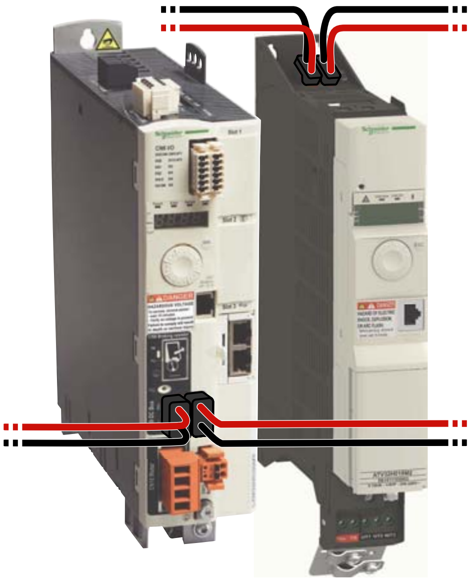
ATV32, LXM32

Common DC bus for ATV32, LXM32
Application note

MNA01M001EN, V1.00, 12.2010



MNA01M001EN, V1.00, 12.2010

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Important information

This document is part of the product.

Carefully read this document and observe all instructions.

Keep this document for future reference.

Hand this document and all other pertinent product documentation over to all users of the product.

Carefully read and observe all safety instructions and the chapter "Before you begin - safety information".

Some products are not available in all countries.
Please consult the latest catalog for information on the availability of products.

Subject to technical modifications without notice.

All details provided are technical data which do not constitute warranted qualities.

Most of the product designations are registered trademarks of their respective owners, even if this is not explicitly indicated.

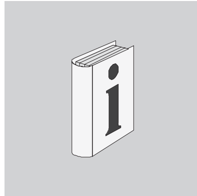
MNA01M001EN, V1.00, 12.2010

Table of contents

MNA01M001EN, V1.00, 12.2010

MNA01M001EN, V1.00, 12.2010

About this manual



This document describes how several Schneider Electric drives types ATV32 and LXM32 can share a common DC bus.
This application note replaces application note MNA01D001.

The information provided in this document supplements the manuals. Before beginning, carefully read the manuals of products used.

Source manuals

The latest versions of the manuals can be downloaded from the Internet at:

http://www.schneider-electric.com

Corrections and suggestions

We always try to further optimize our manuals. We welcome your suggestions and corrections.

Please get in touch with us by e-mail:
techcomm@schneider-electric.com.

Work steps

If work steps must be performed consecutively, this sequence of steps is represented as follows:

■ Special prerequisites for the following work steps

▶ Step 1

◁ Specific response to this work step

▶ Step 2

If a response to a work step is indicated, this allows you to verify that the work step has been performed correctly.

Unless otherwise stated, the individual steps must be performed in the specified sequence.

Making work easier

Information on making work easier is highlighted by this symbol:

Sections highlighted this way provide supplementary information on making work easier.

SI units

SI units are the original values. Converted units are shown in brackets behind the original value; they may be rounded.

Example:
Minimum conductor cross section: 1.5 mm^2 (AWG 14)

Glossary

Explanations of special technical terms and abbreviations.

Index

List of keywords with references to the corresponding page numbers.

MNA01M001EN, V1.00, 12.2010

1 Introduction

1

A drive system requires energy for acceleration or constant movement that must be supplied to the system. During deceleration, a motor acts as a generator. A considerable portion of the kinetic energy is re-generated as electrical energy.

Since electrical energy can only be stored to a limited extent in a single drive, a drive uses a braking resistor to transform the excess energy into thermal energy.

Use of electrical energy

If an application uses several drive systems, the regenerated energy can be used to accelerate other motors. The regenerated power can be used efficiently during anti-cyclical operation, i.e. one motor decelerates while another motor accelerates at the same time. The energy can be exchanged when the DC buses of the drives are connected.

Drives supporting the use of a common DC bus

The following drives can be operated via a common DC bus:

- Single-phase drives with single-phase drives
  - ATV32••••M2 with ATV32••••M2
  - ATV32••••M2 with LXM32••••M2
  - LXM32••••M2 with LXM32••••M2
- Three-phase drives with three-phase drives
  - ATV32••••N4 with ATV32••••N4
  - LXM32••••N4 with LXM32••••N4
  - ATV32••••N4 with LXM32••••N4

It is not permissible to operate single-phase drives in combination with three-phase drives.

MNA01M001EN, V1.00, 12.2010

2 Before you begin - safety information

2

The information provided in this document supplements the manuals. Before beginning, carefully read the manuals of products used.

2.1 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.

2.2 Intended use

The functions described in this document are only intended for use for the products described in this document.

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).

Operate the product only with the specified cables and accessories. Use only genuine accessories and spare parts.

The product must NEVER be operated in explosive atmospheres (hazardous locations, Ex areas).

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.

MNA01M001EN, V1.00, 12.2010

2.3 Hazard categories

Safety instructions to the user are highlighted by safety alert symbols in the manual. In addition, labels with symbols and/or instructions are attached to the product that alert you to potential hazards.

Depending on the seriousness of the hazard, the safety instructions are divided into 4 hazard categories.

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

⚠ WARNING
WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

⚠ CAUTION
CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

CAUTION
CAUTION used without the safety alert symbol, is used to address practices not related to personal injury (e.g. **can result** in equipment damage).

MNA01M001EN, V1.00, 12.2010

2.4 Basic information

⚠ 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 board, operate with mains voltage. Do not touch. Only use electrically insulated tools.
- Do not touch unshielded components or terminals with voltage present.
- The motor generates 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 in the motor cable.
- Do not short across the DC bus terminals or the DC bus capacitors.
- 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. Measure the voltage on the DC bus as per chapter "DC bus voltage measurement" and verify the voltage is < 42 V_{dc}. The DC bus LED is not an indicator of the absence of DC bus voltage.
- Install and close all covers before applying voltage.

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

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical 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 functions.
- System control paths may include communication links. Consideration must be given to the implication 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 or serious injury.

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”.

2.5 DC bus voltage measurement

Disconnect all power prior to starting work on the product.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Only appropriately trained persons who are familiar with and understand the safety instructions in the chapter "Before you begin - safety information" may perform the measurement.

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

The DC bus voltage can exceed 800 V_{dc}. Use a properly rated voltage-sensing device for measuring. Procedure:

▶ Disconnect the voltage supply to all connections.

▶ Wait 15 minutes to allow the DC bus capacitors to discharge.

▶ Measure the DC bus voltage between the DC bus terminals to verify that the voltage is < 42 V_{dc}.

▶ If the DC bus capacitors do not discharge properly, contact your local Schneider Electric representative. Do not repair or operate the product.

The DC bus LED is not an indicator of the absence of DC bus voltage.

2.6 Standards and terminology

Technical terms, terminology and the corresponding descriptions in this manual are intended to use the terms or definitions of the pertinent standards.

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

Among others, these standards include:

- IEC 61800 series: "Adjustable speed electrical power drive systems"
- IEC 61158 series: "Industrial communication networks - Fieldbus specifications"
- IEC 61784 series: "Industrial communication networks - Profiles"
- IEC 61508 series: "Functional safety of electrical/electronic/programmable electronic safety-related systems"

Also see the glossary at the end of this manual.

MNA01M001EN, V1.00, 12.2010

3 Technical Data

3

3.1 Firmware version

A common DC bus with ATV32 and LXM32 drives requires the devices to have at least the specified firmware versions:

Device type	Firmware version
ATV32	V1.3
LXM32A, LXM32C	V01.04.00
LXM32M	V01.02.00

3.2 Drive data

3.2.1 Permissible device types for common DC bus

The following single-phase drives can be operated via a common DC bus:

ATV32H0••M2•	ATV32HU••M2•	LXM32•U••M2•	LXM32•D••M2•
ATV32H018M2•	ATV32HU11M2•	LXM32•U45M2•	LXM32•D18M2•
ATV32H037M2•	ATV32HU15M2•	LXM32•U90M2•	LXM32•D30M2•
ATV32H055M2•	ATV32HU22M2•		
ATV32H075M2•			

Table 3.1 Single-phase drives

The following three-phase drives can be operated via a common DC bus:

ATV32H0••N4•	ATV32HU••N4•	ATV32HD••N4•	LXM32•U••N4•	LXM32•D••N4•
ATV32H037N4•	ATV32HU11N4•	ATV32HD11N4•	LXM32•U60N4•	LXM32•D12N4•
ATV32H055N4•	ATV32HU15N4•	ATV32HD15N4•		LXM32•D18N4•
ATV32H075N4•	ATV32HU22N4•			LXM32•D30N4•
	ATV32HU30N4•			LXM32•D72N4•
	ATV32HU40N4•			
	ATV32HU55N4•			
	ATV32HU75N4•			

Table 3.2 Three-phase drives

MNA01M001EN, V1.00, 12.2010

3.2.2 ATV32: DC bus data

Single-phase ATV32 drives

ATV32H... (1 ~)		**018M2**		**037M2**		**055M2**		**075M2**			
Nominal voltage (1 ~)	[V_{ac}]	200	240	200	240	200	240	200	240		
Nominal voltage DC bus	[V]	283	339	283	339	283	339	283	339		
Undervoltage limit	[V]	200	200	200	200	200	200	200	200		
Overvoltage limit	[V]	415	415	415	415	415	415	415	415		
Maximum continuous power via DC bus	[kW]	0.3	0.3	0.58	0.58	0.84	0.84	1.1	1.1		
Maximum continuous current via DC bus	[A]	3.4	2.8	6.0	5	7.9	6.7	10.1	8.5		

ATV32H... (1 ~)		**018M2**	**037M2**	**055M2**	**075M2**	
Capacitance of internal capacitor	[µF]	220	440	880	880	
External braking resistor minimum	[Ω]	40	40	40	40	
Parameter dCCC [DC-Bus compat.] = no (default value) 1)						
Switch-on voltage braking resistor	[V]	395	395	395	395	
Energy absorption of internal capacitors E_{var} at nominal voltage 200 V	[Ws]	8	17	33	33	
Energy absorption of internal capacitors E_{var} at nominal voltage 240 V	[Ws]	5	9	18	18	

1) Parameter dCCC [DC-Bus compat.] has no effect in the case of single-phase ATV32 drives

Table 3.3 Data for single-phase drives ATV32H0

ATV32H... (1 ~)		**U11M2**		**U15M2**		**U22M2**					
Nominal voltage (1 ~)	[V_{ac}]	200	240	200	240	200	240				
Nominal voltage DC bus	[V]	283	339	283	339	283	339				
Undervoltage limit	[V]	200	200	200	200	200	200				
Overvoltage limit	[V]	415	415	415	415	415	415				
Maximum continuous power via DC bus	[kW]	1.56	1.56	2.08	2.08	2.9	2.9				
Maximum continuous current via DC bus	[A]	13.6	11.5	17.6	14.8	23.9	20.1				

ATV32H... (1 ~)		U11M2	U15M2	U22M2		
Capacitance of internal capacitor	[μF]	1680	1680	2240		
External braking resistor minimum	[Ω]	27	27	25		
Parameter dCCC [DC-Bus compat.] = no (default value) 1)						
Switch-on voltage braking resistor	[V]	395	395	395		
Energy absorption of internal capacitors E_{var} at nominal voltage 200 V	[Ws]	64	64	85		
Energy absorption of internal capacitors E_{var} at nominal voltage 240 V	[Ws]	35	35	46		

1) Parameter dCCC [DC-Bus compat.] has no effect in the case of single-phase ATV32 drives

Table 3.4 Data for single-phase drives ATV32HU

Three-phase ATV32 drives

ATV32H... (3 ~)		037N4		055N4		075N4		U11N4		U15N4	
Nominal voltage (3 ~)	[V_{ac}]	380	500	380	500	380	500	380	500	380	500
Nominal voltage DC bus	[V]	537	707	537	707	537	707	537	707	537	707
Undervoltage limit	[V]	390	390	390	390	390	390	390	390	390	390
Overvoltage limit	[V]	820	820	820	820	820	820	820	820	820	820
Maximum continuous power via DC bus	[kW]	0.6	0.6	0.84	0.84	1.1	1.1	1.6	1.6	2.1	2.1
Maximum continuous current via DC bus	[A]	2.5	2.0	3.4	2.6	4.4	3.4	6.1	4.6	8.0	6.0

MNA01M001EN, V1.00, 12.2010

ATV32H... (3 ~)		037N4	055N4	075N4	U11N4	U15N4
Capacitance of internal capacitor	[µF]	110	220	220	220	220
External braking resistor minimum	[Ω]	80	80	80	54	54
Parameter dCCC [DC-Bus compat.] = no (default value)						
Switch-on voltage braking resistor	[V]	820	820	820	820	820
Energy absorption of internal capacitors E_{var} at nominal voltage 380[V]	[Ws]	21	42	42	42	42
Energy absorption of internal capacitors E_{var} at nominal voltage 500 V	[Ws]	9	19	19	19	19
Parameter dCCC [DC-Bus compat.] = MAin **or** dCCC [DC-Bus compat.] = bUS (reduced switch-on voltage)						
Switch-on voltage braking resistor	[V]	780	780	780	780	780
Energy absorption of internal capacitors E_{var} at nominal voltage 380 V	[Ws]	18	35	35	35	35
Energy absorption of internal capacitors E_{var} at nominal voltage 500 V	[Ws]	6	12	12	12	12

Table 3.5 Data for three-phase drives ATV32H0/ATV32HU

ATV32H... (3 ~)		U22N4		U30N4		U40N4		U55N4		U75N4	
Nominal voltage (3 ~)	[V_{ac}]	380	500	380	500	380	500	380	500	380	500
Nominal voltage DC bus	[V]	537	707	537	707	537	707	537	707	537	707
Undervoltage limit	[V]	390	390	390	390	390	390	390	390	390	390
Overvoltage limit	[V]	820	820	820	820	820	820	820	820	820	820
Maximum continuous power via DC bus	[kW]	2.9	2.9	3.9	3.9	5.07	5.07	6.8	6.8	9.1	9.1
Maximum continuous current via DC bus	[A]	10.6	8.1	13.6	10.3	16.8	12.9	25.2	19.4	32.2	24.8

MNA01M001EN, V1.00, 12.2010

ATV32H... (3 ~)		U22N4	U30N4	U40N4	U55N4	U75N4
Capacitance of internal capacitor	[µF]	280	390	550	780	1110
External braking resistor minimum	[Ω]	54	54	36	27	27
Parameter dCCC [DC-Bus compat.] = nO (default value)						
Switch-on voltage braking resistor	[V]	820	820	820	820	820
Energy absorption of internal capacitors E_{var} at nominal voltage 380 V	[Ws]	54	75	106	150	213
Energy absorption of internal capacitors E_{var} at nominal voltage 500 V	[Ws]	24	34	47	67	96
Parameter dCCC [DC-Bus compat.] = MAIn **or** dCCC [DC-Bus compat.] = bUS (reduced switch-on voltage)						
Switch-on voltage braking resistor	[V]	780	780	780	780	780
Energy absorption of internal capacitors E_{var} at nominal voltage 380 V	[Ws]	45	62	88	125	178
Energy absorption of internal capacitors E_{var} at nominal voltage 500 V	[Ws]	15	21	30	42	60

Table 3.6 Data for three-phase drives ATV32HU

ATV32H... (3 ~)		D11N4		D15N4							
Nominal voltage (3 ~)	[V_{ac}]	380	500	380	500						
Nominal voltage DC bus	[V]	537	707	537	707						
Undervoltage limit	[V]	390	390	390	390						
Overvoltage limit	[V]	820	820	820	820						
Maximum continuous power via DC bus	[kW]	12.9	12.9	17.2	17.2						
Maximum continuous current via DC bus	[A]	43.8	33.6	56.7	43.5						

ATV32H... (3 ~)		D11N4	D15N4			
Capacitance of internal capacitor	[µF]	1410	1660			
External braking resistor minimum	[Ω]	16	16			
Parameter dCCC [DC-Bus compat.] = no (default value)						
Switch-on voltage braking resistor	[V]	820	820			
Energy absorption of internal capacitors E_{var} at nominal voltage 380 V	[Ws]	271	319			
Energy absorption of internal capacitors E_{var} at nominal voltage 500 V	[Ws]	122	143			
Parameter dCCC [DC-Bus compat.] = MAin **or** dCCC [DC-Bus compat.] = buS (reduced switch-on voltage)						
Switch-on voltage braking resistor	[V]	780	780			
Energy absorption of internal capacitors E_{var} at nominal voltage 380 V	[Ws]	226	266			
Energy absorption of internal capacitors E_{var} at nominal voltage 500 V	[Ws]	77	90			

Table 3.7 Data for three-phase drives ATV32HD

MNA01M001EN, V1.00, 12.2010

3.2.3 LXM32: DC bus data

Single-phase LXM32 drives

LXM32•... (1 ~)		**U45M2**		**U90M2**		**D18M2**		**D30M2**			
Nominal voltage (1 ~)	[V_{ac}]	115	230	115	230	115	230	115	230		
Nominal voltage DC bus	[V]	163	325	163	325	163	325	163	325		
Undervoltage limit	[V]	55	130	55	130	55	130	55	130		
Voltage limit: Start of Quick Stop	[V]	60	140	60	140	60	140	60	140		
Overvoltage limit	[V]	450	450	450	450	450	450	450	450		
Maximum continuous power via DC bus	[kW]	0.2	0.5	0.4	0.9	0.8	1.6	0.8	2.2		
Maximum continuous current via DC bus	[A]	1.5	1.5	3.2	3.2	6.0	6.0	10.0	10.0		

LXM32•... (1 ~)		**U45M2**	**U90M2**	**D18M2**	**D30M2**	
Capacitance of internal capacitor	[µF]	390	780	1170	1560	
Resistance value of internal braking resistor	[Ω]	94	47	20	10	
Continuous power internal braking resistor P_{PR}	[W]	10	20	40	60	
Peak energy E_{CR}	[Ws]	82	166	330	550	
External braking resistor minimum	[Ω]	68	36	20	12	
External braking resistor maximum [1]	[Ω]	110	55	27	16	
Maximum continuous power external braking resistor	[W]	200	400	600	800	
Parameter`DCbus_compat` **= 0** (default value)						
Switch-on voltage braking resistor	[V]	430	430	430	430	
Energy absorption of internal capacitors E_{var} at nominal voltage 115 V +10%	[Ws]	30	60	89	119	
Energy absorption of internal capacitors E_{var} at nominal voltage 200 V +10%	[Ws]	17	34	52	69	
Energy absorption of internal capacitors E_{var} at nominal voltage 230 V +10%	[Ws]	11	22	33	44	
Parameter`DCbus_compat` **= 1** (reduced switch-on voltage)						
Switch-on voltage braking resistor	[V]	395	395	395	395	
Energy absorption of internal capacitors E_{var} at nominal voltage 115 V +10%	[Ws]	24	48	73	97	
Energy absorption of internal capacitors E_{var} at nominal voltage 200 V +10%	[Ws]	12	23	35	46	
Energy absorption of internal capacitors E_{var} at nominal voltage 230 V +10%	[Ws]	5	11	16	22	

1) The maximum specified braking resistor can derate the peak power of the device. Depending on the application, it is possible to use a higher ohm resistor.

Table 3.8 Data for single-phase drives LXM32•

MNA01M001EN, V1.00, 12.2010

Three-phase LXM32 drives

LXM32•... (3 ~)		U60N4	D12N4	D18N4	D30N4	D72N4
Nominal voltage (3 ~) 1)	[V_{ac}]	208	208	208	208	208
Nominal voltage DC bus	[V]	294	294	294	294	294
Undervoltage limit	[V]	150	150	150	150	150
Voltage limit: Start of Quick Stop	[V]	160	160	160	160	160
Overvoltage limit	[V]	820	820	820	820	820
Maximum continuous power via DC bus	[kW]	0.4	0.8	1.7	2.8	6.5
Maximum continuous current via DC bus	[A]	1.5	3.2	6.0	10.0	22.0

1) LXM32A, LXM32C: 208V_{ac} (3*200V_{ac} ... 3*240V_{ac}) DOM >10.05.2010, firmware version ≥V01.04.00
LXM32M: 208V_{ac} (3*200V_{ac} ... 3*240V_{ac}) DOM >10.05.2010, firmware version ≥V01.02.00

LXM32•... (3 ~)		U60N4		D12N4		D18N4		D30N4		D72N4	
Nominal voltage (3 ~)	[V_{ac}]	400	480	400	480	400	480	400	480	400	480
Nominal voltage DC bus	[V]	566	679	566	679	566	679	566	679	566	679
Undervoltage limit	[V]	350	350	350	350	350	350	350	350	350	350
Voltage limit: Start of Quick Stop	[V]	360	360	360	360	360	360	360	360	360	360
Overvoltage limit	[V]	820	820	820	820	820	820	820	820	820	820
Maximum continuous power via DC bus	[kW]	0.8	0.8	1.6	1.6	3.3	3.3	5.6	5.6	13.0	13.0
Maximum continuous current via DC bus	[A]	1.5	1.5	3.2	3.2	6.0	6.0	10.0	10.0	22.0	22.0

MNA01M001EN, V1.00, 12.2010

LXM32•... (3 ~)		U60N4	D12N4	D18N4	D30N4	D72N4
Capacitance of internal capacitor	[μF]	110	195	390	560	1120
Resistance value of internal braking resistor	[Ω]	132	60	30	30	10
Continuous power internal braking resistor P_{PR}	[W]	20	40	60	100	150
Peak energy E_{CR}	[Ws]	200	400	600	1000	2400
External braking resistor minimum	[Ω]	100	47	33	15	8
External braking resistor maximum 1)	[Ω]	145	73	50	30	12
Maximum continuous power external braking resistor	[W]	200	500	800	1500	3000
Parameter `DCbus_compat` 2)						
Switch-on voltage braking resistor	[V]	780	780	780	780	780
Energy absorption internal capacitors E_{var} at nominal voltage 208 V +10% 3)	[Ws]	28	49	98	141	282
Energy absorption of internal capacitors E_{var} at nominal voltage 380 V +10%	[Ws]	14	25	50	73	145
Energy absorption of internal capacitors E_{var} at nominal voltage 400 V +10%	[Ws]	12	22	43	62	124
Energy absorption of internal capacitors E_{var} at nominal voltage 480 V +10%	[Ws]	3	5	10	14	28

1) The maximum specified braking resistor can derate the peak power of the device. Depending on the application, it is possible to use a higher ohm resistor.
2) Parameter DCbus_compat has no effect in the case of three-phase LXM32 drives.
3) LXM32A, LXM32C: $208V_{ac}$ ($3*200V_{ac}$ ... $3*240V_{ac}$) DOM >10.05.2010, firmware version≥V01.04.00
LXM32M: $208V_{ac}$ ($3*200V_{ac}$ ... $3*240V_{ac}$) DOM >10.05.2010, firmware version≥V01.02.00

Table 3.9 Data for three-phase drives LXM32•

3.3 Fuses

A common DC bus for several drives can be implemented in different ways, see chapter 4 "Engineering".

Depending on the application you need mains fuses and DC bus fuses.

3.3.1 Mains fuse

The fuse ratings depend on the power of the drives and the conductor cross section. See manual of the respective product for more information.
The maximum permissible fuse ratings must not be exceeded.

3.3.1.1 Maximum permissible fuse ratings for mains fuses

Fuses for single-phase drives

Maximum fuse ratings for single-phase drives:

Single-phase drives 1)		**Maximum fuse rating**
ATV32••••M2	[A]	25
LXM32••••M2	[A]	25

1) Only use the drives listed in chapter 3.2 "Drive data".

Fuses for three-phase drives

Maximum fuse rating for three-phase drives:

Three-phase drives 1)		**Maximum fuse rating**
ATV32H0••N4	[A]	32
ATV32HU••N4	[A]	32
ATV32HD••N4	[A]	32
LXM32••••N4	[A]	32

1) Values only for the types listed in chapter 3.2 "Drive data"

3.3.2 Fuse for DC bus

Use suitable fuses for the common DC bus. See chapter 3.2 "Drive data" for information on the DC bus voltage and the maximum continuous current via the DC bus.

See chapter 7.2 "DC fuses", page 65 for fuses for the DC bus.

Choose fuse ratings as low as possible according to the power of the drive as well as the conductor cross section.
The maximum permissible fuse ratings must not be exceeded.

Example

A drive has a maximum continuous current of 6A via the DC bus. 10A fuses are used as DC bus fuses for this drive..

MNA01M001EN, V1.00, 12.2010

3.3.2.1 Maximum permissible fuse ratings for DC bus fuses

DC bus: Fuse for single-phase drives

Maximum fuse rating of the fuses for the DC bus for single-phase drives:

Single-phase drives [1)]		Maximum fuse rating
ATV32••••M2	[A]	25
LXM32••••M2	[A]	25

1) Values only for the types listed in chapter 3.2 "Drive data"

DC bus: Fuse for three-phase drives

Maximum fuse rating of the fuses for the DC bus for three-phase drives:

Three-phase drives [1)]		Maximum fuse rating
ATV32H0••N4	[A]	32
ATV32HU••N4	[A]	32
ATV32HD••N4	[A]	32
LXM32••••N4	[A]	32

1) Values only for the types listed in chapter 3.2 "Drive data"

3.4 Cables for DC bus

Minimum requirements for a common DC bus cable

A cable for the common DC bus must meet the following requirements.

Shield:	Shielded at cable lengths of > 0.2 m
Twisted Pair:	Twisted pair at cable lengths of > 0.2 m
Cable:	Two wires, shielded
Maximum cable length of a DC bus connection cable	3 m
Special features:	• Insulation must be rated for the DC bus voltage • Conductor cross section according to the calculated current, but at least 2* 6 mm^2 (2* AWG 10)

Table 3.10 Required properties of the DC bus cables

NOTE: The connection of the fuses for the DC bus must be rated for the total DC bus current of all drives. Analyze the most critical case (for example EMERGENCY STOP) and select an appropriate conductor cross section.

Properties of the DC bus cable VW3M7102R150

Shield:	Shielded
Twisted Pair:	Twisted pair
Cable:	2* 6 mm^2 (2* AWG 10)

Table 3.11 Properties of the cableVW3M7102R150

Crimp contact VW3M2207

Crimp contact		
Connection cross section	[mm^2]	3 ... 6 (AWG12 ... AWG10)

Table 3.12 Properties of the crimp contact

3.5 Braking resistor

The resistance values for external braking resistors must not be below the minimum resistance specified for the drives.

ATV32 ATV32 drives have an internal braking resistor. One or more external braking resistors must be connected, depending on the dynamics of the application.

LXM32 LXM32 drives have an internal braking resistor. If the internal braking resistor is insufficient for the dynamics of the application, one or more external braking resistors must be connected.

3.5.1 External braking resistors (accessories)

VW3A760...		**1Rxx** 1)	**2Rxx**	**3Rxx**	**4Rxx** 1)	**5Rxx**	**6Rxx**	**7Rxx** 1)
Resistance	[Ω]	10	27	27	27	72	72	72
Continuous power	[W]	400	100	200	400	100	200	400
Maximum time in braking at 115 V / 230 V	[s]	0.72	0.552	1.08	2.64	1.44	3.72	9.6
Peak power at 115 V / 230 V	[kW]	18.5	6.8	6.8	6.8	2.6	2.6	2.6
Maximum peak energy at 115 V / 230 V	[Ws]	13300	3800	7400	18100	3700	9600	24700
Maximum time in braking at 400 V	[s]	0.12	0.084	0.216	0.504	0.3	0.78	1.92
Peak power at 400 V	[kW]	60.8	22.5	22.5	22.5	8.5	8.5	8.5
Maximum peak energy at 400 V	[Ws]	7300	1900	4900	11400	2500	6600	16200
Degree of protection		IP65	IP65	IP65	IP65	IP65	IP65	IP65
UL approval (file no.)			E233422	E233422		E233422	E233422	

1) Resistors with a continuous power of 400 W are NOT UL/CSA-approved.

VW3A77...		**01**	**02**	**03**	**04**	**05**		
Resistance	[Ω]	100	60	28	15	10		
Continuous power	[W]	200	400	750	2500	2500		
Maximum time in braking at 115 V / 230 V	[s]				3.5	1.98		
Peak power at 115 V / 230 V	[kW]				18.5	12.3		
Maximum peak energy at 115 V / 230 V	[Ws]				43100	36500		
Maximum time in braking at 400 V	[s]				0.65	0.37		
Peak power at 400 V	[kW]				60.8	40.6		
Maximum peak energy at 400 V	[Ws]				26500	22500		
Degree of protection		IP20	IP20	IP20	IP20	IP20		
UL approval (file no.)		E221095	E221095	E221095	E221095	E221095		

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3.6 Mains filter

The fuse rating upstream of the common external mains filter must not be greater than the nominal current of the external mains filter.

NOTE: Three-phase mains filters do not have a neutral conductor connection; they are only approved for three-phase devices.

See the manual of the respective product for information on external mains filters.

3.7 Mains reactors

If one drive requires a mains reactor, then all drives connected via the DC bus must be equipped with mains reactors.

The fuse rating upstream of the common mains reactor must not be greater than the nominal current of the mains reactor.

See the manual of the respective product for information on mains reactors.

MNA01M001EN, V1.00, 12.2010

4 Engineering

This chapter provides engineering information for a common DC bus for several drives.

ATV32: See the "Altivar 32 - Installation manual" for vital engineering information concerning the ATV32 drive.

LXM32: See the Engineering chapter in the LXM32 product manual for vital engineering information concerning the LXM32 drive.

⚠ WARNING
DESTRUCTION OF SYSTEM COMPONENTS AND LOSS OF CONTROL
Incorrect use of a parallel connection of the DC bus may destroy the drives immediately or after a delay. • Note the requirements concerning the use of a parallel DC bus connection.
Failure to follow these instructions can result in death, serious injury or equipment damage.

4.1 EMC specifics

If drives are to be operated via a common DC bus, the following aspects must be considered in terms of EMC:

- Keep DC bus cables as short as possible.
- Shielded DC bus cables must be used at a cable length of > 0.2 m. In the case of shielded DC bus cables, connect the cable shield to the shield connection (large surface area contact).

MNA01M001EN, V1.00, 12.2010

4.2 Mounting distances

When planning mounting distances, consider the space required for the DC bus cables.

4.3 Energy balance

To be able to estimate the effect of a planned interconnection of drives, you should create an energy balance of the individual drives over a movement cycle.
A movement cycle consists of the following phases: acceleration, continuous movement and deceleration.

The energy generated during deceleration can be used by other drives connected via a common DC bus. Excess energy must be absorbed by the braking resistors.

MNA01M001EN, V1.00, 12.2010

4.3.1 Energy absorption

Energy absorption is influenced by the following factors:

- DC bus capacitors E_{var} in the drive
- Electrical losses of the drive system E_{el}
- Mechanical losses of the facility and the drive system E_{mech}
- Braking resistor E_B

The energy E_{var} is the square difference between the voltage prior to deceleration and the response threshold.

The energy absorption through the DC bus capacitors is lowest when the voltage is highest. In the calculation, use the values of the highest mains voltage.

Electrical losses E_{el}

The electrical losses E_{el} of the drive system can be estimated on the basis of the peak power of the drive. The maximum power dissipation is approximately 10% of the peak power at a typical efficiency of 90%. If the current during deceleration is lower, the power dissipation is reduced accordingly.

Mechanical losses E_{mech}

The mechanical losses result from friction during operation of the system. Mechanical losses are negligible if the time required by the system to coast to a stop without a driving force is considerably longer than the time required to decelerate the system. The mechanical losses can be calculated from the load torque and the velocity from which the motor is to stop.

Braking resistor

Two characteristic values determine the energy absorption of a braking resistor.

- The continuous power P_{PR} is the amount of energy that can be continuously absorbed without overloading the braking resistor.
- The maximum energy E_{CR} limits the maximum short-term power that can be absorbed.

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Rating

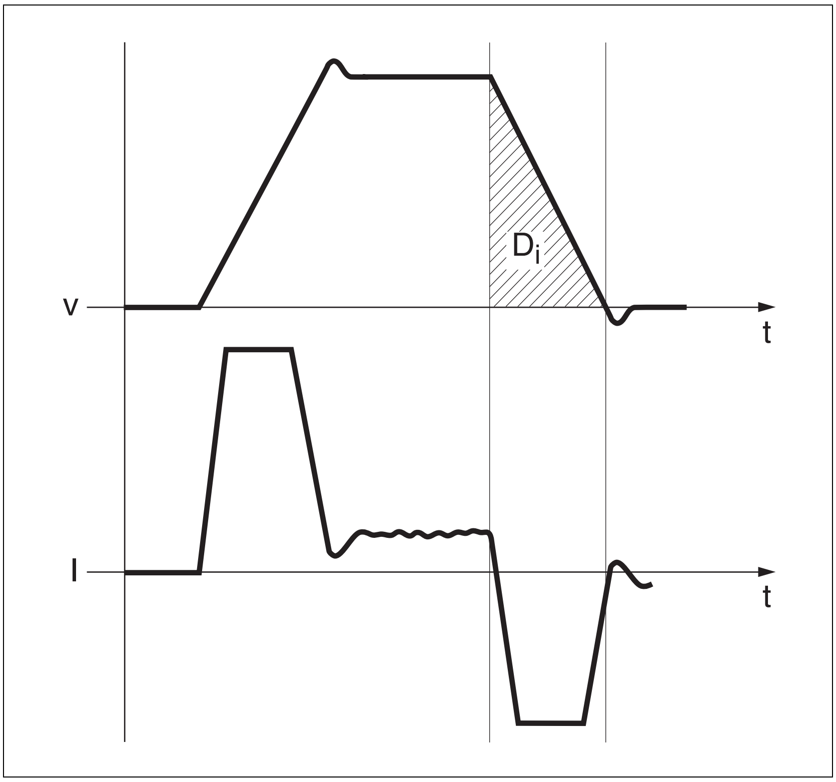

Figure 4.1 Movement cycle: Profile for energy assessment

This profile with velocity (v) and motor phase current (I) is also used for rating the motor and the braking resistor. The deceleration segment to be considered is labeled D_i.

Calculation of the energy at constant deceleration:

The total inertia (J_t) must be known.

J_t with:

$J_t = J_m + J_c$

J_m: Motor inertia with or without holding brake

J_c: Load inertia

The energy for each deceleration segment is calculated as follows:

$$E_i = \frac{1}{2} J_t \cdot \omega_i^2 = \frac{1}{2} J_t \cdot \left[\frac{2\pi n_i}{60}\right]^2$$

Units: E_i in Ws (wattseconds), J_t in kgm^2, ω in rad and n_i in min^{-1}.

See the technical data for the energy absorption E_{var} of the devices (without consideration of an internal or external braking resistor).

In the next calculation steps, only consider those segments D_i, whose energy E_i exceeds the energy absorption of the device (see chapter 3.2 "Drive data"). These excess energies E_{Di} must be diverted by means of the braking resistor (internal or external).

E_{Di} is calculated using the following formula:

$E_{Di} = E_i - E_{var}$ (in Ws)

The continuous power P_c is calculated for each machine cycle:

$$P_c = \frac{\sum E_{Di}}{\text{Cycletime}}$$

Units: P_c in [W], E_{Di} in [Ws] and cycle time T in [s]

These calculations allow you to select the required braking resistor.

4.4 Prerequisites for a common DC bus

You may only connect Schneider Electric drives types ATV32 and LXM32; see chapter 3.2.1 "Permissible device types for common DC bus", page 15.

The following conditions must be satisfied:

- Only drives with identical nominal voltages may be connected via a common DC bus.
- Only drives with the same number of phases may be connected via a common DC bus. Only connect three-phase drives and three-phase drives or single-phase drives and single-phase drives via a common DC bus.
- Single-phase drives must be connected to the same mains phase.
- Use only DC bus cables that comply with the specification listed in chapter 3.4 "Cables for DC bus", page 26.

4.5 Structure of a common DC bus

The structure of a common DC bus can differ according the requirements. See the concepts below:

- Common mains fuse
- Separate mains fuses
- DC supply via a drive
- DC supply via DC power supply unit

4.5.1 Common mains fuses

All drives are connected to the mains supply via common mains fuses.

Conditions

For DC bus connections for drives with common mains fuses the following conditions must be met:

- All drives have common mains fuses.

Single-phase drives ••M2	Three-phase drives ••N4
Maximum input current of all connected drives: 25 A.	Maximum input current of all connected drives: 32 A.

- The current of all drives supplied via the DC bus must not exceed the maximum values listed in the following table, even when regeneration conditions are present. If the following maximum values are exceeded DC fuses must be used.

Single-phase drives ••M2	Three-phase drives ••N4
Maximum DC bus current: 25 A.	Maximum DC bus current: 32 A.

- Only drives with an identical number of phases may be connected via a common DC bus. Only connect three-phase drives and three-phase drives or single-phase drives and single-phase drives via a common DC bus.
- Only drives with identical nominal voltages may be connected via a common DC bus.
- ••M2 drives: Connect single-phase drives only to the same phase.
- Activate mains phase monitoring for all drives.
- If you want to operate ATV32•••• and LXM32•••• drives via a common DC bus, you must activate the following parameters for each device:

Drive	Parameter
ATV32••••	dCCC [DC-Bus compat.]
LXM32••••	DCbus_compat

- ATV32••••: The power of the ATV32•••• drives sharing a common DC bus may differ by a maximum of one level in continuous power. See chapter 3.2 "Drive data" for the maximum power of the drives.
- ATV32••••: Set the type of DC bus connection via parameter dCCn [DC-Bus chaining]. Additional conditions may apply for setting this parameter, see Altivar 32 Programming manual.

Single-phase drives Common mains fuse: ATV32••••M2, LXM32••••M2

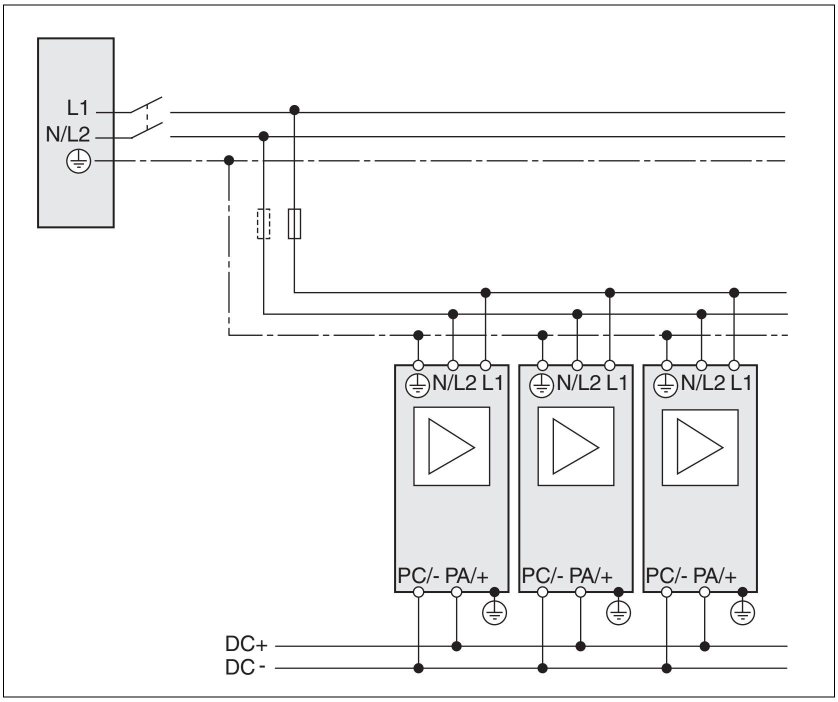

Figure 4.2 Common mains fuse: DC bus of single-phase drives

Three-phase drives Common mains fuse: ATV32••••N4, LXM32••••N4

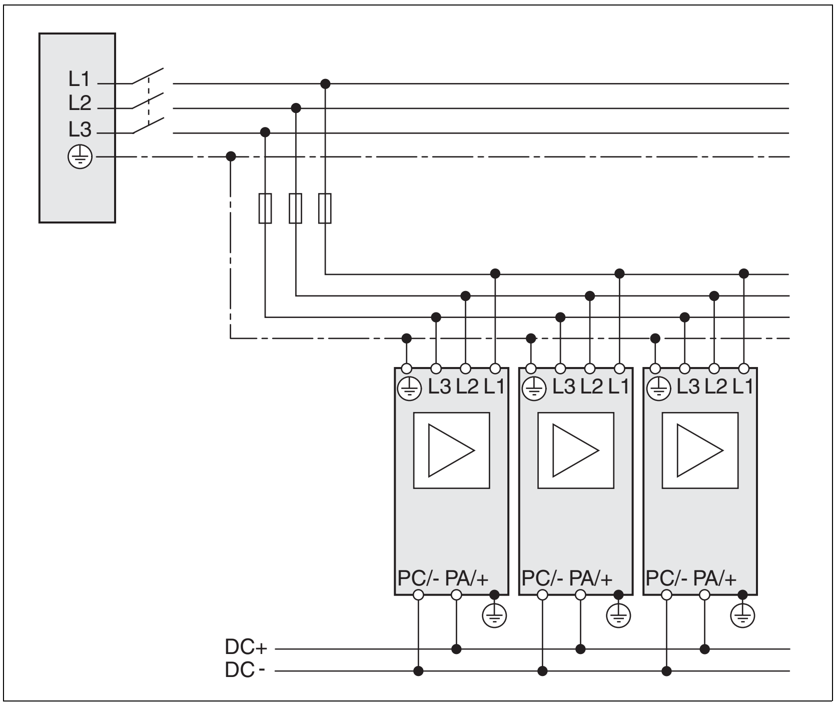

Figure 4.3 Common mains fuse: DC bus of three-phase drives

4.5.2 Separate mains fuses

Each drive is connected to the mains supply via its own mains fuses.

Conditions The following conditions must be met for the DC bus connection of drives with separate mains fuses:

- Each individual drive requires its own mains fuses; see chapter 3.3.1 "Mains fuse", page 24.
- Separate fuses for the DC bus must be used for each individual drive. See chapter 3.3.2 "Fuse for DC bus", page 24 for permissible fuse ratings.
- Only drives with an identical number of phases may be connected via a common DC bus. Only connect three-phase drives and three-phase drives or single-phase drives and single-phase drives via a common DC bus.
- Only drives with identical nominal voltages may be connected via a common DC bus.
- ••M2 drives: Connect single-phase drives only to the same phase.
- Activate mains phase monitoring for all drives.
- If you want to operate ATV32•••• and LXM32•••• drives via a common DC bus, you must activate the following parameters for each device:

Drive	Parameter
ATV32••••	dCCC [DC-Bus compat.]
LXM32••••	DCbus_compat

- ATV32••••: The power of the ATV32•••• drives sharing a common DC bus may differ by a maximum of one level in continuous power. See chapter 3.2 "Drive data" for the maximum power of the drives.
- ATV32••••: Set the type of DC bus connection via parameter dCCn [DC-Bus chaining]. Additional conditions may apply for setting this parameter, see Altivar 32 Programming manual.

NOTE: The connection of the fuses for the DC bus must be rated for the total DC bus current of all drives. Analyze the most critical case in your application (for example EMERGENCY STOP) and select an appropriate conductor cross section.

Single-phase drives Separate mains fuses: ATV32••••M2, LXM32••••M2

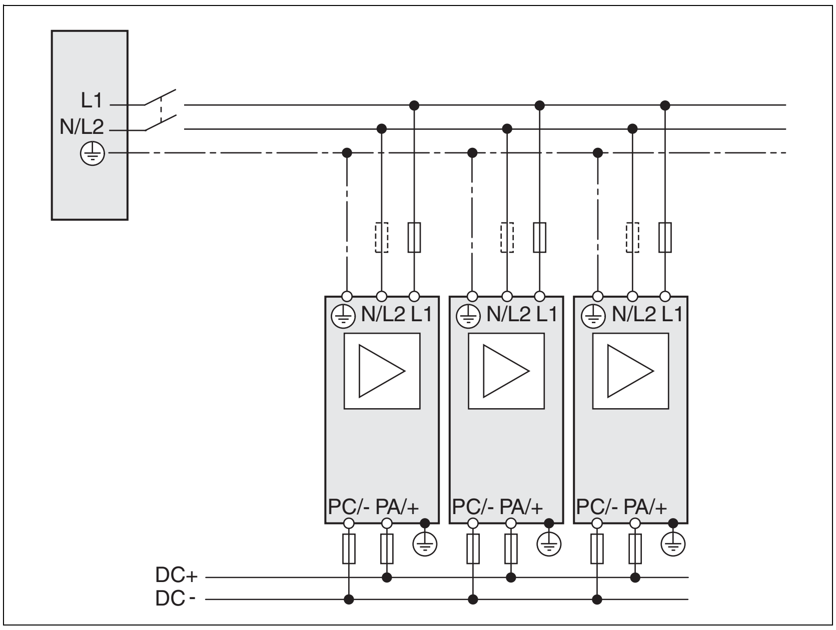

Figure 4.4 Separate mains fuses: DC bus of single-phase drives

Three-phase drives Separate mains fuses: ATV32••••N4, LXM32••••N4

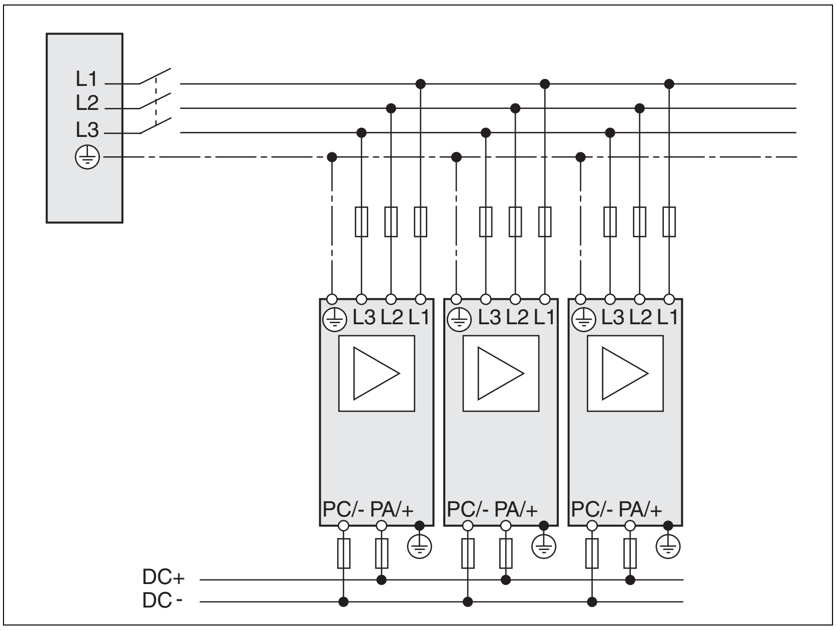

Figure 4.5 Separate mains fuses: DC bus of three-phase drives

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4.5.3 DC supply via a drive

The drives are supplied via an appropriately rated drive via the DC bus.

Conditions The following conditions must be met for the DC bus connection of drives with one supplying drive:

- Fuses must be used for the DC bus. See chapter 3.3.2 "Fuse for DC bus", page 24 for permissible fuse ratings.
- Only drives with an identical number of phases may be connected via a common DC bus. Only connect three-phase drives and three-phase drives or single-phase drives and single-phase drives via a common DC bus.
- Only drives with identical nominal voltages may be connected via a common DC bus.
  In the case of LXM32•••• drives, set the same voltage for all drives with the parameter `MON_MainsVolt`.
- If you want to operate ATV32•••• and LXM32•••• drives via a common DC bus, you must activate the following parameters for each device:

Drive	Parameter
ATV32••••	dCCC [DC-Bus compat.]
LXM32••••	`DCbus_compat`

- ATV32••••: Set the type of DC bus connection via parameter dCCn [DC-Bus chaining]. Additional conditions may apply for setting this parameter, see Altivar 32 Programming manual.

NOTE: The connection of the fuses for the DC bus must be rated for the total DC bus current of all drives. Analyze the most critical case in your application (for example EMERGENCY STOP) and select an appropriate conductor cross section.

DC supply via a drive

Separate fuses for the DC bus must be used for each individual drive. See chapter 3.3.2 "Fuse for DC bus", page 24 for permissible fuse ratings.

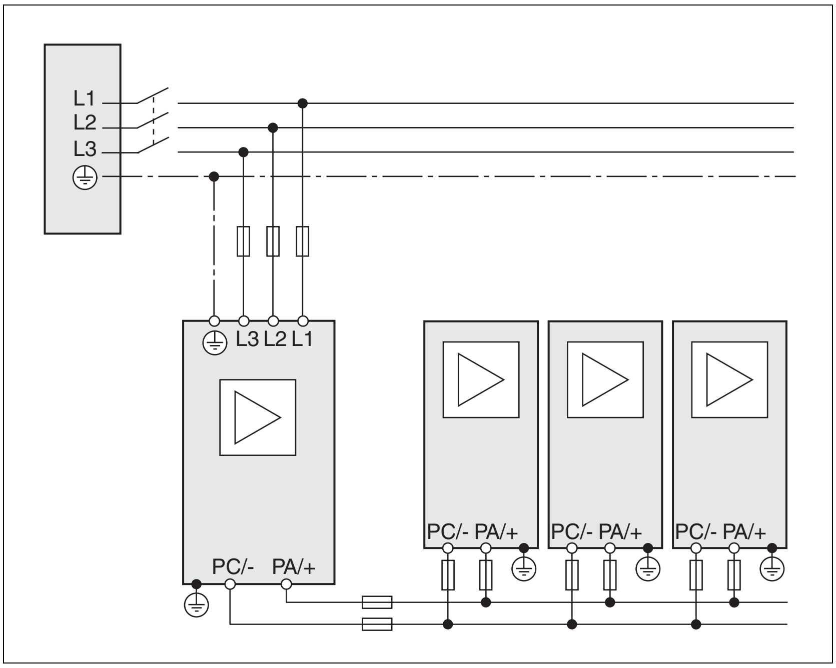

Figure 4.6 A drive supplies additional drives via the DC bus. Separate fuses for the DC bus must be used for each individual drive.

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Special case

If the following additional condition is met, the fuses between the supplying drive and the supplied DC bus are sufficient:

- The current of all drives supplied via the DC bus does not exceed the values listed in the following table.

Single-phase drives ••M2	**Three-phase drives ••N4**
Maximum input current of all connected drives: 25 A.	Maximum input current of all connected drives: 32 A.
Maximum fuse rating for DC bus fuses: 25 A.	Maximum fuse rating for DC bus fuses: 32 A.
Maximum DC bus current: 25 A.	Maximum DC bus current: 32 A.

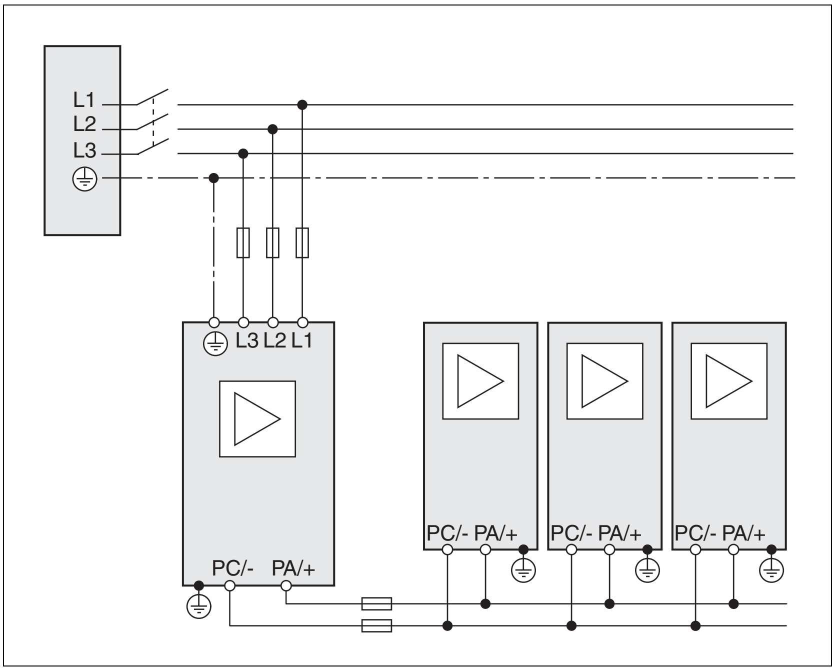

Figure 4.7 A drive supplies additional drives via the DC bus. With appropriate DC bus current, fuses must only be used between the supplying drive and the supplied DC bus.

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4.5.4 DC supply via DC power supply unit

Drives are powered via the DC bus by means of a DC bus power supply unit.

Conditions

The following conditions must be met for the DC bus connection of drives with a supplying DC power supply unit:

- Fuses must be used for the DC bus. See chapter 3.3.2 "Fuse for DC bus", page 24 for permissible fuse ratings.
- Only drives with an identical number of phases may be connected via a common DC bus. Only connect three-phase drives and three-phase drives or single-phase drives and single-phase drives via a common DC bus.
- Only drives with identical nominal voltages may be connected via a common DC bus.
  In the case of LXM32•••• drives, set the same voltage for all drives with the parameter `MON_MainsVolt`.
- The power supply unit must be selected according to drives to be supplied.
- If you want to operate ATV32•••• and LXM32•••• drives via a common DC bus, you must activate the following parameters for each device:

Drive	Parameter
ATV32••••	dCCC [DC-Bus compat.]
LXM32••••	`DCbus_compat`

- ATV32••••: Set the type of DC bus connection via parameter dCCM [DC-Bus chaining]. Additional conditions may apply for setting this parameter, see Altivar 32 Programming manual.

NOTE: The connection of the fuses for the DC bus must be rated for the total DC bus current of all drives. Analyze the most critical case in your application (for example EMERGENCY STOP) and select an appropriate conductor cross section.

Separate fuses for the DC bus must be used for each individual drive. See chapter 3.3.2 "Fuse for DC bus", page 24 for permissible fuse ratings.

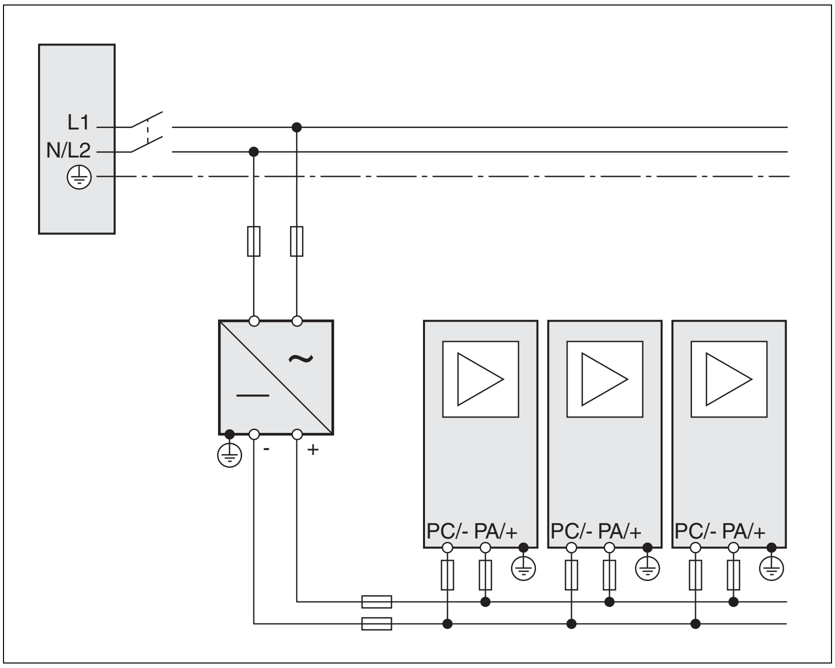


Figure 4.8 A DC power supply unit supplies additional drives via the DC bus. Separate fuses for the DC bus must be used for each individual drive.

MNA01M001EN, V1.00, 12.2010

4.6 Accessories for the common DC bus

4.6.1 Braking resistors

Excess energy in the common DC bus must be absorbed by the braking resistors. Depending on the application, one or more braking resistors can be connected. Consider the internal braking resistors of LXM32 drives in your calculations.

NOTE: If ATV32 drives and LXM32 drives are connected via the DC bus, the external braking resistors must be connected to the LXM32 drive with the greatest nominal power.

NOTE: If drives with a different nominal power are connected via the DC bus, you must connect braking resistors to the drive with the greatest nominal power. See the manual of the respective product for more information.

4.6.1.1 Rating the braking resistor

⚠ WARNING

MOTOR WITHOUT BRAKING EFFECT

An insufficient braking resistor causes overvoltage on the DC bus and switches off the power stage. The motor is no longer actively decelerated.

- Verify that the braking resistor has a sufficient rating.
- Check the parameter settings for the braking resistor.
- Check the I^2t value under the most critical condition by performing a test run. The device switches off at an I^2t value of 100%.
- When performing the calculation and the test run, take into account the fact that the DC bus capacitors can absorb less braking energy at higher mains voltages.

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

⚠ WARNING

HOT SURFACES

The braking resistor may heat up to over 250°C (480°F) during operation.

- Avoid contact with the hot braking resistor.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of the braking resistor.
- Provide for good heat dissipation.
- Check the temperature of the braking resistor under the most critical condition by performing a test run.

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

Braking resistors are required for dynamic applications. During deceleration, the kinetic energy is transformed into electrical energy in the motor. The electrical energy increases the DC bus voltage. The braking resistor is activated when the defined threshold value is exceeded. The braking resistor transforms electrical energy into heat. If highly dynamic deceleration is required, the braking resistor must be well adapted to the system.

Further information on the subject	Page
Technical data chapter 3.5 "Braking resistor"	27
Commissioning chapter 6.2 "LXM32: Setting the braking resistor parameters"	63

See also chapter 4.3 "Energy balance", page 30 for rating information.

LXM32: Internal braking resistor

A braking resistor to absorb braking energy is integrated in LXM32 drives. The device is shipped with the internal braking resistor active.

If the braking energy of all drives sharing a common DC bus is greater than the energy the internal braking resistors can absorb, you must use an external braking resistor. Consider the most extreme case of your application in calculating the braking energy.
Example: In the case of an EMERGENCY STOP, all drives decelerate simultaneously; the braking resistors must be able to absorb the entire braking energy.

External braking resistor

An external braking resistor is required in applications in which the braking energy is greater than the energy that can be absorbed by the drives sharing a common DC bus. Consider the most extreme case of your application in calculating the braking energy.
Example: In the case of an EMERGENCY STOP, all drives decelerate simultaneously; the braking resistors must be able to absorb the entire braking energy.

LXM32: Monitoring

LXM32 drives monitor the power of the connected braking resistor. The load on the braking resistor can be read out.
The connection of the external braking resistor is short-circuit protected. There is no protection in the case of a ground fault.

Calculation of external braking resistor

The rating of an external braking resistor depends on the required peak power and continuous power with which the braking resistor can be operated.

The resistance value R is derived from the required peak power and the DC bus voltage.

$$R = U^2 \ / \ P_{max}$$

U :	Switching threshold [V]
P_{max} :	Peek power [W]
R:	Resistance [Ohm]

If 2 or more braking resistors are connected to one drive, note the following criteria:

- The braking resistors must be connected in parallel or in series so the required resistance is reached. Only connect resistors with identical resistance in parallel in order to evenly distribute the load to all braking resistors.
- The total resistance of all external braking resistors connected to one drive must not fall below a lower limit, see chapter 3.5 "Braking resistor".
- The continuous power of the network of connected braking resistors must be calculated. The result must be greater than or equal to the actually required continuous power.

Use only resistors that are specified as braking resistors. See chapter 3.5 "Braking resistor", page 27 for suitable braking resistors.

Connection of braking resistor

Braking resistors with degree of protection IP65 may be installed outside the control cabinet in an appropriate environment.

The external braking resistors listed in the Accessories chapter are shipped with an information sheet that provides details on installation.

Further procedure:

- Connect the braking resistors to the drive.
- LXM32: Check the parameter `RESint_ext` during commissioning. This parameter allows you to switch between internal and external braking resistor.
- LXM32: If you have connected an external braking resistor to an LXM32 drive, you must set the parameters for the external braking resistor during commissioning.
- During commissioning, test the braking resistors under realistic conditions, see page 61.

Wire ferrules: If you use wire ferrules, use only wire ferrules with collars for these connection terminals.

4.6.1.2 Rating information

To rate the braking resistor, calculate the proportion contributing to absorbing braking energy.

An external braking resistor is required if the kinetic energy that must be absorbed exceeds the total of the internal proportions, including the internal braking resistor.

The energy E_{var} is the square difference between the voltage before the deceleration process and the response threshold.

The voltage prior to the deceleration process depends on the mains voltage. The energy absorption by the DC bus capacitors is lowest when the mains voltage is highest. In the calculation, use the values for the highest mains voltage.

Energy absorption braking resistor

Two characteristic values determine the energy absorption of the braking resistor.

- The continuous power P_{PR} is the amount of energy that can be continuously absorbed without overloading the braking resistor.
- The maximum energy E_{CR} limits the maximum short-term power that can be absorbed.

If the continuous power was exceeded for a specific time, the braking resistor must remain without load for a corresponding period.

The characteristic values P_{PR} and E_{CR} of the internal braking resistor can be found in chapter 3 "Technical Data".

See page 31 for information on assessing the electrical and mechanical losses.

Example: LXM32 drive

Deceleration of a rotary motor with the following data:

- Initial speed of rotation: n = 4000 min^{-1}
- Rotor inertia: J_R = 4 $kgcm^2$
- Load inertia: J_L = 6 $kgcm^2$

Calculation of the energy to be absorbed:

$E_B = 1/2 * J * (2*\pi*n * 1/60)^2$

to 88 Ws

Electrical and mechanical losses are ignored.

In this example, the DC bus capacitors absorb 23 Ws (the value depends on the device type, see chapter 3 "Technical Data").

The internal braking resistor must absorb the remaining 65 Ws. It can absorb a pulse of 80 Ws. If the load is decelerated once, the internal braking resistor is sufficient.

If the deceleration process is repeated cyclically, the continuous output must be considered. If the cycle time is longer than the ratio of the energy to be absorbed E_B and the continuous power P_{PR}, the internal braking resistor is sufficient. If the system decelerates more frequently, the internal braking resistor is not sufficient.

In the example, the ratio E_B/P_{PR} is 1.3 s. If the cycle time is shorter, an external braking resistor is required.

MNA01M001EN, V1.00, 12.2010

Selecting an external braking resistor

The selection is made in two steps:

- The maximum energy during deceleration must be less than the peak energy that the internal braking resistor can absorb: $(E_{Di})<(E_{Cr})$. In addition, the continuous power of the internal braking resistor must not be exceeded: $(P_C)<(P_{Pr})$. If these conditions are met, then the internal braking resistor is sufficient.
- If one of the conditions is not met, you must use an external braking resistor. The braking resistor must be rated in such a way that the conditions are met. The resistance of the braking resistor must be between the specified minimum and maximum values, since otherwise the load can no longer be decelerated or the product might be destroyed.

See chapter 3.5 "Braking resistor", page 28 for technical data on the external braking resistors.

4.6.2 Mains reactor

A mains reactor is required if at least one of the following criteria is met:

- The output power of the drive is to be increased.
- The short-circuit current rating (SCCR) of the supplying mains is greater than specified for the drives.
- Current harmonics are to be reduced.

The mains reactor for several drives with a common AC fuse must be rated in such a way that the nominal current of the mains reactor is greater than the total of the input current of the drives.
See the manual of the respective product for information on mains reactors.

The fuse rating of the fuse upstream of the mains reactor must not be greater than the nominal current of the mains reactor.

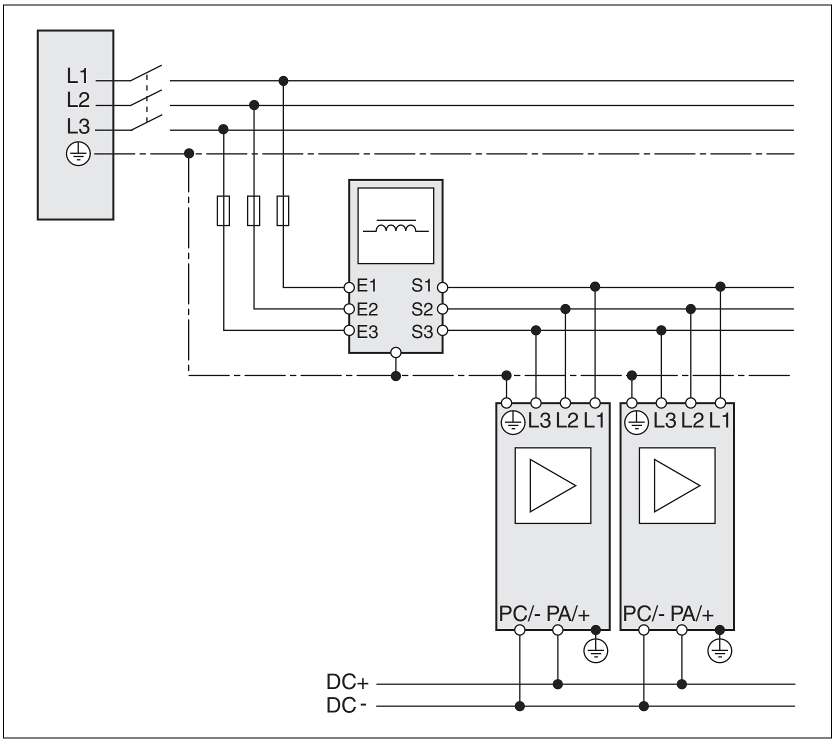


Figure 4.9 Wiring of drives with common AC fuse and a mains reactor, example shows three-phase drives.

MNA01M001EN, V1.00, 12.2010

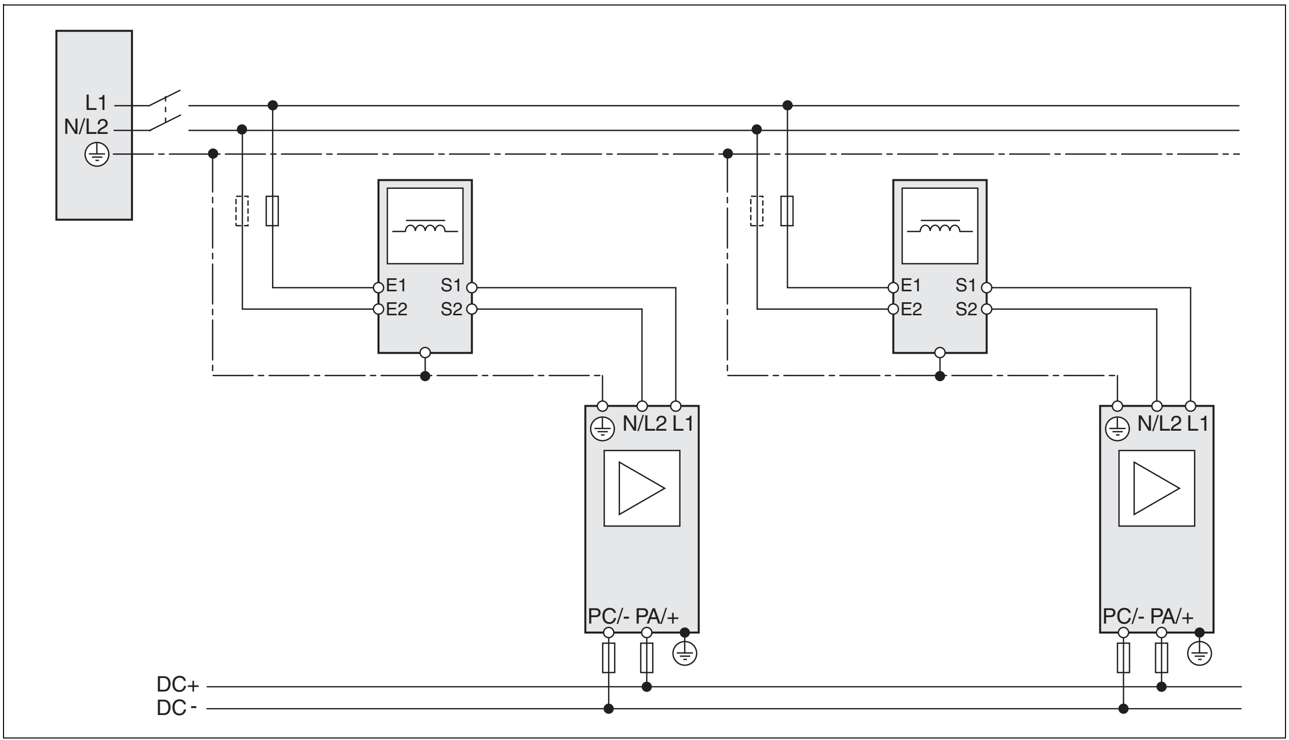


Figure 4.10 Wiring of drives with individual AC fuses and mains reactors, example shows singe-phase drives.

See the manual of the respective product for information on mains reactors.

MNA01M001EN, V1.00, 12.2010

4.6.3 External mains filter

The emission depends on the length of the motor cables. If the required limit value is not reached with the internal mains filter, you must use an external mains filter. See manual of the respective product for information on mains filters.

The mains filter for several drives with a common AC fuse must be rated in such a way that the nominal current of the external mains filter is greater than the total of the input current of the drives.

The fuse rating of the fuse upstream of the external mains filter must not be greater than the nominal current of the external mains filter.

Mount the external mains filter in such a way that the lines from the mains filter to the drives are as short as possible. For EMC reasons, route the cables from the mains filter to the drives separately from the line to the mains filter.

NOTE: External three-phase mains filters do not have a neutral conductor connection; they are only approved for three-phase devices.

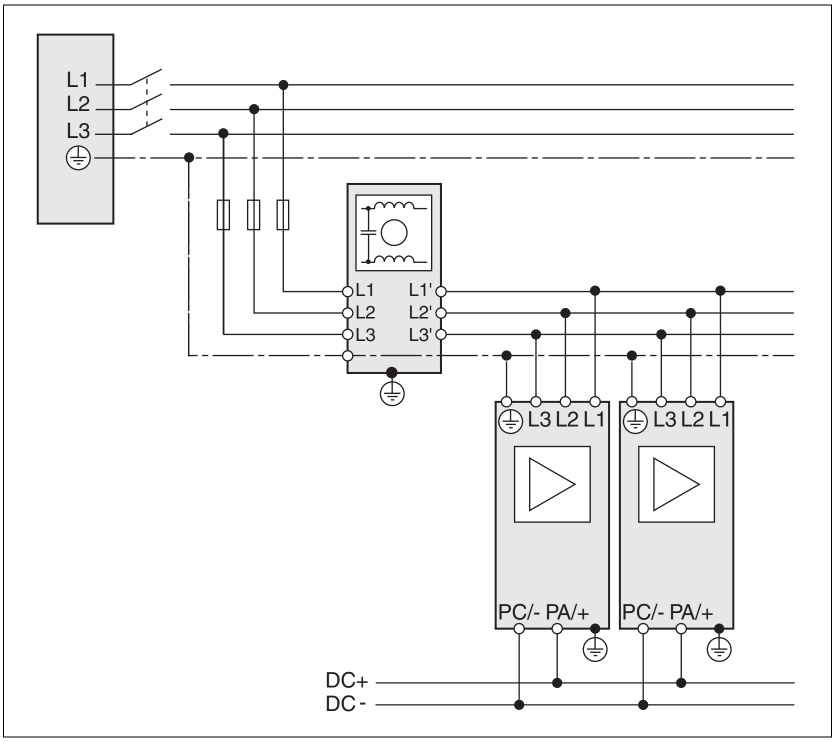


Figure 4.11 Wiring of an external mains filter, example shows three-phase drives.

See the manual of the respective product for information on external mains filters.

4.6.4 Mains reactor and external mains filter

If a mains reactor and an external mains filter are required, the mains reactor and external mains filter must be arranged according to the following illustrations for EMC reasons.

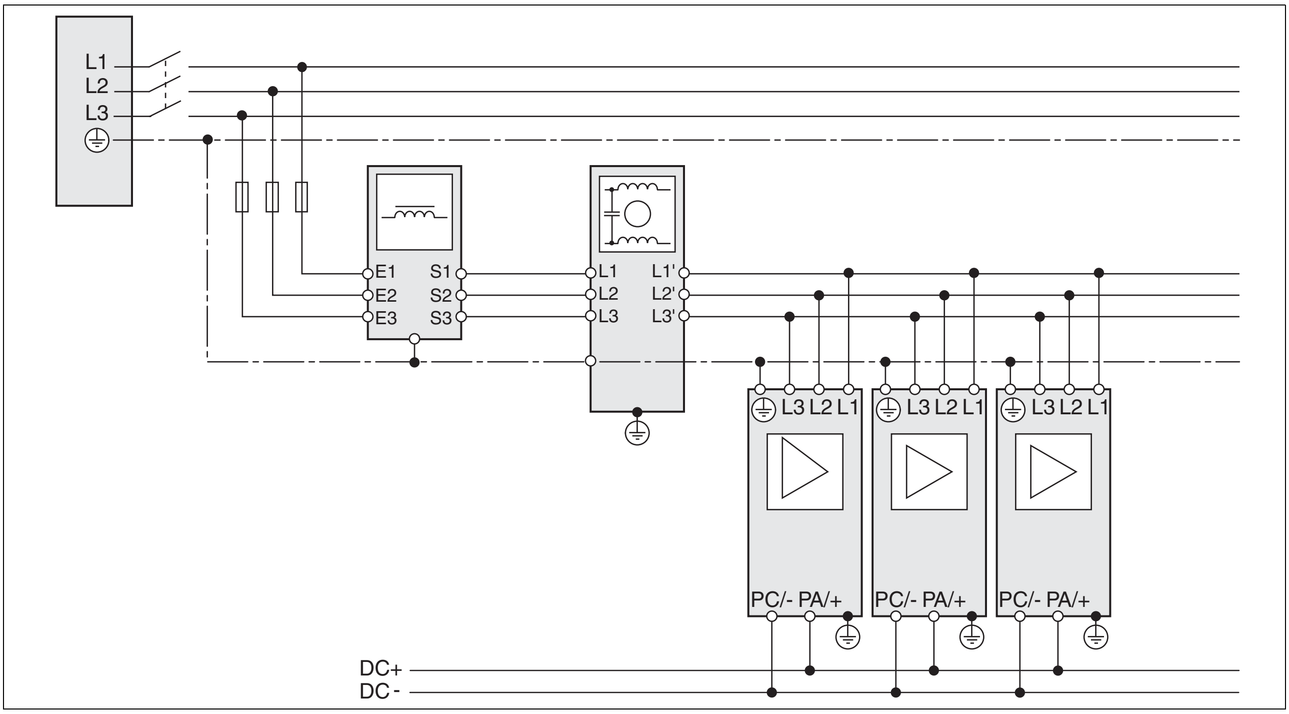


Figure 4.12 Wiring of drives with common mains fuse, mains reactor and mains filter, example shows three-phase drives.

4.6.5 Cables for DC bus

The DC bus is connected by means of a plug and socket connection or screw terminals.
See the manual of the respective product for tightening torque of the screw terminals.

Cable specifications See chapter 3.4 "Cables for DC bus", page 26 for the cable specifications. Connector kits and pre-assembled cables can be found in chapter 7 "Accessories and spare parts", page 65.

5 Installation

5

An engineering phase is mandatory prior to mechanical and electrical installation. See chapter 4 "Engineering", page 29, for basic information.

⚠ WARNING

DESTRUCTION OF SYSTEM COMPONENTS AND LOSS OF CONTROL

Incorrect use of a parallel connection of the DC bus may destroy the drives immediately or after a delay.

- Note the requirements concerning the use of a parallel DC bus connection.

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

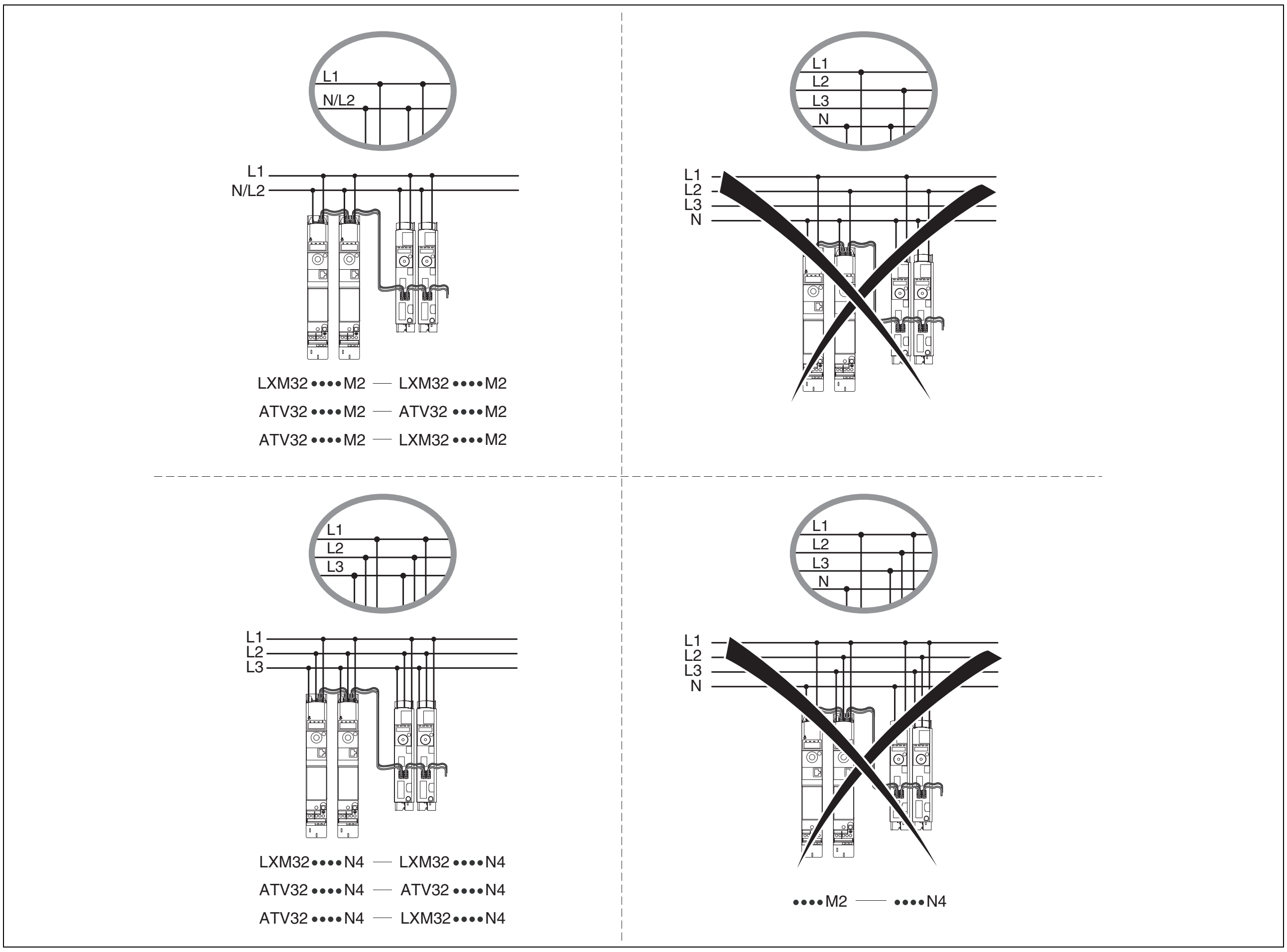


Figure 5.1 Specifications for drives with mains supply

MNA01M001EN, V1.00, 12.2010

5.1 Cables for DC bus

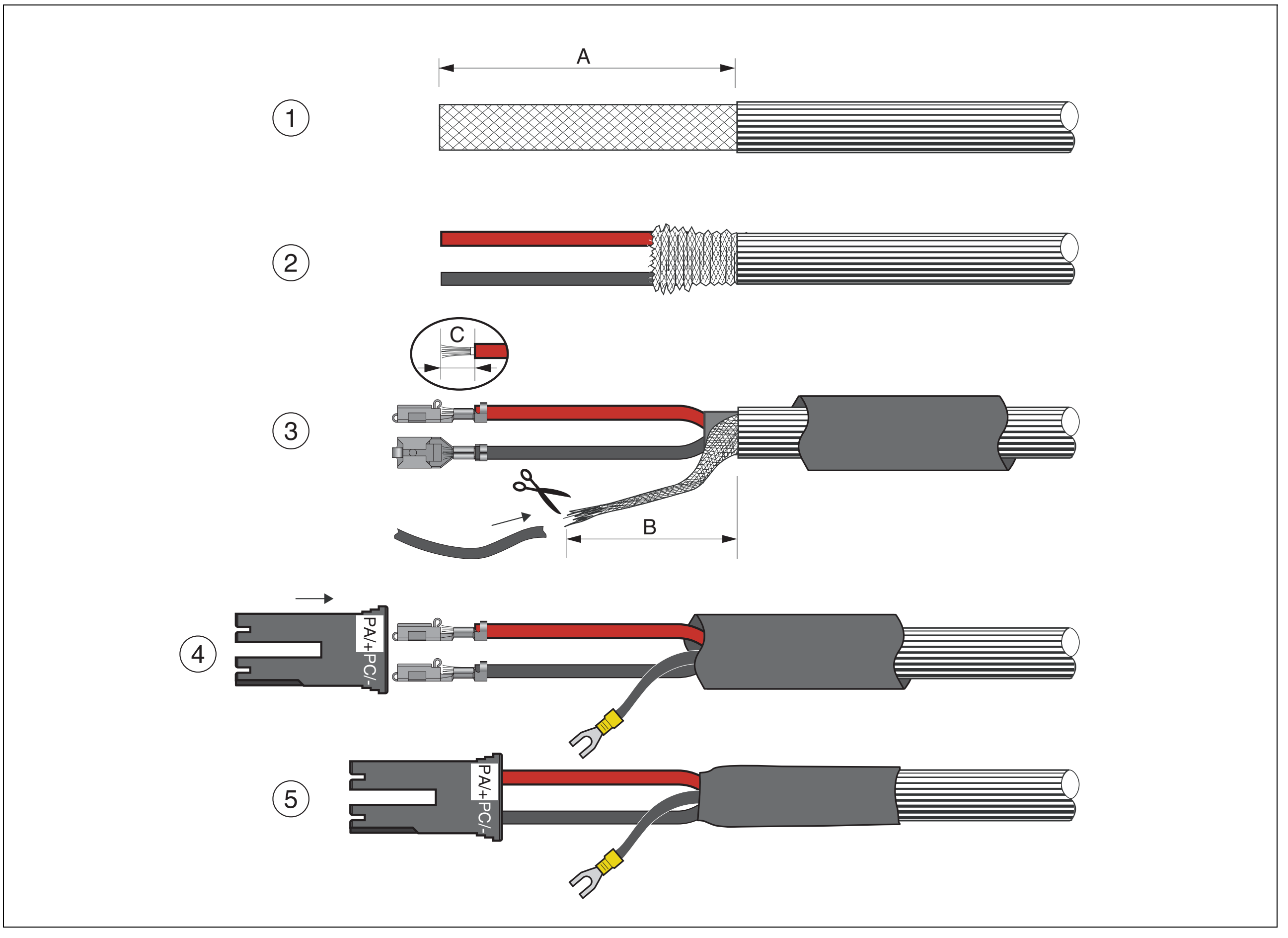
Pre-assembled cables are available for common DC bus. If the pre-assembled cables do not have the required length, use cables and crimp contacts, see chapter 7.1 "DC bus accessories", page 65.

Properties of the DC bus cable

Note the DC bus cable properties, see chapter 3.4 "Cables for DC bus" , page 26.

Assembling DC bus cables

The following instructions apply to all ATV32 types with plug connections for the DC bus and to LXM32.



MNA01M001EN, V1.00, 12.2010

	Part	Length in mm (inches)
A	Cable jacket	130 (5.2)
B	Length of shield connection	60 (2.5)
C	Stripping length crimp contact	6 (0.25)
	Diameter ring-type cable lug / fork-type cable lug	For M5 screw

- (1) Strip the cable jacket, length A.
- (2) Slide back the shield braiding. Open the shield braiding and twist it to a shield connection.
- (3) Shorten the twisted shield connection to length B and insulate the shield braiding with heat shrink tube.
  Crimp the crimp contacts to the two stripped conductors. The stripping length is C. See chapter 7.1 "DC bus accessories", page 65 for information on the crimping tool.
- (4) Crimp a fork-type cable lug to the shield connection wire.
  Push the crimp contacts into the connector housing. Polarity: the red wire is PA/+, the black wire is PC/-.
- (5) Secure the shield with heat shrink tube.

5.2 Wiring the DC bus

CAUTION

EQUIPMENT DAMAGE CAUSED BY INCORRECT POLARITY

- Verify correct polarity during installation.

Failure to follow these instructions can result in equipment damage.

The DC bus is connected by means of a plug and socket connection or screw terminals.

Cable specifications

See chapter 3.4 "Cables for DC bus", page 26 for the cable specifications. Pre-assembled cables and connector kits can be found in chapter 7 "Accessories and spare parts", page 65.

Connector coding

The connectors are coded. If you do not use pre-assembled cables, verify that the crimp contacts properly snap into the connector. Verify that PA/+ is connected to PA/+ and PC/- is connected to PC/-. Incorrect wiring will destroy the devices.

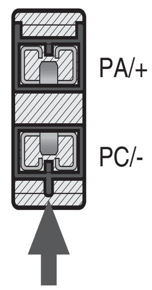


Figure 5.2 Connector coding

Connector lock

The connector has a snap lock mechanism. Pull the connector housing to unlock the connector.

NOTE: Both wires in the connector housing must be able to move independently for unlocking.

If you want to remove the DC bus connection cable, you must open the connector lock by pulling at the housing. LXM32: The connection cable is easier to remove if you remove the motor connector first.

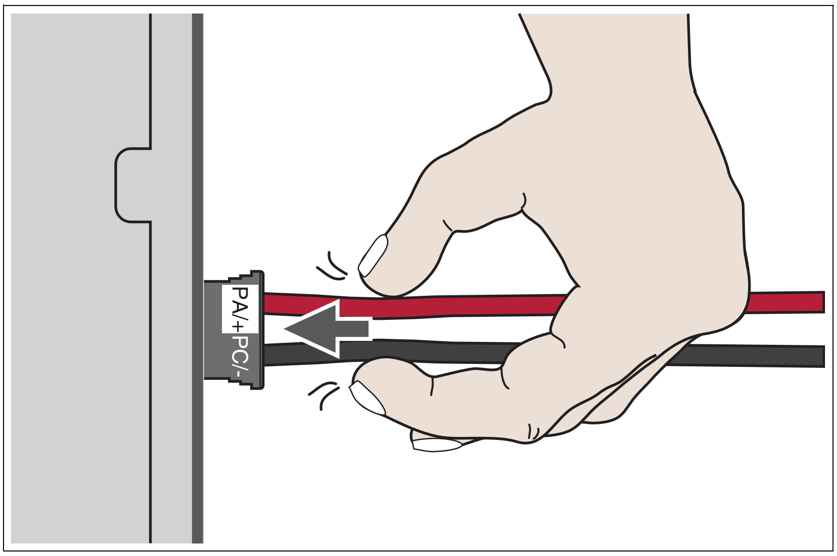


Figure 5.3 Unlocking the DC bus connector, step 1: Push cables towards connector.

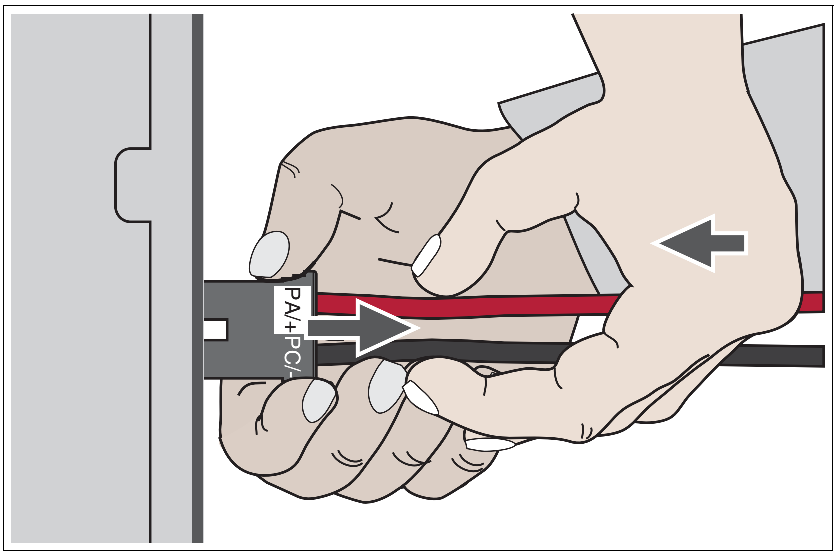


Figure 5.4 Unlocking the DC bus connector, step 2: Push cables towards connector, at the same time remove the connector with the other hand.

If the two wires cannot move freely, the DC bus connector will not unlock.

- Push the two wires towards the connector (see Figure 5.3).
- While pushing the wires towards the connector, pull the connector at the connector housing with the other hand.The connector is unlocked and you can remove the DC bus connection cable (see). The connector is unlocked and you can remove the DC bus connection cable (see Figure 5.4).

MNA01M001EN, V1.00, 12.2010

5.2.1 Connecting the DC bus

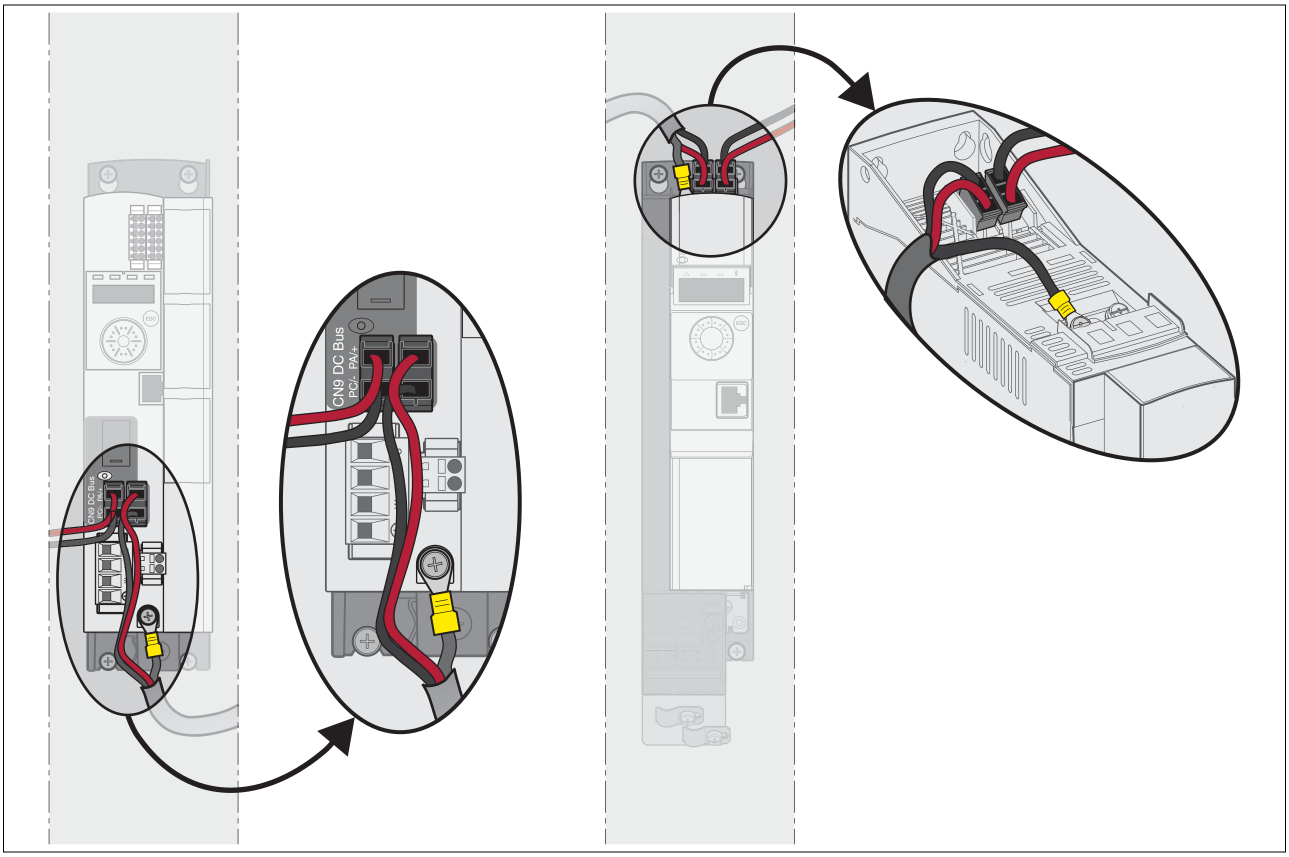


Figure 5.5 DC bus connection with plug contacts: left LXM32, right ATV32

- ▶ Verify that all requirements for a common DC bus are met.
- ▶ Use pre-assembled cables whenever possible (page 65) to reduce the risk of wiring errors.
- ▶ Only connect the devices with the specified accessories. The connectors are coded. Connect PA/+ to PA/+ and PC/- to PC/-.

5.3 Checking installation

- ▶ Verify that all requirements for a common DC bus are met. (Chapter 4.5 "Structure of a common DC bus")
- ▶ Verify that Y capacitors are activated (factory setting), see manual of the respective product.
- ▶ Verify that the wiring complies with the specifications as per chapter 4 "Engineering".
- ▶ Verify that the fuses used are correct. The maximum permissible fuse ratings must not be exceeded. See chapter 3.3.1 "Mains fuse", page 24 and chapter 3.3.2 "Fuse for DC bus", page 24 for the fuse ratings.
- ▶ Verify proper wiring. Verify that PA/+ is only connected to PA/+. Verify that PC/- is only connected to PC/-.
- ▶ Verify that the shield is connected to a large surface area if you use shielded DC bus cables.
- ▶ Verify that the connector locks are properly snapped in.

6 Commissioning

6

For commissioning, follow the commissioning instructions for the individual devices in the manual of the respective product.

⚠ WARNING

DESTRUCTION OF SYSTEM COMPONENTS AND LOSS OF CONTROL

Incorrect use of a parallel connection of the DC bus may destroy the drives immediately or after a delay.

- Note the requirements concerning the use of a parallel DC bus connection.

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

MNA01M001EN, V1.00, 12.2010

6.1 Commissioning procedure

Commissioning steps:

- ▶ Verify proper installation of the drives and the connections for the common DC bus, see chapter 5.3 "Checking installation", page 59.
- ▶ Switch on the controller supply voltage simultaneously for all devices since the braking resistor controller needs the controller supply voltage.
- ▶ Activate mains phase monitoring for the drives with mains supply.
- ▶ Verify that only drives with identical nominal voltages have been connected.
LXM32: Set the same voltage for all LXM32•••• drives.

Drive	Parameter
LXM32	`MON_MainsVolt`

- ▶ If you want to operate ATV32•••• and LXM32•••• drives via a common DC bus, you must activate the following parameters for each device:

Drive	Parameter
ATV32	dCCC [DC-Bus compat.]
LXM32	`DCbus_compat`

- ▶ ATV32••••: Set the type of DC bus connection via parameter dCCn [DC-Bus chaining]. Additional conditions may apply for setting this parameter, see Altivar 32 programming manual.

Drive	Parameter
ATV32	dCCn [DC-Bus chaining]

- ▶ LXM32: Set the parameters for the braking resistors of LXM32•••• drives, see page 63.

Drive	Parameter

LXM32	`RESint_ext`
	`RESext_P`
	`RESext_R`
	`RESext_ton`

- ▶ Commission the drives, see the descriptions in the manuals for the individual products.

6.2 LXM32: Setting the braking resistor parameters

⚠ WARNING

MOTOR WITHOUT BRAKING EFFECT

An insufficient braking resistor causes overvoltage on the DC bus and switches off the power stage. The motor is no longer actively decelerated.

- Verify that the braking resistor has a sufficient rating.
- Check the parameter settings for the braking resistor.
- Check the I^2t value under the most critical condition by performing a test run. The device switches off at an I^2t value of 100%.
- When performing the calculation and the test run, take into account the fact that the DC bus capacitors can absorb less braking energy at higher mains voltages.

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

⚠ WARNING

HOT SURFACES

The braking resistor may heat up to over 250°C (480°F) during operation.

- Avoid contact with the hot braking resistor.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of the braking resistor.
- Provide for good heat dissipation.
- Check the temperature of the braking resistor under the most critical condition by performing a test run.

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

▶ Check the parameter `RESint_ext`. If you have connected an external braking resistor, you must set the parameter to "external".

▶ If you have connected an external braking resistor, (value of the parameter `RESint_ext` is set to "external"), you must assign the appropriate values to the parameters `RESext_P`, `RESext_R` and `RESext_ton`. Verify that the selected external braking resistor is really connected.

▶ Test the function of the braking resistor under realistic, worst case conditions.

If the regenerated power becomes greater than the power that can be absorbed by the braking resistor, an error message is generated and the power stage is disabled.

See the product manual for a description of the parameters.

7 Accessories and spare parts

7

7.1 DC bus accessories

Description	Order no.
LXM ATV DC bus connection cable, pre-assembled, 0.1 m, 5 pieces	VW3M7101R01
LXM ATV cable for DC bus, 2* 5.3 mm^2 (2* AWG 10), shielded, 15 m	VW3M7102R150
DC bus connector kit, connector housing and contacts, 10 pieces	VW3M2207

A crimping tool is required for the crimp contacts of the connector kit.
Manufacturer:
Tyco Electronics, Heavy Head Hand Tool, Tool Pt. No 18025

7.2 DC fuses

The following DC fuses are offered by SIBA.
http://www.siba-fuses.com

Description	SIBA order no.
DC fuse, DC 700V 10A	50 201 06.10
DC fuse, DC 700V 16A	50 201 06.16
DC fuse, DC 700V 25A	50 201 06.25
DC fuse, DC 700V 32A	50 201 06.32
DC fuse, DC 700V 40A	50 201 06.40
DC fuse, DC 700V 50A	50 201 06.50
DC fuse, DC 700V 63A	50 201 06.63

MNA01M001EN, V1.00, 12.2010

7.3 External braking resistors

Description	Order no.
Braking resistor IP65; 10 Ω; maximum continuous power 400 W; 0.75 m connection cable, UL	VW3A7601R07
Braking resistor IP65; 10 Ω; maximum continuous power 400 W; 2 m connection cable, UL	VW3A7601R20
Braking resistor IP65; 10 Ω; maximum continuous power 400 W; 3 m connection cable, UL	VW3A7601R30
Braking resistor IP65; 27 Ω; maximum continuous power 100 W; 0.75 m connection cable, UL	VW3A7602R07
Braking resistor IP65; 27 Ω; maximum continuous power 100 W; 2 m connection cable, UL	VW3A7602R20
Braking resistor IP65; 27 Ω; maximum continuous power 100 W; 3 m connection cable, UL	VW3A7602R30
Braking resistor IP65; 27 Ω; maximum continuous power 200 W; 0.75 m connection cable, UL	VW3A7603R07
Braking resistor IP65; 27 Ω; maximum continuous power 200 W; 2 m connection cable, UL	VW3A7603R20
Braking resistor IP65; 27 Ω; maximum continuous power 200 W; 3 m connection cable, UL	VW3A7603R30
Braking resistor IP65; 27 Ω; maximum continuous power 400 W; 0.75 m connection cable, UL	VW3A7604R07
Braking resistor IP65; 27 Ω; maximum continuous power 400 W; 2 m connection cable, UL	VW3A7604R20
Braking resistor IP65; 27 Ω; maximum continuous power 400 W; 3 m connection cable, UL	VW3A7604R30
Braking resistor IP65; 72 Ω; maximum continuous power 100 W; 0.75 m connection cable, UL	VW3A7605R07
Braking resistor IP65; 72 Ω; maximum continuous power 100 W; 2 m connection cable, UL	VW3A7605R20
Braking resistor IP65; 72 Ω; maximum continuous power 100 W; 3 m connection cable, UL	VW3A7605R30
Braking resistor IP65; 72 Ω; maximum continuous power 200 W; 0.75 m connection cable, UL	VW3A7606R07
Braking resistor IP65; 72 Ω; maximum continuous power 200 W; 2 m connection cable, UL	VW3A7606R20
Braking resistor IP65; 72 Ω; maximum continuous power 200 W; 3 m connection cable, UL	VW3A7606R30
Braking resistor IP65; 72 Ω; maximum continuous power 400 W; 0.75 m connection cable	VW3A7607R07
Braking resistor IP65; 72 Ω; maximum continuous power 400 W; 2 m connection cable	VW3A7607R20
Braking resistor IP65; 72 Ω; maximum continuous power 400 W; 3 m connection cable	VW3A7607R30
Braking resistor IP65; 100 Ω; maximum continuous power 100 W; 0.75 m connection cable	VW3A7608R07
Braking resistor IP65; 100 Ω; maximum continuous power 100 W; 2 m connection cable	VW3A7608R20
Braking resistor IP65; 100 Ω; maximum continuous power 100 W; 3 m connection cable	VW3A7608R30
Braking resistor IP20; 15 Ω; maximum continuous power 2500 W; connection terminals, UL	VW3A7704
Braking resistor IP20; 10 Ω; maximum continuous power 2500 W; connection terminals, UL	VW3A7705

MNA01M001EN, V1.00, 12.2010

8 Glossary

8

8.1 Units and conversion tables

The value in the specified unit (left column) is calculated for the desired unit (top row) with the formula (in the field).

Example: conversion of 5 meters [m] to yards [yd]
5 m / 0.9144 = 5.468 yd

8.1.1 Length

	in	ft	yd	m	cm	mm
in	-	/ 12	/ 36	* 0.0254	* 2.54	* 25.4
ft	* 12	-	/ 3	* 0.30479	* 30.479	* 304.79
yd	* 36	* 3	-	* 0.9144	* 91.44	* 914.4
m	/ 0.0254	/ 0.30479	/ 0.9144	-	* 100	* 1000
cm	/ 2.54	/ 30.479	/ 91.44	/ 100	-	* 10
mm	/ 25.4	/ 304.79	/ 914.4	/ 1000	/ 10	-

8.1.2 Mass

	lb	oz	slug	kg	g
lb	-	* 16	* 0.03108095	* 0.4535924	* 453.5924
oz	/ 16	-	* $1.942559*10^{-3}$	* 0.02834952	* 28.34952
slug	/ 0.03108095	/ $1.942559*10^{-3}$	-	* 14.5939	* 14593.9
kg	/ 0.45359237	/ 0.02834952	/ 14.5939	-	* 1000
g	/ 453.59237	/ 28.34952	/ 14593.9	/ 1000	-

8.1.3 Force

	lb	oz	p	dyne	N
lb	-	* 16	* 453.55358	* 444822.2	* 4.448222
oz	/ 16	-	* 28.349524	* 27801	* 0.27801
p	/ 453.55358	/ 28.349524	-	* 980.7	* $9.807*10^{-3}$
dyne	/ 444822.2	/ 27801	/ 980.7	-	/ $100*10^{3}$
N	/ 4.448222	/ 0.27801	/ $9.807*10^{-3}$	* $100*10^{3}$	-

8.1.4 Power

	HP	W
HP	-	* 746
W	/ 746	-

8.1.5 Rotation

	min^{-1} (RPM)	rad/s	deg./s
min^{-1} (RPM)	-	* π / 30	* 6
rad/s	* 30 / π	-	* 57.295
deg./s	/ 6	/ 57.295	-

8.1.6 Torque

	lb·in	lb·ft	oz·in	Nm	kp·m	kp·cm	dyne·cm
lb·in	-	/ 12	* 16	* 0.112985	* 0.011521	* 1.1521	* $1.129*10^6$
lb·ft	* 12	-	* 192	* 1.355822	* 0.138255	* 13.8255	* $13.558*10^6$
oz·in	/ 16	/ 192	-	* $7.0616*10^{-3}$	* $720.07*10^{-6}$	* $72.007*10^{-3}$	* 70615.5
Nm	/ 0.112985	/ 1.355822	/ $7.0616*10^{-3}$	-	* 0.101972	* 10.1972	* $10*10^6$
kp·m	/ 0.011521	/ 0.138255	/ $720.07*10^{-6}$	/ 0.101972	-	* 100	* $98.066*10^6$
kp·cm	/ 1.1521	/ 13.8255	/ $72.007*10^{-3}$	/ 10.1972	/ 100	-	* $0.9806*10^6$
dyne·cm	/ $1.129*10^6$	/ $13.558*10^6$	/ 70615.5	/ $10*10^6$	/ $98.066*10^6$	/ $0.9806*10^6$	-

8.1.7 Moment of inertia

	$lb·in^2$	$lb·ft^2$	$kg·m^2$	$kg·cm^2$	$kp·cm·s^2$	$oz·in^2$
$lb·in^2$	-	/ 144	/ 3417.16	/ 0.341716	/ 335.109	* 16
$lb·ft^2$	* 144	-	* 0.04214	* 421.4	* 0.429711	* 2304
$kg·m^2$	* 3417.16	/ 0.04214	-	* $10*10^3$	* 10.1972	* 54674
$kg·cm^2$	* 0.341716	/ 421.4	/ $10*10^3$	-	/ 980.665	* 5.46
$kp·cm·s^2$	* 335.109	/ 0.429711	/ 10.1972	* 980.665	-	* 5361.74
$oz·in^2$	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	-

8.1.8 Temperature

	°F	°C	K
°F	-	(°F - 32) * 5/9	(°F - 32) * 5/9 + 273.15
°C	°C * 9/5 + 32	-	°C + 273.15
K	(K - 273.15) * 9/5 + 32	K - 273.15	-

8.1.9 Conductor cross section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm^2	42.4	33.6	26.7	21.2	16.8	13.3	10.5	8.4	6.6	5.3	4.2	3.3	2.6

AWG	14	15	16	17	18	19	20	21	22	23	24	25	26
mm^2	2.1	1.7	1.3	1.0	0.82	0.65	0.52	0.41	0.33	0.26	0.20	0.16	0.13

8.2 Terms and Abbreviations

See chapter 2.6 "Standards and terminology" for information on the pertinent standards on which many terms are based. Some terms and abbreviations may have specific meanings with regard to the standards.

AC Alternating current

DC Direct current

DC bus Circuit that supplies the power stage with energy (direct voltage).

Drive system System consisting of controller, power stage and motor.

EMC Electromagnetic compatibility

Error Discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition.

Error class Classification of errors into groups. The different error classes allow for specific responses to errors, for example by severity.

Factory setting Factory settings when the product is shipped

Fault Fault is a state that can be caused by an error. Further information can be found in the pertinent standards such as IEC 61800-7, ODVA Common Industrial Protocol (CIP).

Fault reset A function used to restore the drive to an operational state after a detected error is cleared by removing the cause of the error so that the error is no longer active.

Parameter Device data and values that can be read and set (to a certain extent) by the user.

PELV Protective Extra Low Voltage, low voltage with isolation. For more information: IEC 60364-4-41

Persistent Indicates whether the value of the parameter remains in the memory after the device is switched off.

Power stage The power stage controls the motor. The power stage generates current for controlling the motor on the basis of the positioning signals from the controller.

Quick Stop Function which can be used for fast deceleration of the motor via a command or in the event of an error.

Warning If the term is used outside the context of safety instructions, a warning alerts to a potential problem that was detected by a monitoring function. A warning does not cause a transition of the operating state.

9 Index

9

MNA01M001EN, V1.00, 12.2010

MNA01M001EN, V1.00, 12.2010

MNA01M001EN, V1.00, 12.2010