sizes 1 and 2 Cable Path

Wire the power cables as shown below.



### Frame Size 3 Cable Path

Wire the power cables as shown below.





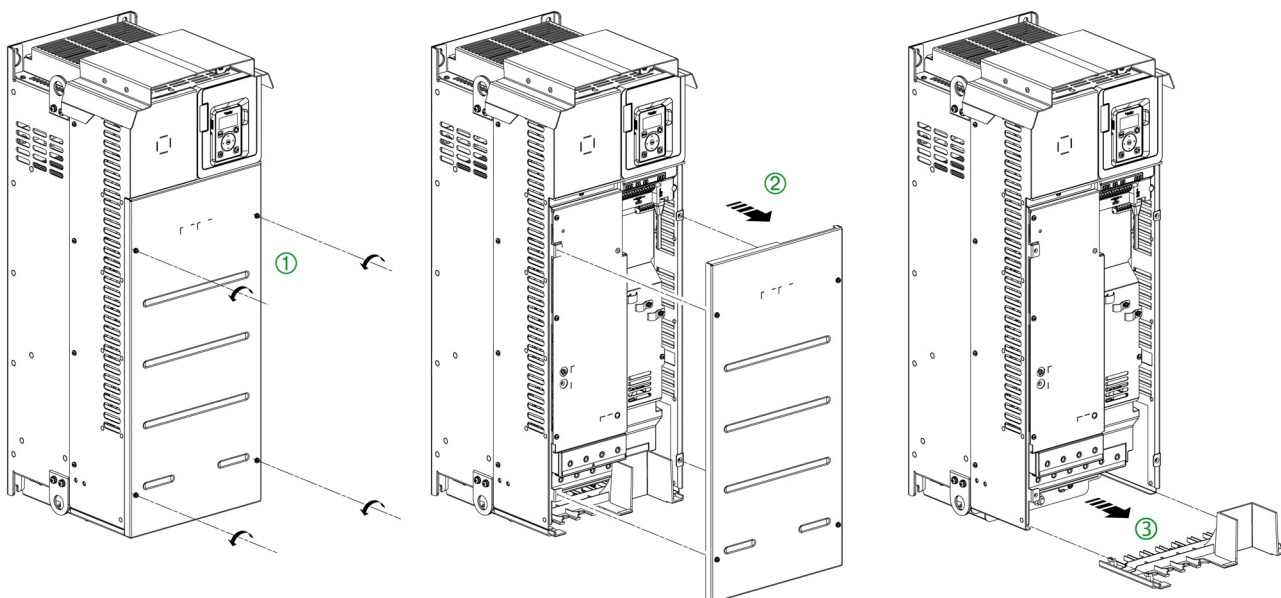
## Access To The Terminals For Frame Sizes 4 and 5

### DANGER

#### HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**

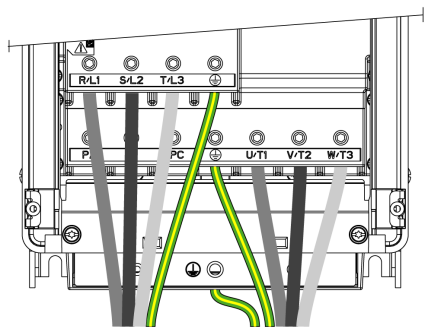


Apply the following instructions to the terminals on **frame sizes 4 and 5** drives

Step	Action
1	Unscrew the 4 screws attaching the front cover
2	Remove the front cover
3	Remove the power terminal cover

## Frame Size 4 And 5 Cable Path

Wire the power cables as shown below.

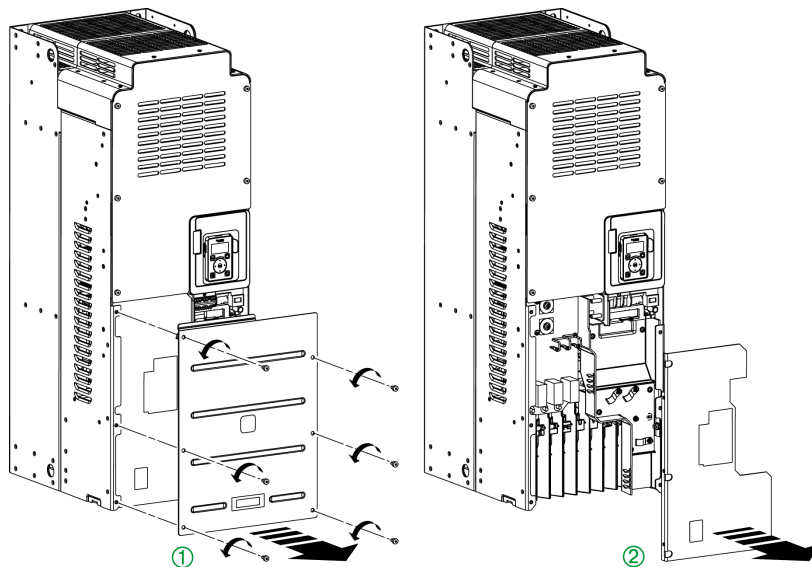


## DANGER

### HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**



Apply the following instructions to access the terminals on **frame sizes 6** drives

Step	Action
1	Unscrew the 6 screws attaching the bottom front cover and remove it
2	Remove the terminal cover
3	Remove the cable duct

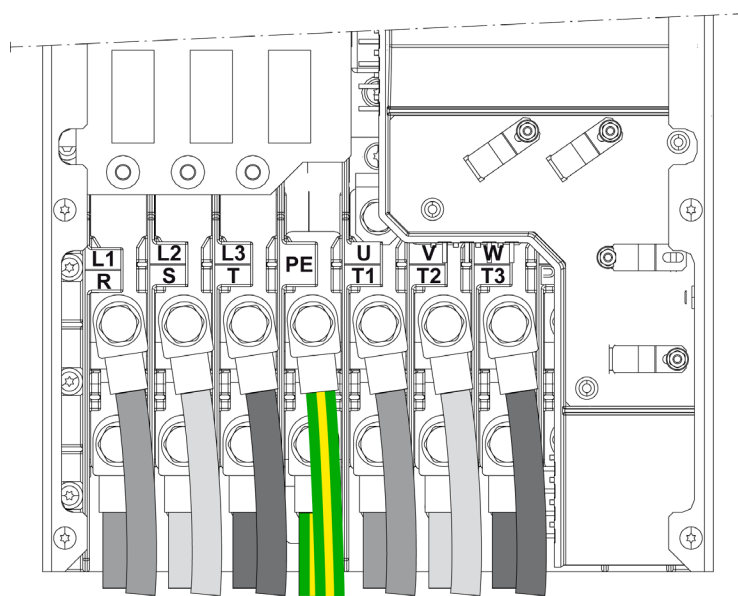
## Frame Size 6 Cable Path

Use 2 or 3 connection cables per terminal, depending on the cable characteristics. Refer to standard IEC 60364-5-52 for cable selection. Permissible cable cross sections are given in the Power Terminals section ([see page 29](#)).

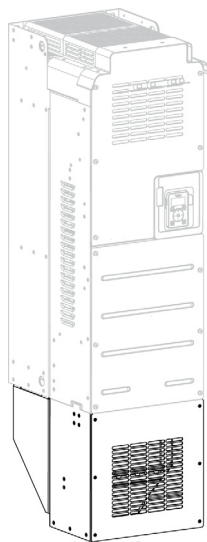
For 3 connection cable wiring:

Step	Action
1	connect the first cable on the lower terminal
2	connect the 2 other cables on the upper terminal

For 2 cable connection, wire the power cables as shown below.



**NOTE:** A conduit box is available as an option. It enables an IP21 degree of protection at the bottom side of the drive. See [www.schneider-electric.com](http://www.schneider-electric.com)



## Electromagnetic Compatibility

### Limit Values

This product meets the EMC requirements according to the standard IEC 61800-3 if the measures described in this manual are implemented during installation. If the selected composition (product itself, mains filter, other accessories and measures) does not meet the requirements of category C1, the following information applies as it appears in IEC 61800-3:

<b>⚠ WARNING</b>
<b>RADIO INTERFERENCE</b>
In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.
<b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b>

### EMC requirements for the control cabinet

EMC measures	Objective
Use mounting plates with good electrical conductivity, connect large surface areas of metal parts, remove paint from contact areas.	Good conductivity due to large surface contact.
Ground the control cabinet, the control cabinet door and the mounting plate with ground straps or ground wires. The conductor cross section must be at least 10 mm <sup>2</sup> (AWG 8).	Reduces emissions.
Fit switching devices such as power contactors, relays or solenoid valves with interference suppression units or arc suppressors (for example, diodes, varistors, RC circuits).	Reduces mutual interference.
Install power components and control components separately.	

### Shielded cables

EMC measures	Objective
Connect large surface areas of cable shields, use cable clamps and ground straps.	Reduces emissions.
Use cable clamps to connect a large surface area of the shields of all shielded cables to the mounting plate at the control cabinet entry.	
Ground shields of digital signal wires ( <a href="#">see page 54</a> ) at both ends by connecting them to a large surface area or via conductive connector housings	Reduces interference affecting the signal wires, reduces emissions
Ground the shields of analog signal wires directly at the device (signal input); insulate the shield at the other cable end or ground it via a capacitor (for example, 10 nF, 100 V or higher).	Reduces ground loops due to low-frequency interference.
Use only shielded motor cables with copper braid and a coverage of at least 85%, ground a large surface area of the shield at both ends.	Diverts interference currents in a controlled way, reduces emissions.

## Cable Installation

EMC measures	Objective
Do not route fieldbus cables and signal wires in a single cable duct together with lines with DC and AC voltages of more than 60 V. (Fieldbus cables, signal lines and analog lines may be in the same cable duct) Recommendation: Use separate cable ducts at least 20 cm apart.	Reduces mutual interference.
Keep cables as short as possible. Do not install unnecessary cable loops, use short cables from the central grounding point in the control cabinet to the external ground connection.	Reduces capacitive and inductive interference.
Use equipotential bonding conductors in the following cases: wide-area installations, different voltage supplies and installation across several buildings.	Reduces current in the cable shield, reduces emissions.
Use fine stranded equipotential bonding conductors.	Diverts high-frequency interference currents
If motor and machine are not conductively connected, for example by an insulated flange or a connection without surface contact, you must ground the motor with a ground strap or a ground wire. The conductor cross section must be at least 10 mm <sup>2</sup> (AWG 6).	Reduces emissions, increases immunity.
Use twisted pair for the DC supply. For digital and analog inputs use shielded twisted cables with a pitch of between 25...50 mm (1...2 in).	Reduces interference affecting the signal cables, reduces emissions.

## Power Supply

EMC measures	Objective
Operate product on mains with grounded neutral point.	Enables effectiveness of mains filter.
Surge arrester if there is a risk of overvoltage.	Reduces the risk of damage caused by overvoltage.

## Additional measures for EMC improvement

Depending on the application, the following measures can improve the EMC-dependent values:

EMC measures	Objective
Use mains reactors	Reduces mains harmonics, prolongs product service life.
Use external mains filters	Improves the EMC limit values.
Additional EMC measures, for example mounting in a closed control cabinet with 15 dB shielding attenuation of radiated interference	

**NOTE:** If using an additional input filter, it should be mounted as close as possible to the drive and connected directly to the supply mains via an unshielded cable.



## Operation on an IT or Corner Grounded System

### Definition

**IT system:** Isolated or impedance grounded neutral. Use a permanent insulation monitoring device compatible with nonlinear loads, such as an XM200 type or equivalent.

**Corner grounded system:** System with one phase grounded.

### Operation



**DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**



Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**

The drives have a built-in EMC filter. As a result they exhibit leakage current to ground. If the leakage current creates compatibility problems with your installation (residual current device or other), then you can reduce the leakage current by removing the screws as shown below. In this configuration the product does not meet the EMC requirements according to the standard IEC 61800-3.

### Setting

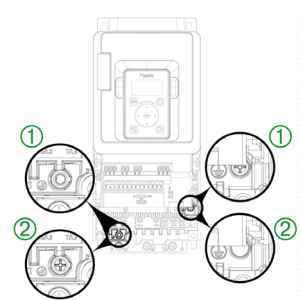
Apply the following instructions to set the drive to operate or not on an IT or Corner Grounded system

Step	Action
1	Remove the front cover (see page 56)
2	For operation on an IT or Corner Grounded system  position the screws as shown on detail ①
3	For operation on a non- IT or Corner Grounded system  position the screws as shown on detail ②
4	Refit the front cover

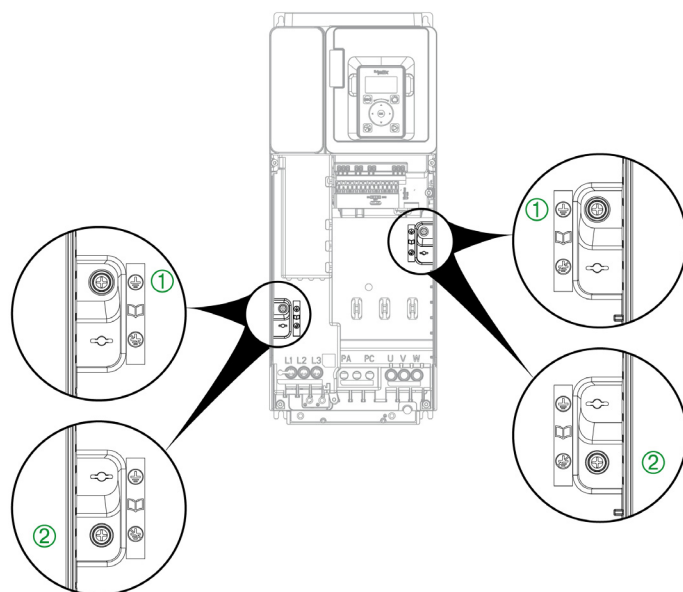
**NOTE:**

- Use only the screws supplied.
- Do not operate the drive with setting screws removed.

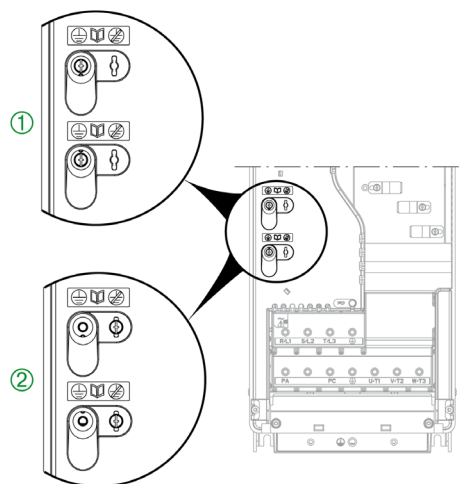
**Setting For Frame Size 1 Products**



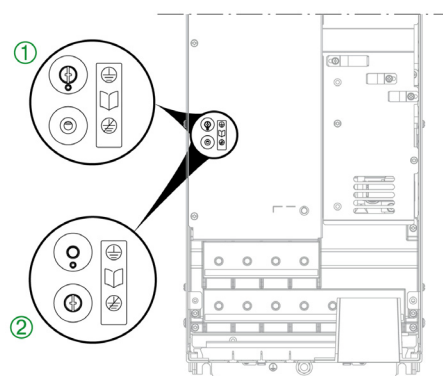
### Setting For Frame Size 3 Products



### Setting For Frame Size 4 Products

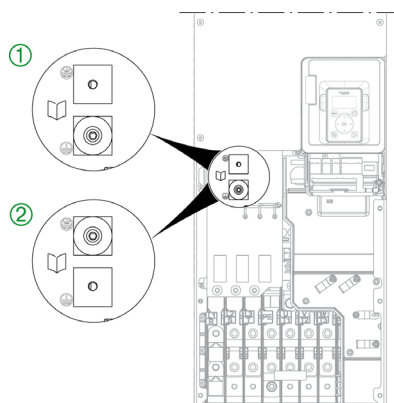


### Setting For Frame Size 5 Products



---

## Setting For Frame Size 6 Products





---

## Wiring The Control Part

### Preliminary Steps

#### **DANGER**

##### **HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**

#### **WARNING**

##### **UNINTENDED BEHAVIOR OF INPUTS AND OUTPUTS**

The functions of the inputs and outputs depend on the selected operating mode and the settings of the corresponding parameters.

- Verify that the wiring is appropriate for the settings.
- Only start the system if there are no persons or obstructions in the hazardous area.
- When commissioning, carefully run tests for all operating states and potential error situations.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

### Access to the Terminals

#### **DANGER**

##### **HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**

To access the control terminals, refer to the procedure described in the Wiring the Power Part chapter ([see page 56](#)).



---

## Chapter 5

### Checking Installation

---

#### Check List Before Switching On

##### Mechanical Installation

Verify the mechanical installation of the entire drive system:

Step	Action	✓
1	Does the installation meet the specified distance requirements?	
2	Did you tighten all fastening screws with the specified tightening torque?	

##### Electrical installation

Verify the electrical connections and the cabling:

Step	Action	✓
1	Did you connect all protective ground conductors?	
2	Do all fuses and circuit breaker have the correct rating; are the fuses of the specified type? (refer to the catalog).	
3	Did you connect or insulate all wires at the cable ends?	
4	Did you properly connect and install all cables and connectors?	
5	Do all plug-in terminals colors and markings correspond to the colors and marking of the control block?	
6	Did you properly connect the signal wires?	
7	Are the required shield connections EMC-compliant?	
8	Did you take all measures for EMC compliance?	

##### Covers And Seals

Verify that all devices, doors and covers of cabinet are properly installed to meet the required degree of protection.



## Chapter 6

### Maintenance

#### Scheduled servicing

##### Servicing

### DANGER

#### HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Read and understand the instructions in **Safety Information** chapter before performing any procedure in this chapter.

**Failure to follow these instructions will result in death or serious injury.**

The metal surfaces of the product may exceed 100 °C (212 °F) during operation.

### WARNING

#### HOT SURFACES

- Ensure that any contact with hot surfaces is avoided.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of hot surfaces.
- Verify that the heat dissipation is sufficient by performing a test run under maximum load conditions.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

### NOTICE

#### RISK OF DAMAGE TO THE DRIVE

Perform the following activities.

**Failure to follow these instructions can result in equipment damage.**

Environment	Part concerned	Action	Periodicity (1)
Knock on the product	Housing - control block (led - display, if any)	Verify the drive visual aspect	At least each year
Corrosion	Terminals - connector - screws - EMC plate	Inspect and clean if required	
Dust	Terminals - fans - blowholes - enclosures air inlets and outlets - cabinets air filters	Inspect and clean if required	
	Floor standing drives filter mats	Inspect	At least each year
		Change	At least each 4 years
Temperature	Around the product	Verify and correct if required	
Cooling	Wall mounting drives fan	Verify the fan operation	At least each year
		Replace the fan, see catalog and the instructions sheets on <a href="http://www.schneider-electric.com">www.schneider-electric.com</a> .	After 3 to 5 years, depending on the operating conditions
	Floor standing drives fan for power part and enclosure door fan	Replace the fans, see catalog and the instructions sheets on <a href="http://www.schneider-electric.com">www.schneider-electric.com</a> .	Every 35000 operating hours or every 6 years
Vibration		Verify tightening torques	At least each year

(1) As from the date of commissioning. The maintenance intervals really necessary depend on the ambient conditions.

**NOTE:** The fan operation depends of the drive thermal state. The drive may be running and the fan not.

---

## Diagnostic And Troubleshooting

Refer to the Programming Manual available on [www.schneider-electric.com](http://www.schneider-electric.com).

## Spares and repairs

Serviceable product. Please refer to your Customer Care Center.

## Long time storage

If the drive was not connected to mains for an extended period of time, the capacitors must be restored to their full performance before the motor is started.

<b><i>NOTICE</i></b>
<b>REDUCED CAPACITOR PERFORMANCE</b> <ul style="list-style-type: none"><li>● Apply mains voltage to the drive for one hour before starting the motor if the drive has not been connected to mains for the following periods of time:<ul style="list-style-type: none"><li>○ 12 months at a maximum storage temperature of +50°C</li><li>○ 24 months at a maximum storage temperature of +45°C</li><li>○ 36 months at a maximum storage temperature of +40°C</li></ul></li><li>● Verify that no Run command can be applied before the period of one hour has elapsed.</li><li>● Verify the date of manufacture if the drive is commissioned for the first time and run the specified procedure if the date of manufacture is more than 12 months in the past.</li></ul> <b>Failure to follow these instructions can result in equipment damage.</b>



If the specified procedure cannot be performed without a Run command because of internal mains contactor control, perform this procedure with the power stage enabled, but the motor being at standstill so that there is no appreciable mains current in the capacitors.

