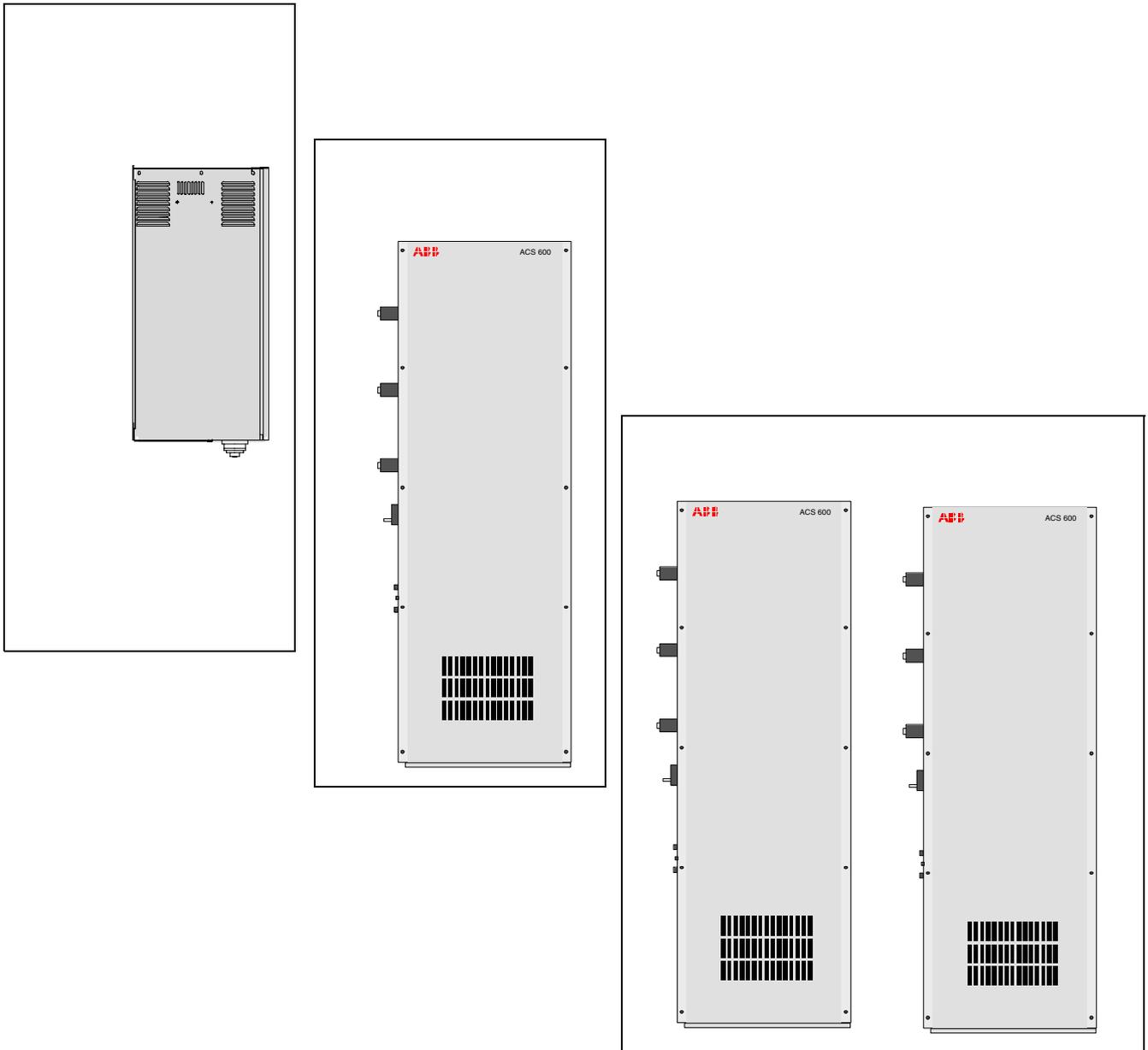


ACS 600

# Converter Module Installation in User-defined Cabinet

ACx 6x1 Frequency Converters  
ACx 604 Converter Modules



# ACS 600 SingleDrive Manuals *(English Originals)*

**GENERAL MANUALS** (appropriate hardware manual is included in the delivery)

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**ACS/ACC/ACP 601 Hardware Manual** EN 61201360

2.2 to 110 kW

- Safety instructions
- Cable selection
- Mechanical and electrical installation
- Maintenance
- Technical data
- Dimensional drawings

**ACS/ACC/ACP 611 Supplement** EN 61504443

(included in ACx 611 deliveries only)

- Safety instructions
- Installation
- Maintenance
- Fault tracing
- Parameters
- Technical data
- Dimensional drawings

**ACS/ACC/ACP 604/607/627 Hardware Manual** EN 61201394, 55

to 630 kW

- Safety instructions
- Cable selection
- Mechanical and electrical installation
- Maintenance
- Technical data
- Dimensional drawings

**ACS/ACC 607/617/627/677 Hardware Manual** EN 61329005

630 to 3000 kW

- Safety instructions
- Cable selection
- Mechanical and electrical installation
- Drive section commissioning
- Maintenance
- Technical data
- Dimensional drawings

**Converter Module Installation in User-defined Cabinet** EN

61264922 (included in modules deliveries only)

- Safety instructions
- Cabinet design
- Wiring
- Installation checks
- Dimensional drawings

**ACS/ACC 624 Drive Modules Supplement** EN 64186477

(included in ACx 624 module deliveries only)

- Safety instructions
- Technical data
- Dimensional drawings

**SUPPLY SECTION MANUALS** (with 630 to 3000 kW units depending on the supply type one of these manuals is included in the delivery)

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**Diode Supply Sections User's Manual (DSU)** EN 61451544

- DSU specific safety instructions
- DSU hardware and software descriptions
- DSU commissioning
- Earth fault protection options

**Thyristor Supply Sections User's Manual (TSU)** EN 64170597

- TSU operation basics
- TSU firmware description
- TSU program parameters
- TSU commissioning

**IGBT Supply Sections User's Manual (ISU)** EN 64013700

- ISU specific Safety Instructions
- Main components of ISU
- ISU ratings
- ISU power losses
- ISU dimensions and weights
- ISU fuses
- ISU program parameters
- Earth fault protection options

**FIRMWARE MANUALS FOR DRIVE APPLICATION**

**PROGRAMS** (appropriate manual is included in the delivery)

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**Standard** EN 61201441

- Control Panel use
- Standard application macros with external control connection diagrams
- Parameters of the Standard Application Program
- Fault tracing
- Fieldbus control

**Note:** a separate Start-up Guide is attached

**Motion Control** EN 61320130

- Control Panel use
- Start-up
- Operation
- Parameters
- Fault tracing
- Fieldbus control

**Crane Drive** EN 3BSE 011179

- Commissioning of the Crane Drive Application Program
- Control Panel use
- Crane program description
- Parameters of the Crane Drive Application Program
- Fault tracing

**System** EN 63700177

- Commissioning of the System Application Program
- Control Panel use
- Software description
- Parameters of the System Application Program
- Fault tracing
- Terms

**Application Program Template** EN 63700185

- Commissioning of the Drive Section
- Control Panel use
- Software description
- Parameters
- Fault tracing
- Terms

**OPTION MANUALS** (delivered with optional equipment)

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**Fieldbus Adapters, I/O Extension Modules, Braking Choppers etc.**

- Installation
- Programming
- Fault tracing
- Technical data

# ACx 6x1 Frequency Converters ACx 604 Converter Modules

## **Converter Module Installation in User-defined Cabinet**

This manual concerns the ACS 601, ACC 601, ACP 601, ACS 611, ACC 611 and ACP 611 frequency converters, and the ACS 604, ACC 604 and ACP 604 frequency converter modules. In the text, they are collectively referred to as ACx 6x1 and ACx 604.

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EN  
EFFECTIVE: 24.11.2000  
SUPERSEDES: 30.12.1999



# Safety Instructions

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## Overview



The safety instructions given in the manuals delivered with the converter module must be followed when installing, operating and servicing the ACS/ACC/ACP 601/611/604. If neglected, physical injury and death may follow, or damage may occur to the frequency converter, the motor and driven equipment. The information provided by the safety chapter must be studied before attempting any work on, or with, the unit.

## Earth (Ground) Connections

The unit (as well as all adjoining equipment) must be properly earthed. When drive modules are assembled into the cabinet, all modules must be for personal safety reasons earthed to prevent dangerous voltages under any circumstances. Connection to ground through fixing screws and cabinet chassis is not good enough. To ensure the continuity of the protection bonding circuit **modules must be connected to cabinet PE busbar by a copper busbar or cable**. The cross-sections must be in accordance with local regulations. From the EMC standpoint the best result is achieved with a flat copper braid.

The cabinet door must be earthed with a copper cable if there are other than low-voltage devices on the door.

## Clearances

Leave at least 12.7 mm air clearance around live contact bolts, busbars and every uninsulated live part.

## Degree of Protection

IP 2x degree of protection with the cabinet door open can be achieved for example by using separate protective plastic or steel sheets in free areas. This protection is required to ensure safety when operation of the converter with the cabinet door open is forced for example for testing purposes. The ACx 604 installation cannot be continuously used at full power with cabinet door open because of the bad cooling air circulation and personal and fire safety reasons.

Protect the always live parts (the terminals and busbars that are not disconnected from the supply network by the main switch, e.g. input terminals) carefully and mark this kind of areas with warning labels.

***Mechanical  
Installation***

**CAUTION!** When someone is working above the ACx 604 module and cabinet, cover the module top and the cabinet roof with e.g. cardboard sheet to prevent dropped nuts and washers from falling into the module/cabinet. If something is dropped into the module/cabinet, it must be removed immediately carefully. Foreign object in the module/cabinet can cause danger and/or damage the equipment. Make sure that dust from drilling does not enter the ACx 600 when installing. Electrically conductive dust inside the unit may cause damage or lead to malfunction.

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# Chapter 1 – Introduction

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## Overview

This paper is intended for people who are responsible for designing a user-defined frequency converter cabinet and installing an ACx 6x1 frequency converter or an ACx 604 converter unit in a user-defined cabinet. It gives additional information to the installation instructions in the respective *Hardware Manual*. There is a special emphasis on meeting the European Union EMC (Electromagnetic Compatibility) Directive requirements.

We expect that you have a basic knowledge of physical and electrical fundamentals, electrical wiring practices, electrical components and electrical schematic symbols.

The dimensional drawings for ACx 604 converter units are included.

## Delivery Check R7, R8, R9

After opening the package check that it contains the following items:

- main parts list
- ACx 604 frequency converter module with NIOC and NAMC control boards inside the module. (If an external drive control unit NDCU is ordered, the control boards are located in it, not inside the module.)
- NDCU-11/51 (if an external drive control unit is ordered)
- wire set for +24 V power supply
- two 2-metre fibre optic cables
- *ACS/ACC/ACP 604/607/627 Hardware Manual*
- *ACS 600 Converter Module Installation in User-defined Cabinet*
- respective *ACS 600 Firmware Manual*
- optional accessories (if ordered) with appropriate manuals
- report on the final testing procedure
- main circuit diagram

**Delivery Check 2 x R8,  
2 x R9**

After opening the package of 2 x R8 and 2 x R9 units check that it contains the following items:

- main parts list
- ACx 604 frequency converter modules (2 pcs)
- Common control components: NDCU-11/51 and NPBU-41
- conductor set of earth fault protection (not used with 12-pulse supplied units). Refer to main circuit diagram 58985732: A13 NEFB X1 to A13 NEFB X1 and A13 NEFB X3 to A4 NINT X43.
- wire set for +24 V power supply
- 6 pieces of 5-metre fibre optic cables
- *ACS/ACC/ACP 604/607/627 Hardware Manual*
- *ACS 600 Converter Module Installation in User-defined Cabinet*
- *respective ACS 600 Firmware Manual*
- optional accessories (if ordered) with appropriate manuals
- a report on the final testing procedure
- main circuit diagram and control circuit diagrams

**Testing**

The ACS 604 modules have been tested by ABB at the factory. Also, current division between the modules of the 2 x R8 and 2 x R9 deliveries has been checked. Only testing of the assembly must be done when installing the modules in user-defined cabinets.

## ***Planning the Installation***

Proper pre-planning minimises the amount of extra work when e.g. additional equipment is fitted later on. The following is a checklist including the most important aspects to consider before installation:

- Mains network type (earthed or floating)
- Cabinet construction, ambient operating conditions
- Cables
- Line filter
- du/dt filter for 690 V units
- Input fuses, mains supply disconnecting device
- CDP 31x Control Panel location and mounting
- Retrofitting additional equipment.

When designing the cabinet construction, three important things must be fulfilled:

1. The EMC shielding and protection against dust and water.
2. Mechanical sizes with the clearances of live parts and the weight of the equipment to be mounted.
3. The free space and air flow in the cabinet for cooling, as well as sufficient ventilation holes or cooler.



## Chapter 2 – Cabinet Design

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### **Cabinet Construction**

The cabinet properties discussed below are essential for safe and efficient use of the ACx 600 frequency converter. The section also includes guidelines for fulfilling EMC requirements.

The cabinet frame must be sturdy enough to carry the weight of the converter unit and other equipment installed in it.

### **Disposition of the Devices**

For easy installation and maintenance spacious layout is recommended. Also sufficient cooling air flow prescribes not to install too much in a too small cabinet. In addition to this, some components require EMC shielding and the cables must be tied tightly inside the cabinet, which requires additional bars and other supporting structures.

The converter unit must be installed in an upright position.

The R7 frame can be mounted by hanging it with four bolts from every corner of the back plate of the module. Because frame R7 requires free air space under the module, this is very useful way to install it. Frames R8 and R9 are heavier and do not require free space under the module, so they can be installed on the floor of the cabinet. However, these heavy modules must be fixed also from the upper end.

Dimensions and fixing points of ACx 604 converter units are presented on the dimensional drawings in *Appendix A*.

For a recommended cabinet layout, see Figures 5 and 6.

### **Cooling**

The cabinet must have enough free space for the converter unit to ensure sufficient cooling. See *Appendix A – Technical Data* in the *Hardware Manual* for cooling space requirements, requirements concerning cooling air humidity and contamination levels.

ACx 604 modules contain their own cooling fans. These fans with filter free or low-back-pressure-filtered ventilation holes are usually sufficient in low protection (...IP 22) cabinets. In those situations you must check the existence of sufficient protection against water drops above the gratings.

When IP54 protection is required, thick filter mats must be used to prevent water plashes going into the cabinet. In most cases there is not enough suitable wall space for required large ventilation holes and hot air fan exhauster must be installed into the cabinet to increase air flow through smaller vents. Cool air intake blower must not be used because of the pumping action between the cabinet and module fans.

To prevent hot air circulation in the cabinet, the cabinet must be splitted to two halves with an air baffle (see Figure 1 and 2). The air baffle can be made from sheet steel and it must be almost leak-proof. Only hole for **whole** module roof or bottom is left open. However, no gaskets are required. The position of the air baffle plate is important - it must be installed at the top of the module with the R8 and R9 module frames. With the R7 module frame the baffle must be mounted at the bottom of the module because of the cooling air grates at the sides of the module. In R8 and R9 case, the hole for the module roof area must be expanded a few centimetres to the direction of the module front cover, because the front cover is lifted up about two centimetres when opening and closing it.

It is possible to use other cooling methods. In many factory processes cool process water is available and a water-air heat exchanger is a very powerful solution. With heat exchangers IP 54 degree of protection is easy to obtain.

When cabinets are installed in a strait room close to each other, there can be problems with air circulation outside the cabinet if ventilation holes are used. A useful idea is to install cool air intake gratings in the lower part of the front door of the cabinet, and construct an external exhaust blower on the roof of the cabinet. Even better circulation prevention can be designed by placing the air exhaust vents on the other walls of the cabinet than the air intake.

Required cooling power is determined from the ambient air temperature compared to the maximum allowed cabinet temperature, which is 60°C. The maximum allowed pressure drop of the cabinet can be found in Table 1.

The cabinet ventilation holes and fan exhausters can be also calculated with specific computer programs provided by cabinet manufacturers. The efficiency of an ACx 604 unit is about 97 ... 98%, so the thermal power of the frequency converter is 3% of the nominal power of the unit.

*Heater* A cubicle heater is required, if there is risk to humidity to be condensed in the cabinet. Drying is the primary function of a cubicle heater. Of course, if there is a risk of cabinet temperature to be below 0 °C after installation, a heater is required for heating. See limits for the ambient conditions in the corresponding manual.

When placing the heater, follow the instructions given by the heater manufacturer.

**Table 1** Pressure difference over the ACx 604 module and the fan type used in the module, maximum allowed pressure drop of the cabinet.

Frame	Pressure difference over the module Pa	Flow m <sup>3</sup> /h	Pressure drop of cabinet Pa	Cooling fan	Additional IP 54 fan
R2	45	40	*	Papst 42 14-VAR ABB	
R3	45	60	*	Papst 42 14-VAR ABB	
R4	30	70/100	*	Papst 42 14-VAR ABB (1 or 2 pcs)	
R5	75	260/280	*	Papst 6224 N-VAR ABB	
R6	70	280	*	Papst 6224 N-VAR ABB	
R7	70	660	*	Papst 6224 N-VAR ABB (2 pcs)	Ziehl R4E 310-F12-05
R8	180	1640	105	Ziehl D4E 180-CA02-31	Ziehl R4E 310-F12-05
2 x R8	180	2 x 1640 + 300	105	Ziehl D4E 180-CA02-31 (2 pcs)	Ziehl R4E 310-F12-05 (2 pcs)
R9	310	1840	130	Ziehl D4E 225-CC01-30	Ziehl R4E 310-F12-05
2 x R9	310	2 x 1840 + 300	130	Ziehl D4E 225-CC01-30 (2 pcs)	Ziehl R4E 310-F12-05 (2 pcs)

\* the temperature in the cabinet at the cooling air intake side must be  $\leq +40$  °C.

**Table 2** Air filters and gratings used in the IP 54 MNS cabinets of ABB Industry. 1) Integral ABB cabinet grating with filter material by Air-tex.\* 2) Grating and filter material by Rittal.\*

	Frame Air Inlet/Outlet	Grating (opening size)	Filter material	Pieces
1)	R7, R8, R9 In	ABB (718 x 312 mm)	Air-tex G-150	1
1)	R7, R8, R9 Out	ABB (518 x 312 mm)	Air-tex G-150	4
2)	2 x R8, 2 x R9 In	Rittal SK 3163100	Rittal SK3183100	10
2)	2 x R8, 2 x R9 Out	Rittal SK 3161100	Rittal SK3171100	20

\* the corresponding Rittal grating (cannot be mounted into the ABB cabinet door): R7, R8, R9 In SK 3163100, filtermat SK3183100, 4 pcs. R7, R8, R9 Out SK 3161100, filtermat SK3171100, 10 pcs.

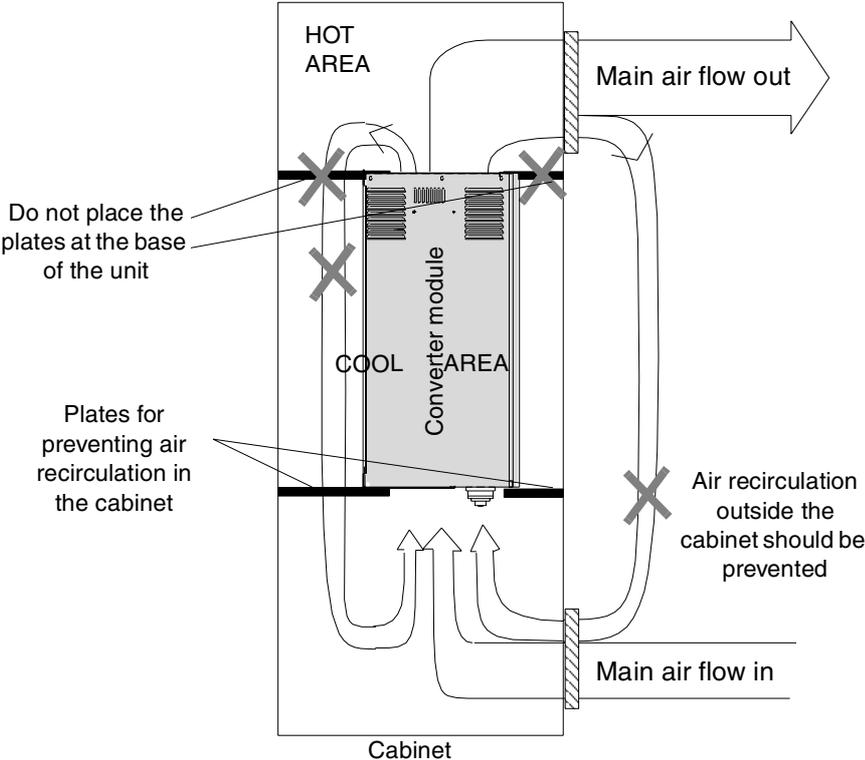


Figure 1 Cooling air circulation chart for a converter unit (R7) in a cabinet. For units R2 to R6 the air baffle plates can be installed at top or base of the frame.

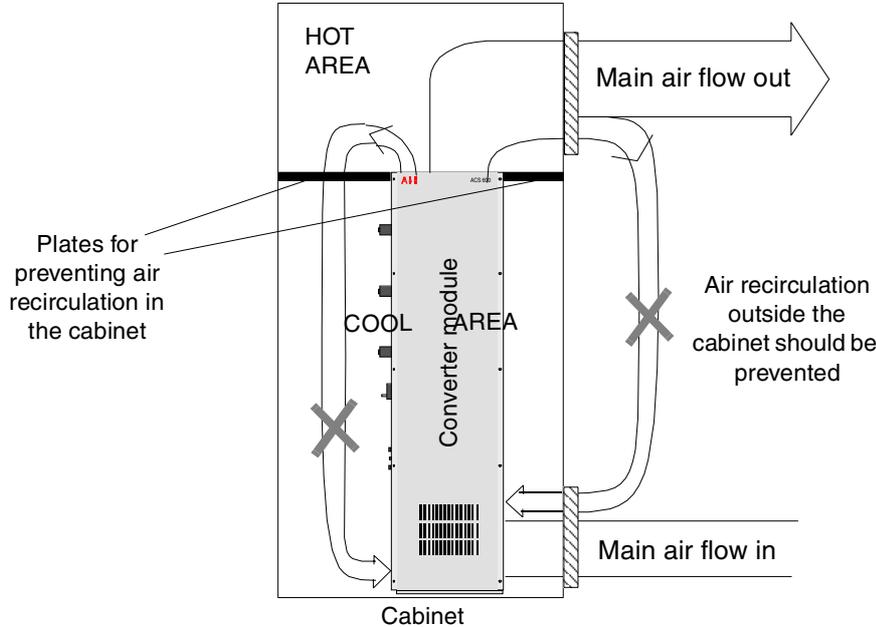


Figure 2 Cooling air circulation chart for a converter unit (R8, R9, 2xR8 and 2xR9) in a cabinet.

**EMC Requirements**

Generally, the fewer and smaller holes there are in the cabinet, the better the interference attenuation. The maximum diameter of a hole in galvanic metal contact in the covering cabinet structure is 10 cm. Special attention must be paid to the cooling air grates.

The best galvanic connection between the steel panels is achieved by welding them together as no holes are necessary. If welding is not possible, the seams between the panels **must be left unpainted** and equipped with special conductive EMC strips to provide adequate galvanic connection. Usually reliable strips are made of flexible silicon mass covered with a metal mesh. The non-tightened touch-contact of the metal surfaces is not sufficient and conductive gasket tape between the surfaces is required. The maximum distance between assembly screws is 10 cm.

Sufficient high-frequency earthing network must be constructed in the cabinet to avoid voltage differences and forming of high-impedance radiator structures. A good high-frequency earthing is made with short flat copper braids for low inductance. One-point grounding for high-frequency cannot be used because of the long distances in the cabinet.

On the other hand, a sturdy low-frequency earthing structure is required to ensure the electrical safety of the parts. Conductive EMC shielding gasket tapes are not sufficient for earthing for electrical safety. Please follow local regulations when designing the protective earth connections.

The door must be galvanically connected to the cabinet, and sealed with conductive EMC strip with no gaps.

**Note:** Frame R7 modules comply with EMC requirements as such (without any additional cabinet).

**Control Section 2 x R8,  
2 x R9**

It is not allowed to install the control boards near a main circuit or hot parts.

An additional mains fuse supervision is required since there is no internal detection of the blowing of a single fuse.

**12-pulse Units**

An additional earth fault protection is required for 12-pulse supplied units since there is no internal protection available.

Requirements for the supply transformer:

- IEC 76 and ANSI/IEEE C57.12.00
- Dyn 11 d0 connection
- Maximum secondary voltage difference 0.3 %
- Short circuit impedances of the secondary windings must be at least 5 % with phase differences less than 3 %.

**Cables** The mains, motor and control cables must be selected according to the specifications in the appropriate *Hardware Manual*. Also, observe the cable routing and length instructions.

**EMC Requirements** EMC compliance of ACx 604 requires 360° high frequency earthing of the screens of motor and control cables at their entries. For the motor cables, the earthing can be implemented by a knitted wire mesh screening as in Figure 3 below.

Signal cables can be earthed by means of conductive screening cushions pressed against the cable screen from both directions (see Figure 4).

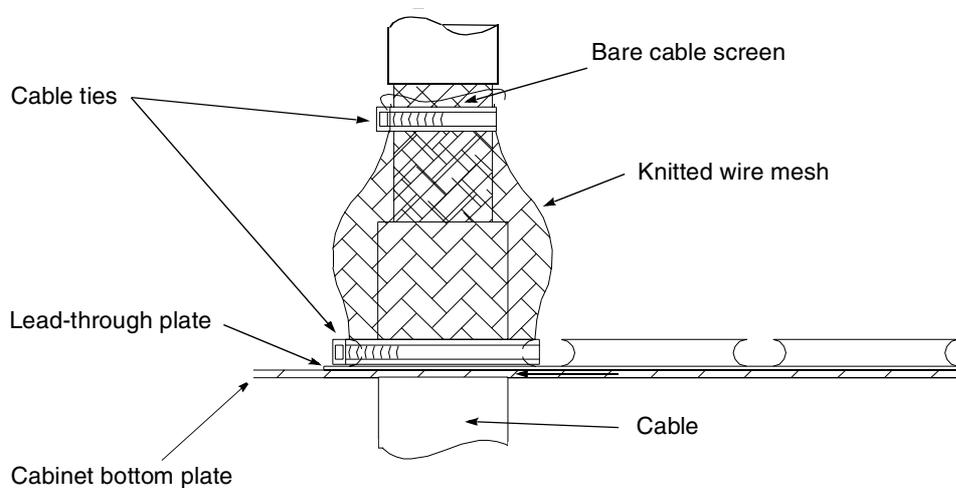


Figure 3 Example: Motor cable entry earthed by means of knitted wire mesh.

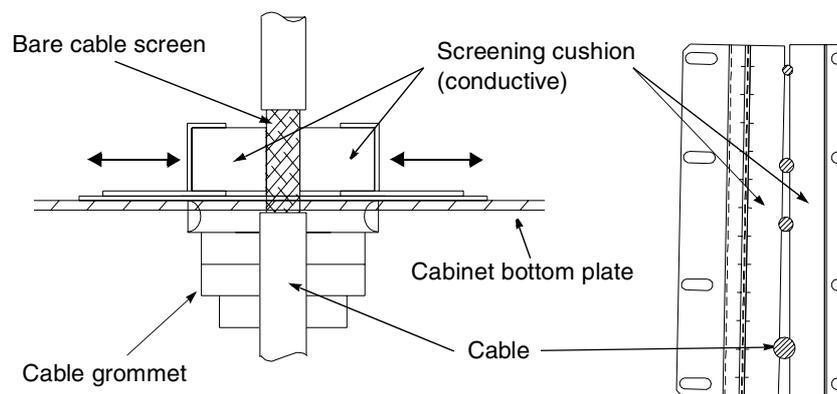


Figure 4 Example of 360° earthing of signal cable entry (side and top views).

**Line Filter** An additional line filter in the mains supply suppresses conducted emissions. The actual filtering performance can only be confirmed by testing. (Generally speaking, the higher the insertion loss of the filter, the better the filtering performance.) The following filter types have been tested and approved by ABB:

ACS 604 Type		Line Filter			
400 V Range	500 V Range	Type	Rated Current (A)	Rated Voltage (V)	Odering Code
0140-3 ...0170-3	0170-5...0210-5	B84143-B320-S20	320	500	10031869
0210-3...0400-3	0260-5...0490-5	B84143-B600-S20	600	500	10031877
0490-3...0610-3	0610-5...0760-5	B84143-B1000-S21	1000	760	10031931

Line Filter Type	Power Loss (W)	Dimensions				Connections		Fixing Points
		Height (mm)	Width (mm)	Depth (mm)	Weight (kg)	Max. Cable Size (mm <sup>2</sup> )	Hole Diameter (mm)	
B84143-B320-S20	30*	392	260	115	21.0	5 × 30	11	6 × Ø12 mm
B84143-B600-S20	57	442.5	260	115	22.0	5 × 30	11	6 × Ø12 mm
B84143-B1000-S21	100	462.5	300	165	28.0	8 × 40	14	6 × Ø12 mm

\*Estimated

Other types of three-phase filters can also be used if they meet the following requirements:

- Adequate attenuation (only verifiable by testing)
- Correct voltage rating
- Frequency rating 50/60 Hz
- Continuous current  $> I_{2N}$  or  $I_{2Nsq}$  of the converter
- Overload current  $> 1.5 \times I_{2hd}$  of the converter (allowed for one minute every 5 minutes).

The mains input cables between the cable entry and the line filter must be screened with a metal enclosure to prevent the coupling of motor cable interference to the filtered input line. Attention must also be paid to the earthing of the filter: the filter housing must be properly connected to the cabinet. It is recommended to use the bottom of the filter for the earthing, together with short and wide busbars.

***du/dt Filter*** Technical data and dimensions of the filters used by ABB are presented in *du/dt Filter Installation Guide* (code: 58933368). For more information on when to use and selection, please consult an ABB representative.

***Common Mode Filter*** See when common mode filters are required in the the appropriate ACS 600 *Hardware Manual* and the installation instruction in [Appendix A – ACx 604 Drawings](#) in this manual.

***Input Fuses & Mains Supply Disconnecting Device*** The mains supply for the ACx 6x1 and ACx 604 converter modules must be equipped with appropriate input fuses and an external supply disconnecting device.

The *Hardware Manual* contains a table of recommended Bussmann fuse types. Fuses from other manufacturers can be used as well if they meet the ratings given in the table.

The supply disconnecting device must be of a type specified by EN-60204-1, Chapter 5.3.2, or by local safety regulations. For 2 x R8 and 2 x R9 cabinets two synchronised 3-pole supply disconnecting devices can be used in parallel providing they are operated by one handle on the door.

The motor must not be controlled with the disconnecting device; the Start and Stop keys of the Control Panel or commands via the I/O (NIOC) board must be used instead. (The maximum number of mains power-ups of the ACS 600 is five in ten minutes.)

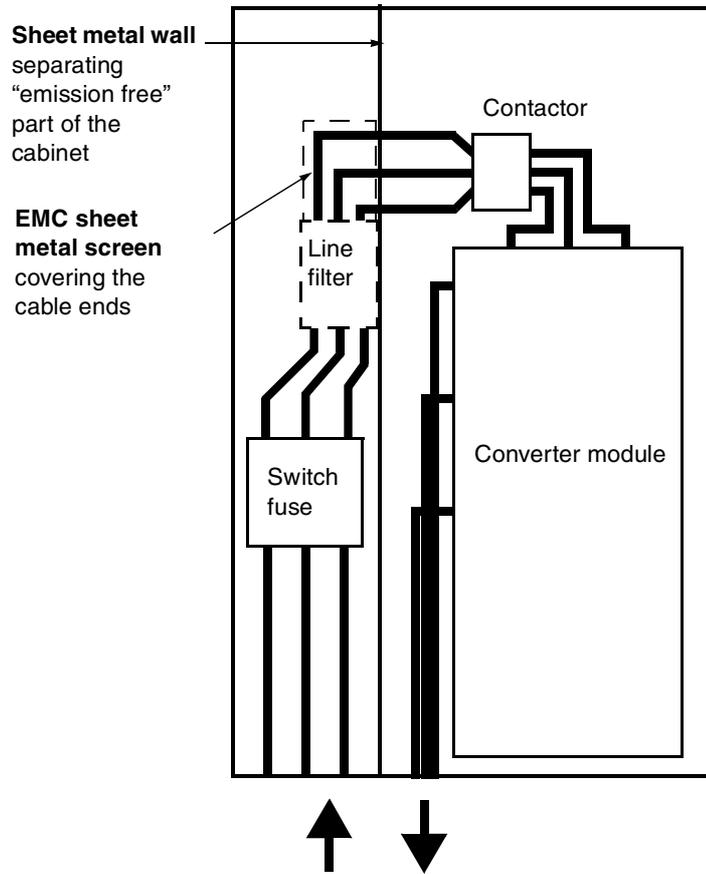
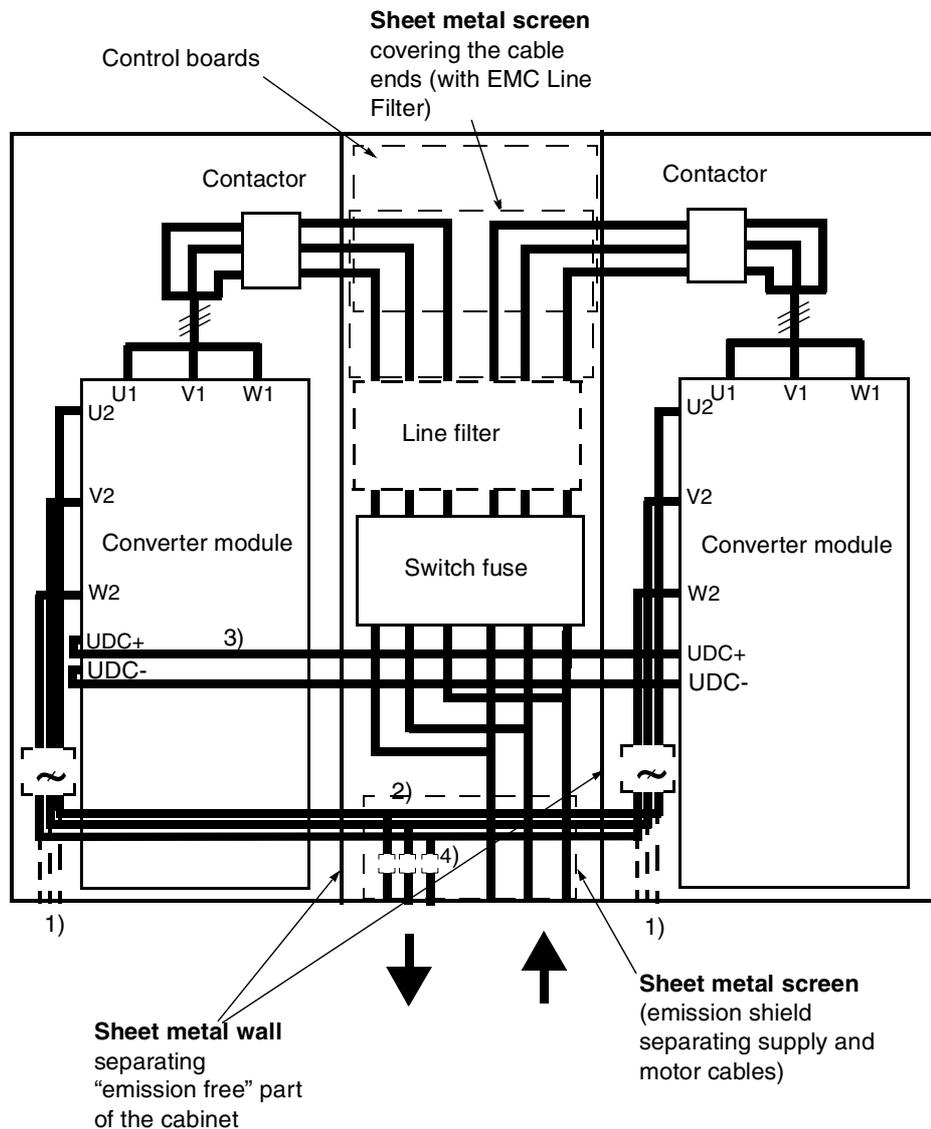


Figure 5 Example of a cabinet layout (R8, R9).



- 1) Alternate motor cable outlet. No EMC emission shield is needed.
- 2) Maximum length difference of the motor phase cables/busbars from the module to the joint is 15 %.
- 3) Conductor cross-section of the cable for connecting the DC intermediate circuits of the modules is 120 mm<sup>2</sup>.
- 4) Common mode filter. See section [Common Mode Filter](#).

- du/dt Filters are recommended for 690 V units. One filter for each phase is
- assembled according to the main circuit diagram into the cool area of the cabinet (at the intake of the cooling air fan). Ensure that the cooling air temperature does not exceed +40 °C. The filters can be fixed to the floor of the cabinet.

Figure 6 Example of a cabinet layout (2 x R8, 2 x R9).

**Control Panel Mounting**

Optional Control Panel Mounting Platform kits, NPMP-0x are available from ABB. These kits include the accessories for installing the Control Panel onto the cabinet door.

The Panel Mounting Platform kit NPMP-0x includes as a minimum the Control Panel Mounting Platform, telephone connector, three-metre telephone cable, an EMC enclosure with fastening screws, NDPI-02 Panel Interface Board, and screws for fastening the board onto the Platform. The Platform is snap-mounted to the door (no screws are required). An opening must be cut to the door panel for the Mounting Platform. (See Figure 7 below.)

The Platform is connected with connector (2) to the NDPI-02 board (3). The board is connected with the cable (4) to the converter unit (**the NAMC-11/51 board terminal X19**, or the NIOC board terminal X29 with units equipped with NAMC-3 board) inside the cabinet.

The Control Panel is normally attached to the Mounting Platform on the cabinet door by pushing it into the recess. The enclosure class of the Control Panel is IP 54 when attached to the Control Panel Mounting Platform. The dimensions of the Control Panel and the Mounting platform are shown in Table 3 below.

*Table 3 Dimensions of the Control Panel and the Control Panel Mounting Platform.*

	<b>Height (mm)</b>	<b>Width (mm)</b>	<b>Depth (mm)</b>
Control Panel (CDP 31x)	170	80	21
Control Panel Mounting Platform	308	160	33/8 *

\* Total depth / protrusion when installed on a metal plate.



**Other Equipment** The possible expansion of the set-up should be given some thought when installing an ACS 600 converter unit in a user-defined cabinet. There are many options available for the ACS 600, e.g. braking choppers, I/O extension modules and fieldbus adapters. These devices have their own space requirements, and they should not obstruct maintenance of the unit.



## Chapter 3 – Checking the Installation

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### Introduction

The assembly of an ACx 604 converter module into a cabinet is inspected according to the following checklists at ABB factory. The components are compared to main part list. The placement of modules and other equipment is compared to assembly drawings. The mounting of modules and other equipment is compared to assembly instructions. The types and cross-sections of busbars are compared to drawings. The types, cross-sections and colours of cables (also twisted cables) are compared to connection tables. Optional marking of cables is compared to main part list.

When installing the ACx 604 module in a user-defined cabinet it is recommended to go through the points of the checklists below before insulation, dielectric and functional tests. Perform insulation and dielectric tests to the cabinet according to IEC-439-1. Follow local safety instructions.

### Visual Inspection

The mechanical and electrical installation must be inspected visually to ensure safe testing and use of the frequency converter.

#### Cabinet Construction

Checks for cabinet construction are listed below. Tips for installations where EMC emissions must be minimised are given in column *Extra requirements for EMC*.

Step	Check item	Extra requirements for EMC
<b>1</b>	<b>Cabinet construction</b>	
1.1	Frame, wall, floor and roof structures, any busbar enclosures and cable entries are correct and completely assembled.	One method to fulfil the requirements: EMC gasket tape is installed between the cabinet walls and frame and EMC conductive strips are used in each door.
1.2	Mechanical joints are tightened and not broken.	
1.3	Parts are clean and painted surfaces not scratched.	The cabinet frame and parts which are in metal to metal contact with the frame (e.g. seams, component fixing points on assembly plates, back of control panel mounting plate) are <b>not</b> finished with non-conducting paint or material.
1.4	IP enclosure class	
1.5	EMC gaskets and sleeves	EMC sleeves are in motor cable entries and EMI conductive cushions in control cable entries. EMC gaskets are in each door.
1.6	There are sufficient amount of supports, bolts and nuts for cables (for customer cables also).	

**Instrumentation, Busbars and Cabling** Checks for instrumentation, busbars, cabling and clearances and creepage distances are listed below.

Step	Check item	More information
<b>2</b>	<b>Instrumentation</b>	
2.1	Type and amount of option modules and other equipment is correct. Option modules and other equipment are not damaged.	
2.2	Option modules and terminals are labelled correctly.	
2.3	The placement of option modules and other equipment inside the cabinet and on the cabinet door is correct.	
2.4	The mounting of option modules and other equipment is correct.	
<b>3</b>	<b>Busbars</b>	
3.1	The types (Al/Cu) and cross sections of busbars are correct.	
3.2	Busbar bendings are unbroken and joint surfaces are clean. There are no metal scraps on the busbars that could cause short circuit.	
3.3	The placement and the mounting of busbars is correct.	
3.4	<b>The electric connection of busbars.</b> Check that the surfaces in electric connections of aluminium and uncoated busbars are rubbed. Check that grease against oxidation is used in electric connections of aluminium busbars. Check that the amount of washers is correct and the sizes of bolts are correct.	
3.5	Busbar supports and lead-in insulators are visually undamaged and ungreased and are placed and mounted correctly.	
3.6	The electric connections on main circuit are tightened to required torque and approved with green colour mark.	
<b>4</b>	<b>Cabling and wiring</b>	
4.1	Wiring of the main circuit. Check <ul style="list-style-type: none"> <li>• AC supply input</li> <li>• AC output</li> <li>• supply for braking chopper (if used)</li> <li>• AC supply for motor fan</li> <li>• supply for auxiliary transformer</li> </ul>	
4.2	Wiring of the 230 VAC circuit. Check <ul style="list-style-type: none"> <li>• terminal strips and relays</li> <li>• supply of cabinet fans (if used)</li> <li>• 24 VDC auxiliary voltage circuit (optional module supply)</li> <li>• supply for cooling fan of the braking resistor(s) (if used)</li> </ul>	
4.3	Wiring of the frequency converter module circuit. <ul style="list-style-type: none"> <li>• Check control cable connections between the terminal strips and I/O board (NIOC(P)).</li> <li>• Check the Control Panel cable connection</li> </ul>	<i>ACx 60x Hardware Manual: Chapter 3</i>
4.4	Cable types, cross sections, colours and optional markings are correct.	
4.5	Check the cabling for circuits susceptible to interference. Check the twisting of cables and cable routes. If an RFI filter is used, check that cables on motor side (interference side) of the filter are not close to supply network side (clean side) of the filter.	<i>ACx 60x Hardware Manual: Chapter 3</i>
4.6	Check that cables without short circuit protection <ul style="list-style-type: none"> <li>• can carry the load current</li> <li>• are shorter than 3 m</li> <li>• are assembled separate to other cables</li> <li>• are protected by an enclosure or duct</li> </ul>	

Step	Check item	More information
4.7	Connectors of cables and fibre optics are undamaged and according to instructions. Check the termination of cables (e.g. AMP connectors), pressing of cable lugs and cable thimbles. Check that connectors are suitable for cables and right tool is used. Check that <ul style="list-style-type: none"> <li>the insulation of the cable is not underneath the connector</li> <li>all strands of the cable are inside the connector</li> <li>connector is not broken</li> <li>the cable is deep enough in its connector (strand ends can be seen)</li> </ul>	
4.8	Connection of cables to devices and terminal blocks. Check that <ul style="list-style-type: none"> <li>the connections of cables to terminals are tight enough by pulling the cable.</li> <li>cable termination on terminals chaining is done correctly.</li> <li>bare conductors are not too far outside the terminal causing an insufficient clearance or loss of shielding against contact.</li> </ul>	
4.9	Cables are not laying against sharp edges or bare live parts. Bending radius of fibre optical cables $\geq 3,5$ cm.	
4.10	The type, markings, insulation plates and jointings of terminal blocks are correct.	
5.	<b>Clearances and creepage distances</b>	
5.1	Clearances outside the modules are at least 12,7 mm	
5.2	Creepage distances outside the modules are at least 12,7 mm	

### **Earthings and Protection**

Checks for earthings and protections are listed below. Tips for installations where EMC emissions must be minimised are given in column *Extra requirements for EMC*.

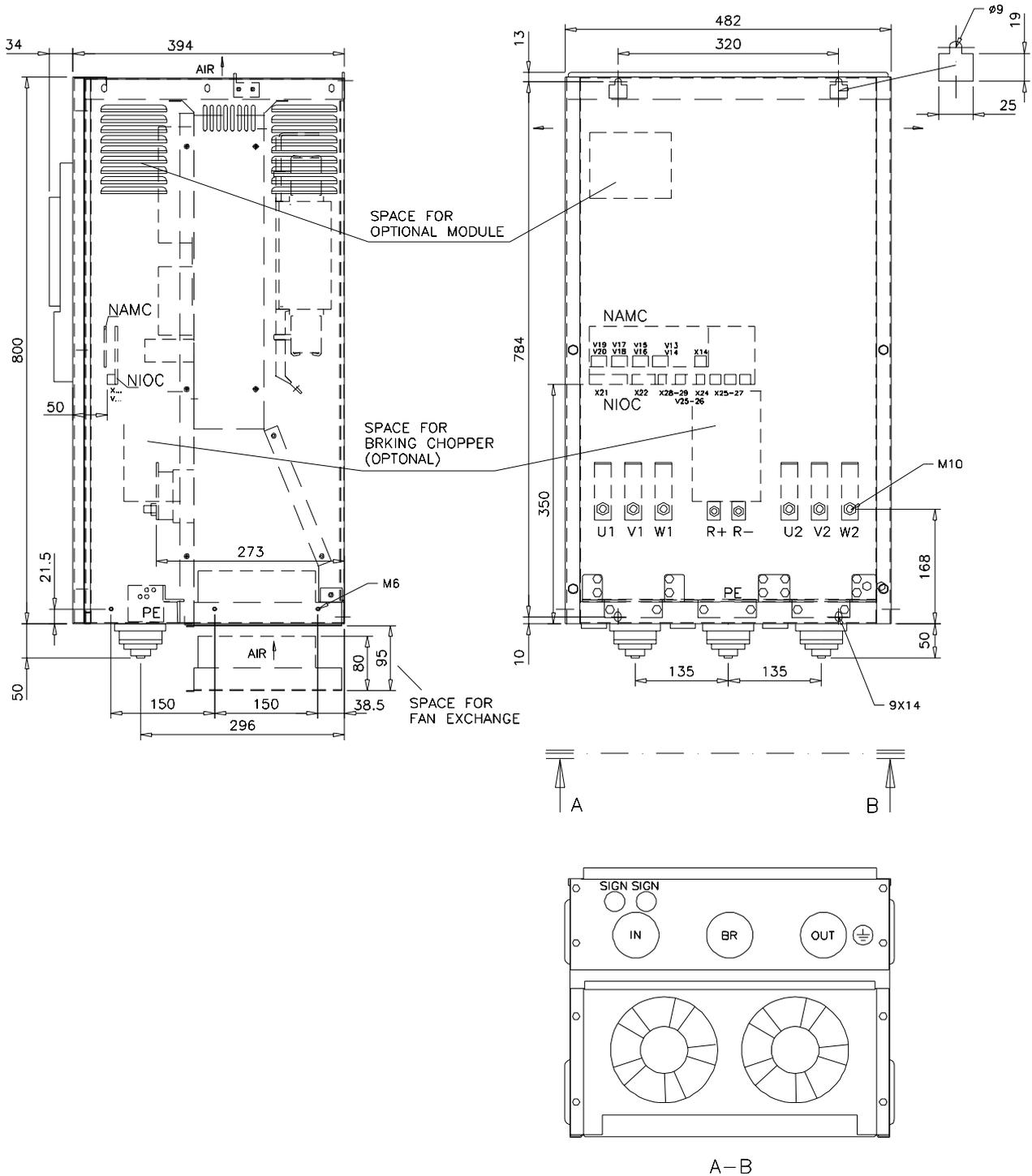
Step	Check item	Extra requirements for EMC
<b>6</b>	<b>Earthings and protection</b>	
6.1	The earthing colours, cross section and earthing points of modules and other equipment are according to circuit diagrams	No long routes for pigtailed
6.2	Connections of PE cables and busbars are tight enough. Pull the cable to test that it does not loosen.	
6.3	Doors equipped with electrical equipment are earthed.	No long earthing routes. From EMC standpoint best result is achieved with a flat copper brad.
6.4	Fans, that can be touched are protected with grid.	
6.5	Live parts inside the doors are protected against direct contact to at least IP 2x (if required).	

**Labels, Switches, Fuses and Doors** Checks for labels, switches, fuses and doors are listed below.

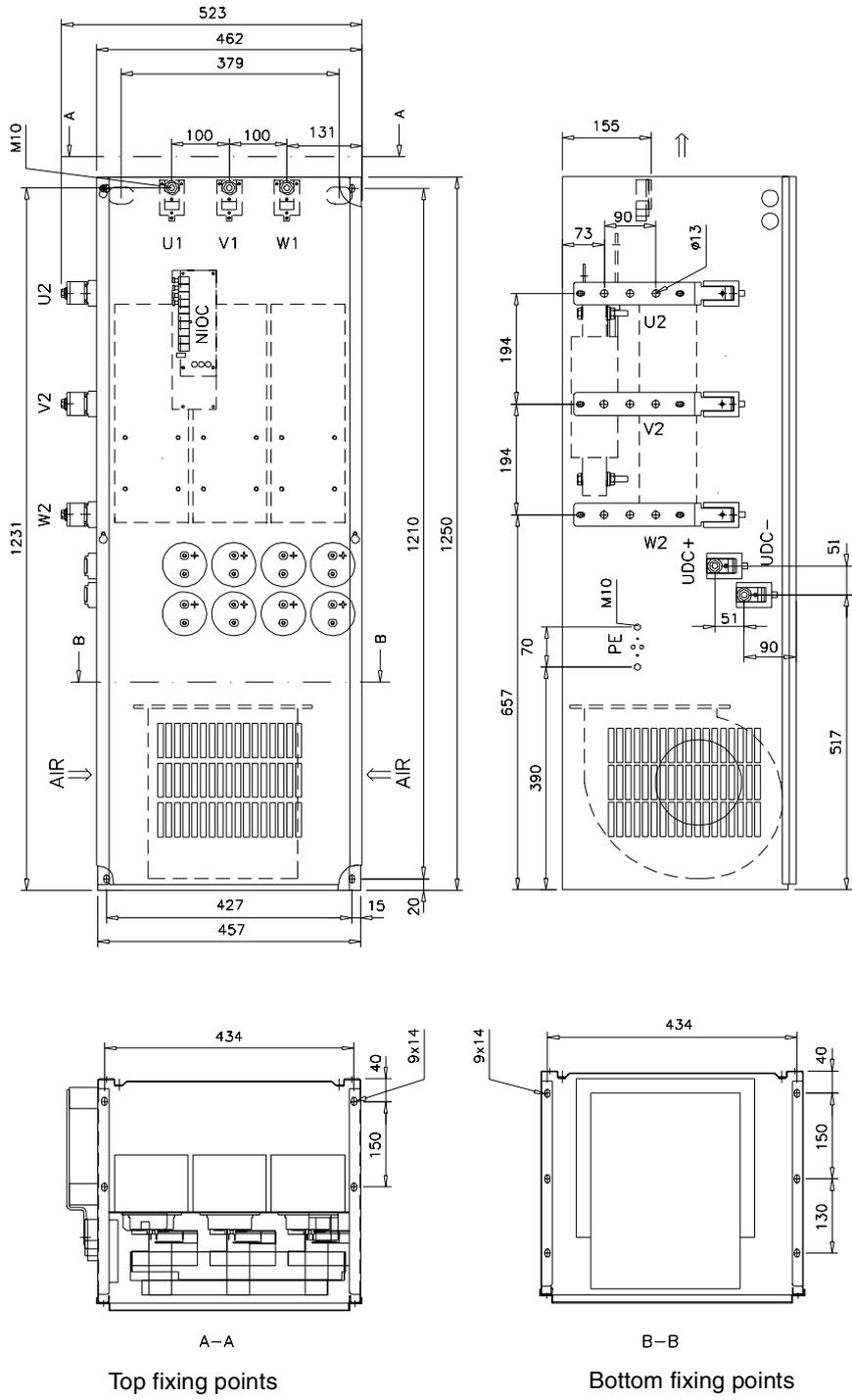
Step	Check item
<b>7</b>	<b>Labels</b>
7.1	<p>There is right information on name plates. The name plates are in right location. Check the name plates for</p> <ul style="list-style-type: none"> <li>• cabinet</li> <li>• main circuit fuses</li> <li>• settings of the circuit-breakers</li> <li>• safety switches of the main circuit.</li> </ul>
7.2	<p>Warning and instruction stickers are in correct locations.</p> <p>Stickers required inside the cabinet:</p> <ul style="list-style-type: none"> <li>•  near all earthing connections</li> <li>• inside the cabinet door main fuse specification label, warning about using only ultrarapid fuses for semiconductor protection, fuse installation (centring) note</li> <li>•  on contact covers</li> <li>• warning of live terminals of a blown fuse on contact cover on the main fuses</li> <li>• warning about apparatus not disconnected from the mains supply by the main switch on contact covers of these busbars and apparatus.</li> <li>• warning sticker for residual voltages of the converter capacitor banks placed on the converter module.</li> </ul> <p>Stickers required on the cabinet door:</p> <ul style="list-style-type: none"> <li>• five-minute warning of residual voltage</li> <li>• </li> <li>• sticker on the control panel mounting platform</li> <li>• the emergency stop and start switch label (if applicable)</li> <li>• the main switch label.</li> </ul>
<b>8</b>	<b>Switches, fuses and doors</b>
8.1	Check the functionality of mechanical switches by closing and opening them.
8.2	Check that fuses are changeable by fuse handle. Check that fuses are in the middle of the socket of the fuse switch.
8.3	<p>When fuse switches or disconnecting switches are closed, the corresponding cabinet doors cannot be opened. Check the fastening and length of the main switch fuse:</p> <ol style="list-style-type: none"> <li>1. Lock the cabinet door with the main switch in OPEN position (0).</li> <li>2. Close the main switch (position 1).</li> <li>3. Unlock the door. It must not be possible to open the door by pulling the handle.</li> </ol>

# Appendix A – ACx 604 Drawings

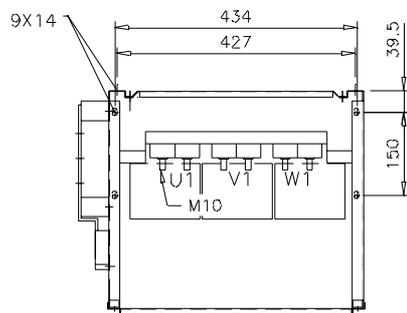
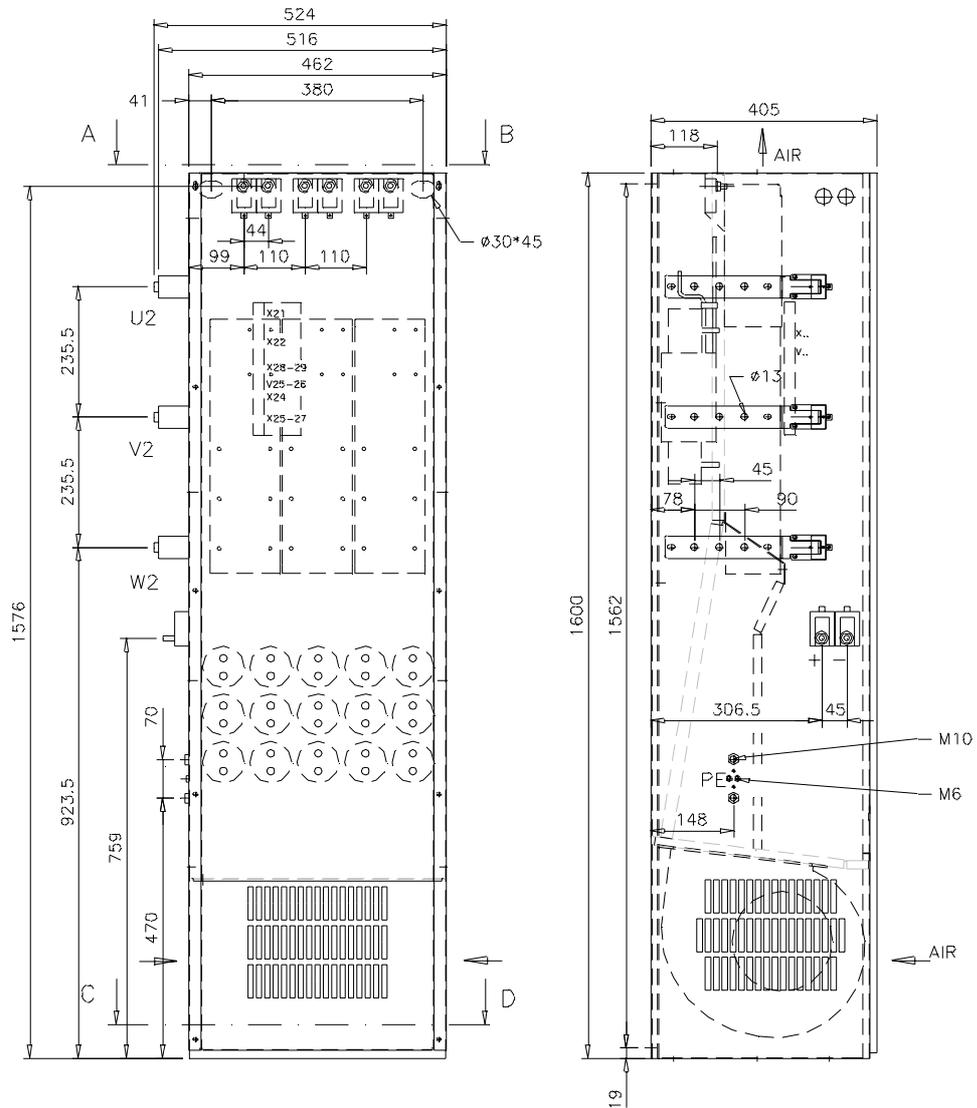
## Frame R7



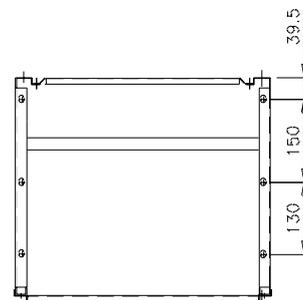
**Frame R8**



**Frame R9**



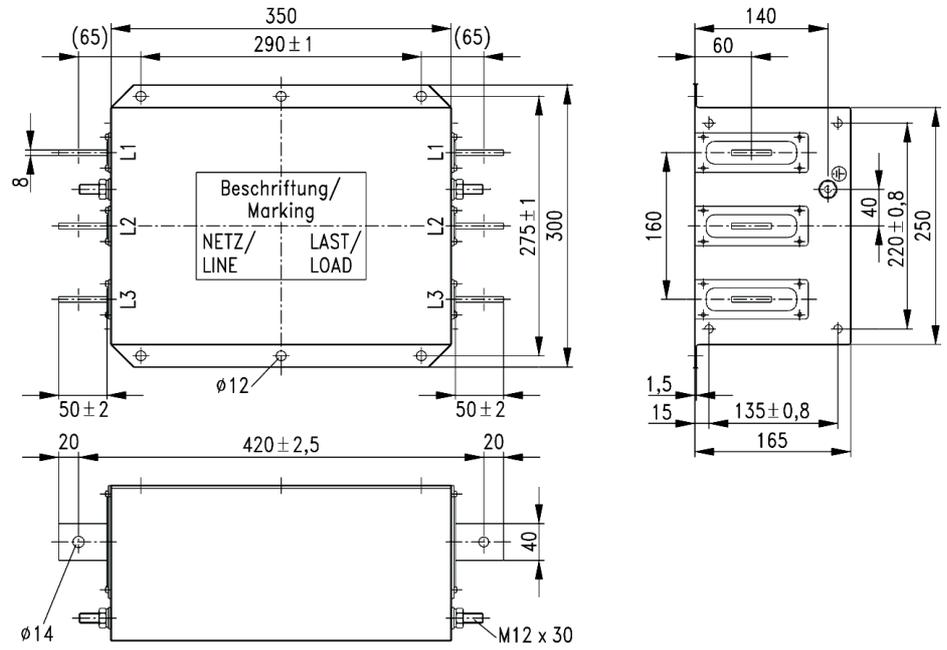
A-B  
Top fixing points



C-D  
Bottom fixing points

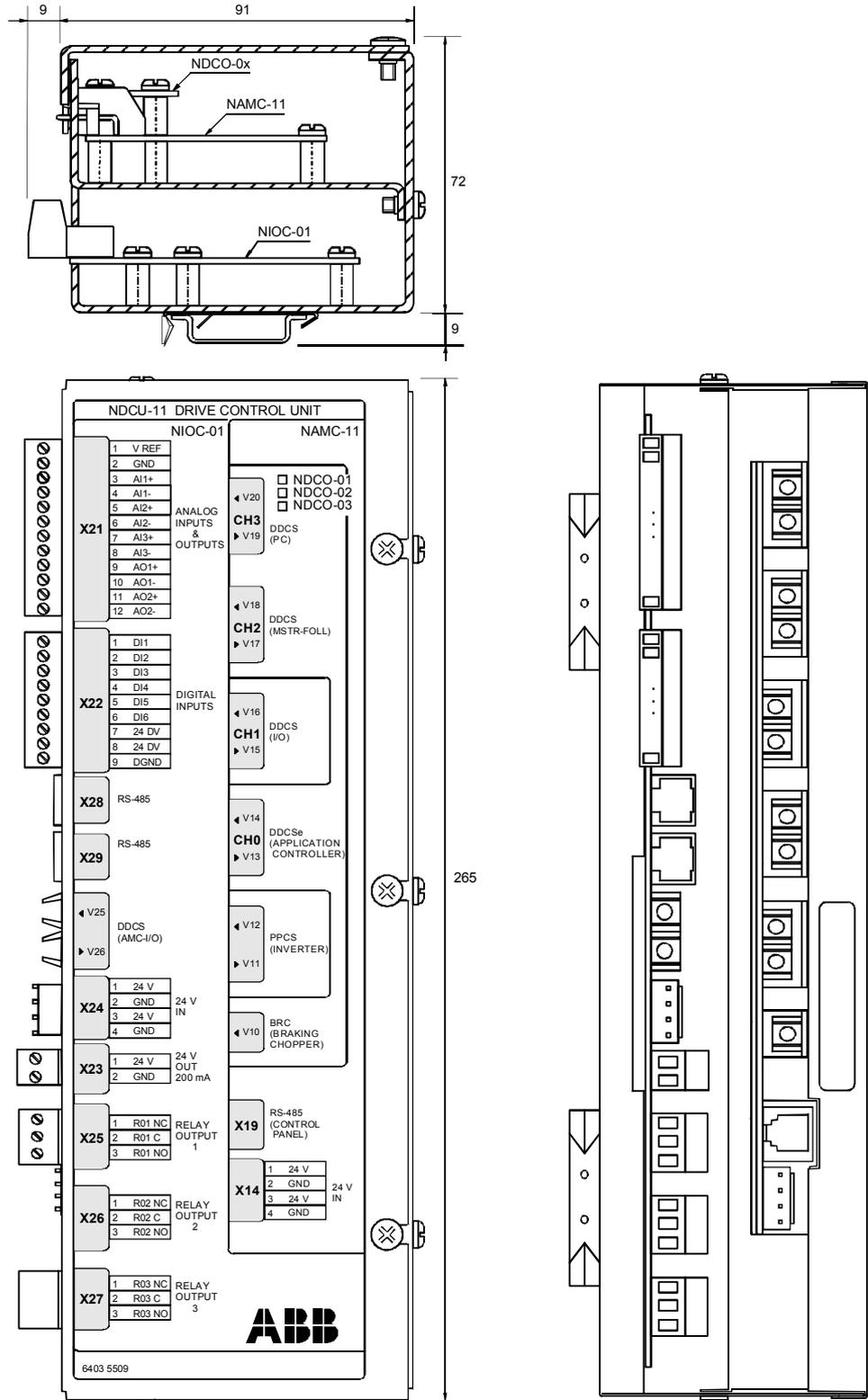


**B84143-B1000-S21**



**Drive Control Unit**  
**NDCU-11** (NIOC-01 +  
 NAMC-11)

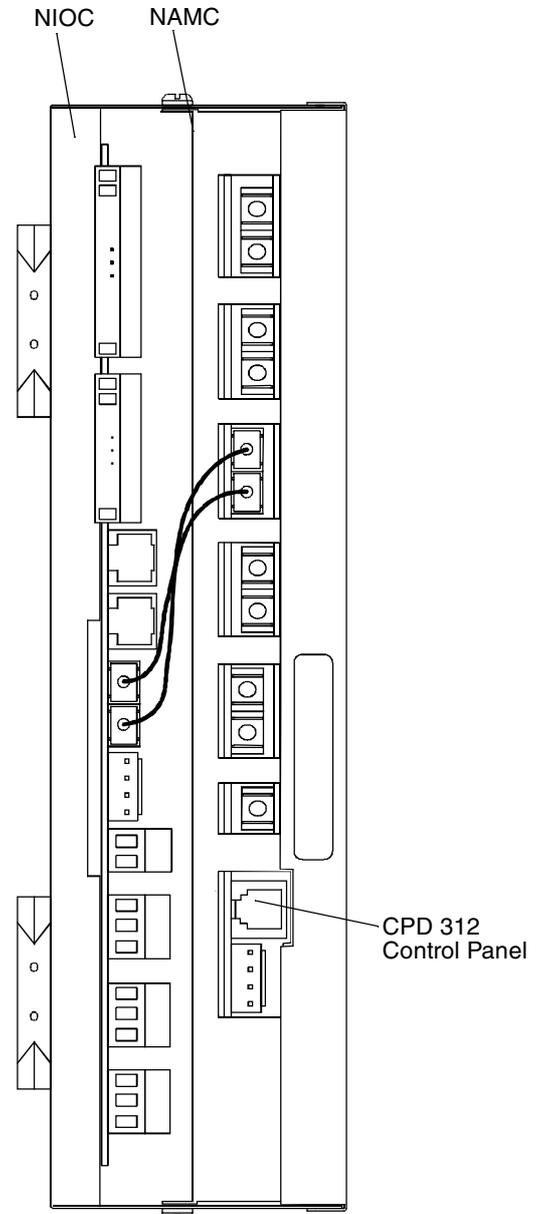
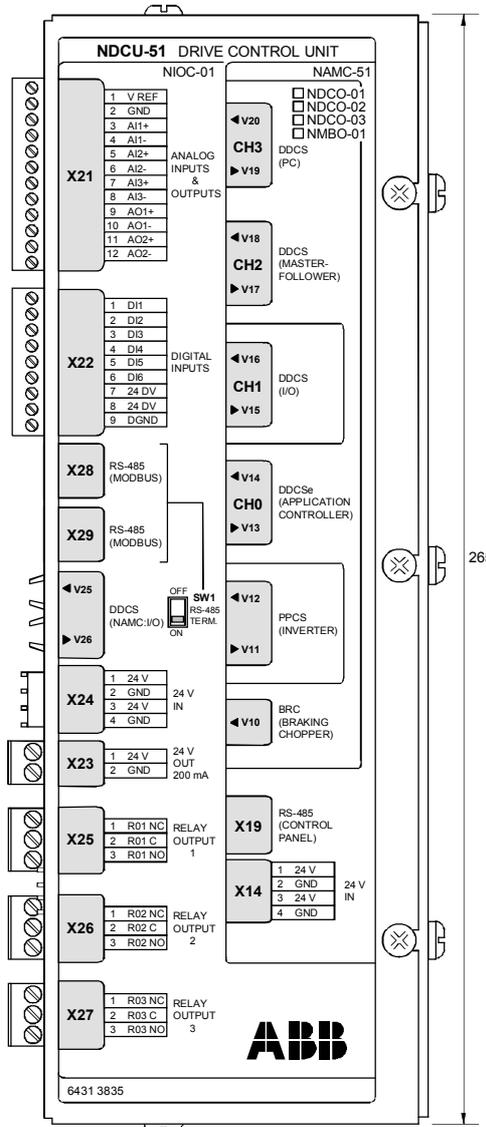
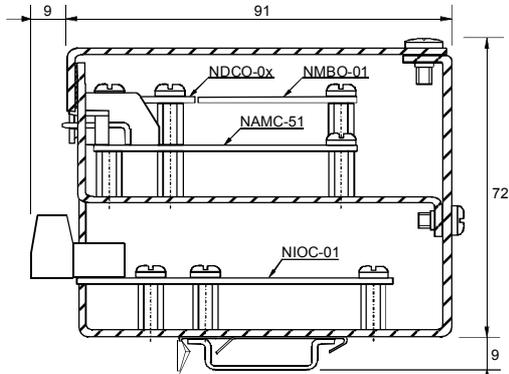
For the electrical connections refer to section *Control Board Connections (Frames R7, R8, R9)* or *Control Board Connections (Frames 2 x R8 and 2 x R9)*.



PDM code 00017350-A

**Drive Control Unit**  
**NDCU-51** (NIOC-01 +  
 NAMC-51)

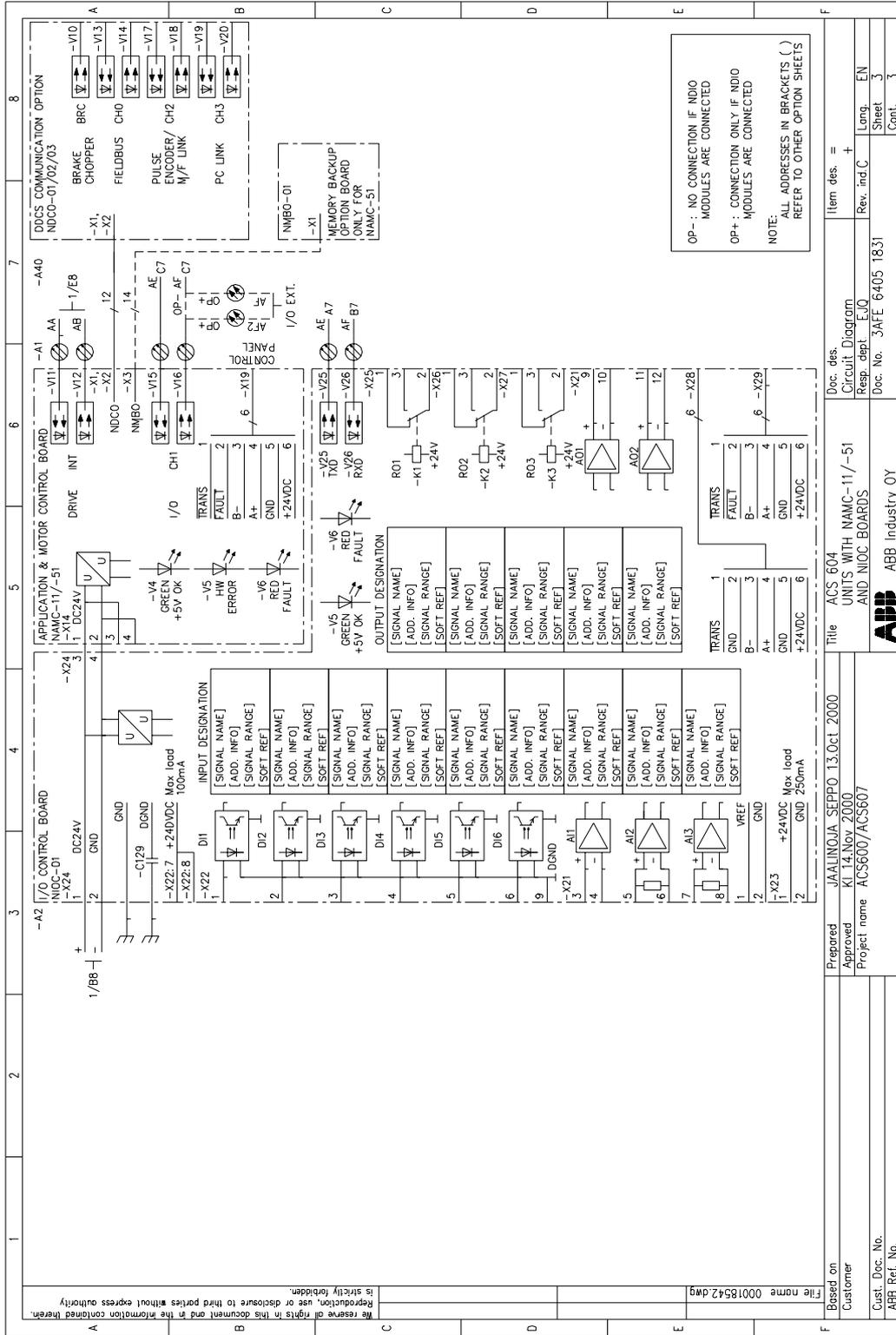
For the electrical connections refer to section *Control Board Connections (Frames R7, R8, R9)* or *Control Board Connections (Frames 2 x R8 and 2 x R9)*. NMBO-01 is an optional memory backup board.



PDM code 00057607-A

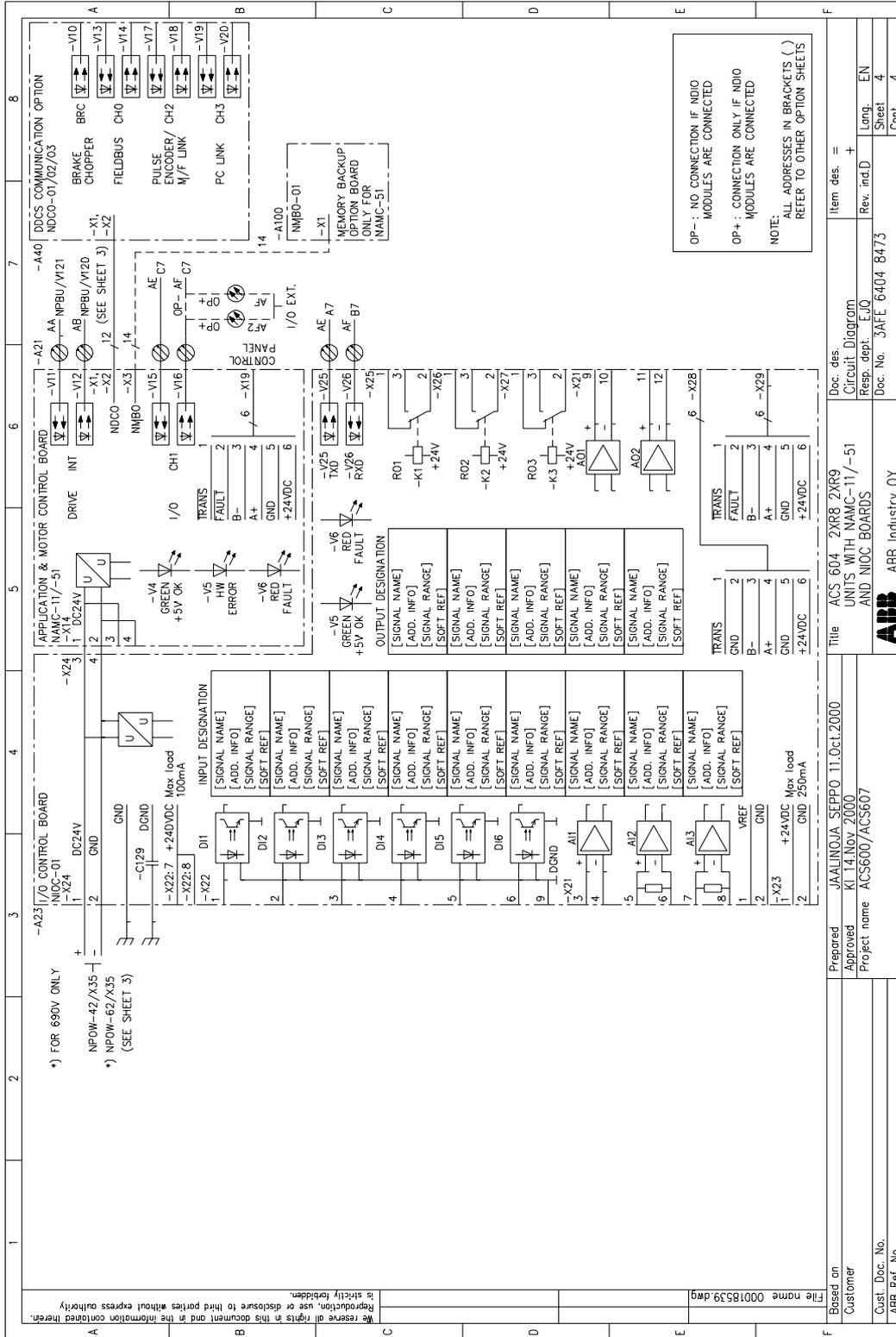
**Control Board Connections (Frames R7, R8, R9)**

A circuit diagram of the control board connections of the ACx 604 modules is shown below. The NIOC and NAMC boards are located inside the module or in the external Drive Control Unit NDCU-11/51.



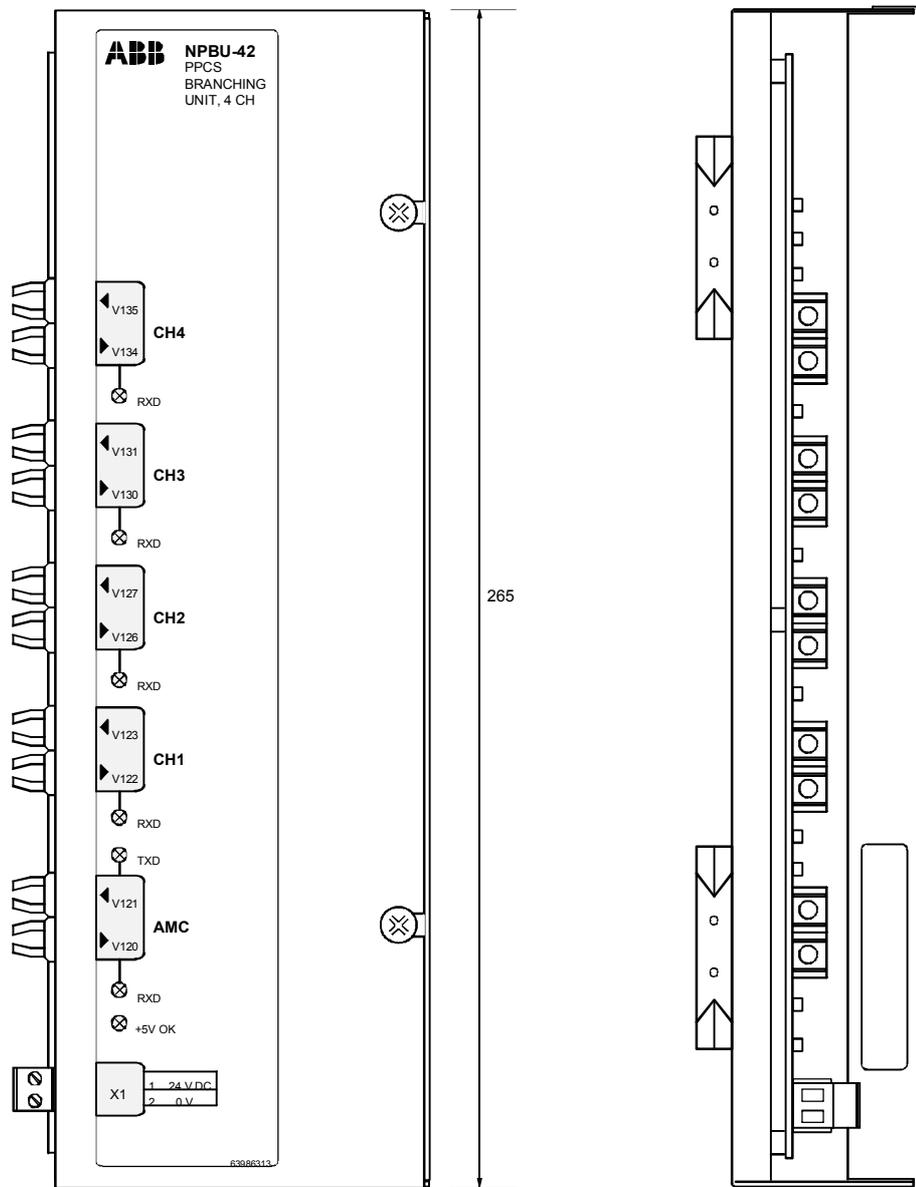
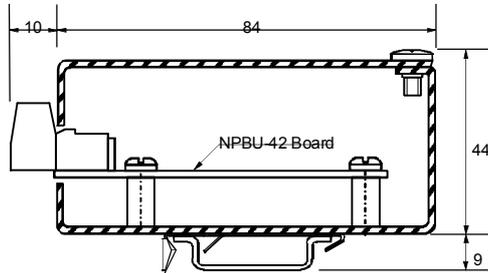
**Control Board Connections (Frames 2 x R8 and 2 x R9)**

A circuit diagram of the control board connections of frame sizes 2 x R8 and 2x R9 is shown below.



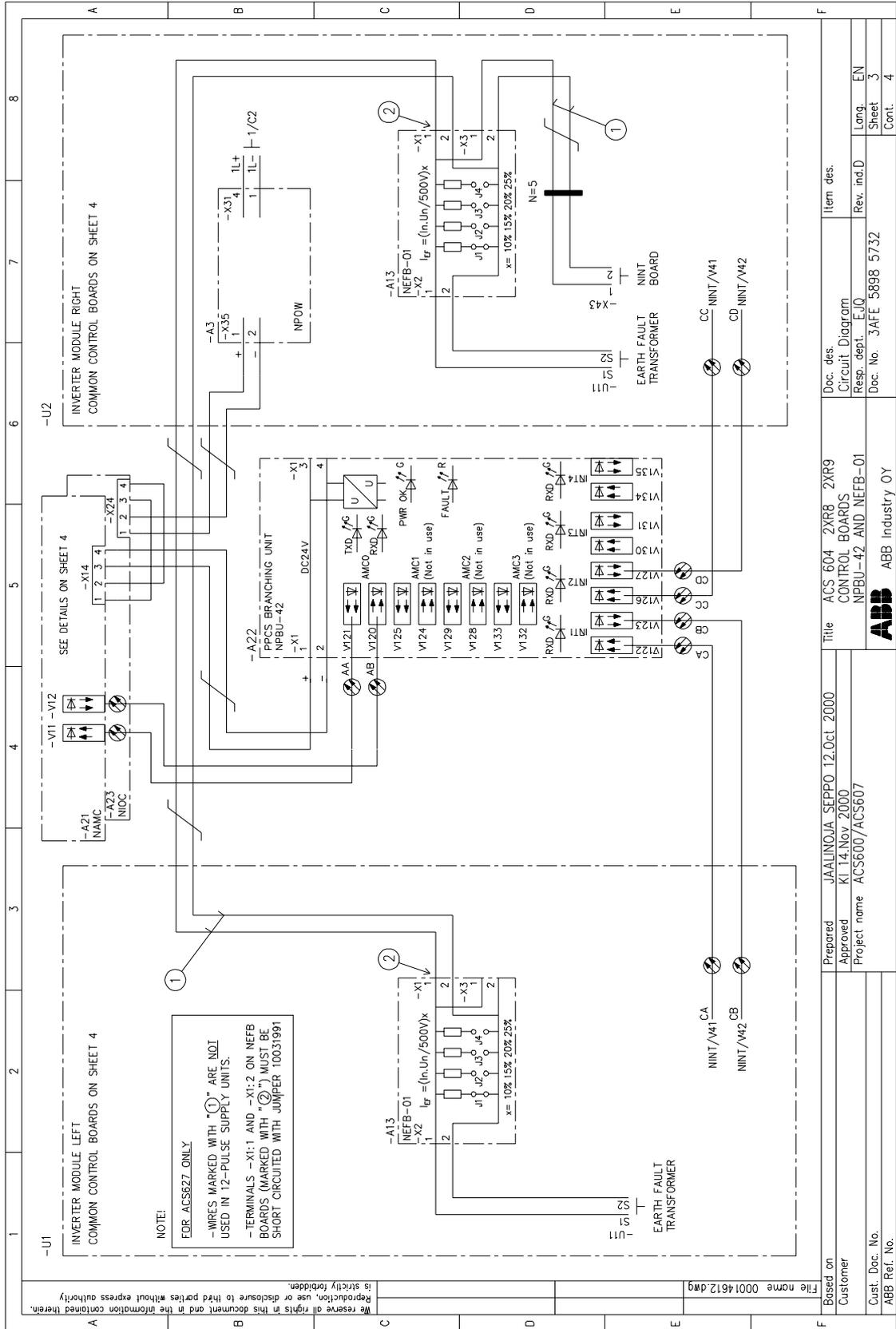
**PPCS Branching Unit  
NPBU-42**

2xR8 and 2xR9 Delivery. For the electrical connections refer to circuit diagram 58985732 and section *Control Board Connections (Frames 2 x R8 and 2 x R9)*.



PDM code 00016444-A

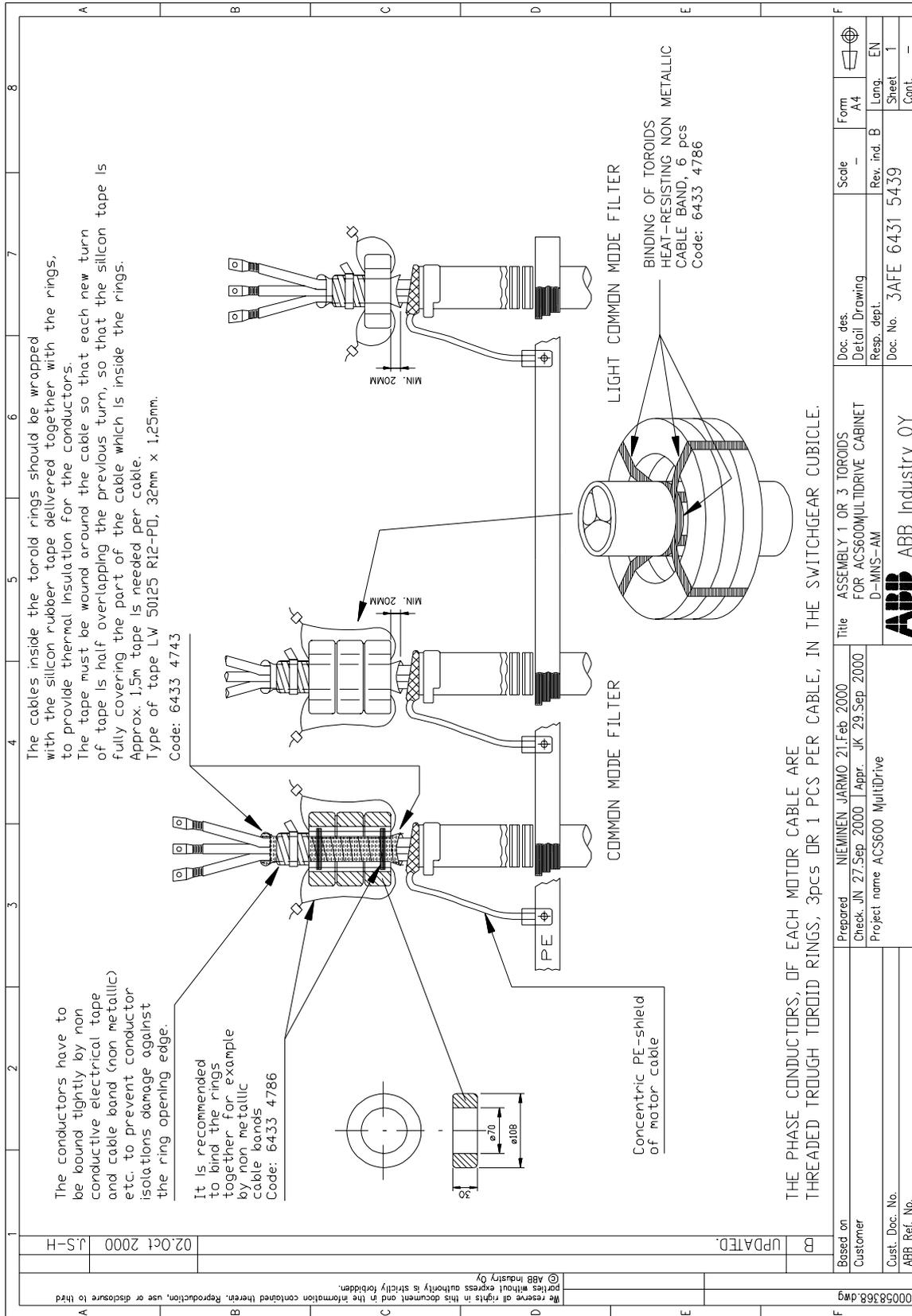
**NPBU-42 Connections**



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Title	ACS 604 2XR8 2XR9 CONTROL BOARDS NPBU-42 AND NEFB-01
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Resp. dept.	EJQ
Doc. No.	3AFE 5898 5732
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Sheet	EN 3
Cont.	4

**Common Mode Filters**







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