

ATV320 DC Bus Sharing

Technical Note

09/2023

This document describes how to design applications using ATV320 drives on a common DC bus

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

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Safety Information



NOTICE

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



The addition of this symbol to a Danger 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, asynchronous motors and intended for industrial use according to this manual. The product may only be used in compliance with all applicable safety standard and local regulations and directives, the specified requirements and the technical data. The product must be installed outside the hazardous ATEX zone. 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.

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.
- Only use properly rated, electrically insulated tools and measuring equipment.
- 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. Take into account that circuit breaker or main switch does not de-energize all circuits.
 - Place a **Do Not Turn On** label on all power switches related to the drive system.
 - Lock all power switches in the open position.
 - Wait 15 minutes to allow the DC bus capacitors to discharge.
 - Follow the instructions given in the chapter "Verifying the Absence of Voltage" in the installation manual of the product.
- Before applying voltage to the drive system:
 - Verify that the work has been completed and that the entire installation cannot cause hazards.
 - If the mains input terminals and the motor output terminals have been grounded and short-circuited, remove the ground and the short circuits on the mains input terminals and the motor output terminals.
 - Verify proper grounding of all equipment.
 - Verify that all protective equipment such as covers, doors, grids is installed and/or closed


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

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.


This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of hazardous atmosphere.

 DANGER
POTENTIAL FOR EXPLOSION
Install and use this equipment in non-hazardous locations only.
Failure to follow these instructions will result in death or serious injury.

Your application consists of a whole range of different interrelated mechanical, electrical, and electronic components, the drive being just one part of the application. The drive by itself is neither intended to nor capable of providing the entire functionality to meet all safety-related requirements that apply to your application. Depending on the application and the corresponding risk assessment to be conducted by you, a whole variety of additional equipment is required such as, but not limited to, external encoders, external brakes, external monitoring devices, guards, etc.

As a designer/manufacturer of machines, you must be familiar with and observe all standards that apply to your machine. You must conduct a risk assessment and determine the appropriate Performance Level (PL) and/or Safety Integrity Level (SIL) and design and build your machine in compliance with all applicable standards. In doing so, you must consider the interrelation of all components of the machine. In addition, you must provide instructions for use that enable the user of your machine to perform any type of work on and with the machine such as operation and maintenance in a safe manner.

The present document assumes that you are fully aware of all normative standards and requirements that apply to your application. Since the drive cannot provide all safety-related functionality for your entire application, you must ensure that the required Performance Level and/or Safety Integrity Level is reached by installing all necessary additional equipment.

 WARNING
INSUFFICIENT PERFORMANCE LEVEL/SAFETY INTEGRITY LEVEL AND/OR UNINTENDED EQUIPMENT OPERATION
<ul style="list-style-type: none"> • Conduct a risk assessment according to EN ISO 12100 and all other standards that apply to your application. • Use redundant components and/or control paths for all critical control functions identified in your risk assessment. • Implement all monitoring functions required to avoid any type of hazard identified in your risk assessment, for example, slipping or falling loads. • Verify that the service life of all individual components used in your application is sufficient for the intended service life of your overall application. • Perform extensive commissioning tests for all potential error situations to verify the effectiveness of the safety-related functions and monitoring functions implemented, for example, but not limited to, speed monitoring by means of encoders, short circuit monitoring for all connected equipment, correct operation of brakes and guards. • Perform extensive commissioning tests for all potential error situations to verify that the load can be brought to a safe stop under all conditions
Failure to follow these instructions can result in death, serious injury, or equipment damage.

A specific application note [NHA80973](#) is available on hoisting machines and can be downloaded on www.se.com.

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

WARNING

UNANTICIPATED EQUIPMENT OPERATION

- 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.

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.

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.

The temperature of the products described in this manual may exceed 80 °C (176 °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 product has sufficiently cooled down before handling it.
- 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.

Machines, controllers, and related equipment are usually integrated into networks. Unauthorized persons and malware may gain access to the machine as well as to other devices on the network/fieldbus of the machine and connected networks via insufficiently secure access to software and networks.

 **WARNING****UNAUTHORIZED ACCESS TO THE MACHINE VIA SOFTWARE AND NETWORKS**

- In your hazard and risk analysis, consider all hazards that result from access to and operation on the network/fieldbus and develop an appropriate cyber security concept.
- Verify that the hardware infrastructure and the software infrastructure into which the machine is integrated as well as all organizational measures and rules covering access to this infrastructure consider the results of the hazard and risk analysis and are implemented according to best practices and standards covering IT security and cyber security (such as: ISO/IEC 27000 series, Common Criteria for Information Technology Security Evaluation, ISO/ IEC 15408, IEC 62351, ISA/IEC 62443, NIST Cybersecurity Framework, Information Security Forum - Standard of Good Practice for Information Security).
- Verify the effectiveness of your IT security and cyber security systems using appropriate, proven methods.

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

 **WARNING****LOSS OF CONTROL**

- Perform a comprehensive commissioning test to verify that communication monitoring properly detects communication interruptions.

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

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.

About the book

Related document

Use your tablet or your PC to quickly access detailed and comprehensive information on all our products on

www.se.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
ATV320 Installation manual	NVE41289 (English), NVE41290 (French), NVE41291 (German), NVE41292 (Spanish), NVE41293 (Italian), NVE41294 (Chinese)
ATV320 Programming manual	NVE41295 (English), NVE41296 (French), NVE41297 (German), NVE41298 (Spanish), NVE41299 (Italian), NVE41300 (Chinese)
Altivar Regenerative Unit User manual	NVE88423 (English)
Altivar Regenerative Unit Sizing Tool	NVE94856 (English)

You can download these technical publications and other technical information from our website at

<https://www.se.com/ww/en/download/>

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.

Also see the glossary at the end of this manual.

Preamble

This document defines the rules to be applied to link two or more ATV320 to a common DC bus. It also gives the limits of the DC bus connection.

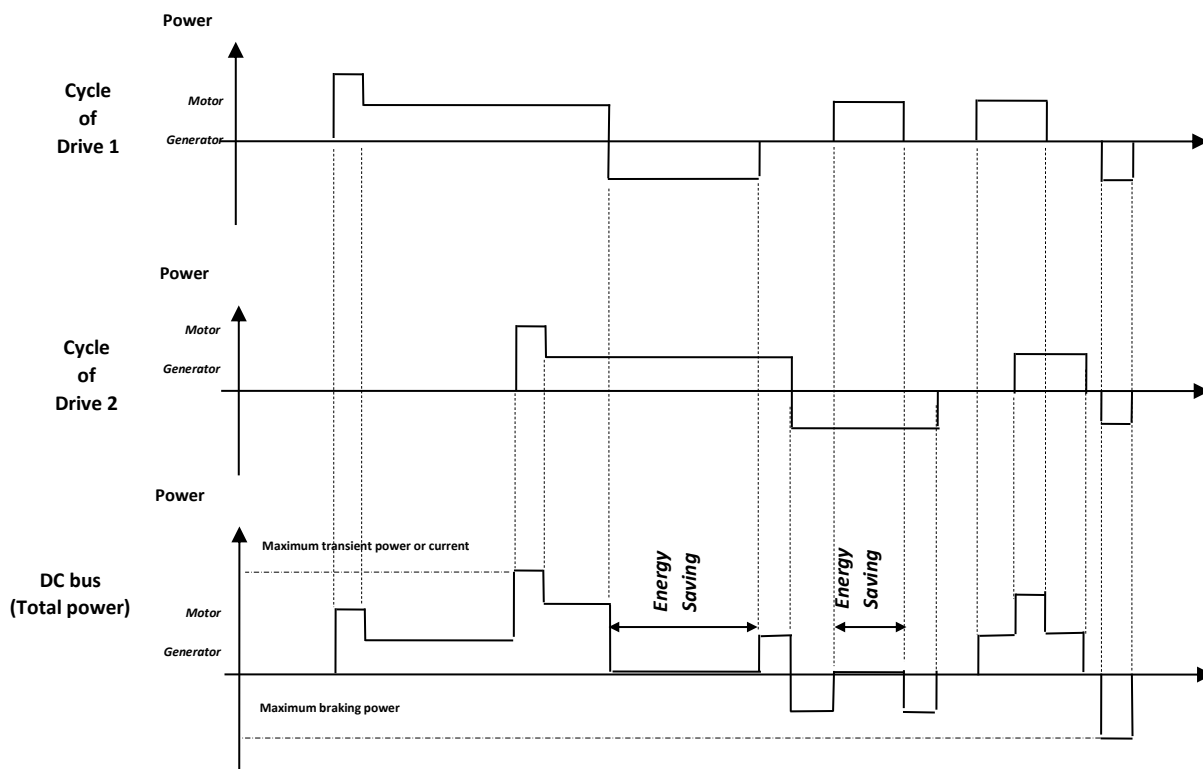
The main target to use a common DC bus is to save energy, as the braking energy of one drive operating in generator mode can be re-used by another drive operating in motor mode instead of dissipating it as heat into a braking resistor. It means that the key point to decide to use a DC bus connection is to define the drives cycles.

The DC bus connection has no sense if all drives are all operating in generator mode or in motor mode at the same time. The first step is to estimate the benefits of using a DC bus connection regarding the drives cycles.

Sharing the DC bus and adjusting the drive cycles to reduce the braking energy during normal operation could also lead to a reduction of the number of braking resistors to use in the application. In order to take advantage of using a common DC bus it is necessary to verify that energy is shared during cycles. The diagram below shows a cycle where energy can be saved when one drive is operating in motor mode and another one operating in braking mode.

When some drives linked on the DC bus are braking and the other drives linked on the DC bus cannot re-use the braking energy, excess energy must be either dissipated into a braking resistor or pushed back to the mains power supply using a regenerative unit. See section “Using a braking unit on a common DC bus”

It is also necessary to consider if some emergency operating modes like “fast stop” or “emergency stop” are required by the application, which will need the full power braking capability of all drives at the same time. This situation cannot lead to braking resistors reduction.



NOTE: If the use cases detailed in this technical note do not correspond to your application, or if you need more support, contact your Customer Care Center.

General instructions when using a common DC link

Short circuit detection

The aim of this detection is to **help to protect other drives** from an internal DC short-circuit in one of the drives linked on the common DC link.

Usually, each drive has to be connected to the DC common link by **2 fuses selected in the semi-conductor protection class**, which have the capability to clear a DC current.

Some ratings of ATV320 drives have specific connectors for easy wiring. In this case DC link fuses cannot be used on these drives. When these drives are powered by the mains power supply, semi-conductor protection fuses have therefore to be used on the 3-phase or single-phase AC input lines.

Disconnection from the DC bus

To easily disconnect one drive from the DC bus while others are in operation, the drives can be wired to the DC bus through an optional **DC voltage switch-disconnector** as shown in the drawings in this document. This device provides switch-on and switch-off on the DC-bus and isolation from the DC-bus voltage when it is switched-off to allow the replacement of the fuses or of the drive.

The DC voltage switch-disconnectors to be associated with the drives are listed in the section “DC switch-disconnector” at the end of this document.

ATV320 configuration

ATV320 drives have a **configuration parameter named “d C C Π”** which must be set-up when the drives are used on a common DC bus, depending on the input mains power supply configuration:

- **d C C Π = Π A 1 n**, when the drive is linked to a DC-bus and also powered by the mains power supply.

This enables the input phase loss fault detection to avoid that a low power drive supplies the other through the DC bus link in case of mains power loss of high power drives.

It also disables the ground fault detection on power ratings 5.5 kW to 15 kW. These drives use an input homopolar current detector (also called “zero current transformer”, ZCT) which can give a wrong information in case of DC-bus sharing.

- **d C C Π = b u S**, when the drive is powered by the DC-bus only.

This disables the input phase loss detection on the drive which is only powered by the DC-bus.

Refer to ATV320 programming manual for more details about how to access and set this parameter

EMC

When a common DC bus is used, conducted and radiated disturbances level cannot be equal to that of a drive alone. The application of the wiring recommendations of this document helps to minimize the increase of disturbances levels.

Group definition for drives association

ATV320 drives have three different mains input voltage ranges:

- 200 V range: 200 ~ 240 V single-phase → Drives references ATV320yyyM2x
 200 ~ 240 V three-phase → Drives references ATV320yyyM3C

- 400 V range: 380 ~ 500 V three-phase → Drives references ATV320yyyN4x

- 600 V range: 525 ~ 600 V three-phase → Drives references ATV320yyyS6C

For “book” form factor: x = B.

For compact form factor: x = C

In this document only 200 V and 400 V ranges are considered.

Drives are grouped according to the following tables, linked to the voltage ratings, the characteristics of the input stage, and the type of the DC terminals.

Refer to the [ATV320 installation manual](#) for terminal location.

Groups	200 ~ 240 V single-phase drives references	Housing form factor	PA/+, PC/- terminals for specific daisy chain cable
20	ATV320U02M2B ... ATV320U07M2B	book	x
21	ATV320U11M2B ... ATV320U22M2B	book	x
22	ATV320U02M2C ... ATV320U07M2C	compact	
23	ATV320U11M2C ... ATV320U22M2C	compact	

Groups	200 ~ 240 V 3-phase drives references	Housing form factor	PA/+, PC/- terminals for specific daisy chain cable
32	ATV320U02M3C ... ATV320U07M3C	compact	
33	ATV320U11M3C ... ATV320U22M3C	compact	
34	ATV320U30M3C, ATV320U40M3C	compact	
35	ATV320U55M3C, ATV320U75M3C	compact	
36	ATV320D11M3C, ATV320D15M3C	compact	

Groups	380 ~ 500 V drives references	Housing form factor	PA/+, PC/- terminals for specific daisy chain cable
40	ATV320U04N4B ... ATV320U15N4B	book	x
41	ATV320U22N4B ... ATV320U40N4B	book	x
43	ATV320U04N4C ... ATV320U15N4C	compact	
44	ATV320U22N4C ... ATV320U40N4C	compact	
45	ATV320U55N4B, ATV320U75N4B ATV320U55N4C, ATV320U75N4C	book compact	
46	ATV320D11N4B ... ATV320D15N4B ATV320D11N4C ... ATV320D22N4C	book compact	

DC bus wiring

Generic recommendations

The DC bus connections between two drives must be designed to be as short as possible and the distance between +DC and -DC cables as reduced as possible in order to reduce the leakage inductance of the wiring, which creates overvoltage during switching. The specific cable to build a daisy chain as described in the next section meet these requirements.

When the DC bus wiring is made with standard cables, the following solutions can be used to meet the DC-bus cable requirements:

- Independent cables with cable clamps,
- Two or three-wires sheathed cable,
- Or 2-wires shielded cable where the shield is grounded.

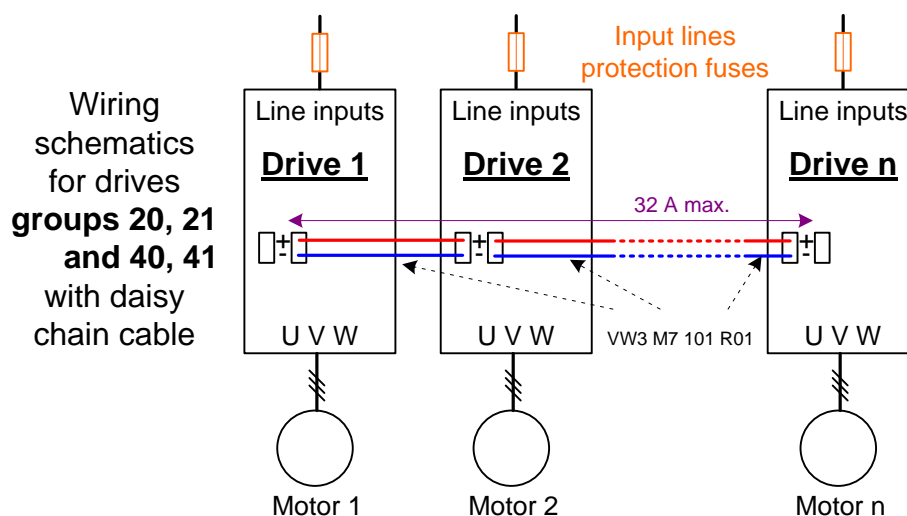
To protect the drives in case of a short-circuit on the DC bus link, **semi-conductor protection class fuses**, selected from the tables at the end of this document, **must be used** in the DC+ and DC- wires of each drive, or in the mains input lines when the daisy chain feature is used which does not allow to put them in the DC lines.

Daisy chain DC terminals

ATV320 range includes drives with standards DC terminals and drives with specific DC terminals which allow to use daisy chain wiring. The daisy chain feature is implemented only in drives of groups 20-21 and 40-41 using the “book” form-factor. The two following options can be used.

Using daisy chain feature

The daisy chain cable reference VW3 M7 101 R01 (see section “Wiring options” at the end of this document) is used to link the drive as shown on the drawing below:



This DC cable does not allow putting fuses in the DC connections. For each drive the protections have to be located on the input lines as shown in the drawing above and selected among the following cases:

- Same protections as the input line protections defined in the drives catalog: circuit-breaker or fast-acting fuses class J. In this case, when a short circuit on the DC bus occurs, the cables are protected, **all input protection lines will trip and all the drives may be destroyed.**
- Using for each drive semi-conductor protection class fuses selected in the fuse table at the end of this document as input line protection. This provides a better protection of the drives in case of a DC-bus short-circuit. The input rectifier will be protected but depending on the drives' operating mode (motor or generator), **the output inverter bridge may be destroyed.**

The terminals for daisy chain are limited to 32 A maximum current.

It is the user's responsibility not to exceed this value, which is about:

- 14.5 kW flowing on the DC bus when the drives are powered with 380 Vac input voltage at minimum tolerance,
- 7.7 kW flowing on the DC bus when the drives are powered with 200 Vac input voltage at minimum tolerance.

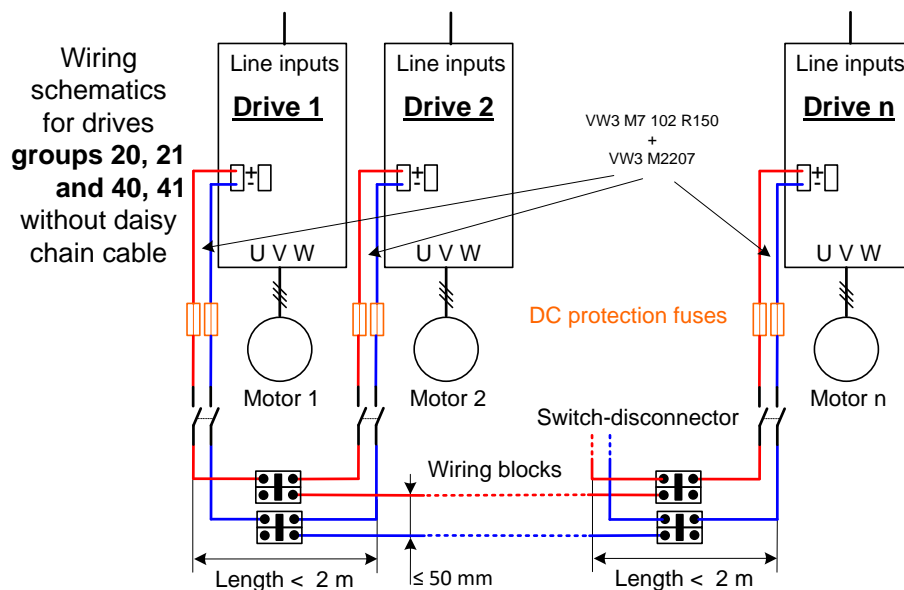
Without daisy chain feature

Cable reference VW3 M7 102 R150 and connectors set reference VW3 M2 207 (see section "Wiring options" at the end of this document) allow to build wires to connect the drives top-side DC terminals ("fast-on" types) to fuses according to the drawing below. This wiring configuration can be used with drives of groups 20, 21 and 40, 41 in the following cases:

- to avoid the power limitation with drives having DC terminals for daisy chaining,
- to get a better protection of the drives by adding semi-conductor protection class fuses on the DC lines of each drive selected from the "Fuses table" section at the end of this document. In this case, the drives' input line protections defined in the catalog can be used.
- to disconnect one drive from the DC-bus, using switch disconnectors listed at the end of this document.

Wiring blocks must be used to build the DC bus. They can be selected in the Schneider-Electric catalog in the LINERGY product range as shown in the "Wiring options" section of this document.

Switch disconnectors are optional to provide easy disconnection of the drives from the DC bus :



Standard wires DC terminals

The DC terminals are similar to the input lines and motor outputs terminals. Same cables as those used for mains input lines can be used for DC bus connections.

The drive DC terminals cannot withstand the total DC-bus current and therefore cannot be used for chaining. **Wiring blocks have to be used to build the DC bus link** and to wire each drive with only one wire for the PA/+ connection and one wire for the PC/- connection.

The wiring blocks can be selected in the Schneider-Electric catalog in the LINERGY product range as shown in the "Wiring options" section of this document.

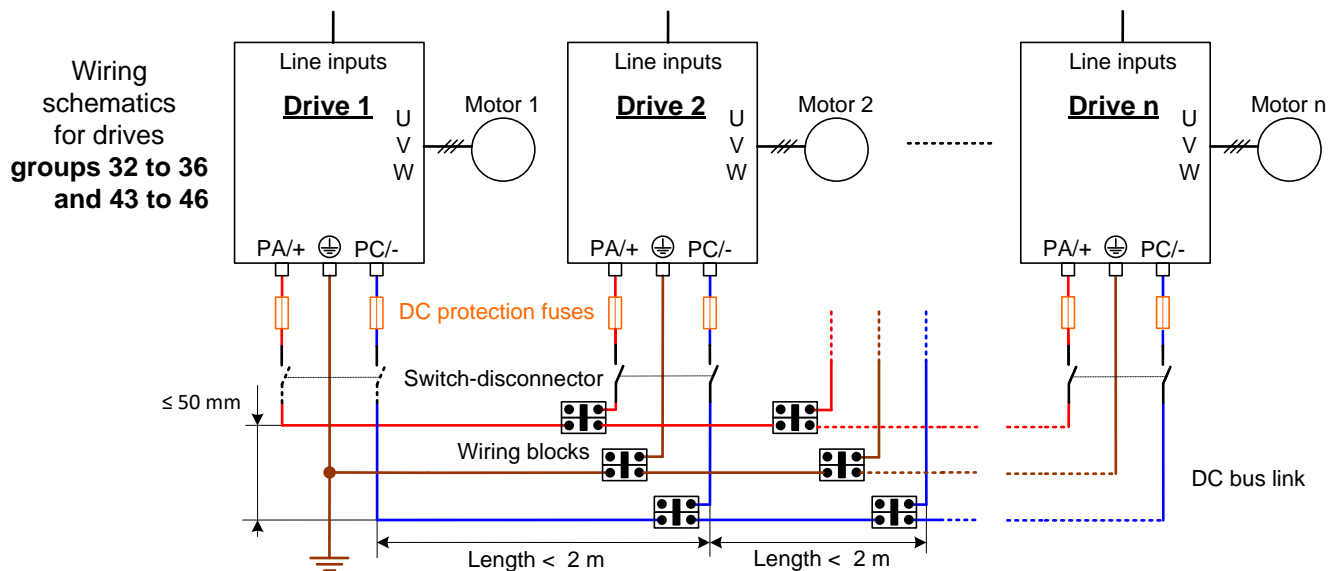
Switch disconnectors listed at the end of this document are optional to provide easy disconnection of the drives from the DC bus.

In order to limit the over-voltages on the common DC bus while drives are operating, the generic wiring recommendations listed at the beginning of this document must be applied.

In addition, the following cabling rules must be respected:

- The total **cable length between PA/+ and PC/-** connections of one drive to PA/+ and PC/- connections of another drive **must be less than 2 m**.
- The ground wire included in the DC bus is optional. It is not a protective ground conductor (PE); it just helps to reduce the conducted and radiated emissions.
- The **distance between +DC and -DC wires must not exceed 5 cm** except close to the junctions' terminals, the switch-disconnector, the fuses holders or the drives PA/+ and PC/- to allow cabling.

The generic wiring diagram in this case is shown on the drawing below:



Building the DC bus using standard and daisy chain DC terminals

The highest wiring impedance must be put on the lowest drives power ratings. To reach this the drives have to be sorted by power ratings, **especially when drives of different groups are used**. If the system connecting point on the mains power supply or on a DC source is close to Drive 1, it must be the highest power rating and Drive n the lowest.

This can be summarized by the following formula using the drives power ratings shown in the above drawing:

$$P(\text{drive 1}) \geq P(\text{drive 2}) \geq \dots \geq P(\text{drive n})$$

In the low-power area of ATV320 drives range (0.2 to 4 kW), there are drives with two kinds of DC terminals:

- daisy chain feature for drives of groups 20-21 and 40-41 using “book” form-factor
- standard DC terminals for drives of groups 22-23, 32-36 and 43-46 using “compact” form-factor.

These drives can be used together on the same DC bus. To sort the drives by power ratings as described above, the following configurations can be used.

Using daisy chain feature

Drives using the daisy chain feature are linked together. The daisy chain including drives n+1 to m is considered as one drive which power rating is $P(\text{daisy chain})$.

The total power of the daisy chain is:

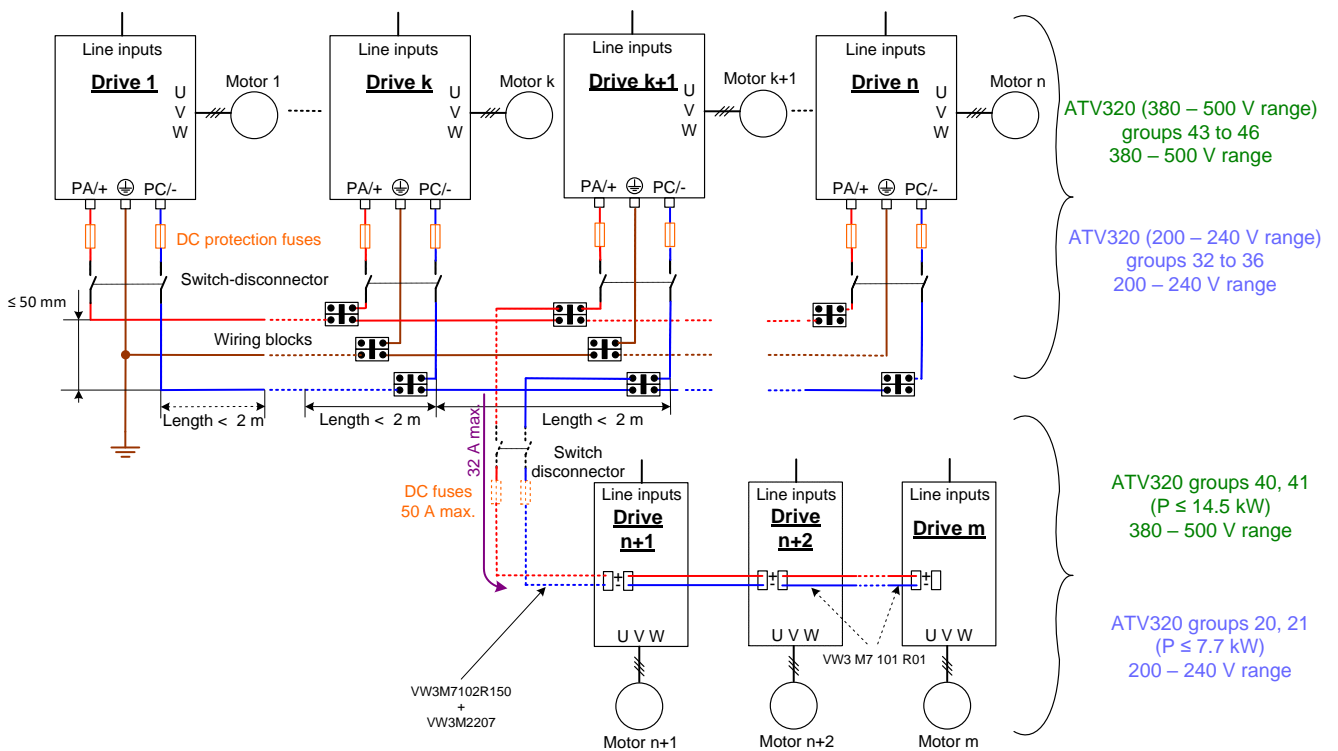
$$P(\text{daisy chain}) = P(\text{drive } n + 1) + P(\text{drive } n + 2) + \dots + P(\text{drive } m) \geq P(\text{drive } k + 1)$$

To sort the drives by power rating as defined above, the following conditions must be met:

$$P(\text{drive } 1) \geq \dots \geq P(\text{drive } k)$$

$$P(\text{drive } k) \geq P(\text{daisy chain}) \geq P(\text{drive } k + 1)$$

$$P(\text{drive } k + 1) \geq \dots \geq P(\text{drive } n)$$



Drives 1 to n with wiring standard DC-bus terminals follow the same cabling rules as before.

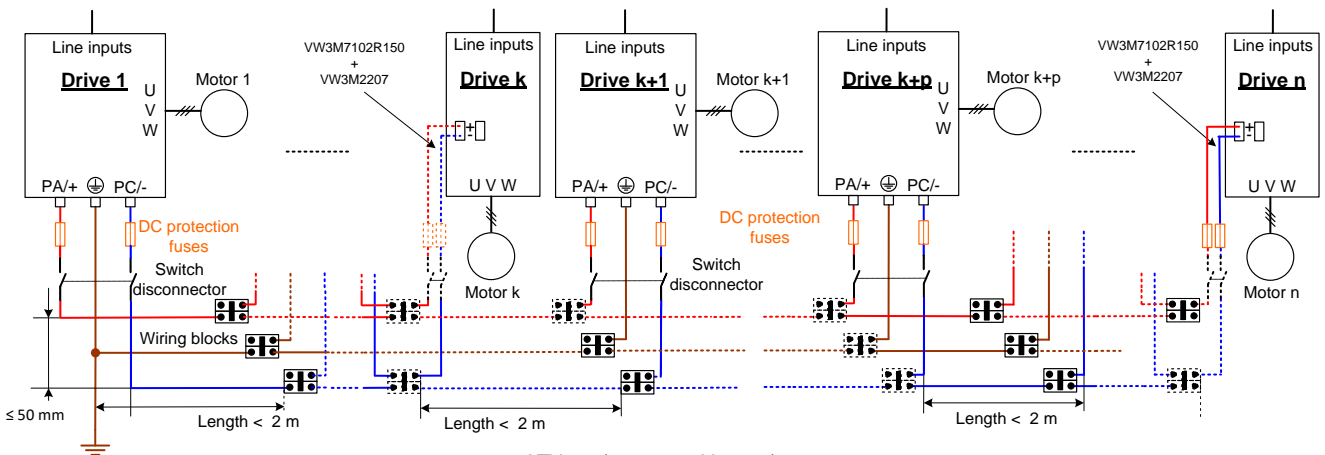
Drives n+1 to m linked together by daisy chain are wired to the DC bus with 2 fuses selected in the semiconductor protection class listed in the fuses table at the end of this document. The fuses rating must be the same as for one drive of the total power of the daisy chain (Example: for 3 drives of 2.2 kW in the daisy chain, select fuses of 7.5 kW drive). The maximum fuses rating is 50 A. It includes transient overloads, aging and temperature coefficient to provide correct operation at 32 A, which is the maximum current that can flow in the terminals of these drives.

The cable to link the drives linked by daisy chain to the group of drives with terminals can be built using the accessory VW3M7102R150 (DC cable) and accessory VW3M2207 (set of 10 connectors).

Without using daisy chain feature.

Drives with daisy chain connectors can be put anywhere in the common DC bus as long as they meet the following condition:

$$P(\text{drive } 1) \geq \dots \geq P(\text{drive } k) \geq P(\text{drive } k + 1) \geq \dots \geq P(\text{drive } k + p) \geq \dots \geq P(\text{drive } n)$$



ATV320 (380 – 500 V range) groups 40, 41, 43 to 46

ATV320 (200 – 240 V range) groups 20 to 23, 32 to 36

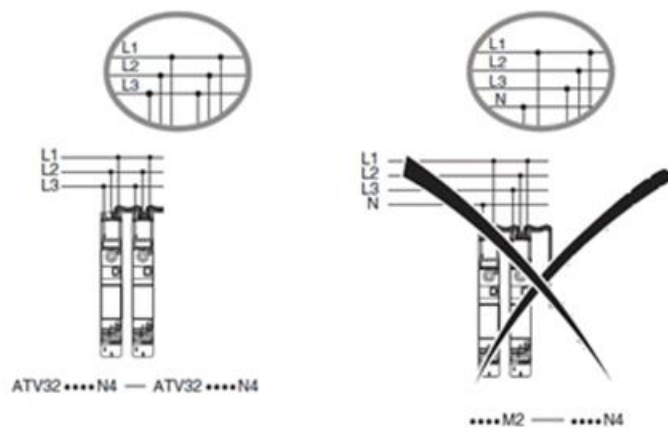
Drives supplied by the AC mains

All wiring instructions for the DC-bus defined in the previous section apply in all these configurations

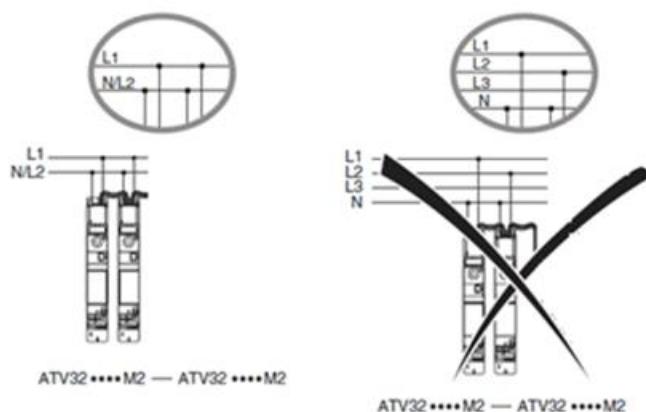
Generic recommendations

When the drives share the same DC bus and are supplied at the same time by the mains on input lines terminals, it has to be by the **same power lines after the same mains transformer**.

Drives of 200 V range cannot share the DC bus with drives of 400 V range.



200 V single-phase drives, supplied by one phase and the neutral of a 400 V mains power supply **must use the same input phase for all drives sharing the DC bus**. If this is not the case, the common DC-bus will be charged at the peak phase to phase voltage, which will lead to the destruction of the drives.



Drives with single-phase 200 V – 240 V and 3-phase 200 V – 240 V input lines must not share a common DC bus, when they are supplied by the mains, because the average DC voltage is different and the 3-phase input rectifiers might be overloaded.

All the drives sharing a common DC bus link must be switched-on at the same time to the mains power supply. If there is a delay between different switch-on, high power drive must be switched on before low power drives. This is to avoid low power drives to charge all the capacitors of the drives wired on the common DC bus.

When drives are powered by the AC mains, all the input rectifiers of the drives linked on the common DC bus are operating. To balance the input currents between drives, **all drives must use the input line choke** defined in the section “Line chokes” at the end of this document.

Optional additional EMC filters listed in the drives’ catalogs **can be used** at the line inputs to reduce the conducted high-frequency disturbances, as shown in the following drawings.

All ATV320 sharing the same DC-bus must be configured with parameter $d C C \Pi = \Pi A \text{ , n}$

Parameter setting $d C C C = A E \mu$ must be verified

3-phase 380 V – 500 V mains input

All recommendations listed in the “DC bus wiring” section must be applied.

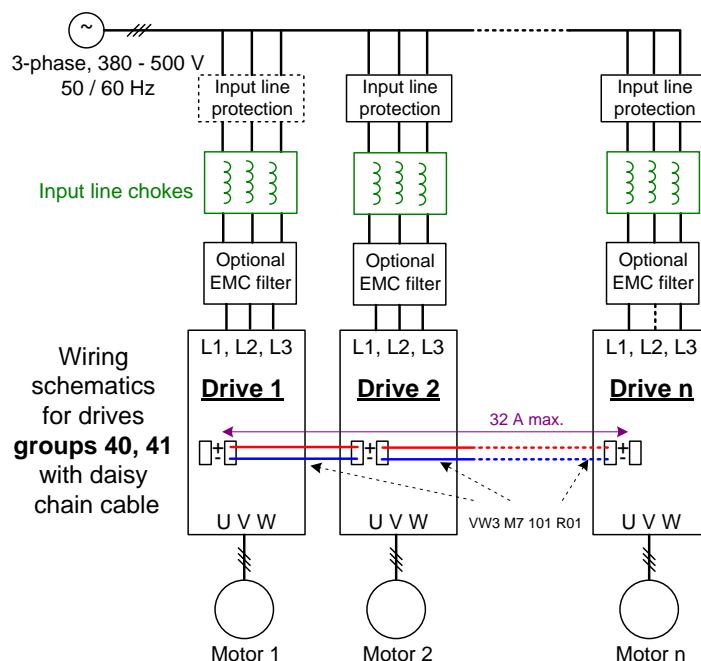
Drives groups 40 and 41 only

Drives of groups 40 and 41 have DC terminals to build a daisy chain using specific cables and connectors.

Using daisy chain feature

This configuration can be used with these drives when the total power of the drives does not exceed 14.5 kW, to limit the current on the drives DC bus terminals at 32 A.

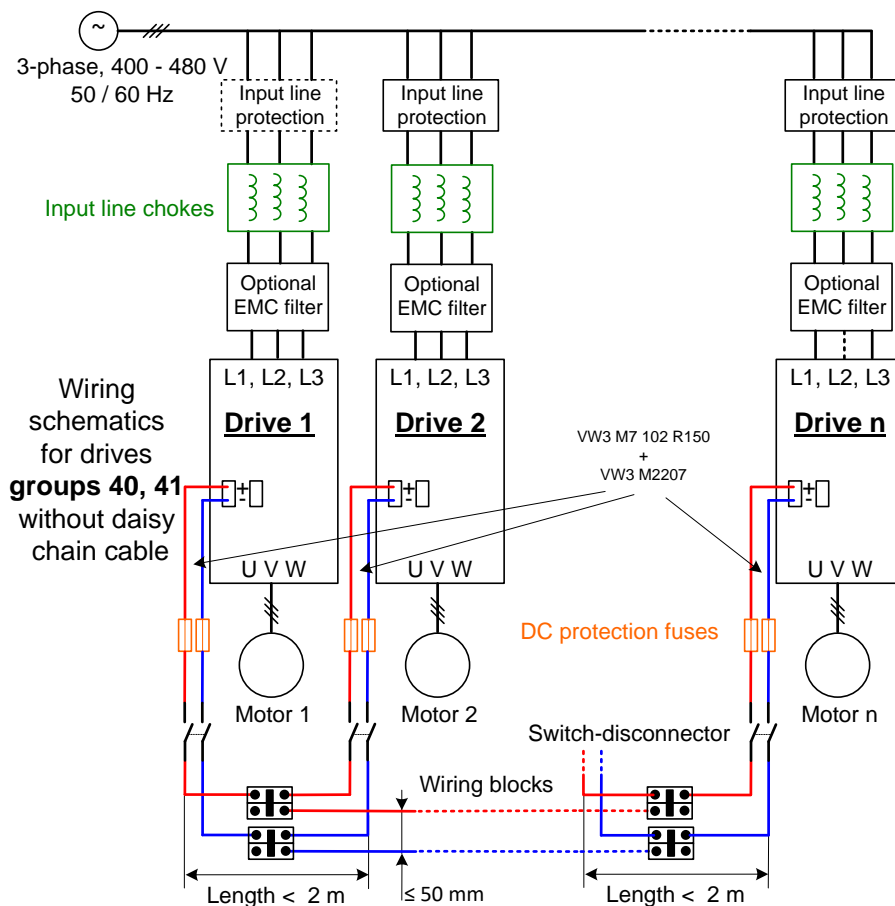
The input protection lines must be defined as described in the DC-bus wiring section at the beginning of this document when the daisy chain feature is used.



Without daisy chain feature

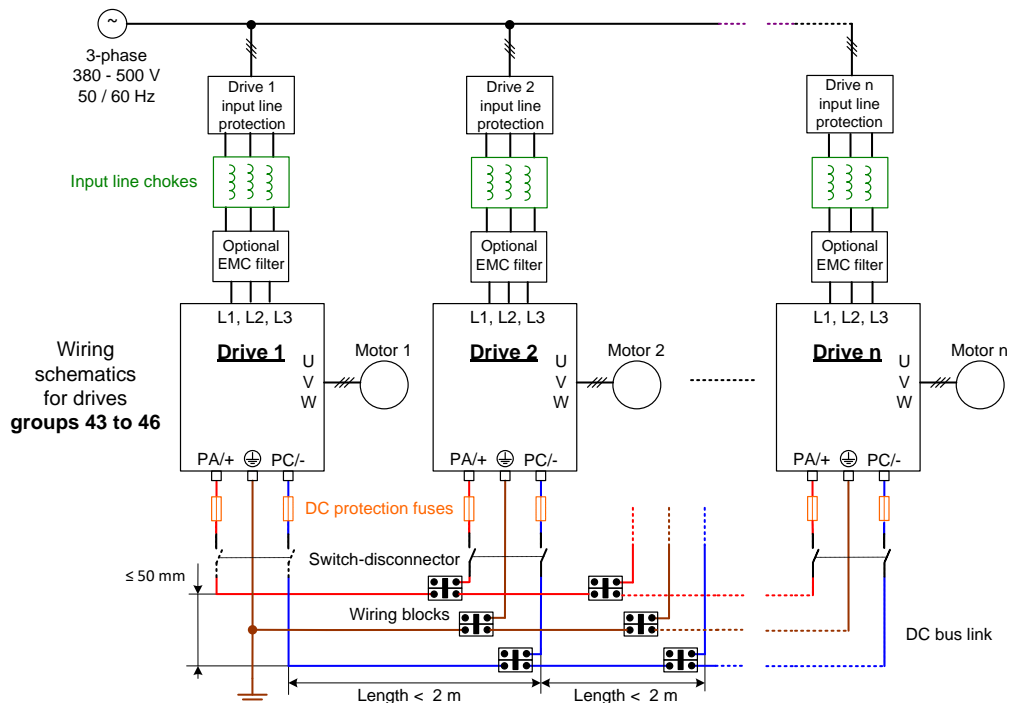
The configuration shown in the drawing below, can be used with drives of these groups to have more than 14.5 kW on the DC-bus or to get a better protection of the drives by adding semi-conductor protection class fuses in the DC lines of each drive. These fuses are selected from the “Fuses table” section at the end of this document.

In this case the 3-phase input lines protections defined in the drives user’s manual are used.



Drives of groups 43 to 46 only

Drives of these groups have standard DC terminals that are same as the input lines and motor terminals.

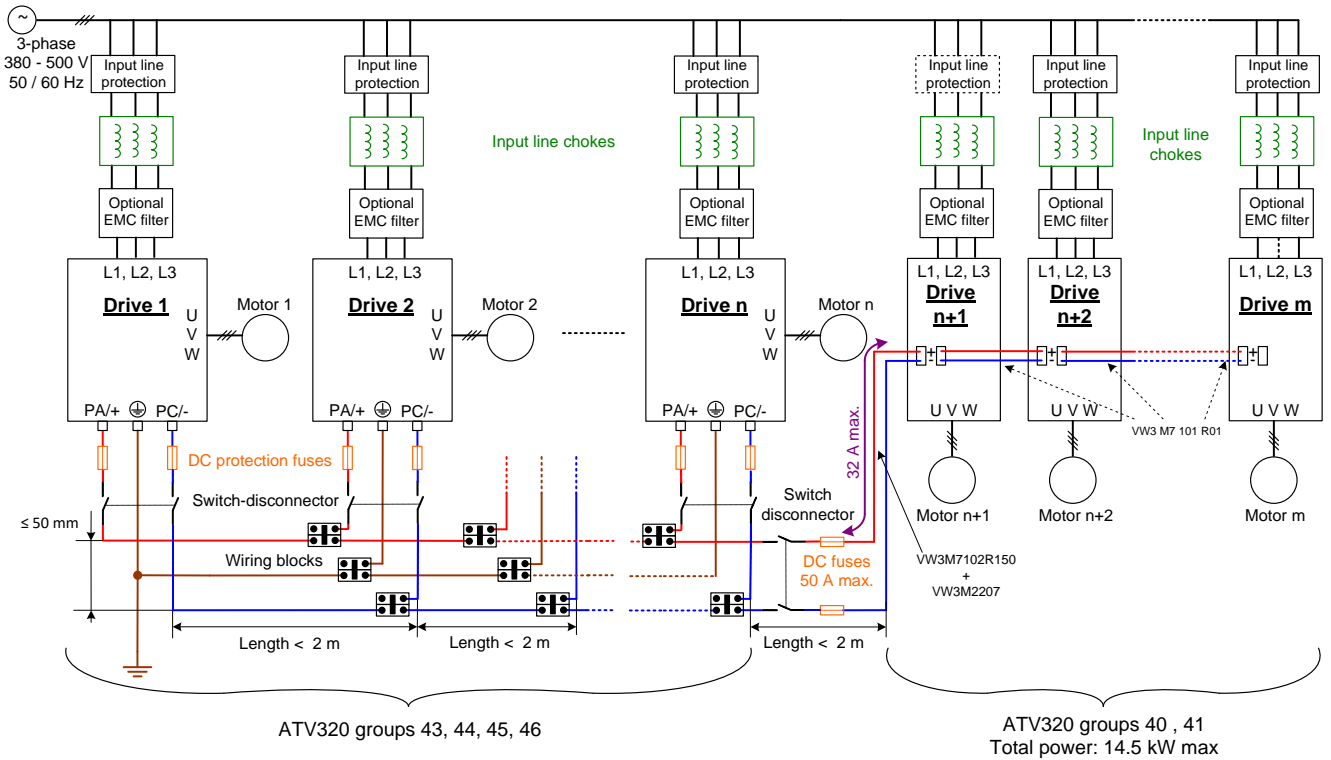


Drives of groups 40 to 46

These configurations combine drives with standard DC terminals and drives with DC terminals for daisy chaining.

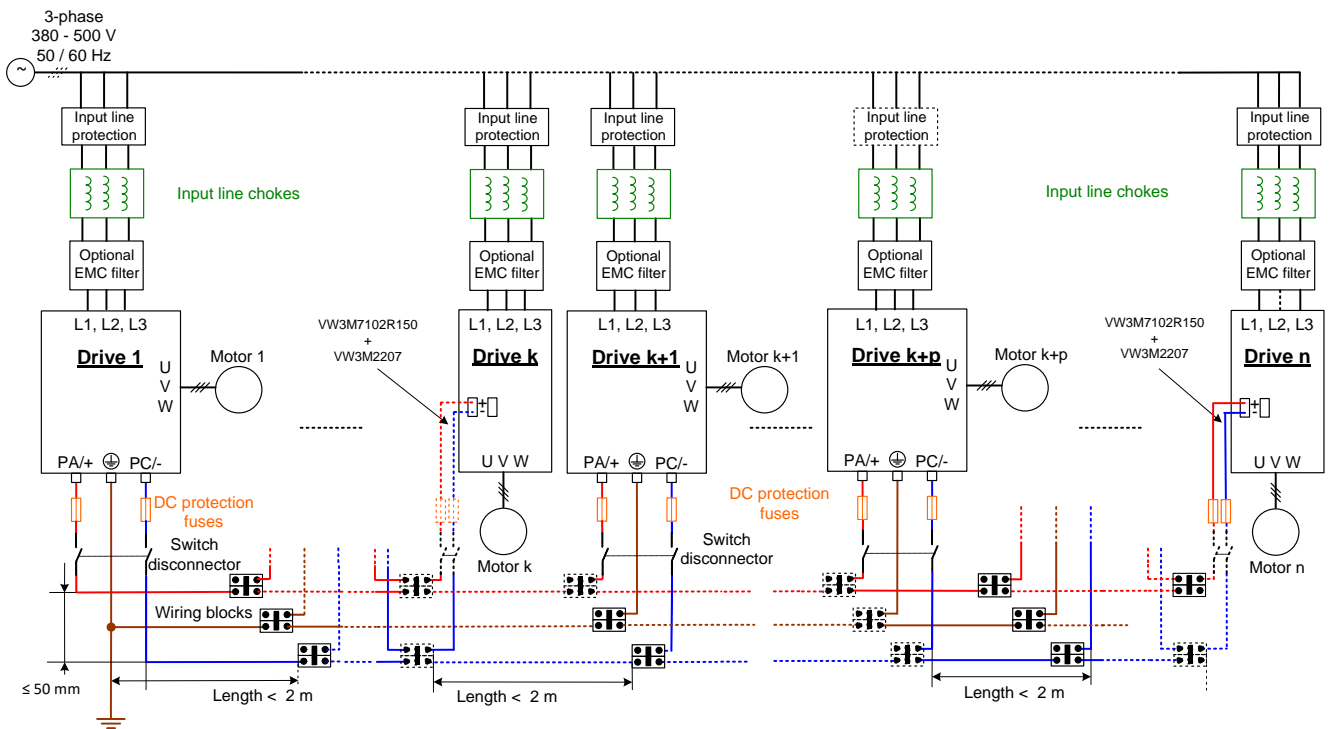
Using daisy chain feature

In this case the total power of drives n+1 to m is limited to 14.5 kW. To get a simple drawing the daisy chain of drives n+1 to m is shown at the end of the common DC-bus. But depending on the total power rating of drives n+1 to m it can be placed between drives 1 to n as described in the “DC bus wiring” section.



Without using daisy chain feature

Drives with daisy chain connectors have to be put in the common DC in order to sort the drives by power ratings as defined in the “DC bus wiring” section.

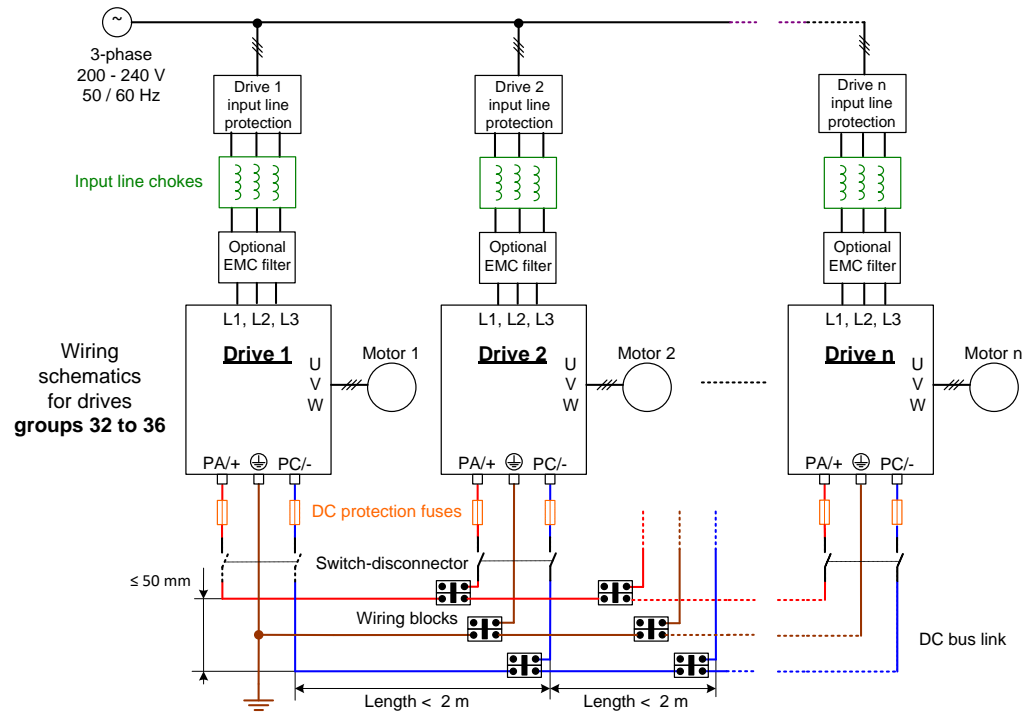


ATV320 (380 – 500 V range) groups 40, 41, 43 to 46

3-phase 200 V – 240 V mains input

This section applies only to drives of groups 32 to 36, which have 3-phase 200 V – 240 V input lines. These drives have only standard DC bus terminals, therefore only the following configuration can be used.

All recommendations listed in the “DC bus wiring” section must also be applied.



As written before in this document, **single-phase units and 3-phase unit cannot share the same DC-bus when they are powered by the AC mains power supply.**

Single-phase 200 V – 240 V mains input

Single-phase devices are used for input line protection, input line choke, and optional EMC filter.

All recommendations listed in the “DC bus wiring” section must be applied

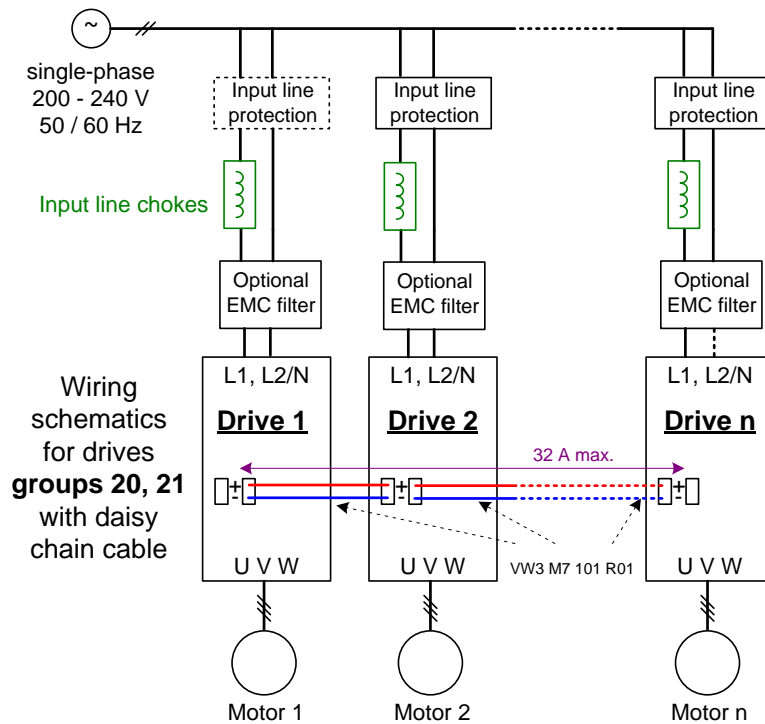
Drives of groups 20 and 21 only

Drives of groups 20 and 21 have DC terminals to build a daisy chain using specific cables and connectors.

Using daisy chain feature

This configuration can be used with drives of groups 20 and 21 when the total power of the drives does not exceed 7.7 kW, to limit the current on the drives DC bus terminals to 32 A.

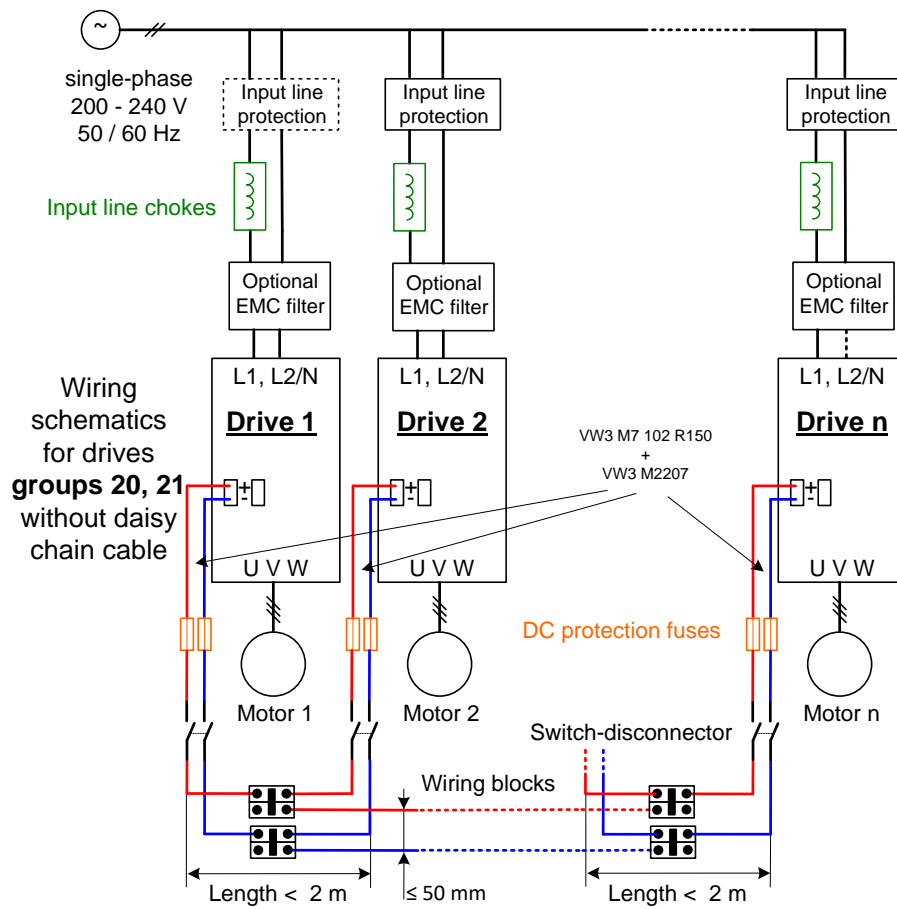
Since there is no possibility to put protection fuses in the DC bus, the input protection lines must be defined as described in the “DC bus wiring” section at the beginning of this document.



Without daisy chain feature

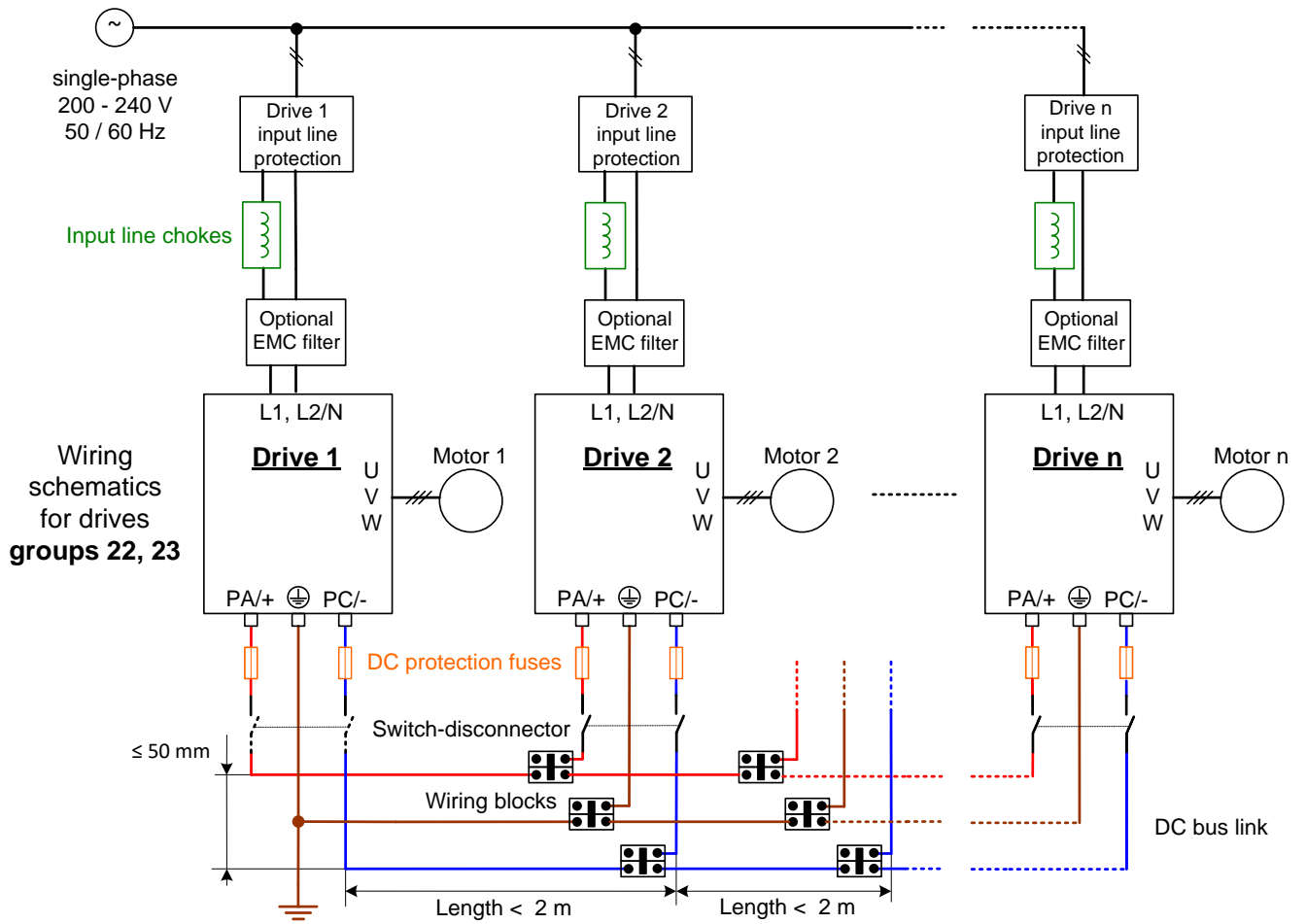
The configuration shown in the drawing below, can be used with drives of groups 20, 21 to have more than 7.7 kW on the DC-bus or to get a better protection of the drives by adding semi-conductor protection class fuses on the DC lines of each drive selected from the “Fuses table” section at the end of this document.

In this case the single-phase input lines protections defined in the drive’s user manual are used.



Drives of groups 22 and 23.

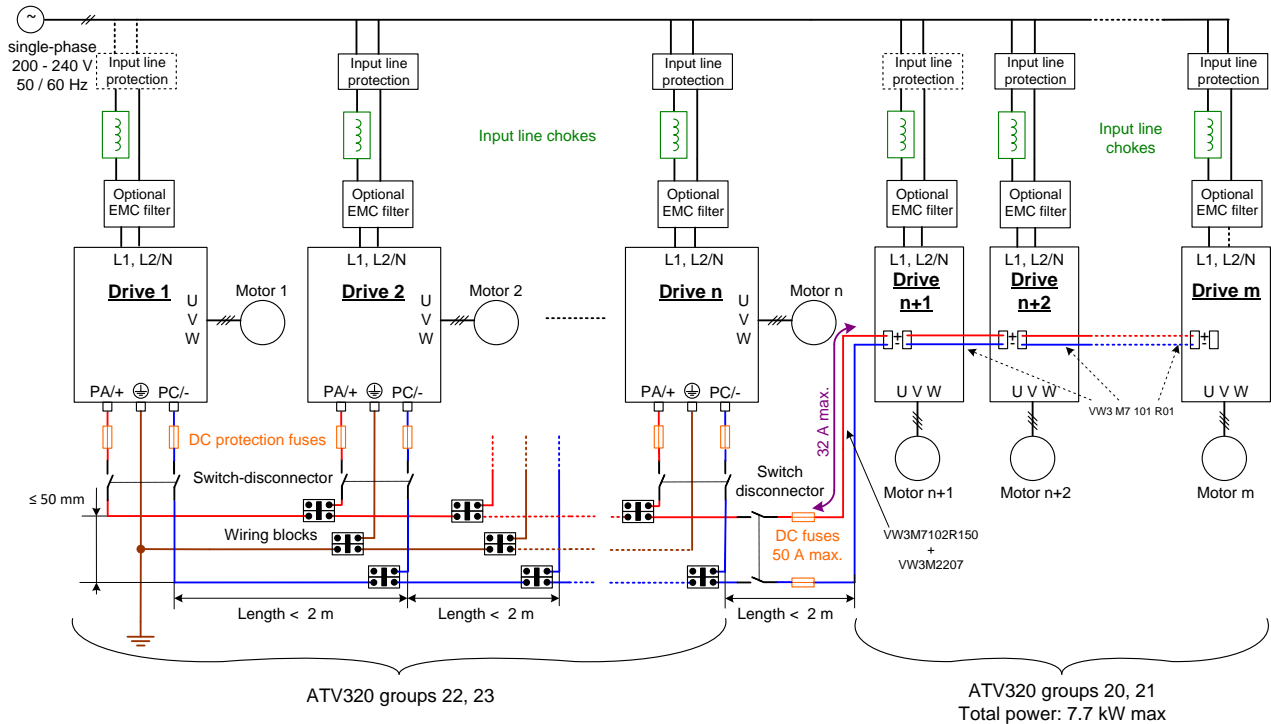
These drives have only standards DC terminals, therefore the configuration shown on the drawing below is used



Drives of groups 20 to 23

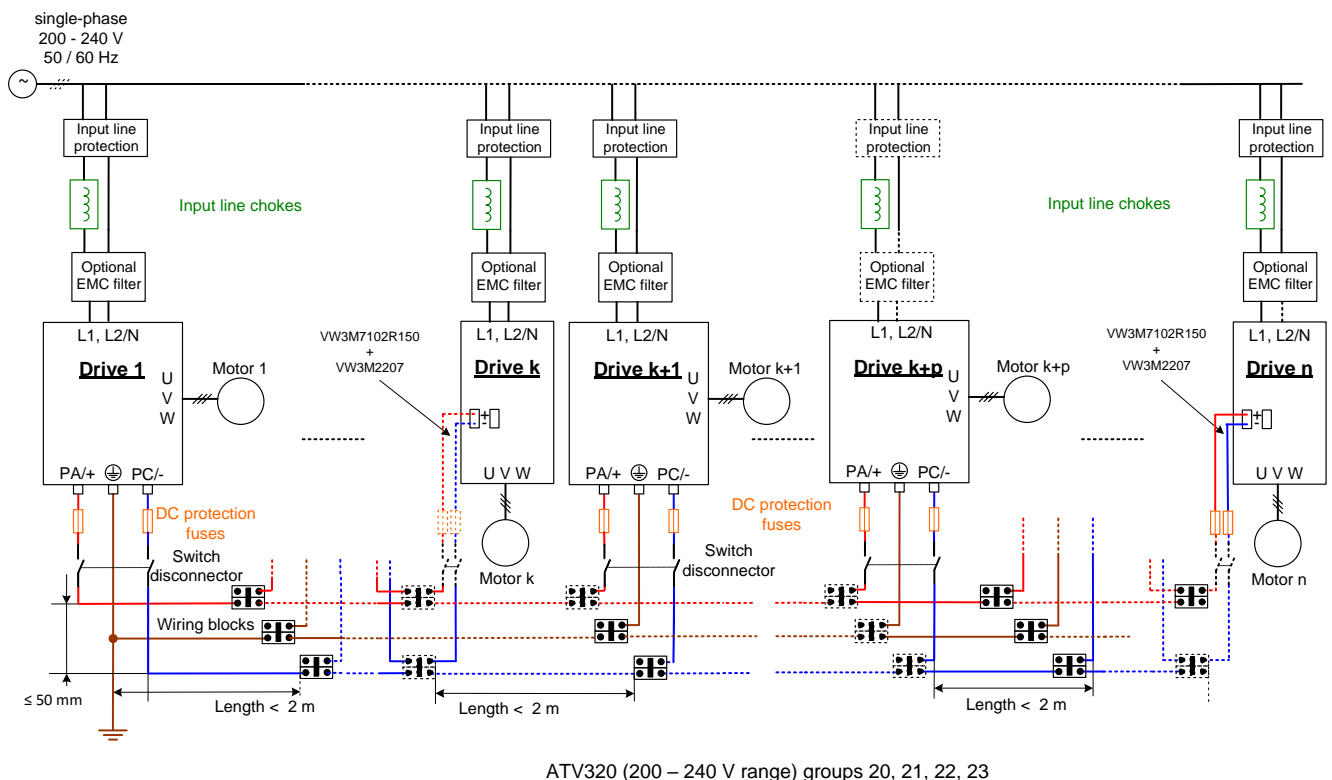
Using daisy chain feature

In this case the total power of drives n+1 to m is limited to 7.7 kW. To get a simple drawing the daisy chain of drives n+1 to m is shown at the end of the common DC-bus. But depending on the total power rating of drives n+1 to m it can be placed between drives 1 to n as described in the “DC bus wiring” section.



Without daisy chain feature

Drives with daisy chain connectors are put in the common DC bus as defined in the “DC bus wiring” section.



Drives supplied by the DC terminals

In these configurations, the drives are not supplied by the mains power supply, but only through PA/+ and PC/- terminals. The DC source can be one of the following:

- A drive (Drive 1) which a part of the power is provided to other drives through the DC bus,
- A dedicated DC power source device to provide DC voltage.

These configurations can be used with both voltage ranges:

- 380 – 500 V mains input lines, with drives ATV320yyyN4x (groups 40 to 46)
- 200 – 240 V mains input lines,
 - with drives ATV320yyyM2x (groups 20, 21)
 - and ATV320yyyM3C (groups 22, 23, 32 to 36), which can be mixed with single-phase drives, but with some limitations described in the next sections.

The wiring recommendations described in the section “DC bus wiring” at the beginning of this document must also be applied in all the following configuration.

Drives supplied by the DC outputs of another drive

ATV320 can supply in a correct way a motor of minimum one third of the drive rated power. It means that the maximum power available to supply a DC bus is two thirds of the drive’s power rating.

The drive which supplies the common DC bus of other drives must always use the input line choke listed in the section “Line chokes” at the end of this document, in order to limit the RMS input current due to increased capacitors value on the DC bus.

The cabling circuits are shown on the drawings in the next sections depending on whether the daisy chain feature is used for drives of groups 40, 41 and 20, 21.

In addition to the general instructions listed in the “DC wiring” section at the beginning of this document must be applied, especially the following:

- The power rating of **drive 1 is always the highest power rating of the full system.**

It must be used with a motor that is at least one third of its rated power to be able to control it properly. This allows maximum two thirds of drive 1 power rating to supply the other drives. The following limitations must be met in order not to exceed the power capability of drive 1 input stage:

$$\frac{1}{3}P(\text{Drive 1}) \leq P(\text{Motor 1}) \leq P(\text{Drive 1})$$

$$P(\text{Motor 1}) + P(\text{Motor 2}) + \dots + P(\text{Motor } n) + P(\text{Motor } n + 1) + \dots + P(\text{Motor } m) \leq P(\text{Drive 1})$$

For example, a drive of 15 kW must be used at least with a 5.5 kW motor, or higher.

This leaves 9.5 kW (or less) to supply all the other drives.

- **Drive 1 must use the input choke** listed in the section “Line chokes” at the end of this document. It must be configured with parameter $d C C \Pi = n o$. Parameter setting $d C C C = A E u$ and $i P L = Y E S$ must be verified
- To protect drive 1 input rectifier in case of short-circuit on the DC bus link, **semi-conductor protection class fuses** must be selected from the table at the end of this document.
- **Drives 2 to n and n+1 to m** must be configured with parameter $d C C \Pi = b u S$. Parameter setting $d C C C = A E u$ must be verified

3-phase 380 V – 500 V mains input

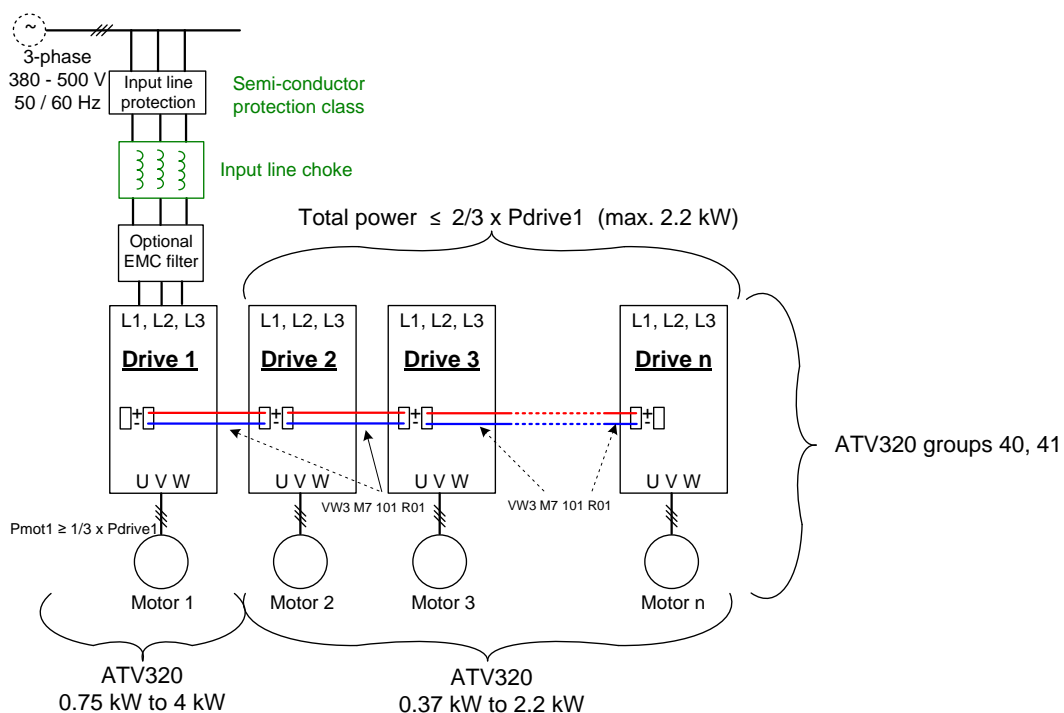
Drives groups 40 and 41 only

Drives of these groups can use the daisy chain feature as shown on the drawing below.

To protect the input rectifier of Drive 1 when a short circuit occurs on the DC bus, the input line protection must be built by using 2 fuses selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. The fuses selection is made according to the rated power of Drive 1.

Any short-circuit on the DC bus will break the input line fuses of Drive 1.

In this configuration, the highest power rating of the drive that can be used as Drive 1 is 4 kW. Since the minimum motor power on 4 kW drive is 1.5 kW the total power of drive 2 to drive n can be maximum 2.2 kW.

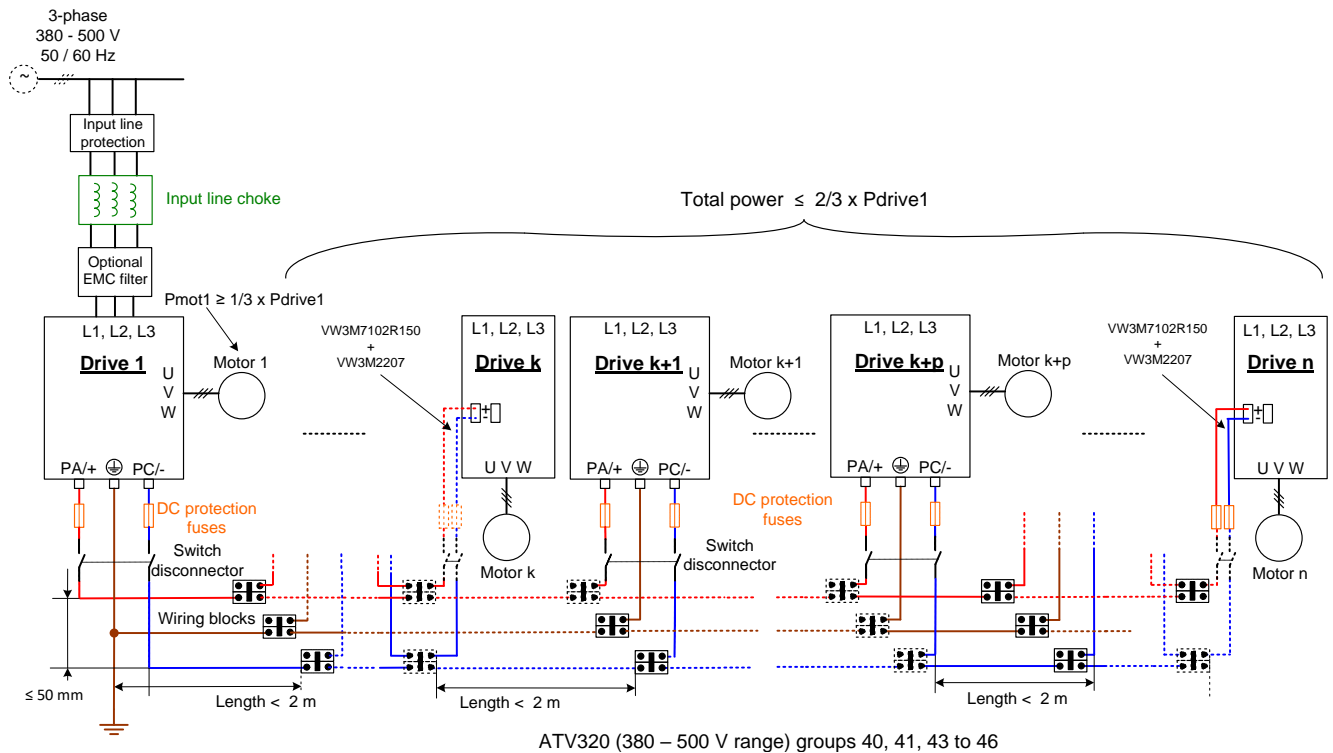


Drives of groups 40 to 46

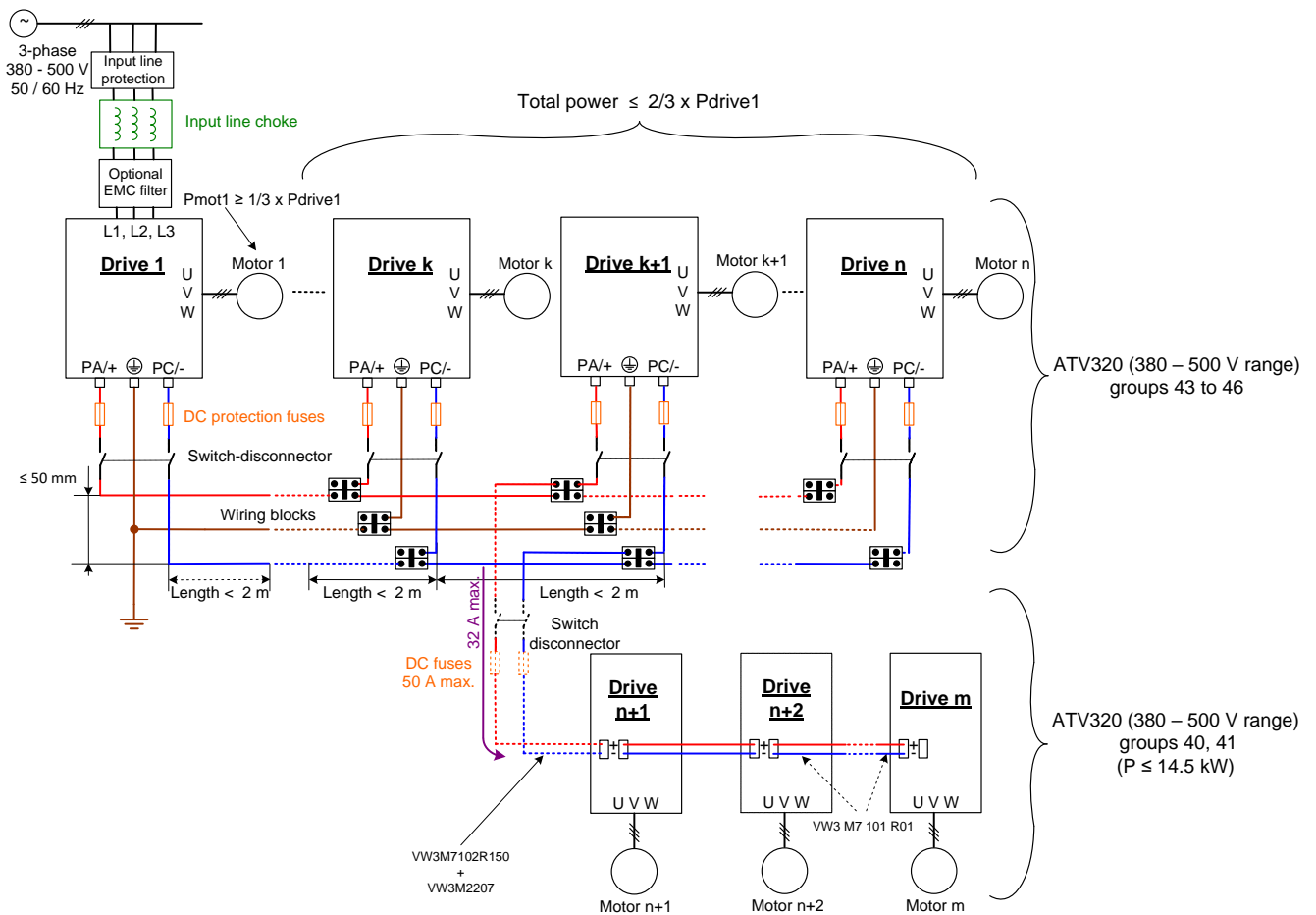
The generic configuration is shown on the drawings below.

All drives of these groups can share the same DC bus. Drives of groups 43 and 44 have a compact form factor with standard terminals for DC bus wiring. When these drives are mixed with drives of groups 40 and 41, the recommendations defined in the “DC bus wiring” section must be applied by using wiring blocks, DC protection fuses and optional switch-disconnector for each drive.

The drives are protected individually by DC protection fuses selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. Wiring blocks are used to build the DC bus and accessories VWM3M7102R150, VWM3M2207 to wire the drives to the DC bus.



ATV320 (380 – 500 V range) groups 40, 41, 43 to 46



If there are only drives n+1 to drives m using the daisy chain feature in association with drive 1, only the DC fuses at the input of the daisy chain are needed. These fuses must be defined as described in the “DC bus wiring” section.

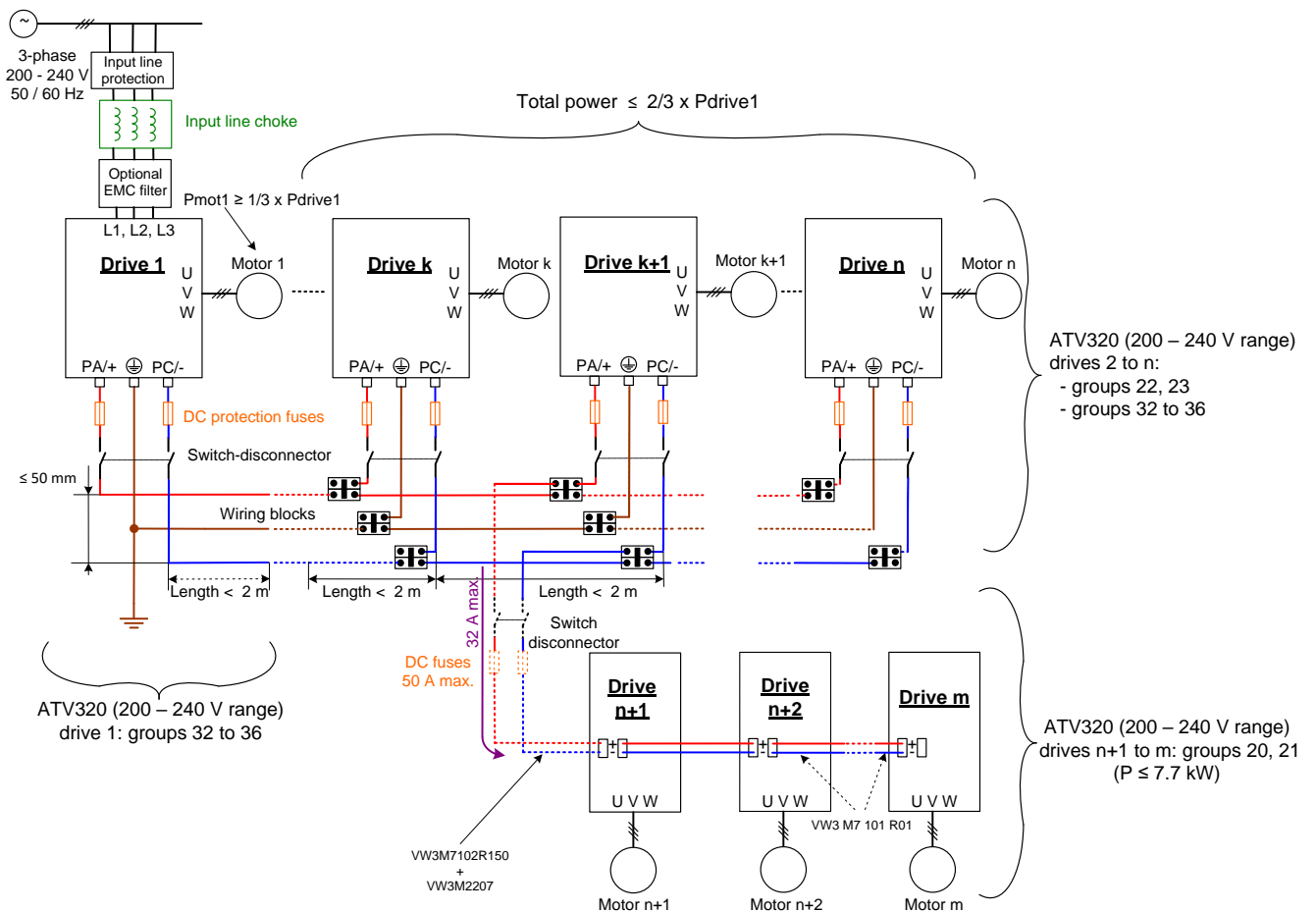
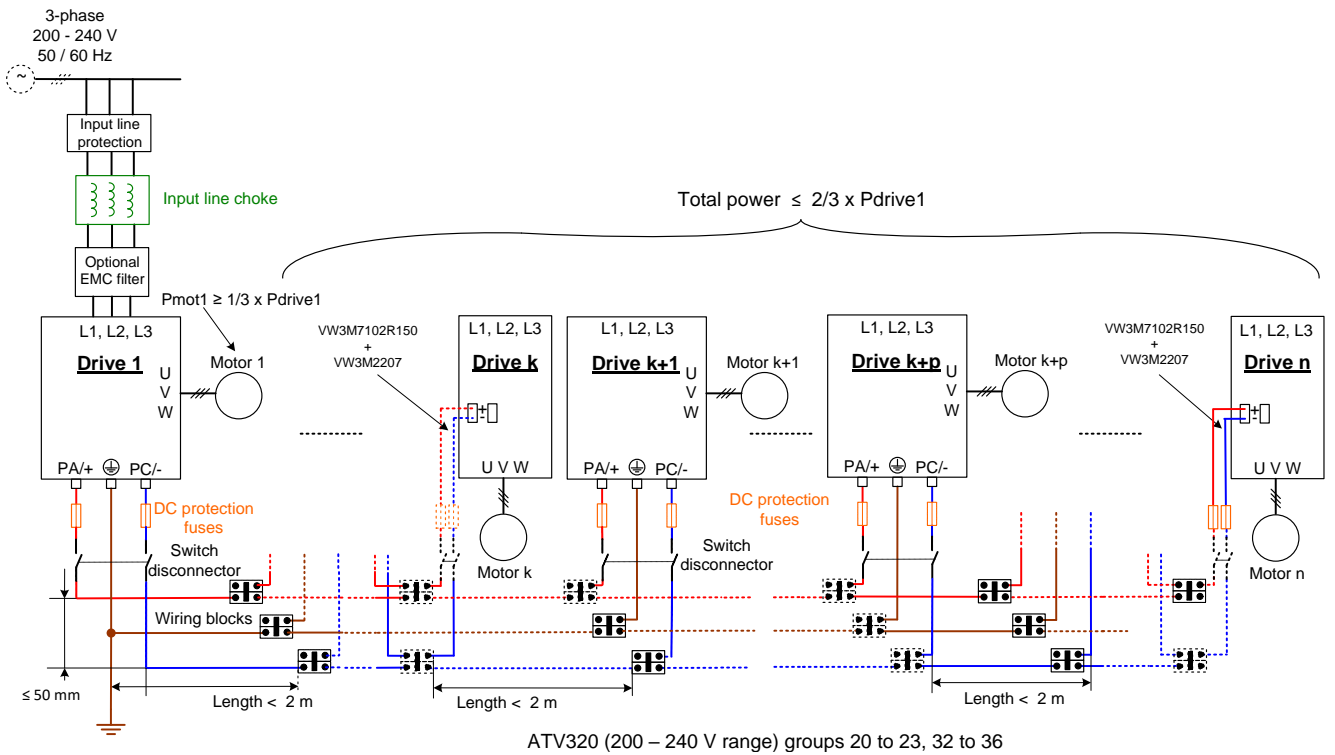
3-phase 200 V – 240 V mains input

Drive 1 must be selected in the range ATV320yyyM3C among drives of groups 32 to 36 to provide low DC bus ripple voltage.

Drives 2 ... n, n+1 ... m, can be selected among groups 32 to 36 (3-phase inputs) and 20 to 23 (single-phase input) because these drives are not powered by the mains power supply. The 3-phase power supply of Drive 1 provides low DC-bus ripple that single-phase input drives are able to accept.

The drives are protected individually by DC protection fuses selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. Wiring blocks are used to build the DC bus and accessories VWM3M7102R150, VWM3M2207 to wire the drives to the DC bus.

The generic configurations are shown on the drawings below.



Single-phase 200 V – 240 V mains input

Drive 1 is selected in the range of ATV320yyyM2x among drives of groups 20 to 23.

Only drives of groups 20 to 23 (single-phase input) can be used as drives 2, ...n, n+1, ... m. **It is not allowed to use drives of groups 32 to 36 (3-phase inputs)** because they do not have enough DC-bus capacitors to accept the DC-bus ripple voltage provided by the single-phase DC-bus source.

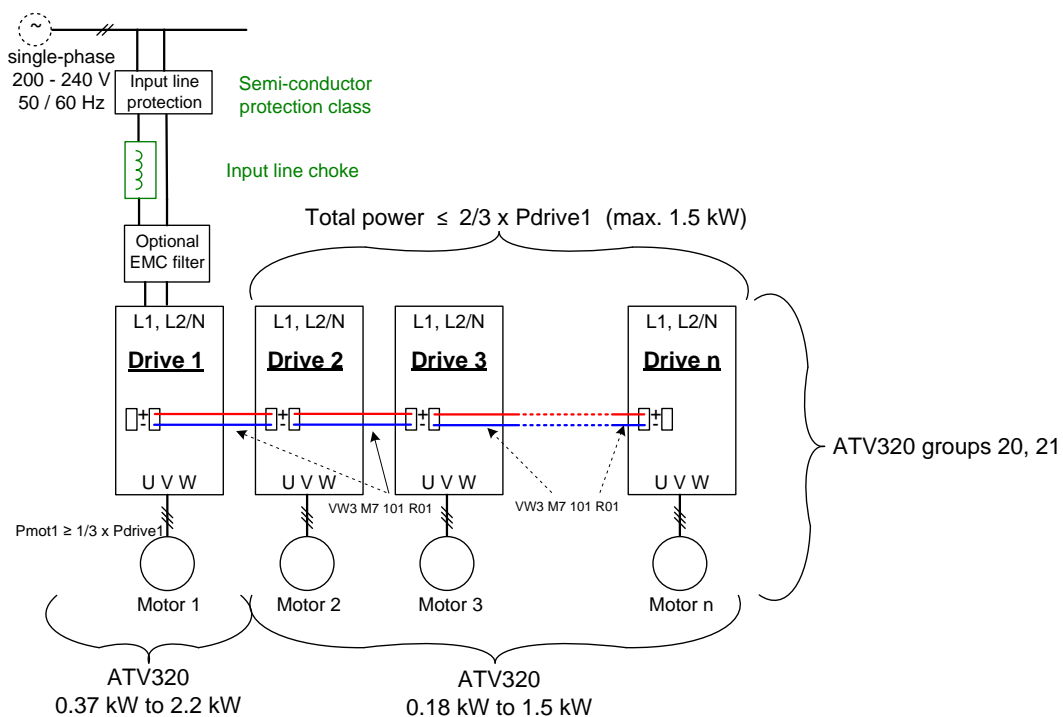
Drives of groups 20 and 21 only

Drives of these groups can use the daisy chain feature as shown on the drawing below.

To protect the input rectifier of Drive 1 when a short circuit occurs on the DC bus, the input line protection must be built by using 2 fuses selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. The fuses selection is made according to the rated power of Drive 1.

Any short-circuit on the DC bus will break the input line fuses of Drive 1.

In this configuration, the highest power rating of the drive that can be used as Drive 1 is 2.2 kW. Since the minimum motor power on 2.2 kW drive is 0.75 kW the total power of drive 2 to drive n can be maximum 1.5 kW.

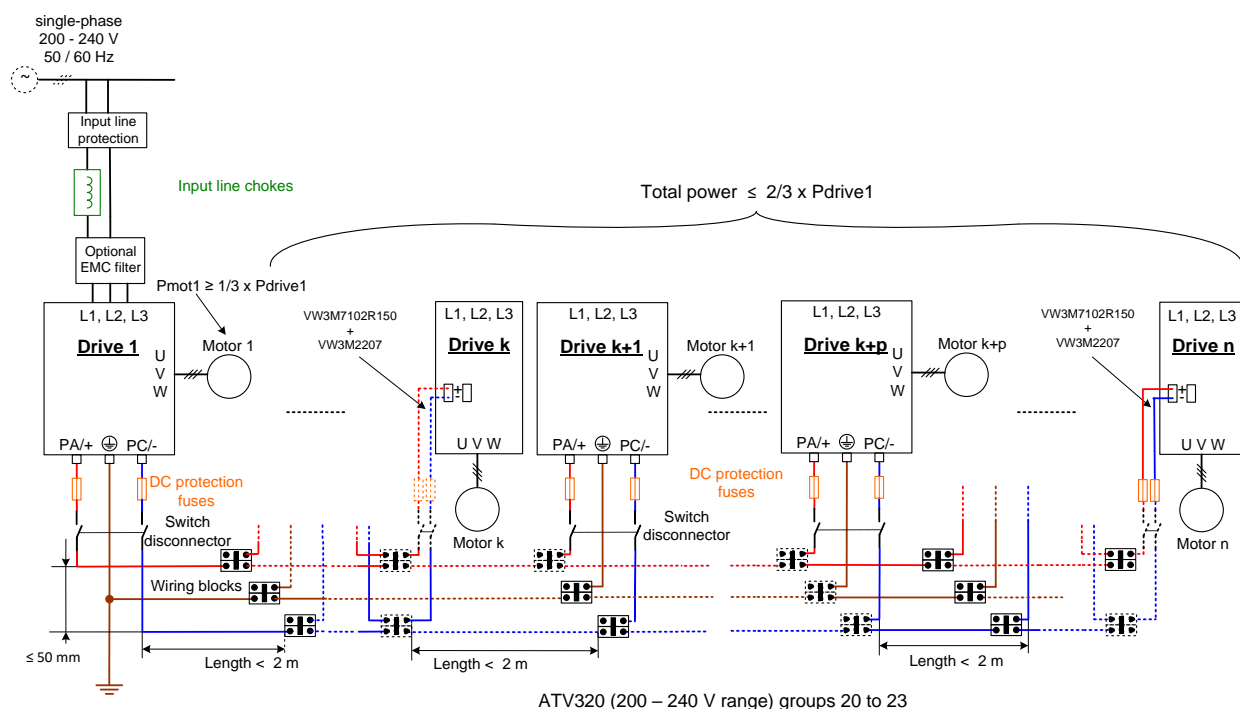


Drives of groups 20, 21 and 22, 23

All drives of these groups can share the same DC bus. Drives of groups 22 and 23 (ATV320yyyM2C) have standard terminals for DC bus wiring. When these drives are mixed with drives of groups 20 and 21, the wiring recommendation of the section “DC bus wiring” must be used.

The drives are protected individually by DC protection fuses selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. Wiring blocks are used to build the DC bus and accessories VWM3M7102R150, VWM3M2207 to wire the drives to the DC bus.

The generic configuration is shown on the drawing below.



Drive supplied by a DC power supply

The DC power supply replaces the drive which shared part of its power with the common DC bus in the configuration of the previous section. The output power rating of the DC source must be greater or equal to the sum of all drives' power rating linked on the common DC bus. It has also to provide the transient overload required by the drives in the application.

The DC source output protection fuses have to be selected according to the DC source user's manual. If this data is not provided, the same semiconductors protection class fuses defined for the drive of the same power rating can be used.

The DC source must guarantee a maximum of 3% DC voltage drop and 5% DC voltage ripple at rated load, it can be either

- 3-phase 380 – 500 V for drives of groups 40 to 46,
- 3-phase 200 V – 240 V for drives of groups 20 to 23 and 32 to 36,
- single-phase 200 V – 240 V for drives of groups 20 to 23 only.

If the DC source is a simple diodes or non-reversible SCR/diodes rectifier, input line chokes or DC output choke might have to be added to reduce the input line RMS current.

If the DC source is an active front-end which performs also input harmonic current mitigation with or without regenerative braking capabilities, no additional parts are needed except those needed by the active DC source itself.

The DC source does not need to provide a soft-charge circuit for the DC-bus capacitors of the drives, because all drives of ATV320 range include a soft-charge circuit to limit the in-rush current when the DC voltage is applied.

In addition to the wiring recommendations defined in the "DC bus wiring" section at the beginning of this document, the following additional requirements must be applied in this case:

- The total power of the motors used with drives powered by the DC source must not exceed its power rating including the transient overload on the motors:

$$P(\text{Motor } 2) + \dots + P(\text{Motor } n) + P(\text{Motor } n + 1) + \dots + P(\text{Motor } m) \leq P(\text{DCsource})$$

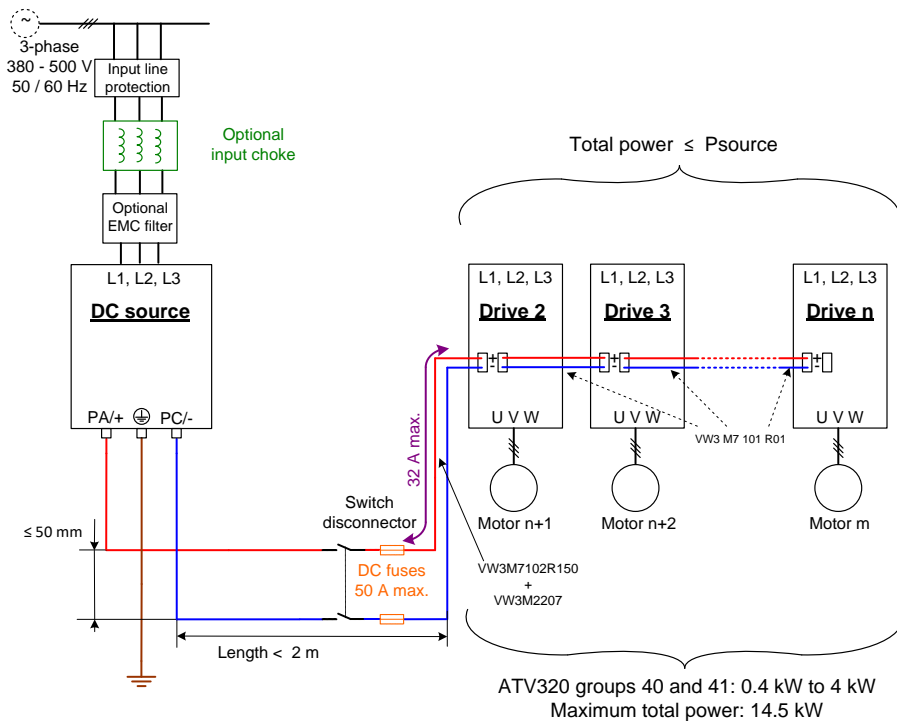
- **Drives** 2 to n and n+1 to m must be configured with parameter $dCCn = buS$.
Parameter setting $dCCC = AEU$ must be verified

3-phase 380 V – 500 V AC input, DC output source

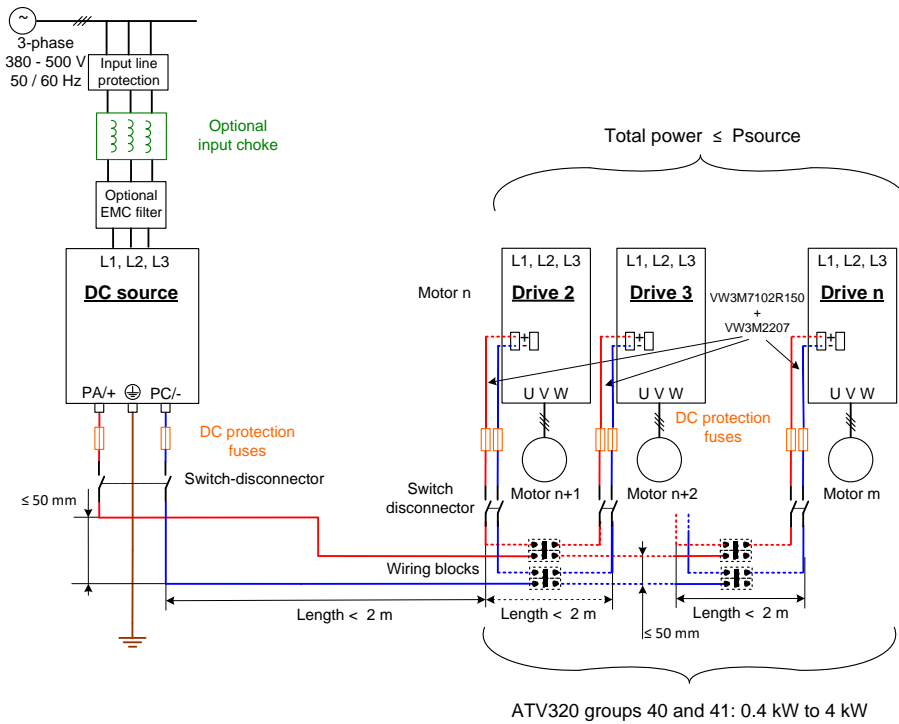
Drives of groups 40 and 41 only

The current in the daisy chain for drives of groups 40 and 41 (drive 2 to drive n in the following drawing) is limited to 32 A. Since these drives can be all in a motor mode when the power come from the DC bus, the total motor power of drives n+1 to drive m must be limited to 14.5 kW in order not to ever exceed 32 A on the DC bus.

The fuses rating must be the same as for one drive of the total power of the daisy chain (Example: for 3 drives of 2.2 kW in the daisy chain, select fuses of 7.5 kW drive). The maximum fuse rating is 50 A. It includes transient overloads, ageing and temperature coefficient to provide correct operation at 32 A.

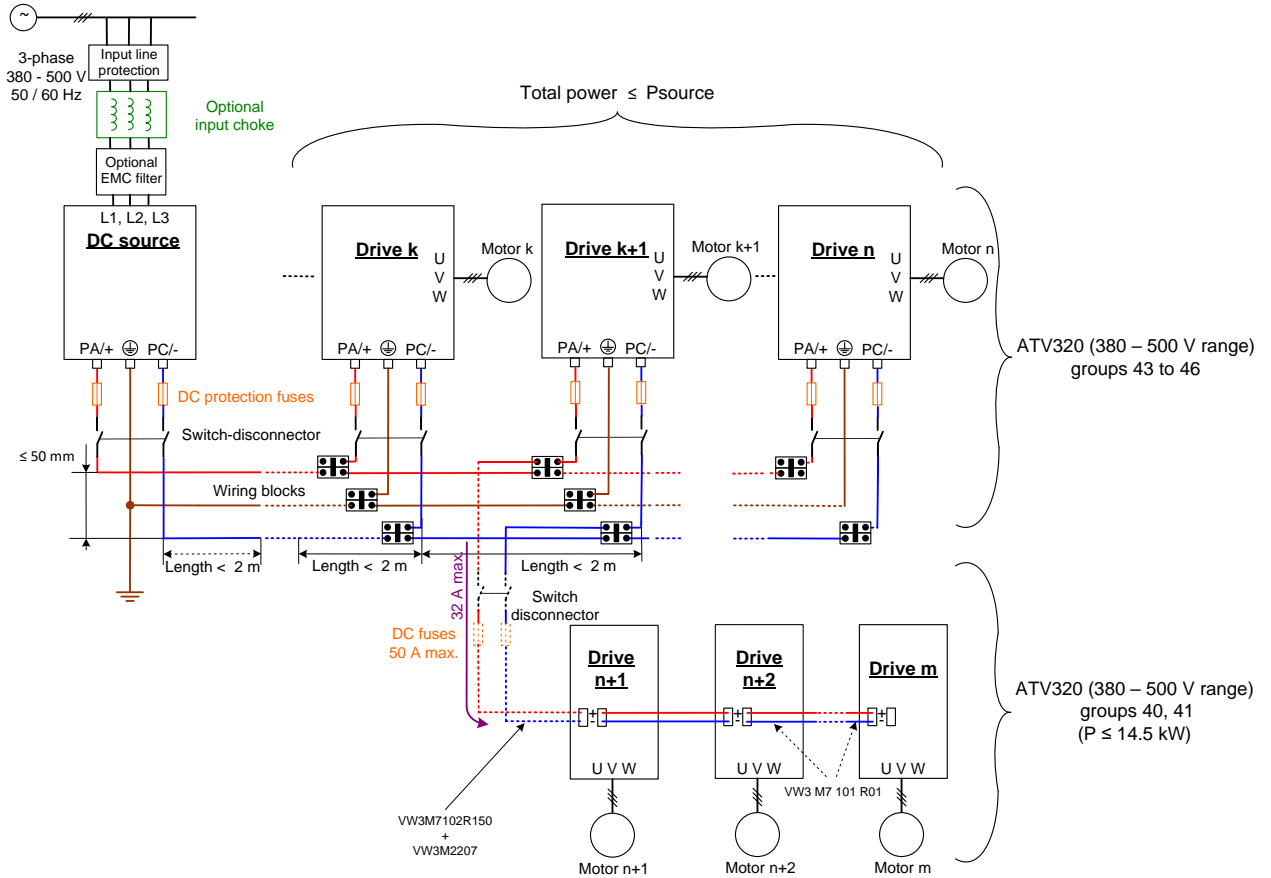
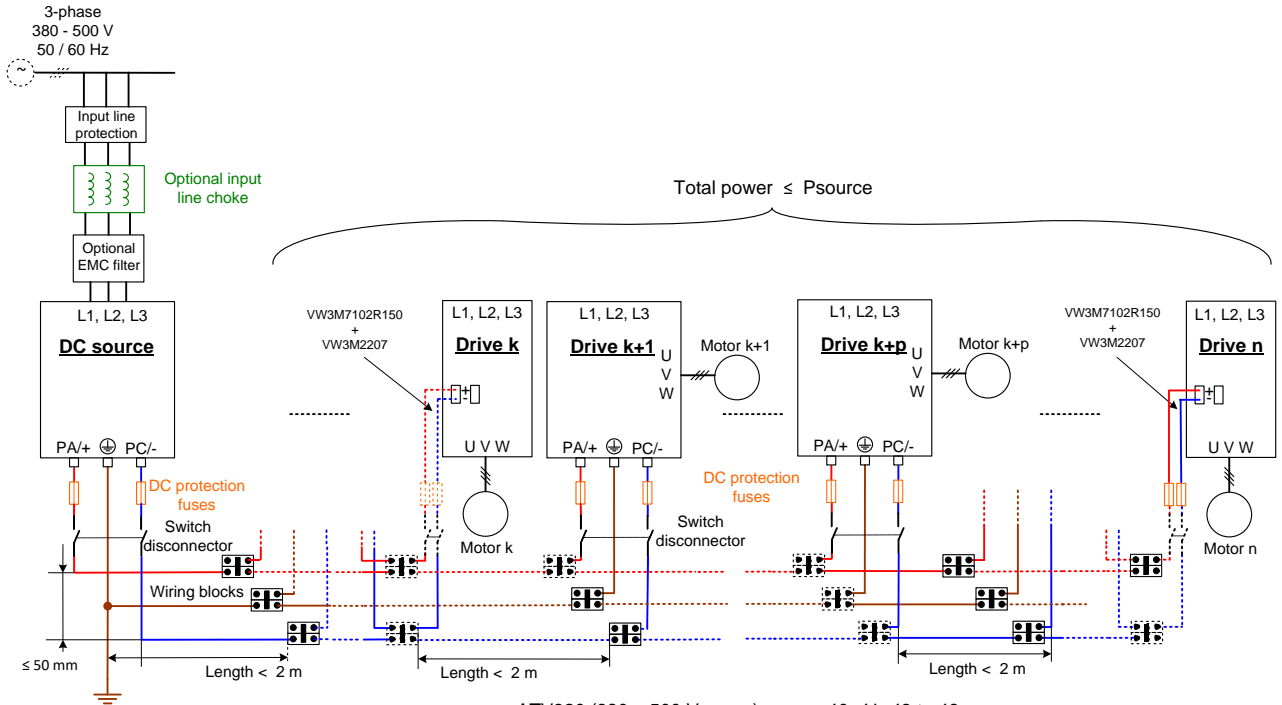


To avoid the limitation at 14.5 kW or to have a better protection of each drive by DC fuses, the following schematics can be used.



Drives of groups 40 to 46

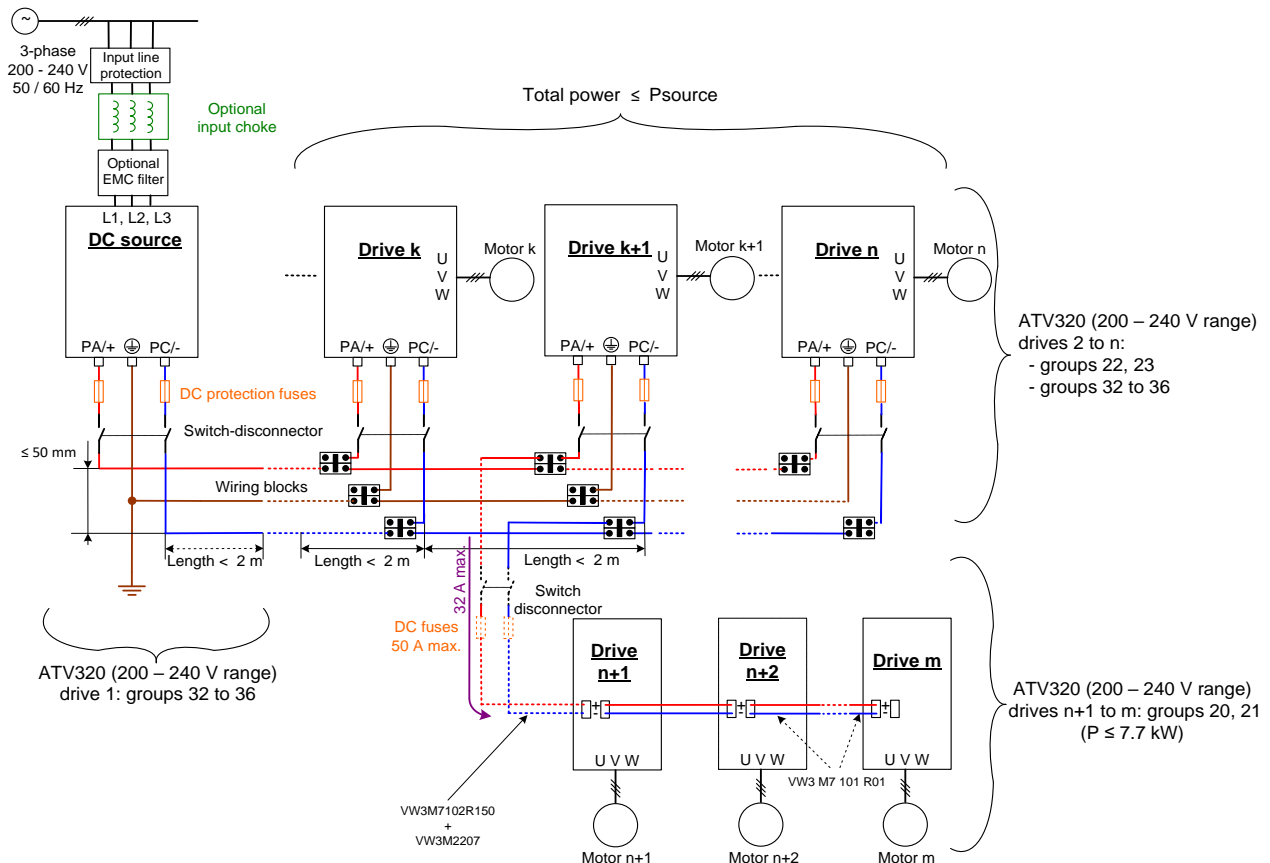
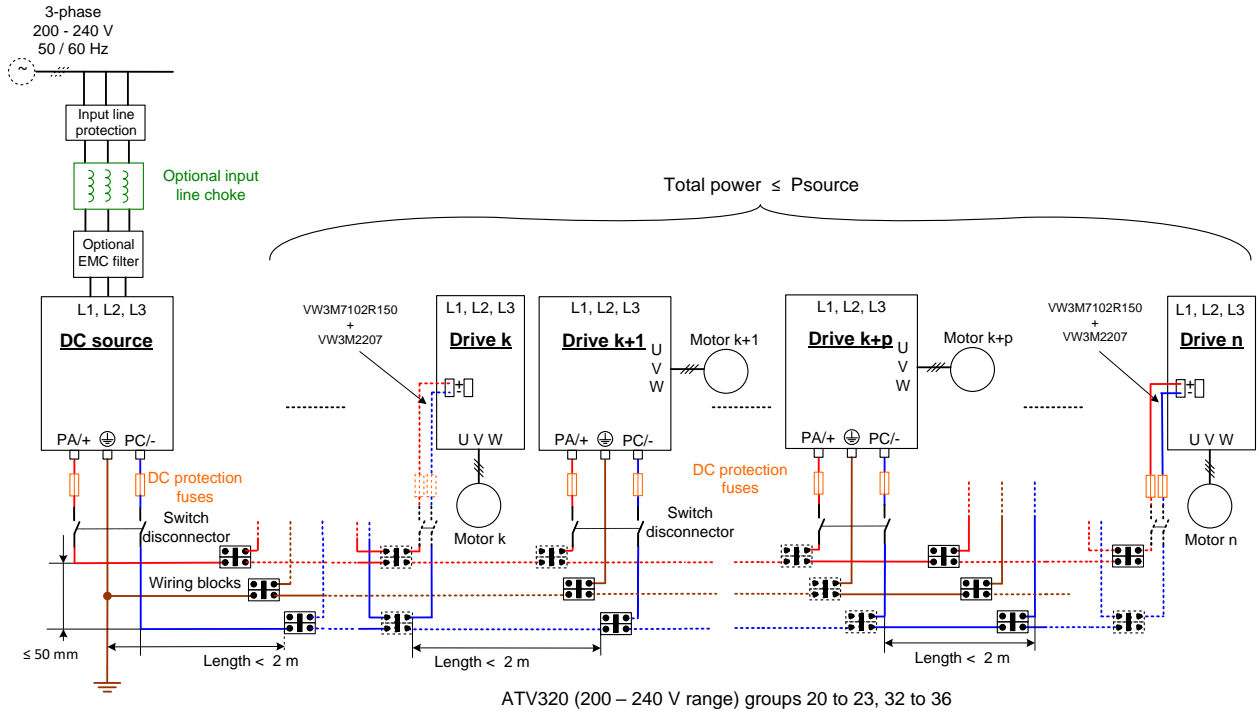
The generic configuration is shown on the two schematics below depending on whether the daisy chain feature is used for drives of groups 40, 41.



3-phase 200 V – 240 V AC input, DC output source

Drives can be selected in the range ATV320yyyM3C (3-phase inputs, groups 32 to 36) and also in the range ATV320yyyM2x (single-phase inputs, groups 20 to 23) because the drives are not powered by the mains power supply. The 3-phase power supply provides low DC-bus ripple that single-phase input drives are able to accept.

All previous recommendations of the “DC bus wiring” section are applicable to these configurations.

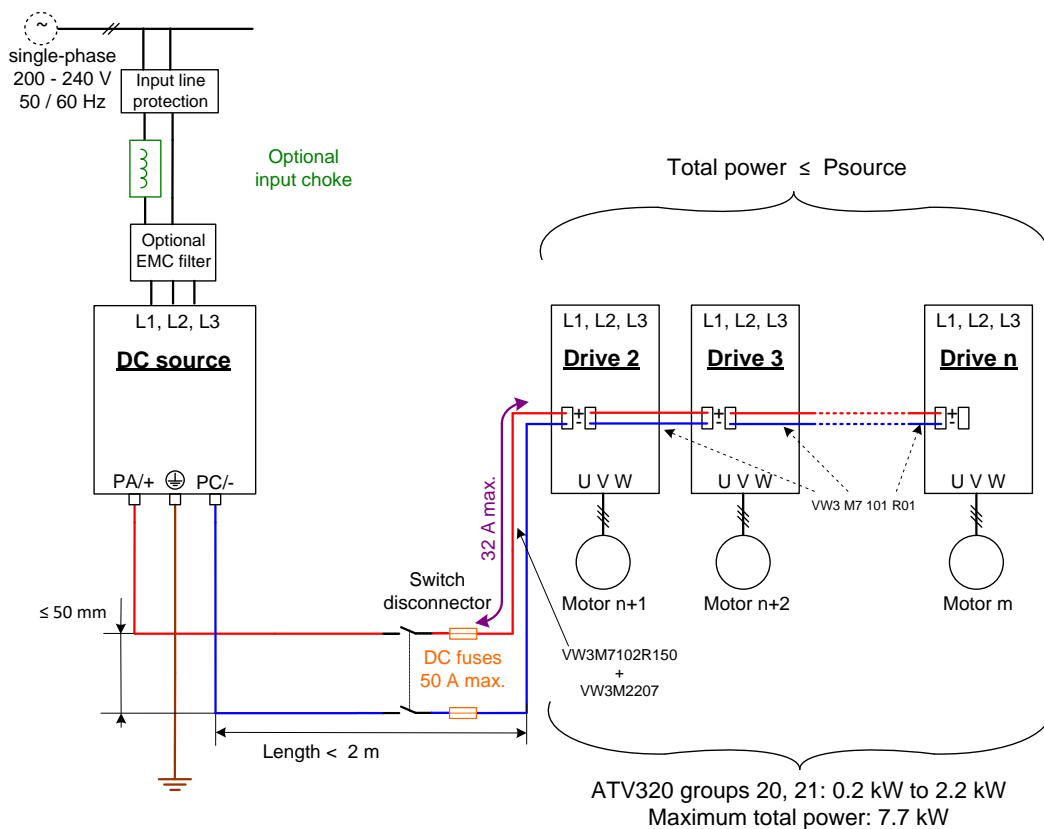


Single-phase 200 V – 240 V AC input, DC output source

Only drives of groups 20 to 23 (single-phase input) can be used. **It is not allowed to use drives of groups 32 to 36 (3-phase inputs)** because they do not have enough DC-bus capacitors to accept the DC-bus ripple voltage provided by the single-phase DC-bus source.

Drives groups 20 and 21 only

If only drives of groups 20 and 21 are used, the daisy chain feature can be used for an easy wiring. In this case, to protect the DC source when a short-circuit occurs on the DC bus, 2 fuses must be used. They have to be selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. The fuses selection is made according to the total power of drive 2 to drive n, taking into account a maximum current rating of 50 A to provide protection at 32 A maximum in the daisy chain.

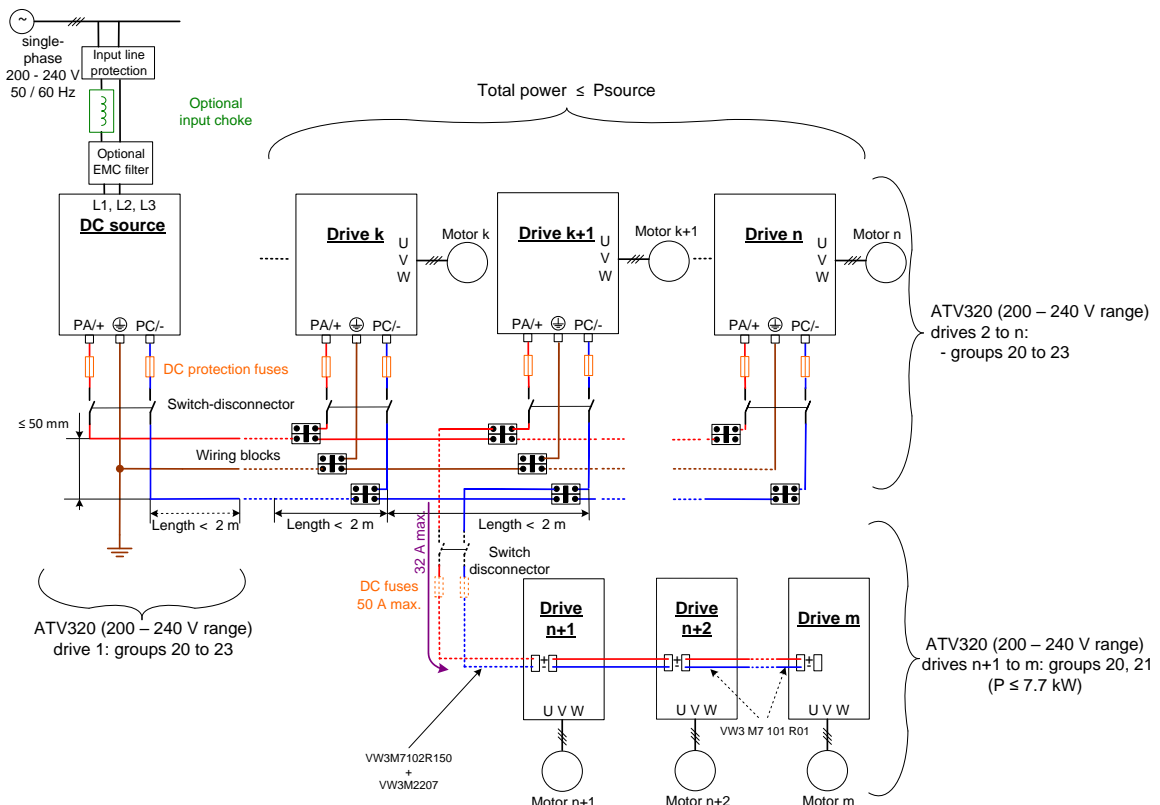
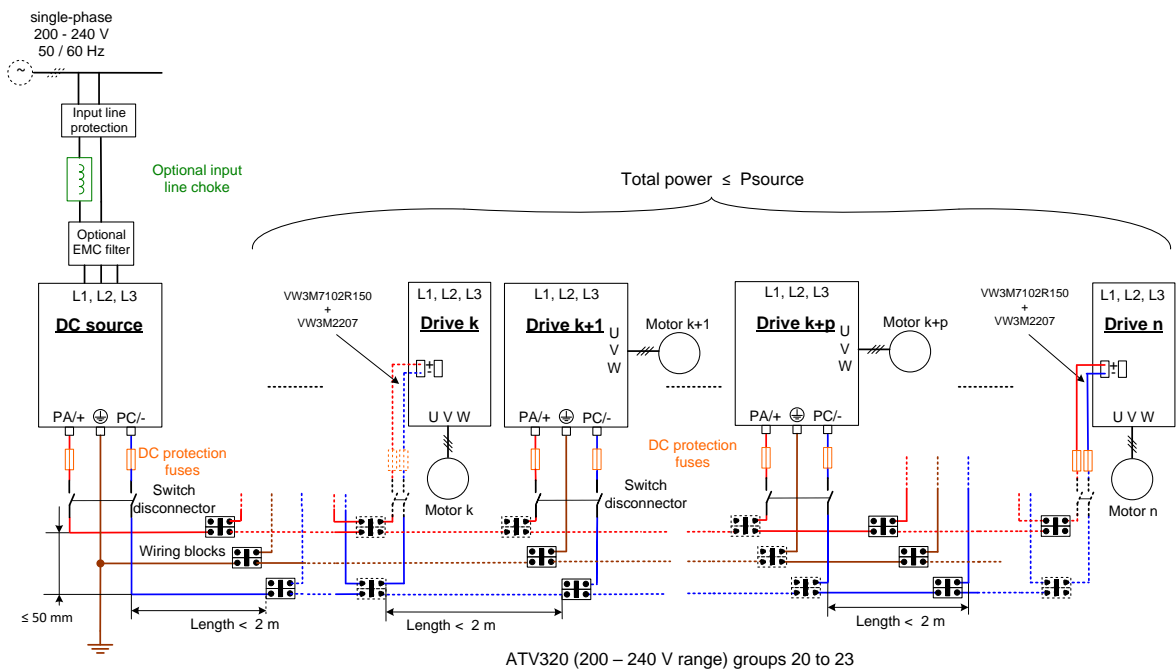


Drives of groups 20, 21 and 22, 23

All drives of these groups can share the same DC bus. Drives of groups 22 and 23 (ATV320yyyM2C) have standard terminals for DC bus wiring. When these drives are mixed with drives of groups 20 and 21, the wiring recommendation of the section “DC bus wiring” must be used.

The drives are protected individually by DC protection fuses selected in the semi-conductor protection class listed in the “Fuses table” section at the end of this document. Wiring blocks are used to build the DC bus and accessories VWM3M7102R150, VWM3M2207 to wire the drives to the DC bus.

The generic configuration is shown on the drawing below.



Using a braking unit on a common DC bus.

When some drives sharing a common DC-bus are braking and if the other drives linked on the same DC-bus are not able to use all this braking energy, the drives' DC bus capacitors will store this energy. This will lead to an increase of the DC bus voltage. To avoid any over-braking error on the drives (error code: $\square b F$) a braking unit can be used. The same solutions as for a single drive can be used:

- braking resistor,
- or regenerative braking unit.

The full knowledge of the application cycles, or the situations which can happen during all drives' operations is necessary to define what are the peak and average power, the braking time and the duty cycle.

⚠ DANGER

HAZARD OF FIRE

- Some braking resistors are equipped with a thermal switch to detect overheating of the resistor. This thermal switch must be used upstream to the drive to switch off the mains contactor in case of overheating detection (1).
- When a braking resistor from third party supplier is used, conduct your own risk assessment according to EN ISO 12100 and all other standards that apply to your application to ensure that any failure mode does not result in unsafe conditions. For example, but not limited to, thermal monitoring must be used to switch off the mains contactor and/or the braking resistor itself in case of overheating detection.

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

(1) Refer to the wiring diagrams provided into the braking resistors instruction sheet [NHA87388](#). This instruction sheet is delivered with the braking resistor and/ or can be downloaded on www.se.com.

Braking resistor.

In any of the above described DC-bus sharing configurations, a braking resistor can be used on each drive linked to the DC-bus, when this feature is included. The braking IGBT integrated in the drives is activated when the DC bus voltage reaches a defined level. Since the DC-bus voltage is common, any braking IGBT of any drive on the DC-bus will operate to discharge the DC-bus through the externally connected resistor.

On each drive equipped with a braking resistor, the parameter “ $b r R$ ” must be set to “ $n \square$ ”

Parameter “ brA ” can be set in different ways on the other drives sharing the common DC-bus:

- “ $b r R$ ” set to “ $n \square$ ” to get the braking performance on drives to follow the deceleration ramp.
- “ $b r R$ ” set to “ $Y E 5$ ” for drives for which it is not necessary to follow the deceleration ramp.

The calculation of the braking resistor is made in the same way as for a single drive, but the total braking power on the DC bus must be considered. This includes the maximum steady state braking power and the deceleration power of all the drives which have the “ $b r R$ ” parameter set to “ $n \square$ ”.

This will give the peak power P_{peak} , the total braking time, the average power P_{avg} and the duty cycle.

Using only one braking resistor

The simplest solution is to use only one braking resistor wired on one of the drives sharing the DC bus. This is possible if the calculated peak braking power P_{peak} and the average braking power P_{avg} are lower than the capabilities of one of the drives sharing the DC bus. The decision process is the following:

1. Select the drive to be equipped by a braking resistor

The peak braking power P_{peak} of the system must be dissipated in the braking resistor. To do it, the maximum resistor value R_{max} is calculated by

$$R_{max} = \frac{(U_{brake})^2}{P_{peak}}$$

with U_{brake} is the DC bus voltage when the braking IGBT starts to operate.

On ATV320yyyN4x range: $U_{brake} = 820 V$.

On ATV320yyyM2x and ATV320yyyM3C ranges: $U_{brake} = 395 V$.

The drive selected must accept a minimum braking resistor value R_{min} lower than R_{max} in order to be able to select a resistor value R defined by

$$R_{min} \leq R \leq R_{max}$$

The highest power rating drive sharing the DC bus equipped with a braking IGBT can be used to drive the braking resistor even if it is not this drive which will brake during the application cycle. Even in “ready” state, ATV320 can activate the braking IGBT.

If no drive on the DC bus has R_{min} specification verifying $R_{min} \leq R_{max}$, it is not possible to use only one braking resistor in the system.

In this case the section “Using more than one braking resistor” later in this document must be considered.

2. Define the braking resistor rated power

The braking torque characteristic and the duty cycle of the application allow to calculate the average braking power P_{avg} . The rated power of the braking resistor R must be greater or equal to this average braking power. The overload factor of the braking resistor must allow to withstand the peak power P_{peak} . The typical braking cycles defined in the ATV320 catalog can help to select a braking resistor.

Using more than one braking resistor

If there is no drive sharing the DC bus having a R_{min} specification which meets the condition $R_{min} \leq R_{max}$, it means that the peak braking power has to be shared by two or more drives depending on the application.

1. Define number and values of braking resistors

The simplest way is to start with the highest power rating drive sharing the DC bus and to define the peak power $P_{peak(R1)}$ that it will be able to dissipate:

$$P_{peak(R1)} = \frac{(U_{brake})^2}{R_1}$$

with $R_1 \geq R_{min(1)}$ where $R_{min(1)}$ is the minimum braking resistor of drive 1.

This has to be continued with the next highest drives' power ratings to define $R_2 \geq R_{min(2)}, \dots, R_n \geq R_{min(n)}$

with $R_2 \geq R_{min(2)}$ where $R_{min(2)}$ is the minimum braking resistor of drive 2, ...

and $R_n \geq R_{min(n)}$ where $R_{min(n)}$ is the minimum braking resistor of drive n

and to calculate

$$P_{peak(R2)} = \frac{(U_{brake})^2}{R_2}, \dots, P_{peak(Rn)} = \frac{(U_{brake})^2}{R_n}$$

until we get

$$P_{peak(R1)} + P_{peak(R2)} + \dots + P_{peak(Rn)} \geq P_{peak}$$

2. Define braking resistors rated power

The braking torque characteristic and the duty cycle of the application allow to calculate the total average braking power P_{avg} , which must be shared between all the braking resistors. The rated power of each resistor $P_{avg(Ri)}$ will be defined with the same ratio to the average braking power as the ratio of the peak power of each resistor to the total peak power.

The peak power of resistor i is

$$P_{peak(Ri)} = \frac{(U_{brake})^2}{R_i}$$

The total peak power for all the resistors is

$$P_{peak} = P_{peak(R1)} + P_{peak(R2)} + \dots + P_{peak(Rn)} = (U_{brake})^2 \cdot \left(\frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n} \right)$$

The ratio $k(R_i)$ of the peak power of resistor i to the total peak power is

$$k(R_i) = \frac{P_{peak(Ri)}}{P_{peak}} = \frac{\frac{1}{R_i}}{\frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}}$$

The average power of resistor i can be calculated by

$$P_{avg(Ri)} = k(R_i) \cdot P_{avg}$$

Example 1: one braking resistor

Let's consider the following system of 3 drives sharing the same DC bus:

ATV320D15N4x + ATV320U75N4x + ATV320U40N4x (x = B for book, x = C for compact form factor)

The application is defined by the following

- ATV320D15N4x never brakes; it can be running or in "ready" state
- ATV320U75N4x and ATV320U40N4x are making cycles and can brake both at rated torque at the same time to decelerate their loads from rated speed down to 0 during 3 s every 40 s.

When ATV320D15N4x is operating at least at 80% of its rated torque, the braking energy of the two other drives is reused by ATV320D15N4x.

When ATV320D15N4x is in "ready" state, the braking energy of ATV320U75N4x and ATV320U40N4x must be dissipated in a braking resistor.

To simplify the calculation, we consider 0.9 as the motors efficiency and 0.95 as the drives efficiency. The total peak power of the system is the sum of the peak power of both drives:

$$P_{peak} = (7.5 \times 0.9 \times 0.95) + (4.0 \times 0.9 \times 0.95) = 6.41 + 3.42 = 9.83 \text{ kW}$$

The maximum resistor R_{max} to get this peak power is

$$R_{max} = \frac{820^2}{9.83 \times 10^3} = 68.4 \Omega$$

The recommended baking resistor value of ATV320D15N4x is given in ATV320 catalog. This value can be used as minimum value:

$$R_{min} = 16 \Omega$$

The condition $R_{min} \leq R_{max}$ is met. It is possible to select a resistor value between 16 Ω and 68.4 Ω

The two drives are braking by doing a deceleration at constant torque, it means that the power is decreasing linearly with speed during 3 s and then there is no braking power during 40 s. The average power during one cycle can be calculated by

$$P_{avg} = \frac{1}{3 + 40} \times \left(\frac{9.83 \text{ kW}}{2} \times 3 + 0 \times 40 \right) = 228.7 \text{ W}$$

The reference VW3A7732, 28 Ω , 300 W wired on the ATV320D15N4x meets the requirements of this application.

Example 2: two braking resistors

Let's consider the following system of 7 drives sharing the same DC bus:

ATV320U75N4x + ATV320U55N4x + 5 x ATV320U22N4x (x = B for book, x = C for compact form factor)

The application is defined by the following

- All drives are making acceleration and deceleration cycles.
- The sequences of the drives are synchronized in a way that there are always drives running using enough power when another one is braking. In this case the DC bus sharing is operating.
- Every 75 s all the drives have to stop at the same time, with a braking torque equal to 1.3 times the rated torque of the motor, during 2s to decrease the speed from rates speed down to 0.

The DC bus sharing does not work to achieve the full braking sequence every 75 s. This braking energy has to be dissipated in braking resistors. Instead of using one braking resistor per drive, it is possible to use less than 7 pieces in this application.

To simplify the calculation, we consider 0.9 as the motors efficiency and 0.95 as the drives efficiency. The total peak power of the system is the sum of the peak power of all drives:

$$P_{peak} = (1.3 \times 7.5 \times 0.9 \times 0.95) + (1.3 \times 5.5 \times 0.9 \times 0.95) + 5 \times (1.3 \times 2.2 \times 0.9 \times 0.95) = 26.7 \text{ kW}$$

$$P_{avg} = \frac{1}{2 + 75} \times \left(\frac{26.7 \text{ kW}}{2} \times 2 + 0 \times 75 \right) = 346.8 \text{ W}$$

The highest drive power rating is ATV320U75N4x. The recommended braking resistor value found in the ATV320 catalog for this drive is $R_1 = 28 \Omega$.

With this value $P_{peak(R1)} = \frac{820^2}{28} = 24.0 \text{ kW}$ which is not enough compared to 26.7 kW

The next highest drive power rating is ATV320U55N4x. The recommended braking resistor value found in the ATV320 catalog for this drive is $R_2 = 60 \Omega$

With this value $P_{peak(R2)} = \frac{820^2}{60} = 11.2 \text{ kW}$.

Now $P_{peak(R1)} + P_{peak(R2)} = 24.0 + 11.2 = 35.2 \text{ kW}$ is greater than 26.7 kW

The application will use

- $R_1 = 28 \Omega$ braking resistor associated with the ATV320U75N4x
- $R_2 = 60 \Omega$ braking resistor associated with the ATV320U55N4x

The total average power of the application is shared between R1 and R2 by the following factors:

$$k(R_1) = \frac{\frac{1}{28}}{\frac{1}{28} + \frac{1}{60}} = 0.68 \Rightarrow P_{avg(R1)} = 0.682 \cdot 346.8 = 236.4 \text{ W}$$

$$k(R_2) = \frac{\frac{1}{60}}{\frac{1}{28} + \frac{1}{60}} = 0.32 \Rightarrow P_{avg(R2)} = 0.318 \cdot 346.8 = 110.3 \text{ W}$$

The selected resistance from the catalog are:

VW3A7732, 28 Ω , 300 W

VW3A7731, 60 Ω , 160 W

Regenerative braking unit.

In any of the above described DC-bus sharing configuration, the regenerative units ATVRU75N4 and/or ATVRD15N4 can be used on the DC-bus. These regenerative braking units are autonomous devices, that compare the input mains voltage level with the DC-bus voltage and start to push-back power to the mains when the difference is greater than a fixed threshold.

The rated power of ATVRU75N4 is 6.8 kW continuous, with 10.2 kW transient overload during 60s.

The rated power of ATVRD15N4 is 13.5 kW continuous, with 20.3 kW transient overload during 60s.

These units can be associated in parallel, up to 3 units of any of the two power ratings, to cover up to 45 kW.

When the average braking power is high, these units have an advantage compared to braking resistors:

- regen units can be integrated in the cabinet because the size is smaller than hoisting type resistors,
- the heat dissipation is very low, because their efficiency is better than 95%,
- depending on the braking power and the cycle, the return on investment by energy saving can be fast.

If we consider the same system as in example 2 in previous section, but with a more severe cycle: the machine has to stop every 20 s. In this case the peak power is the same as in the previous cycle, but the average power becomes:

$$P_{avg} = \frac{1}{2 + 20} \times \left(\frac{26.7 \text{ kW}}{2} \times 2 + 0 \times 20 \right) = 1213.6 \text{ W}$$

This leads to select braking resistors of same value but with higher average power:

VW3A7742, 28 Ω , 1100 W 570 mm x 190 mm x 180 mm

VW3A7741, 60 Ω , 500 W 465 mm x 175 mm x 100 mm

To compare with power regenerative units, the peak power of 26.7 kW is achieved by using

1x ATVRD15N4 399 mm x 235 mm x 105 mm

+ 1x ATVRU75N4 337 mm x 175 mm x 80 mm

The two units are wired in parallel, which gives a total of 30.5 kW transient power, more than enough average power, with smaller overall dimensions.

Considering a global efficiency of the two regen units of 95% and assuming 8 hours per days, 220 days per year of the system operation, the total energy saved per year is:

$$E_{saved} = 1213.6 \times 0.95 \times 8 \times 220 = 2029.3 \text{ kWh}$$

Depending on the local energy cost and the buying price difference between the two resistors and the two regen units, it is easy to calculate the return on investment of the regen solution.

Fuse table

The fuses to be used with the drives sharing a common DC bus must be selected in the **semiconductors protection class**. The following table give for each drive the rating of the fuse as it is given in the fuses' suppliers catalogs. It takes into account the following parameters:

- The current rating of the fuse is given at 30°C, the value listed in this table takes into account the derating to be applied on the fuse to operate in the 50°C drive's environment,
- The current rating of the fuse takes also into account the drive's overload (1.5 rated current during 60s) and the thermal cycling when the drive is running or stopped.

To protect the input rectifiers of the drives the fuses must be associated in the following way:

- Either one fuse: one fuse on the PA/+ terminal,
- Either two fuses: one fuse on the PA/+ terminal and one fuse on the PC/- terminal,
- Either three fuses on the input mains lines (for drives groups 20, 21 and 40, 41 with daisy chain feature)

single-phase, 200 V – 240 V range

IEC and UL fuses table

Drives		Semi-conductor protection class fuses ratings of MERSEN				
Reference	Power (kW)	Current rating (A)	DC voltage (V)		Fuse reference	Fuse support reference
			IEC	UL		
ATV320U02M2x	0.18	8	700	500	FR10GR69V8 ⁽¹⁾	US102I ⁽¹⁾
ATV320U04M2x	0.37	12.5	700	500	FR10GR69V12.5 ⁽¹⁾	US102I ⁽¹⁾
ATV320U06M2x	0.55	16	700	500	FR10GR69V16 ⁽¹⁾	US102I ⁽¹⁾
ATV320U07M2x	0.75	20	700	500	FR10GR69V20 ⁽¹⁾	US102I ⁽¹⁾
ATV320U11M2x	1.1	25	700	500	FR10GR69V25 ⁽¹⁾	US102I ⁽¹⁾
ATV320U15M2x	1.5	32	700	500	FR10GR69V32 ⁽¹⁾	US102I ⁽¹⁾
ATV320U22M2x	2.2	50	700	500	FR10GR69V50 ⁽¹⁾	US142I ⁽¹⁾

x B: book form factor, C: compact form factor

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

3-phase, 200 V – 240 V range

IEC and UL fuses table up to 4 kW

Drives		Semi-conductor protection class fuses ratings of MERSEN				
Reference	Power (kW)	Current rating (A)	DC voltage (V)		Fuse reference	Fuse support reference
			IEC	UL		
ATV320U02M3C	0.18	6	700	500	FR10GR69V6 ⁽¹⁾	US102I ⁽¹⁾
ATV320U04M3C	0.37	10	700	500	FR10GR69V10 ⁽¹⁾	US102I ⁽¹⁾
ATV320U06M3C	0.55	12.5	700	500	FR10GR69V12.5 ⁽¹⁾	US102I ⁽¹⁾
ATV320U07M3C	0.75	16	700	500	FR10GR69V16 ⁽¹⁾	US102I ⁽¹⁾
ATV320U11M3C	1.1	16	700	500	FR10GR69V16 ⁽¹⁾	US102I ⁽¹⁾
ATV320U15M3C	1.5	25	700	500	FR10GR69V25 ⁽¹⁾	US102I ⁽¹⁾
ATV320U22M3C	2.2	32	700	500	FR10GR69V32 ⁽¹⁾	US102I ⁽¹⁾
ATV320U30M3C	3.0	40	700	500	FR10GR69V40 ⁽¹⁾	US142I ⁽¹⁾
ATV320U40M3C	4.0	50	700	500	FR10GR69V50 ⁽¹⁾	US142I ⁽¹⁾

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

IEC fuses table from 5.5 to 15 kW

Drives		Semi-conductor protection class fuses ratings of MERSEN			
reference	Power (kW)	Current rating (A)	IEC DC voltage (V)	Fuse reference	Fuse support reference
ATV320U55M3C	5.5	80	700	FR22GR69V80 ⁽¹⁾	US222I ⁽¹⁾
ATV320U75M3C	7.5	100	700	FR22GR69V100 ⁽¹⁾	US222I ⁽¹⁾
ATV320D11M3C	11	125	700	NH00GS69V125PV ⁽¹⁾	BB002EPBR ⁽¹⁾
ATV320D15M3C	15	160	700	NH00GS69V160PV ⁽¹⁾	BB002EPBR ⁽¹⁾

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

UL fuses table from 5.5 to 15 kW

Drives		Semi-conductor protection class fuses ratings of MERSEN			
reference	Power (kW)	Current rating (A)	UL DC voltage (V)	Fuse reference	Fuse support reference
ATV320U55M3C	5.5	80	500	FR22GR69V80 ⁽¹⁾	US222I ⁽¹⁾
ATV320U75M3C	7.5	100	500	FR22GR69V100 ⁽¹⁾	US222I ⁽¹⁾
ATV320D11M3C	11	125	500	2 x HSJ125 ⁽²⁾	2 x 62001J ⁽²⁾
ATV320D15M3C	15	160	500	2 x HSJ160 ⁽²⁾	2 x 62001J ⁽²⁾

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

⁽²⁾ with two fuses: one fuse on the PA/+ terminal and one fuse on the PC/- terminal

380 V – 500 V range

IEC fuses table

Drives		Semi-conductor protection class fuses ratings of MERSEN			
Reference	Power (kW)	Current rating (A)	IEC DC voltage (V)	Fuse reference	Fuse support reference
ATV320U04N4x	0.37	6	700	2x FR10GR69V6 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U06N4x	0.55	8	700	2x FR10GR69V8 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U07N4x	0.75	10	700	2x FR10GR69V10 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U11N4x	1.1	12.5	700	2x FR10GR69V12.5 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U15N4x	1.5	16	700	2x FR10GR69V16 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U22N4x	2.2	20	700	FR10GR69V20 ⁽¹⁾	US102I ⁽¹⁾
ATV320U30N4x	3.0	25	700	FR10GR69V25 ⁽¹⁾	US102I ⁽¹⁾
ATV320U40N4x	4.0	32	700	2x FR10GR69V32 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U55N4x	5.5	50	1000	FR27GB80V50T ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320U75N4x	7.5	63	1000	FR27GB80V63T ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D11N4x	11	80	1000	FR27GB80V80T ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D15N4x	15	100	1000	FR27GB80V100T ⁽¹⁾	PS272PREBS ⁽¹⁾

x B: book form factor, C: compact form factor

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

⁽²⁾ with two fuses: one fuse on the PA/+ terminal and one fuse on the PC/- terminal

UL fuses table

Drives		Semi-conductor protection class fuses ratings of MERSEN			
Reference	Power (kW)	Current rating (A)	UL DC voltage (V)	Fuse reference	Fuse support reference
ATV320U04N4x	0.37	6	1000	2x DCT6-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U06N4x	0.55	8	1000	2x DCT8-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U07N4x	0.75	10	1000	2x DCT10-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U11N4x	1.1	12	1000	2x DCT12-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U15N4x	1.5	15	1000	2x DCT15-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U22N4x	2.2	20	1000	2x DCT20-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U30N4x	3.0	25	1000	2x DCT25-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U40N4x	4.0	30	1000	2x DCT30-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U55N4x	5.5	50	1000	HSJ50 ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320U75N4x	7.5	60	1000	HSJ60 ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D11N4x	11	80	950	2x HSJ80 ⁽²⁾	2x 61036HPJ ⁽²⁾
ATV320D15N4x	15	100	950	2x HSJ100 ⁽²⁾	2x 61036HPJ ⁽²⁾

x B: book form factor, C: compact form factor

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

⁽²⁾ with two fuses: one fuse on the PA/+ terminal and one fuse on the PC/- terminal

525 V – 600 V range

IEC fuses table

Drives		Semi-conductor protection class fuses ratings of MERSEN			
Reference	Power (kW)	Current rating (A)	IEC DC voltage (V)	Fuse reference	Fuse support reference
ATV320U07S6C	0.75	4	700	2x FR10GR69V4 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U15S6C	1.5	8	700	2x FR10GR69V8 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U22S6C	2.2	10	700	2x FR10GR69V10 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U40S6C	4.0	16	700	2x FR10GR69V16 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U55S6C	5.5	32	700	2x FR10GR69V32 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U75S6C	7.5	40	1000	FR27GB80V40T ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D11S6C	11	63	1000	FR27GB80V63T ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D15S6C	15	80	1000	FR27GB80V80T ⁽¹⁾	PS272PREBS ⁽¹⁾

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

⁽²⁾ with two fuses: one fuse on the PA/+ terminal and one fuse on the PC/- terminal

UL fuses table

Drives		Semi-conductor protection class fuses ratings of MERSEN			
Reference	Power (kW)	Current rating (A)	UL DC voltage (V)	Fuse reference	Fuse support reference
ATV320U07S6C	0.75	4	1000	2x DCT4-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U15S6C	1.5	8	1000	2x DCT8-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U22S6C	2.2	10	1000	2x DCT10-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U40S6C	4.0	15	1000	2x DCT15-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U55S6C	5.5	30	1000	2x DCT30-2 ⁽²⁾	2x US101IHEL ⁽²⁾
ATV320U75S6C	7.5	40	950	HSJ40 ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D11S6C	11	60	950	HSJ60 ⁽¹⁾	PS272PREBS ⁽¹⁾
ATV320D15S6C	15	80	950	2x HSJ80 ⁽²⁾	2x 61036HPJ ⁽²⁾

⁽¹⁾ with one fuse: one fuse on the PA/+ terminal

⁽²⁾ with two fuses: one fuse on the PA/+ terminal and one fuse on the PC/- terminal

DC switch-disconnector.

To disconnect one drive from the DC bus while other drives remain in operation, each drive can be equipped by a DC switch-disconnector selected in the following table. It takes into account:

- the derating to be applied to these devices to operate at 50°C ambient temperature,
- the additional line chokes,
- the operation overload on the drives.

For 380 – 500 V drives range

These devices use 2x 2 poles in series and must be installed as described in the device's instruction sheet for use at 800 V DC voltage.

Drives		DC switch-disconnector			
reference	Power (kW)	Short name	Reference	DC voltage @50°C (V)	Rated current @50°C (A)
ATV320U04N4x	0.37	C60NA-DC	A9N61690	800	30
ATV320U06N4x	0.55				
ATV320U07N4x	0.75				
ATV320U15N4x	1.5				
ATV320U22N4x	2.2				
ATV320U30N4x	3.0				
ATV320U40N4x	4.0				
ATV320U55N4x	5.5				
ATV320U75N4x	7.5				
ATV320D11N4x	11				
ATV320D15N4x	15	C120NA-DC	A9N61701	1000	96

For 200 V – 240 V drives range

These devices use 2x 2 poles in series and must be installed as described in the device's instruction sheet for use at 500 V DC voltage.

Single phase

Drives		DC switch-disconnector			
reference	Power (kW)	Short name	Reference	DC voltage @50°C (V)	Rated current @50°C (A)
ATV320U02M2x	0.18	C60NA-DC	A9N61690	500	46
ATV320U04M2x	0.37				
ATV320U06M2x	0.55				
ATV320U07M2x	0.75				
ATV320U15M2x	1.5				
ATV320U22M2x	2.2				

3-phase

Drives		DC switch-disconnector			
reference	Power (kW)	Short name	Reference	DC voltage @50°C (V)	Rated current @50°C (A)
ATV320U02M3C	0.18	C60NA-DC	A9N61690	500	46
ATV320U04M3C	0.37				
ATV320U06M3C	0.55				
ATV320U07M3C	0.75				
ATV320U15M3C	1.5				
ATV320U22M3C	2.2				
ATV320U30M3C	3.0				
ATV320U40M3C	4.0				
ATV320U55M3C	5.5				
ATV320U75M3C	7.7				
ATV320D11M3C	11	C120NA-DC	A9N61701	500	96
ATV320D15M3C	15				

Line chokes

Additional line chokes are required by drives when they share the DC bus and they are supplied by the mains. The association is listed in the following table.

For 380 – 500 V drives range

Drive			External lines chokes	
Power rating kW	Catalog reference	Group	Inductance mH	Reference
0.37	ATV320U04N4x	40, 43	10.0	VW3A4551
0.55	ATV320U06N4x	40, 43	10.0	VW3A4551
0.75	ATV320U07N4x	40, 43	10.0	VW3A4551
1.1	ATV320U11N4x	40, 43	10.0	VW3A4551
1.5	ATV320U15N4x	40, 43	10.0	VW3A4551
2.2	ATV320U22N4x	41, 44	4.0	VW3A4552
3	ATV320U30N4x	41, 44	4.0	VW3A4552
4	ATV320U40N4x	41, 44	4.0	VW3A4552
5.5	ATV320U55N4x	45	2.0	VW3A4553
7.5	ATV320U75N4x	45	2.0	VW3A4553
11	ATV320D11N4x	46	1.0	VW3A4554
15	ATV320D15N4x	46	1.0	VW3A4554

For 200 – 240 V drives range

Single-phase

Drive			External lines chokes	
Power rating kW	Catalog reference	Group	Inductance mH	Reference
0.18	ATV320U02M2x	20, 22	10.0	VZ1L004M010
0.37	ATV320U04M2x	20, 22	10.0	VZ1L004M010
0.55	ATV320U06M2x	20, 22	5.0	VZ1L004M050
0.75	ATV320U07M2x	20, 22	5.0	VZ1L004M050
1.1	ATV320U11M2x	21, 23	2.0	VZ1L018UM20
1.5	ATV320U15M2x	21, 23	2.0	VZ1L018UM20
2.2	ATV320U22M2x	21, 23	2.0	VZ1L018UM20

3-phase

Drive			External lines chokes	
Power rating kW	Catalog reference	Group	Inductance mH	Reference
0.18	ATV320U02M3C	32	10.0	VW3A4551
0.37	ATV320U04M3C	32	10.0	VW3A4551
0.55	ATV320U06M3C	32	10.0	VW3A4551
0.75	ATV320U07M3C	32	10.0	VW3A4551
1.1	ATV320U11M3C	33	4.0	VW3A4552
1.5	ATV320U15M3C	33	4.0	VW3A4552
2.2	ATV320U22M3C	33	2.0	VW3A4553
3	ATV320U30M3C	34	2.0	VW3A4553
4	ATV320U40M3C	34	1.0	VW3A4554
5.5	ATV320U55M3C	35	1.0	VW3A4554
7.5	ATV320U75M3C	35	1.0	VW3A4554
11	ATV320D11M3C	36	0.5	VW3A4555
15	ATV320D15M3C	36	0.5	VW3A4555

Wiring Options

Daisy Chain (Fast on connection)

Both connectors link with wire (wire is AWG 10. / length: 0,18m)

Reference: VW3 M7 101 R01



Free wire connector (Fast on connection)

Connector with free wire

Reference: VW3 M7 102 R150 (wire is AWG 10. / length: 15m)

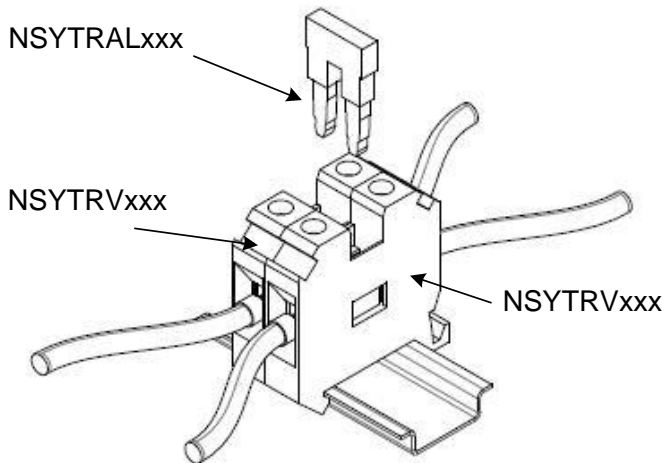
Reference: VW3 M2207 (kits for 10 connectors)



Remark: Cable length between two drives on DC bus does not exceed 2 meters

Wiring blocks

Description	Set 1	Set 2	Set 3
Pass-through 1-pole 1x1 terminal block	NSYTRV102	NSYTRV162	NSYTRV352
Jumper to connect 2 blocks	NSYTRAL102	NSYTRAL162	NSYTRAL352
Rated current at 690 V	54 A	73 A	126 A
Maximum current at 1000 V	76 A	101 A	125 A
Cable cross section capability	0.5 – 16 mm ²	1.5 – 25 mm ²	1.5 – 50 mm ²





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