COMSYS

ADF System Integration
Manual

comsys.se/ADF

Safety notes

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

> ⚠ **ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or loss of life, property damage, or economic loss.

> NOTE Provides additional information to clarify or simplify a procedure.

> ⚠ **ATTENTION:** Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.
>
> **ATTENTION:** The product contains DC bus capacitors which retain hazardous voltages in excess of 1000 V after input power has been disconnected. After disconnecting input power, wait at least sixty (60) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.
>
> **ATTENTION:** This product may have been modified from factory in order for the auxiliary power to be supplied externally. After disconnecting main fuses, the external auxiliary power must also be disconnected.
>
> **ATTENTION:** Before manipulating current transformers, make sure that the secondary is short-circuited. Never open the secondary of a loaded current transformer. You must always wear isolating gloves and eye-protection when working on electrical installations. Also make sure that all local safety regulations are fulfilled.
>
> **ATTENTION:** Only qualified personnel or other trained personnel who understand the potential hazards involved may make service, updates, troubleshooting, repair or similar work to the product. Any such activities not made corrects may result in uncontrolled operation. Failure to observe this precaution could result in damage to equipment and bodily injury. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by **Comsys** for any consequences arising out of the use of this material.

The information in this document is subject to change without notice.

Standards

These products are CE compliant, which means that the products are in conformity with the European Community low voltage directives 2014/35/EU and 93/68/EEC and it bears the CE label.

The following standards apply:

Table 1: Standards

Standards	
Electromagnetic compatibility	EN 61000-6-2, EN 61000-6-4
Electrical design and safety	EN 62477-1, EN 50178 / VDE0160
Protection class	IP20 according to IEC 60529
Approval marking	2014/35/EU, 93/68/EEC, 2011/65/EU

UL/cUL Standards

The UL/cUL versions are approved according to UL/CSA standards. ADF PPM300s do exist in a UL/cUL listed version. SCC2 is as well UL/cUL listed.

Table 2: UL/cUL Standards

Standards	
Electrical design and safety	UL508/CSA22.2

File no NMTR.E357863.

DNV certification

DNV type approval exists for ADF PPM300s (excluding UL version of the PPM300) as well as the SCC2-P3 and SCC2-P6

Certification no TAE00002GN

Document revision

Table 3: Document revision

Revision	Date	History:	Status:
REV00	2014-11-22	DRAFT - ORIGINAL DOCUMENT	FOR REVIEW
REV01	2016-04-21	DRAFT – FOR REVIEW	DRAFT
REV02	2016-04-27	MAJOR CHANGES	RELEASED
REV03	2019-01-15	REDESIGN, OEM HMI INCLUDED, IP43 INCLUDED, PPM300v2B INCLUDED	RETRACTED
REV04	2019-02-01	FIXED ERROR ON BCE PIN NUMBERING	RELEASED
REV05	2021-04-30	MINOR UPDATES	RELEASED

Contents

List of figures

List of tables

1 Overview

1.1 Content

This manual describes the hardware, installation and maintenance topics of the Comsys ADF PPM300v2(B) series of active filter inverter modules.

1.2 Organization of manual

This manual covers installation and hardware setup:

ADF System Integration Manual, doc no 1 199 366 (this document)

Please also refer to the ADF P100/P300 User manual for instructions on how to commission ADF units and/or integrated components:

ADF P25/P100/P300 User Manual, doc no 1 199 172

1.3 Related documentation

The ADF P300 is considered to be the reference implementation for systems using PPM300 modules.

- ADF P300 Hardware Manual (doc no 1 199 171)
- ADF P300 Circuit Diagram (doc no 100 389; 100 823; 100 824)

2 System Overview

The ADF PPM300v2(B) is a series of inverter modules specially designed for system integrators. The PPM300v2(B) must be used in conjunction with a control module (CM300) or either the SCC2-P3 or SCC2-P6 control computer to create active filter functionality.
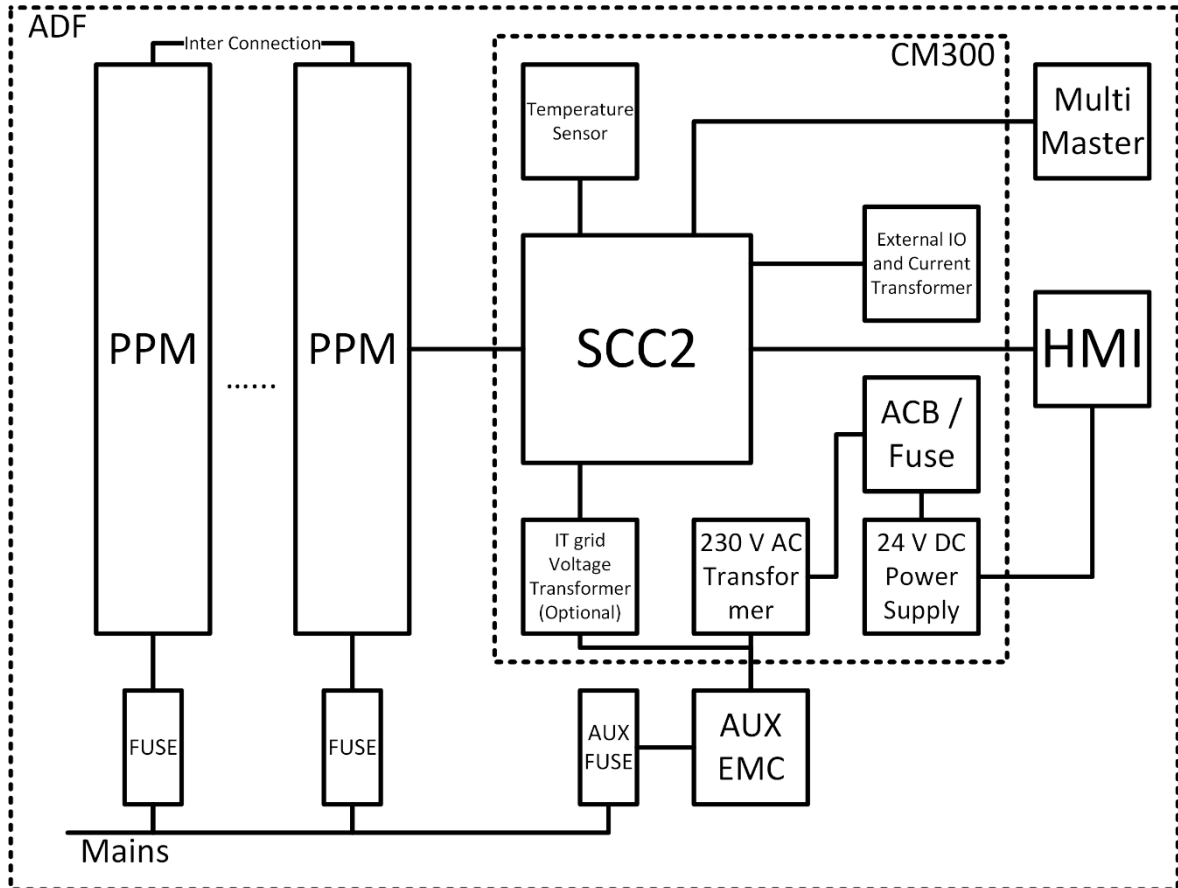
Figure 1: System overview of a typical ADF

The system overview in Figure 1 shows a typical ADF setup and the needed components to build an ADF. Some components are not mandatory or could be achieved differently. The following sections in the manual describes all components.

2.1 PPM300 – Power Processor Module

The PPM300 is the main Power Unit of every ADF system. Each module is enclosed with the needed Power electronics components. It has to be uses in conjunction with a control unit (SCC2). Up to 6 Power Units can be used with one control unit.

The PPM300 currently exists in two generations; PPM300v2 and PPM300v2B. For standard air cooled units, Comsys suggests to use the PPM300v2B. Only for liquid cooled as well as UL systems, only the older PPM300v2 generation exists.

The name is composed out of "*PPM300*" (Module type); "*v2*" or "*v2B*" (Generation); "*3*" (3-wire); "*A*" or "*W*" (Cooling type: A = air cooled, W = liquid cooled); "*120*" (Current rating); "*480*" (Voltage rating).

Table 4: PPM article numbers

Art No	Model	Description
Generation v2 Modules below		
101 764	PPM300v2-3-A-120/480-OEM	Inverter module, 3ph-3w, air cooled (EOL)
101 766	PPM300v2-3-A-120/480-IT-OEM	Inverter module, 3ph-3w, air cooled, IT (EOL)
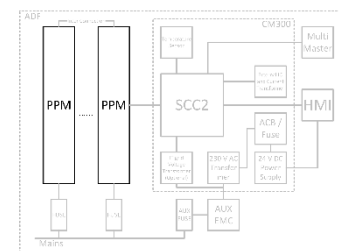
101 765	PPM300v2-3-A-90/690-OEM	Inverter module, 3ph-3w, air cooled
101 767	PPM300v2-3-A-90/690-IT-OEM	Inverter module, 3ph-3w, air cooled, IT
101 209	PPM300v2-3-A-110/480-UL-OEM	Inverter module, 3ph-3w, air cooled, UL/cUL certified
101 210	PPM300v2-3-A-90/600-UL-OEM	Inverter module, 3ph-3w, air cooled, UL/cUL certified
Generation v2B Modules below		
101 362	PPM300v2B-3-A-50/480-TN-OEM	Inverter module, 3ph-3w, air cooled
101 365	PPM300v2B-3-A-50/480-IT-OEM	Inverter module, 3ph-3w, air cooled, IT
101 363	PPM300v2B-3-A-75/480-TN-OEM	Inverter module, 3ph-3w, air cooled
101 366	PPM300v2B-3-A-75/480-IT-OEM	Inverter module, 3ph-3w, air cooled, IT
101 364	PPM300v2B-3-A-90/480-TN-OEM	Inverter module, 3ph-3w, air cooled
101 367	PPM300v2B-3-A-90/480-IT-OEM	Inverter module, 3ph-3w, air cooled, IT
101 368	PPM300v2B-3-A-120/480-TN-OEM	Inverter module, 3ph-3w, air cooled
101 370	PPM300v2B-3-A-120/480-IT-OEM	Inverter module, 3ph-3w, air cooled, IT
Liquid Cooled Generation v2 Modules below		
410 026	PPM300v2-3-W-140/690-TN-OEM	Inverter module, 3ph-3w, liquid cooled
410 039	PPM300v2-3-W-140/690-IT-OEM	Inverter module, 3ph-3w, liquid cooled

The PPM300 module and its internal components is shown in the figure below.
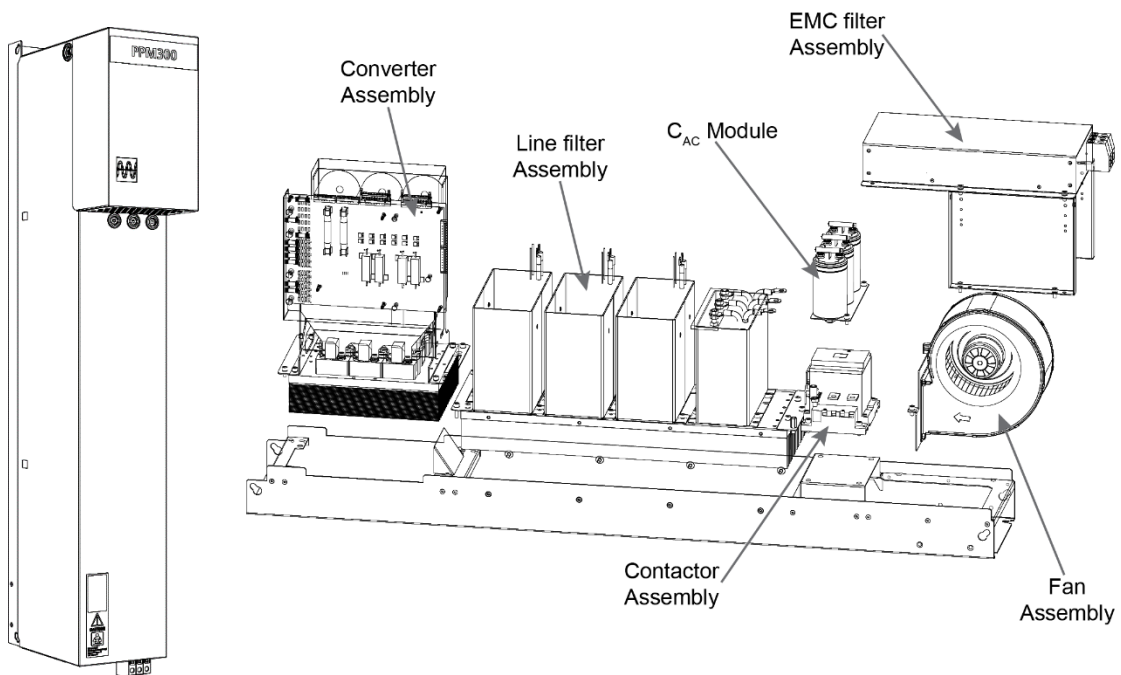
Figure 2: ADF PPM300v2 main components overview

Internally, the PPM300 without the top hood mounted is called the PEM (as in Power Electronics Module).

NOTE Throughout this manual, especially in circuit diagram, the PPM300 is sometimes referred to as the PEM.

2.2 Control Module overview (CM300) (EOL)

NOTE   The CM300 is EOL and no longer being produced. It will be replaced by the newer CM-CAB product.

The control module, CM300, is a system that can be used in conjunction with up to three PPM300 modules (in versions called CM300-P3) and up to six PPM300 modules (in versions called CM300-P6). It contains all needed control and auxiliary circuits in a prewired fashion.

The CM300 is designed to be used in an 800 mm TS8 Rittal cabinet but could also be mechanically adapted to fit other cabinets.

230 V$_{AC}$ Auxilliary voltage supply   24 V$_{DC}$ Auxilliary voltage supply   SCC2 Control Computer   Automation circuit board (ACB)
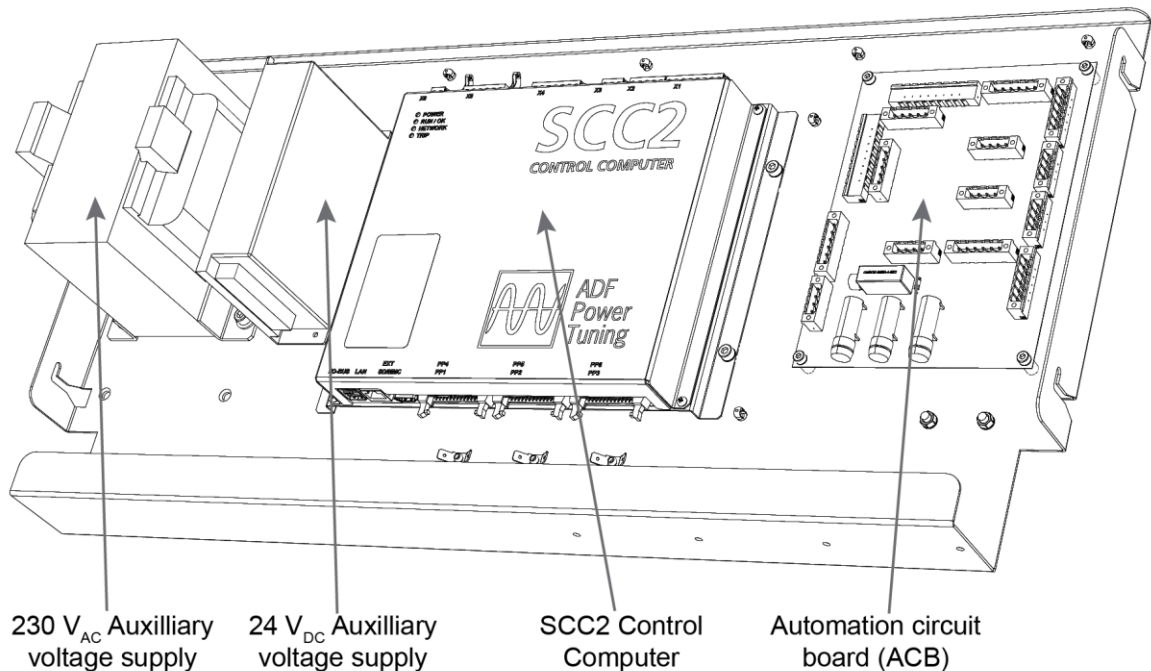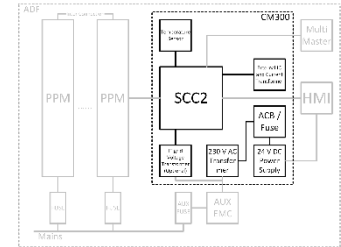
Figure 3: CM300 Main Components

The following table outlines the available CM300 configurations at the time of writing:

Table 5: CM300 article number

Art No	Article name	No # PPM300 modules	Description
100661	CM300 380-480V TN	1 - 3	CM300-P3, TN/TT, 380 – 480 V
100750	CM300 380-480V IT	1 - 3	CM300-P3, IT, 380 – 480 V
100776	CM300 215-415V TN	1 - 3	CM300-P3, TN/TT, 215 – 415 V
100777	CM300 215-415V IT	1 - 3	CM300-P3, IT, 215 – 415 V
100778	CM300 475-600V TN	1 - 3	CM300-P3, TN/TT, 480 – 600 V
100779	CM300 475-600V IT	1 - 3	CM300-P3, IT, 480 – 600 V
100780	CM300 690V IT	1 - 3	CM300-P3, IT, 690 V
100781	CM300 690V TN	1 - 3	CM300-P3, TN/TT, 690 V
100783	CM300 690V TN P6	1 - 6	CM300-P6, TN/TT, 690 V

NOTE   Please note that P6 versions have a build to order auxiliary transformer which may result in longer lead times. Specify voltage when requesting a P6 version.

2.3 Main feeder power fuses

A main fuse must protect each module. Fusing must be individual per module. It is strongly recommended to use fast fuses. In the reference implementation (ADF P300), the following fuses are used:

Size NH000, 250A, 690V aR type, such as *Cooper Bussmann CB170M1571D*. Alternative Brand: FERRAZ Shawmut NH000UD69V250PV
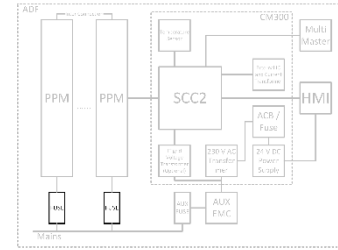
Other fuses can be used but must then be tested and evaluated by the integrator.

The correct fuse size selection for the different module types can be done based on the table below.

Table 6: Main fuse selection

Model	Nominal Current	Recommended fuse	Minimum fuse rating (IEC 60269 type gG)	Minimum fuse rating (NEMA)
Air cooled modules v2 type				
PPM300v2-3-A-120/480-OEM	120 A	CB170M1571D	160 A	N/A
PPM300v2-3-A-120/480-IT-OEM	120 A	CB170M1571D	160 A	N/A
PPM300v2-3-A-90/690-OEM	90 A	CB170M1571D	125 A	N/A
PPM300v2-3-A-90/690-IT-OEM	90 A	CB170M1571D	125 A	N/A
PPM300v2-3-A-110/480-UL-OEM	110 A	CB170M1571D	N/A	200 A
PPM300v2-3-A-90/600-UL-OEM	90 A	CB170M1571D	N/A	100 A
Air cooled modules v2B type				
PPM300v2B-3-A-50/480-TN-OEM	50 A	CB170M1571D	80 A	N/A
PPM300v2B-3-A-50/480-IT-OEM	50 A	CB170M1571D	80 A	N/A
PPM300v2B-3-A-75/480-TN-OEM	75 A	CB170M1571D	100 A	N/A
PPM300v2B-3-A-75/480-IT-OEM	75 A	CB170M1571D	100 A	N/A
PPM300v2B-3-A-90/480-TN-OEM	90 A	CB170M1571D	125 A	N/A
PPM300v2B-3-A-90/480-IT-OEM	90 A	CB170M1571D	125 A	N/A
PPM300v2B-3-A-120/480-TN-OEM	120 A	CB170M1571D	160 A	N/A
PPM300v2B-3-A-120/480-IT-OEM	120 A	CB170M1571D	160 A	N/A
Liquid cooled modules v2 type				
PPM300v2-3-W-140/690-TN-OEM	140 A	CB170M1571D	160 A	N/A
PPM300v2-3-W-140/690-IT-OEM	140 A	CB170M1571D	160 A	N/A

Table 7: Main fuse article number

Art No	Article Name	Description
440 085	Fuse type NH000 250A aR 690V	Main fuses as used in ADF P300

The reference implementation uses NH00 fuse disconnector by Rittal. The Rittal article number 9343.000

Table 8: NH Fuse disconnector

Art No	Article Name	Description
100 431	NH fuse-switch-discon 160A	NH Fuse disconnector (Rittal 9343.000)

Other fuses can be used but must be tested and approved by integrator.

2.4 AUX Supply

2.4.1 AUX Fusing

The reference implementation has internal fuse blocks for protection of the Auxiliary power circuit.

Other fuses can be used but must then be tested and evaluated by the integrator.
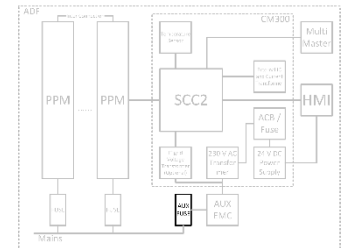
Table 9 Auxiliary fuse selection

Product line	Fuse type	Brand
480 V, IEC	Ferrule fuse link, 10x38, aM, 500 V_{AC}, 10A	Cooper Bussman CBC10M10
690 V, IEC	Ferrule fuse link, 10x38, gG, 690 V_{AC}, 10A	Mersen FR10GG69V10
480/600 V UL/cUL	Ferrule fuse link, UL-approved class CC cat. JDDZ 10 A motor or transformer protection fuse	Cooper Bussman CBLP-CC-10

Table 10: AUX fuse article number

Art No	Article Name	Description
100 168	Fuse slow CC 600V 10A LP-CC-10	AUX fuse for U/cUL type systems

2.4.2 AUX EMC

An EMC-Filter is recommended for the auxiliary power and measurement circuits. It is required to meet EMC standards and protect the system from voltage spikes.

The EMC-Filter should cover:

- Voltage measurements (SCC2 – X4 or CM300)
- Auxiliary voltage (AUX transformer)
- Pre-charging (PPM300 – J3/4 Phase 1-3)
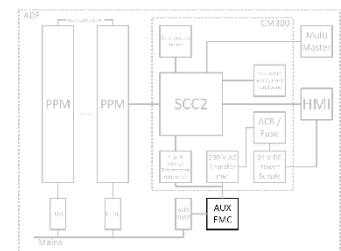
Comsys recommends one of the EMC filter in the following table. The EMC filter is sufficient for 1 – 6 modules.

Table 11: EMC article number

Art No	Article Name	Description
917 003	4F480-007.260CMS	AUX EMC Filter for 480 V in TN/TT grids
917 006	4F480-007.260CMS-IT	AUX EMC Filter for 480 V in IT grids
917 002	3F690-016.230CMS	AUX EMC Filter for 690 V in TN/TT grids
100 250	3F690-016-230CMS-IT	AUX EMC Filter for 690 V in IT grids

2.4.3 230 V_{AC}

Several power circuits within the PPM300v2(B) operates on 230 V_{AC}. The auxiliary voltage transformer converts mains voltage to 230 V_{AC}. The 230 V_{AC} transformer needs to be appropriately fused.

Comsys has a set of AUX transformers that can be used. The different transformer can be found in the following table.
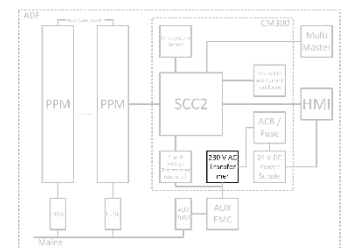
Table 12: AUX Transformer article number

Art No	Article Name	Description
100 311	Transformer SUL96C 215-415V	AUX Transformer 415 V ADF P100
100 320	Transformer SUL96C 380-480V	AUX Transformer 480 V ADF P100
100 321	Transformer SUL96C 475-600V	AUX Transformer 600 V ADF P100
100 343	Trafo Pri 208-690V OFL-200	AUX Transformer 690 V ADF P100
102 549	Transformer OFT-250VA 525-690V	AUX Transformer 525-690V ADF P300 CAB4

Art No	Article Name	Description
102 598	Transformer OFT-250VA 208-480V	AUX Transformer 208-480V ADF P300 CAB4
102 455	Transformer OFT-750T 208-690V	AUX Trafo 208-690 V ADF P300

2.4.4 24 V$_{DC}$

The SCC2 control computer and internal circuits need 24 V$_{DC}$. The 24 V$_{DC}$ supply needs to be appropriately fused.

Table 13: 24 VDC article number

Art No	Article Name	Description
100 043	PSU 24VDC 50 W	24 V$_{DC}$ PSU suitable for up to 1 module
100 044	PSU 24VDC 100 W	24 V$_{DC}$ PSU suitable for up to 3 modules
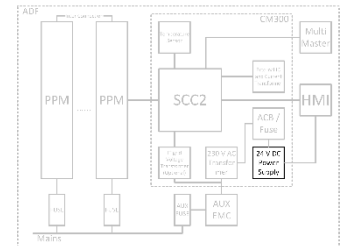
2.5 ACB / Fuse

The Automation Circuit Board (ACB) routs all signal and auxiliary circuit inside the ADF. Additional functions are fusing for 230 V$_{AC}$ as well as the main contactor relay.

The ACB card is not required in a system integration design. Fuse and relay would need to be implemented in a different approach if the ACB card is not used.

Comsys suggests not to use the ACB card. Long term, the ACB is planned to be phased out.

Table 14: ACB article number

Art No	Article Name	Description
490 065	ACB UL	Automation Circuit Board
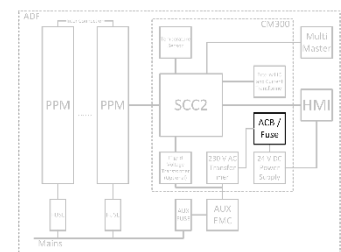
2.6 SCC2 – Control Computer

The SCC2 control computer is a stand-alone digital processing system, containing all functions for controlling the power processor modules (PPM). It also features protection circuitry for monitoring and main contactor control. The SCC2 control computer is an essential part of the ADF and is always needed in a system integration.

The SCC2 exists in two variants SCC2 P3 for the operation of 1 – 3 PPMs and the SCC2 P6 for the operation of 1 – 6 PPMs.

A license key is needed in the setup for the SCC2 P6.
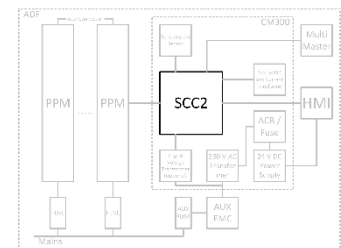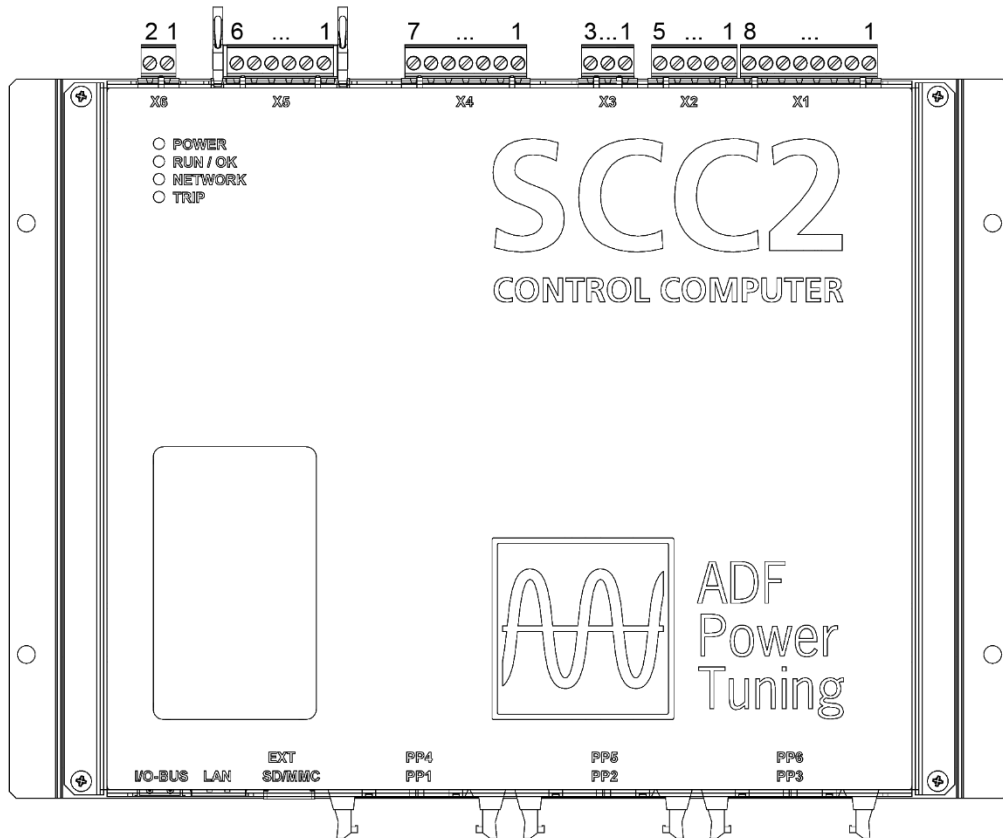
Figure 4: SCC2 control computer front panel indicators location

The following SCC2 variants are available for system integration:

Table 15: SCC2 article number

Art No	Article Name	Description
100 791	SCC2 P3 OEM	SCC2 Control computer, up to 3 modules
101 202	SCC2 P6 OEM	SCC2 Control computer, up to 6 modules

2.7 IT grid voltage transformer

To use an ADF in an IT grid, it is often necessary to increase the resistance between phase and earth. To do so Comsys suggests using voltage transformers in the measurement circuit.

Comsys offers a fitting IT grid voltage transformer setup. Article number can be found in the table below.

A license key is needed in the setup for the voltage transformer. The VT's transform the grid from a Delta to a Y grid. The license key tells the SCC2 to transform the measurement back.

Table 16: IT grid VT article number

Art No	Article Name	Description
100 865	IT-ASS CM300 215-690V	IT grid voltage transformer
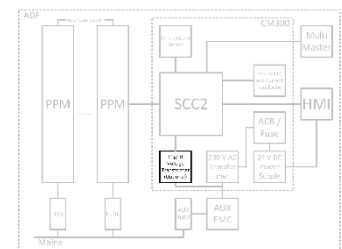
2.8 HMI – Human Machine Interface (optional)

2.8.1 HMI-B – Basic HMI

The Basic HMI consist of a self-illuminating button. Basic operations like start and stop, can be performed on the Basic HMI. Basic information is shown with different colored LEDs inside the button.

The ADF is powered ON by pressing this button short and powered OFF by pressing the button for two seconds.
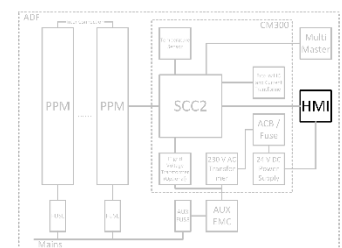
The HMI-B is supplied with a 2 m USB cable to connect to the SCC2 I/O Bus. Additionally, it is supplied with 24 V input as well as a switchable 24 V output. It can switch the 24 V supply for the SCC2 and thereby turn on and off the ADF. The LED modes is shown in the table below:

Table 17: Basic HMI indication

LED Mode	Indicated system status	Button action
OFF	The system is powered off.	Boot system
Fading red	System in trip and log is being written to SD-card.	None
Solid red	System in trip and no SD-card write is in progress.	Acknowledge all alarms
Fading yellow	Pre-charge / all other states.	None
Solid yellow	In standby waiting for start condition.	Exit standby and enter stopped mode
Fading green	System is stopped.	Start system
Solid green	System is running.	Stop the system
Solid orange	HMI-B malfunction	None

Table 18: Basic HMI article number

Art No	Article Name	Description
100 923	HMI OEM-B	ADF HMI-3 Basic OEM Kit

2.8.2 HMI-E – Extended HMI

The HMI-E is a combination of the HMI-B and a 4.3" color touchscreen. All settings, configuration and operation can be performed from the HMI (Human- Machine Interface) panel, see Figure 5. Please refer to the ADF P100/P300 User Manual (1 199 172) on how to use the Extended HMI.

Table 19: Extended HMI article number

Art No	Article Name	Description
100 924	HMI OEM-E	ADF HMI-3 Extended OEM Kit Extended 4.3" graphical HMI
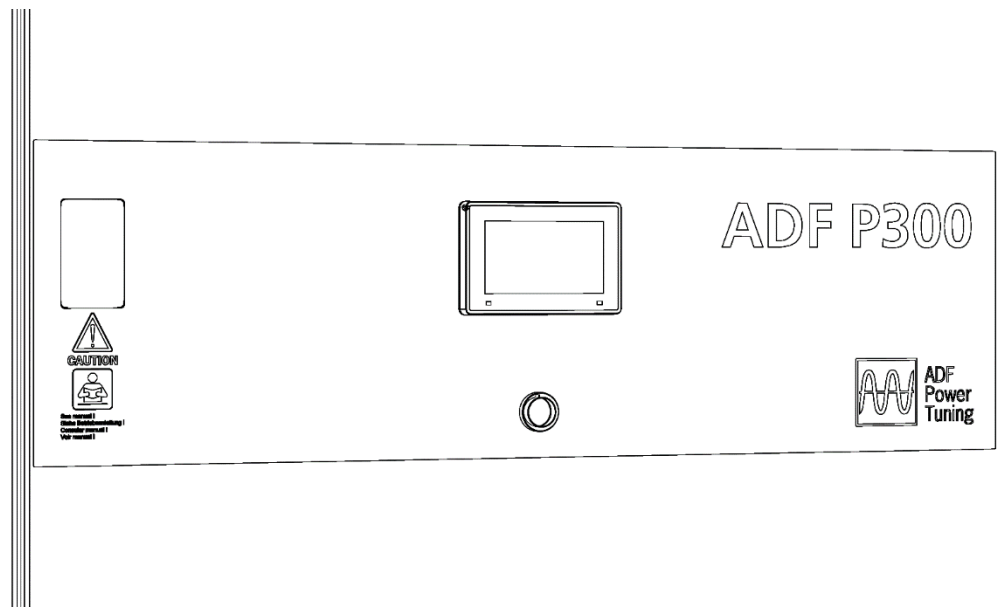
Figure 5: HMI-3 Extended (and Basic) as mounted on ADF P300

2.9 Temperature sensor

The temperature sensor is used for measuring the ambient temperature in the ADF. The temperature sensor is a specific design for the ADF. Only Comsys temperature sensors can be used here.

Comsys suggest using a temperature sensor to avoid the ADF running during high ambient temperatures. Operation without temperature sensor is possible.

The temperature sensor is connected to the SCC2 I/O Bus with an USB cable which must be ordered separately.

Table 20: Temperature sensor article number

Art No	Article Name	Description
101 600	I2C TEMP STICK	Temperature sensor to measure ambient temperature
100 429	CALE USB A/M-Mini 2.0 2m BLACL	2 m (6.5 ft.) USB 2.0 cable A/M-Mini
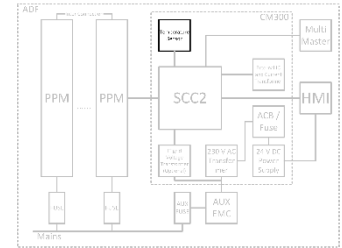
2.10 User I/O & Current Sensor I/O

The user signal interface terminals, X11/X12 are used for connecting current transformers, interface to external devices via alarm outputs and digital inputs and for interconnecting the systems for parallel operation. See the ADF P300 Hardware manual for more information on how to connect current transformers (CTs), digital inputs and outputs.
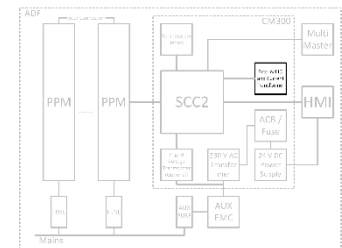
2.11 Multi-Master Interface (optional)

For paralleling several SCC2 units, a multi-master interface must be used. The multi-master interface enables multiple SCC2s to work together as if they were one unit. This is needed if several ADFs will be operated in closed loop operation.

The multi-master interface consists of a 1.6 m long cable connected on one side to the EXT bus of the SCC2 and of the other side it has two RJ45 terminals for the interconnection of several SCC2s. The RJ45 terminals are mounted in a housing with DIN-rail connection possibility.
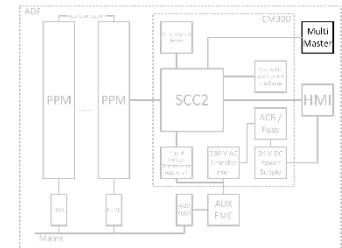
Table 21: Multi-Master article number

Art No	Article Name	Description
416 072	Multi Master CM300	Multi-Master adapter. Can be used for all system integration

2.12 Pre-fabricated cables

2.12.1 Cable harness 2/3 stack (Interconnection)

Connecting multiple PPM modules within one cabinet requires some interconnection between these modules.

Comsys offers pre-fabricated sets of cables for an active filter with 2 or with 3 modules.

Each set of cable consist of an DC-Link interconnection as well as an AUX interconnection. The DC-Link interconnection itself is built up out of two sets, the DC-Link positive in red and the DC-Link negative in black. The AUX interconnection is a set of blue cables.

Table 22: Article number interconnection

Art No	Article Name	Description
100 618	Cable Harness P300-2 Stack	Interconnection cable harness for 2 PP Modules
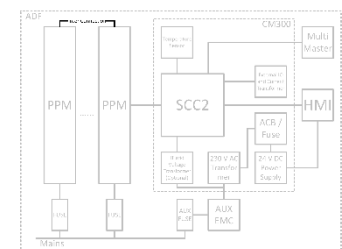
| 100 619 | Cable Harness P300-3 Stack | Interconnection cable harness for 3 PP Modules |

2.12.2 Interconnection for 4 – 6 modules

With more than 3 modules and using the SCC2-P6, a system is built out of "1-Stack", "2-Stack" and "3-Stack" systems. An extra P6 interconnection cable to connect two of these systems is needed. An extra 2-Stack cable set if suggested for this. Only the AUX interconnection cable is needed. The DC-Link interconnection of the 2-Stack cable set is to be discarded.

Comsys suggest the following setup:

	SCC2 connection 1-3	SCC2 connection 4-6	Needed components
4 module system	Use PPM1 and PPM2	Use PPM4 and PPM5	3x 100 618 One of the 2-Stack DC-Interconnection need to be discarded
5 module system	Use PPM1, PPM2 and PPM3	Use PPM4 and PPM5	2x 100 618 1x 100 619 One of the 2-Stack DC-Interconnection need to be discarded
6 module system	Use PPM1, PPM2 and PPM3	Use PPM4, PPM5 and PPM6	1x 100 618 2x 100 619 One of the 2-Stack DC-Interconnection need to be discarded

2.13 Mechanical options

2.13.1 TS8 roof (IP20)

The reference implementation in the ADF P300 designed for a Rittal TS8 cabinet uses a special roof to avoid circulating the warm air back into the cabinet. A setup like this or similar is required to avoid overheating of the active filter. Together with the roof, a gasket inside the cabinet is needed to seal off the cabinet. Furthermore, three additional gaskets are needed for each PPM opening (see table below). They will be used for covering up the opening in case no modules are installed on a certain location. These gaskets are furthermore required in a IP21 solution to avoid water standing on the cabinet to flow inside.

Art No	Article Name	Description
100 128	Top Roof CAB300 v2	Roof for Rittal TS8. Provides IP20 cover
101 011	Gasket kit CAB-8 IP20	Gasket to seal of the roof from the cabinet
100 582	Gasket CAB IP21	Gaskets needed for IP21 and to avoid air circulation (3 are needed per roof)

2.13.2 IP21 roof

IP21 roof for the reference implementation in the ADF P300. Used to avoid water dripping from the top. TS8 roof (IP20) is needed to be used in combination with this roof.

Art No	Article Name	Description
101 010	Top Roof IP21 CAB-8 Complete	IP21 solution for Rittal TS8

2.13.3 IP43 roof

IP43 roof for the reference implementation in the ADF P300. Used to avoid water dripping from the top. TS8 roof (IP20) is needed to be used in combination with this roof.

Art No	Article Name	Description
101 009	Top Roof IP43 CAB-8 Complete	IP43 solution for Rittal TS8

3 Bare-minimum ADF implementation

The following circuit diagram outlines the bare minimum ADF system. There are EMC filters included; these are needed in most markets, but not all; however, Comsys ADF EMC filter also provides over-voltage protection for components, and should never be left out. There is no HMI, no ON-OFF switch, and no controlled pre-charge; the pre-charge is "always on". The digital inputs and outputs of the SCC2 are not utilized. The corresponding unused terminals are left out from the system.
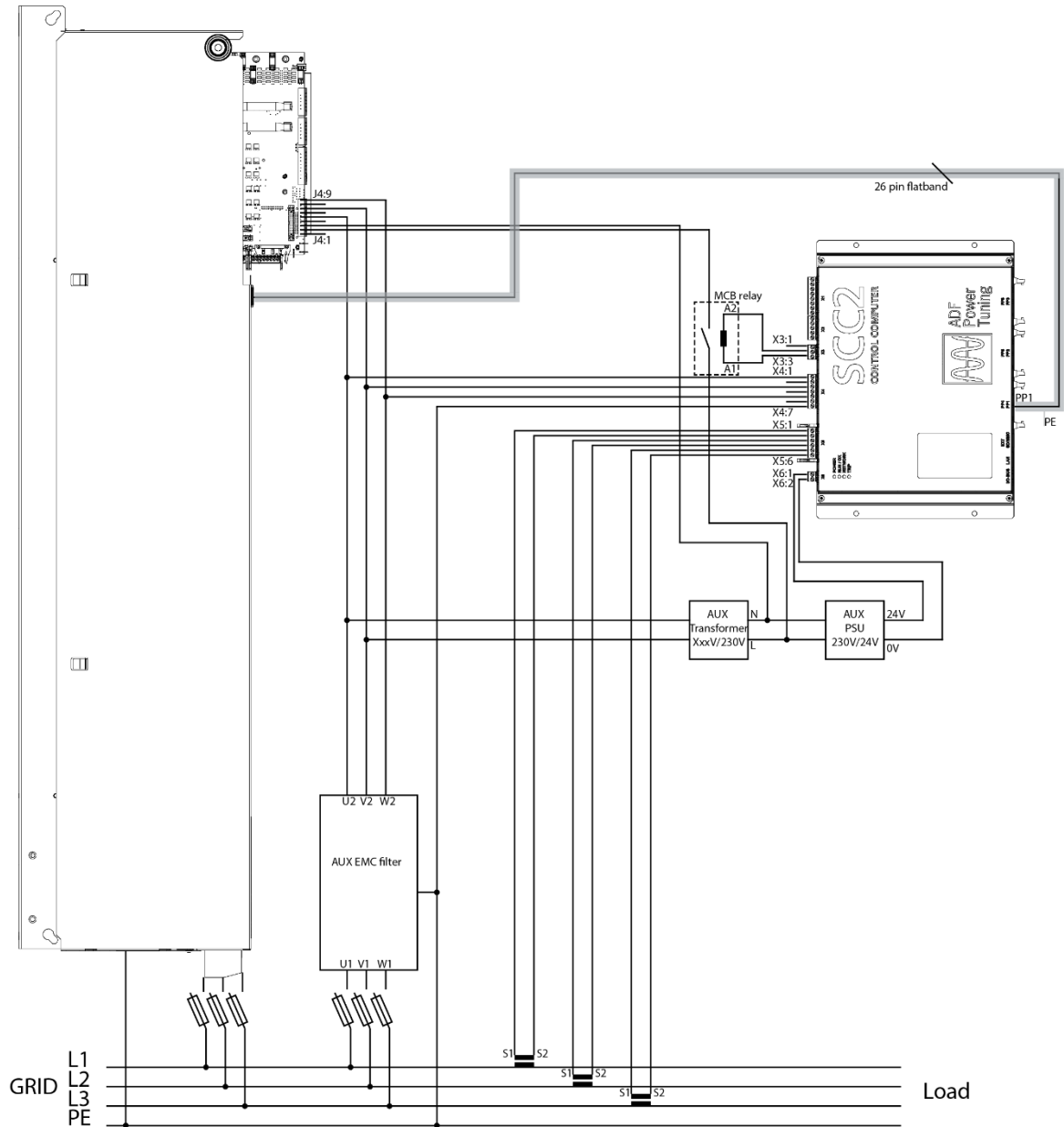
Figure 6: Minimum ADF configuration schematic (PPM300 and SCC2 are not to scale)

Figure 6 gives as quick overview of a minimum configuration. The system needs 230 V_{AC} and 24 V_{DC} auxiliary voltages. The 230 V_{AC} will supply the internal fan in the PPM300 module as well as the main contactor. The 230 V_{AC} for the main contactor is supplied via the MCB relay to pins J4:2-3 (on PPM300).

Contactor and fan control is supplied to the module from the SCC2 via the X3:2-3 (on SCC2) to A1 and A2 on the MCB relay. Please note that the MCB relay must be purchased externally.

The 24 V_{DC} must be fed to the SCC2 via X6:1 (24 V_{DC}) and X6:2 (0 V). This can be done through the HMI-B or HMI-E. In this example the HMI is left out.

The 26 pin flat-band cable from the PPM300 to the SCC2 transfers control signals, 24 V$_{DC}$, and reads temperature, voltage and current from the PPM300. The 26-pin flat-band cable is included in the PPM300 module and already mounted on the converter.

CT current measurements are connected to X5 on the SCC2, input pairs 1-2/ 3-4/ 5-6. The CT circuit must use 5A secondary. Please refer to the ADF P300 or ADF P100 Hardware manuals for more information.

Main power is connected to the PPM300 via the integrated EMC filter, inputs marked U1, V1, and W1. Main voltages must be measured by the SCC2 for proper operation, and these can be supplied via an EMC filter (marked AUX EMC filter in the sketch above). From the secondary of this EMC filter, the three phases then go to the SCC2 for voltage measurement (X4:1,3,5,7) and to the PPM300 module for pre-charging (J3:5,7,9).

> **ATTENTION:** The main drawback of the minimal configuration is that the pre-charge is always on. Pre-charge can be controlled with a three-phase contactor. Further, there is no connected HMI, which means that the system must be controlled either via digital inputs or field bus.

> NOTE   All inputs/outputs are described in more detail later in this manual.

> **ATTENTION:** The minimal configuration only supports a single PPM300 module. If several modules are supposed to work in parallel, additional wiring between the modules is needed. This is detailed in section 4.1.7.

4   Component details

4.1   PPM300 – Power Processor Module

4.1.1   Technical Drawings

Dimensions of PPM300 are given in the below drawing.
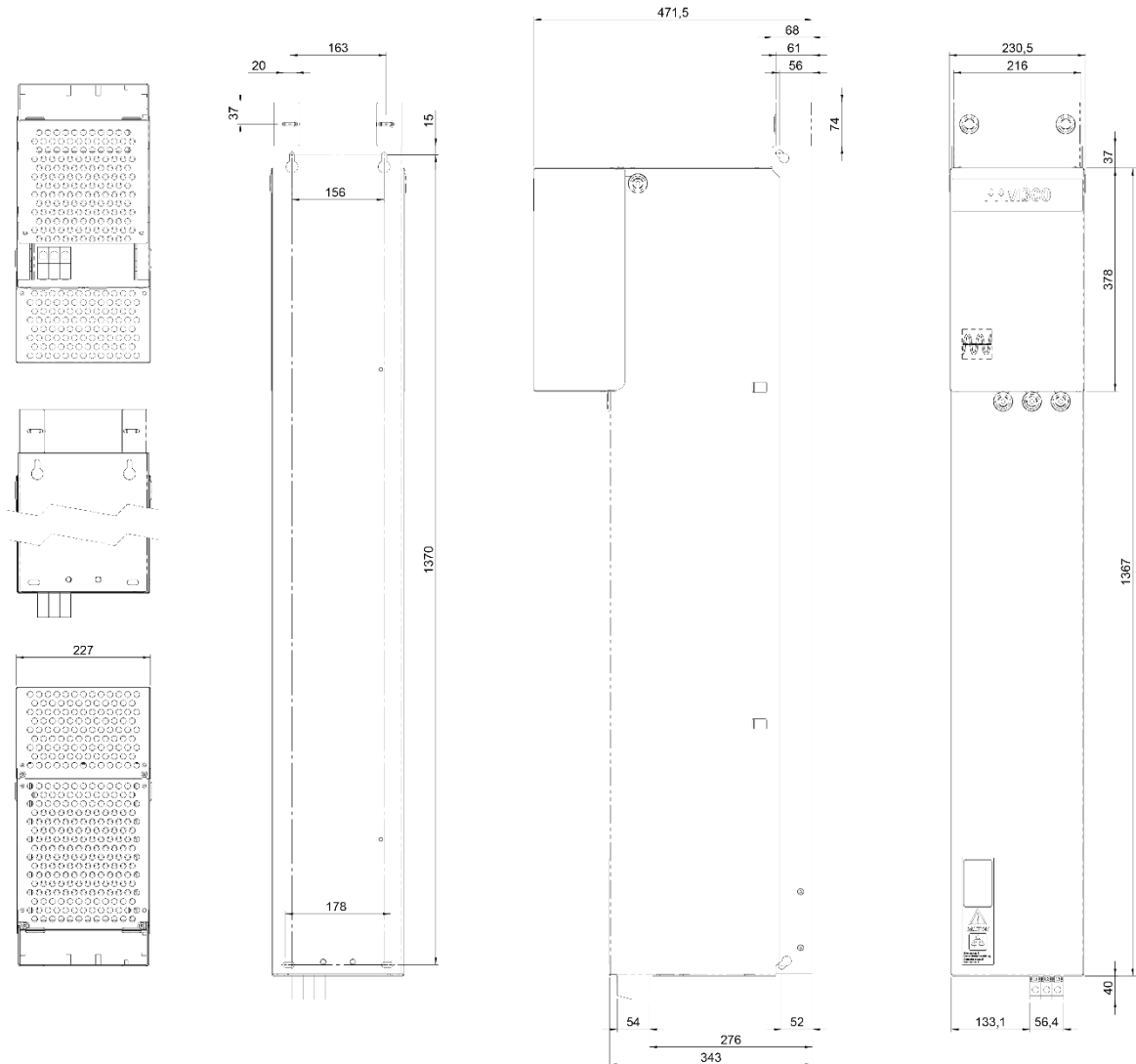
Figure 7: PPM300 Dimensions (all dimensions in mm)

4.1.2   Fixating of PPMs

The mounting pattern for the PPM300 did change over the time. The distance between the top two holes has been 156 mm since version 1 of the modules. The distance between the bottom two holes has been in the past 178 mm. To make both, top and bottom holes, to the same distance, the two bottom holes have been change into long holes. Supporting both, 156 mm as well as 178 mm. Comsys suggests to use the distance of 156 mm on top and bottom.

Additionally, every PPM is supplied with a supporting guidance bar. This bar can be installed underneath the PPM and hold the PPM during the installation process.
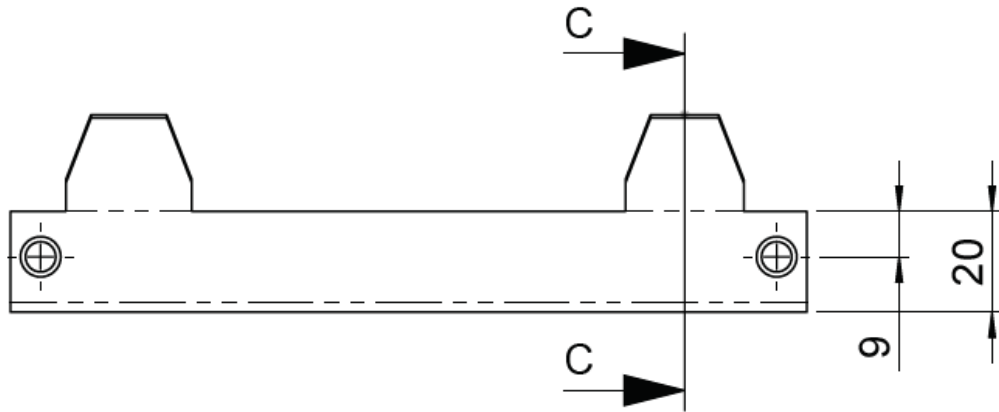
Figure 8: Supporting guidance bar
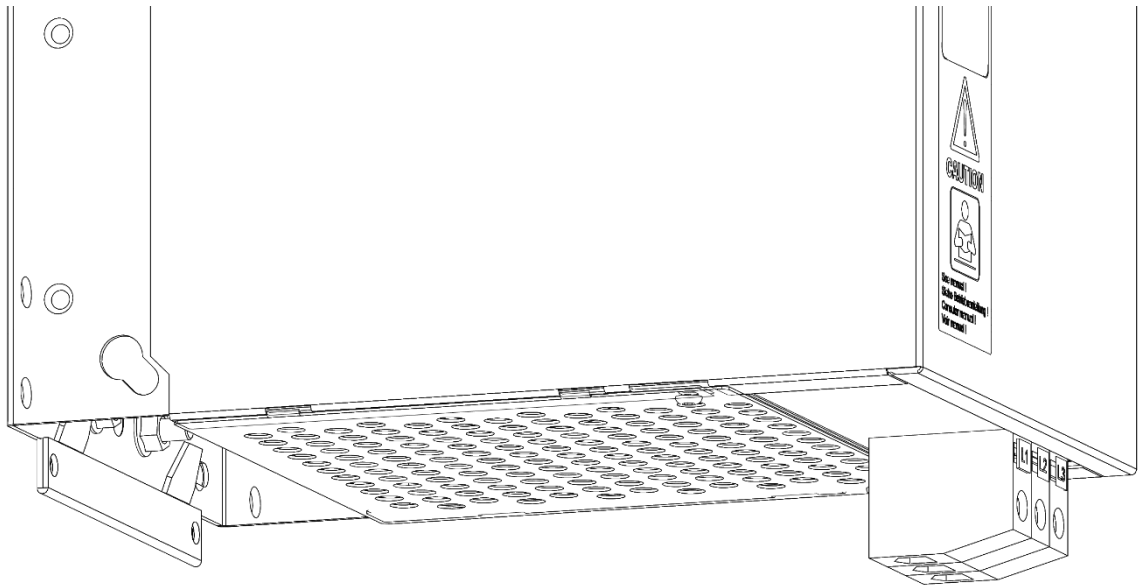
Figure 9: PPM installed together with the supporting guidance bar

4.1.3 Drill pattern
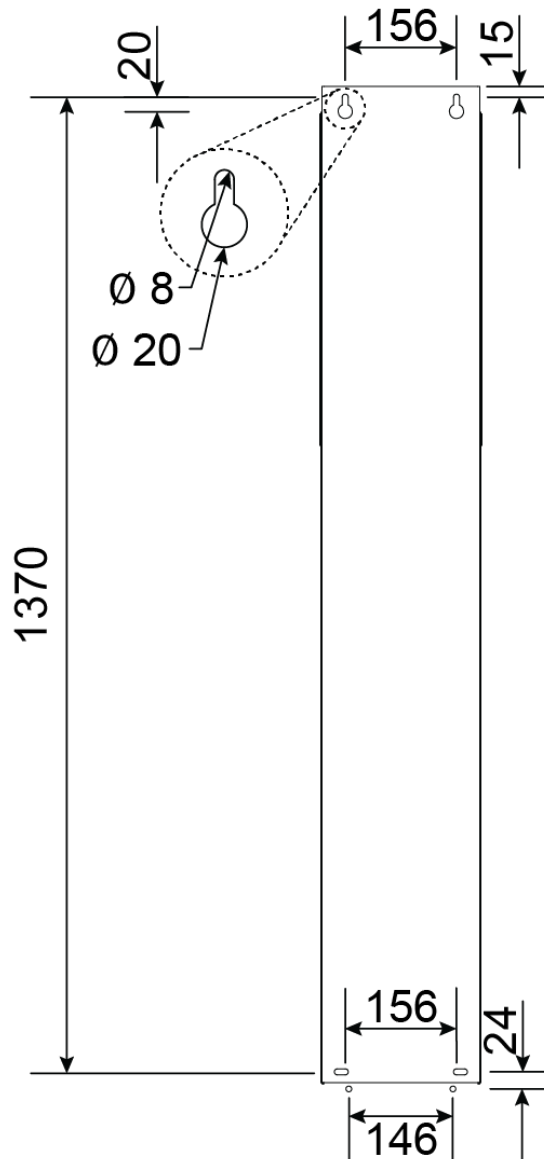
Figure 10: PPM drill pattern

4.1.4 Power connection

Main power input terminals are located at the bottom of the module.

4.1.5 Liquid connection

Liquid cooled modules have inlet and return cooling media feeders placed at bottom of module.

G1/2" BSPP male stainless steel. Tested for 10 bar.
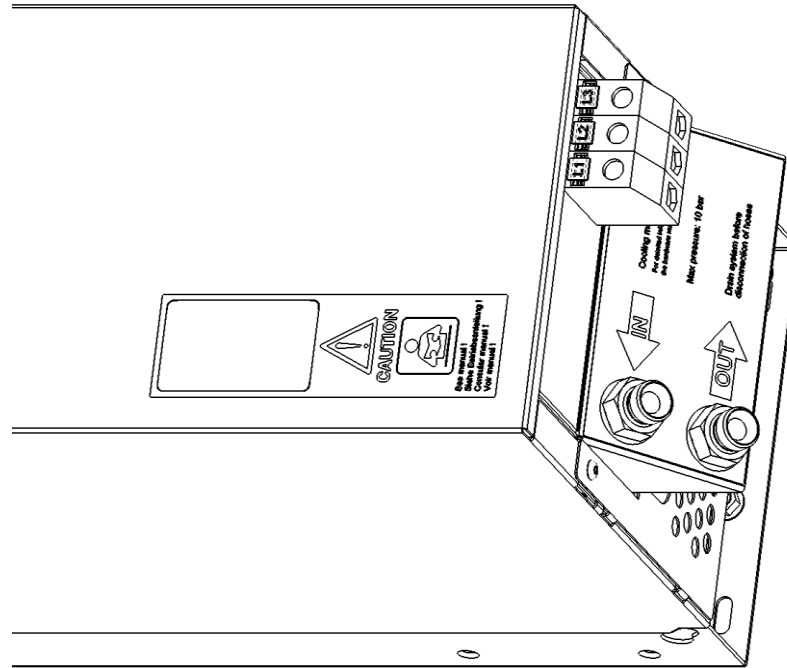
Figure 11: PPM300-3-W-xxx/yyy Connectors

4.1.6 Auxiliary circuits

The auxiliary circuits in the PPM300 inverter module are responsible for fan power supply and contactor (230 V$_{AC}$).

The terminals J1 to J4 can be found behind the while DC-link cover.
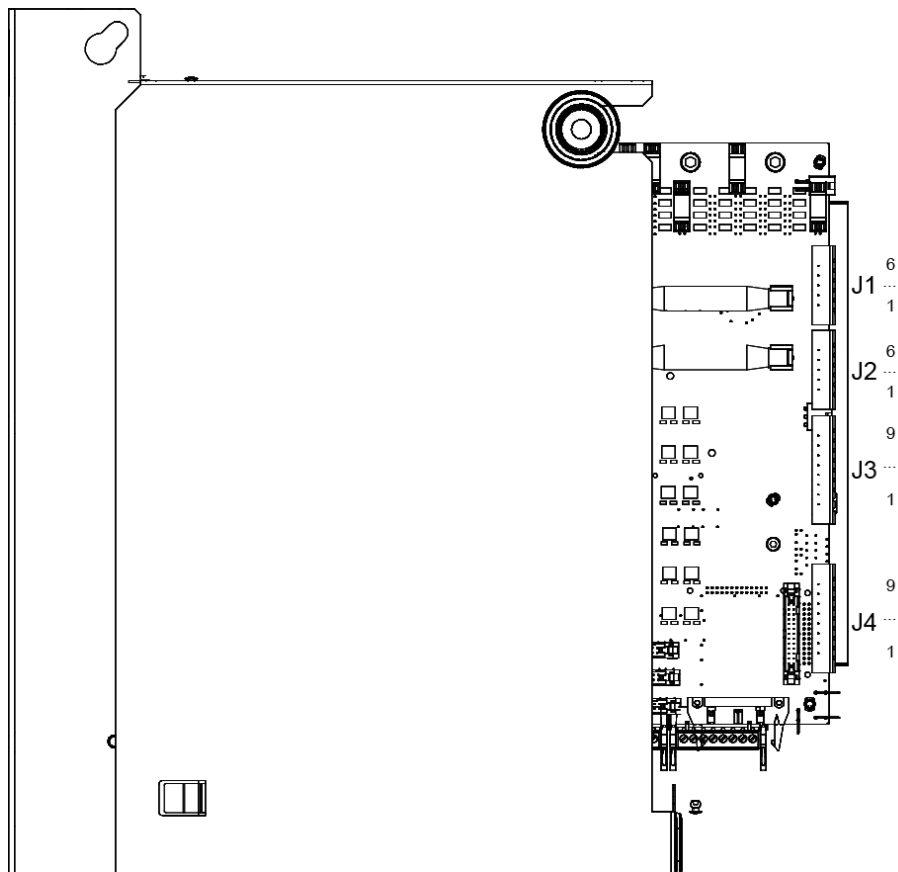
Figure 12: PPM with exposed J1 - J4 terminals

All 6 pins on J1 are connected to DC-Link negative. All 6 pins on J2 are connected to DC-Link positive. J3 and J4 are interchangeable. These terminals are used to bring 3-phases for pre-charge as well as a 230 V signal for the fan and contactor to the PPM. The second connector can then be used to share these signals with the next PPM.

Preconfigured interconnection cable (see section 2.12.1) are black for DC-Link negative, red for DC-Link positive and blue for AUX interconnection.

4.1.6.1   J1 – DC-Link negative Interconnection

This connector contains the negative side of the DC-Link. All pins are connected on the same signal. The connection is used to interlink the installed modules. The signal is fused with a 30 A fuse inside the converter.

J1 is a 6 pin header type Phoenix MSTB 2,5/6-GF-5,08. The corresponding plug MSTB 2,5/6-STF-5,08 is part of the PPM300 delivery.

Table 23: J1 – DC-Link negative Interconnection

Pin	Description
1	DC Voltage negative
2	DC Voltage negative
3	DC Voltage negative
4	DC Voltage negative
5	DC Voltage negative
6	DC Voltage negative

To interconnect two modules, three pins needs to be used with a cable size of AWG16. An extra insulation is needed to increase protection to 1200 V. Comsys suggest using a Glass textile sleeving with acrylic coating like kalTHERM® 155-SGA/UL.

Comsys also offers this cable preconfigured for the interconnection. See section 2.12.1 for more details.

4.1.6.2   J2 – DC-Link positive Interconnection

This connector contains the positive side of the DC-Link (up to 1200 V). All pins are connected on the same signal. The connection is used to interlink the installed modules. The signal is fused with a 30 A fuse inside the converter.

J2 is a 6 pin header type Phoenix MSTB 2,5/6-GF-5,08. The corresponding plug MSTB 2,5/6-STF-5,08 is part of the PPM300 delivery.

Table 24: J2 – DC-Link positive Interconnection

Pin	Description
1	DC Voltage positive
2	DC Voltage positive
3	DC Voltage positive
4	DC Voltage positive
5	DC Voltage positive
6	DC Voltage positive

To interconnect two modules, three pins needs to be used with a cable size of AWG16. An extra insulation is needed to increase protection to 1200 V. Comsys suggest using a Glass textile sleeving with acrylic coating like kalTHERM® 155-SGA/UL.

Comsys also offers this cable preconfigured for the interconnection. See section 2.12.1 for more details.

4.1.6.3   J3/J4 – Module Interconnection

This connector contains auxiliary signals for the PPM300 modules. J3 and J4 are mostly mirrored. J3 pin 2 is directly connected to J4 pin 2. This is the same for pins 2 – 9. Only pin 1 does not have the direct connection.

J3 and J4 are each a 9 pin header type Phoenix MSTB 2,5/9-GF-5,08. The corresponding plug MSTB 2,5/9-STF-5,08 is part of the PPM300 delivery.

Comsys also offers this cable preconfigured for the interconnection. See section 2.12.1 for more details.

Table 25: J3 / J4 – Module Interconnection

Pin	Description
1	FEEDBACK (not used anymore)
2	AUX230L
3	AUX230N
4	N/A
5	Phase 1
6	N/A
7	Phase 2
8	N/A
9	Phase 3

4.1.6.3.1   Feedback (not used anymore)

The feedback signal is outdated and is not used in the systems anymore in most systems. Software 2.0.0 or later must be used to leave this signal free; however there is one exception, as 150 A PPM300v2B-3-A-150/480 modules are still using the signal to feedback (from J3:1/J4:1 on module).

In the case of a single 150 A module, one pin (J3:1/J4:1) should get 24VDC input, and the other (J4:1/J3:1) should be returned to SCC2 X3:1. In the case of 2 or more modules, refer to the table below:

Pin	PPM1	PPM2
J3:1	+24V	Feedback from PPM1:J4:1
J4:1	Feedback to PPM2:J3:1	Feedback to SCC2:X3:1

And in the case of three modules:

Pin	PPM1	PPM2	PPM3
J3:1	+24V	Feedback from PPM1:J4:1	Feedback from PPM2:J4:1
J4:1	Feedback to PPM2:J3:1	Feedback to PPM3:J3:1	Feedback to SCC2:X3:1

> NOTE   The feedback signal above is **only** needed for PPM300v2B-3-A-150/480; in order for this functionality to be used, you need SCC2 Software 2.1 or later.

4.1.6.3.2   AUX230L and AUX230N

This is the switched 230 V_{AC} power supply for the PPM300 modules. It controls the internal MCB as well as the internal main fan. Each module consumes about 165 W.

4.1.6.3.3   Phase 1 / Phase 2 / Phase 3

These signals are used for pre-charging the internal DC-Link. The pre-charge consumes at a peak about 0.5 A for a short time.

4.1.6.4   PE

Each power module needs to be connected to protective earth.

Connect the protective earth to the PE screw stud. Connecting points are two M8 screws. A cable area of at least 16 mm^2 is recommended. Tighten the connection with a torque of 20 Nm.

> ⚠ **ATTENTION:** The protective earth connection must be connected to PE in the installation and NOT to the neutral (N/PEN).

4.1.6.5   PP-cable

Each power module has one integrated PP-cable for digital signal wiring with the control computer. This cable needs to be connected on PP1 … PP6 of the SCC2 control computer. The PP1 … PP6 signals control the inverters and read out error values and status values. The cables are flat band cables. The PP-cable has a length of 2100 mm.

Each PP cable also includes a 60 mm long PE cable with a 6.3 x 0.8 mm faston receptacle that needs to be grounded outside of the SCC2.

4.1.6.6   XB (PPM300v2B-3-A-150/480 only)

This input feeds the top fan with 24VDC. It is a 2-pin Molex Minifit female.

Pin 1 = +24 VDC. Pin 2 = 0 VDC.

4.1.7   PPM300 Module control interconnection

Interconnection is performed via the J1 – J4 as seen in Figure 12, mounted on the side in the converter module in the PPM300 module.

The module has two rubber grommets on the side in the top of the module. These are intended to take the black and the red cable from one to the next module. Three more rubber grommets are in the front of the module, just below the converter assembly. These grommets can be used to bring the blue cable in and out of the module.

> ⚠ **ATTENTION:** When using a SCC2-P6 control, **never** interconnect the DC-bus from the PPM banks PP1..3 and PP4..6 as these are counter-switching! Doing so will damage the EMC filters. See the figures below for examples.

The PPM300 modules can be internally connected in the following ways (see figures below).

Figure 13: Interconnection with one module
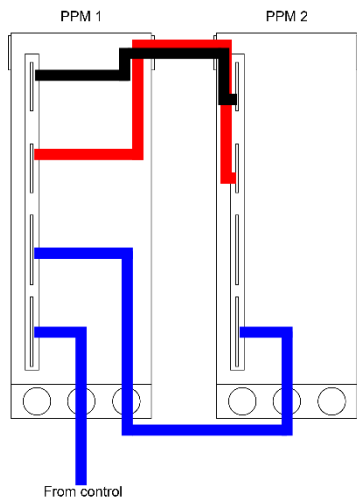
Figure 14: Interconnection with two modules
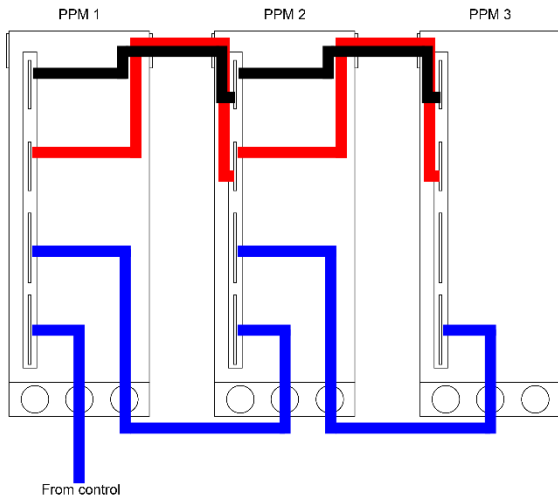
Figure 15: Interconnection with three modules
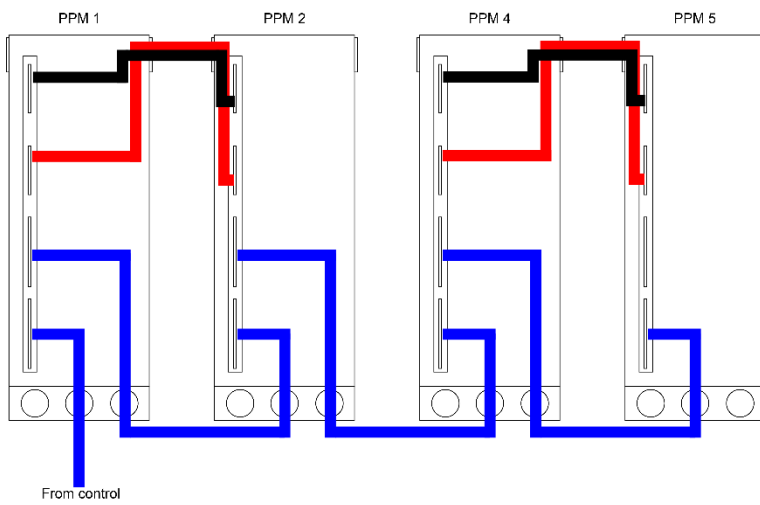
Figure 16: Interconnection with four modules
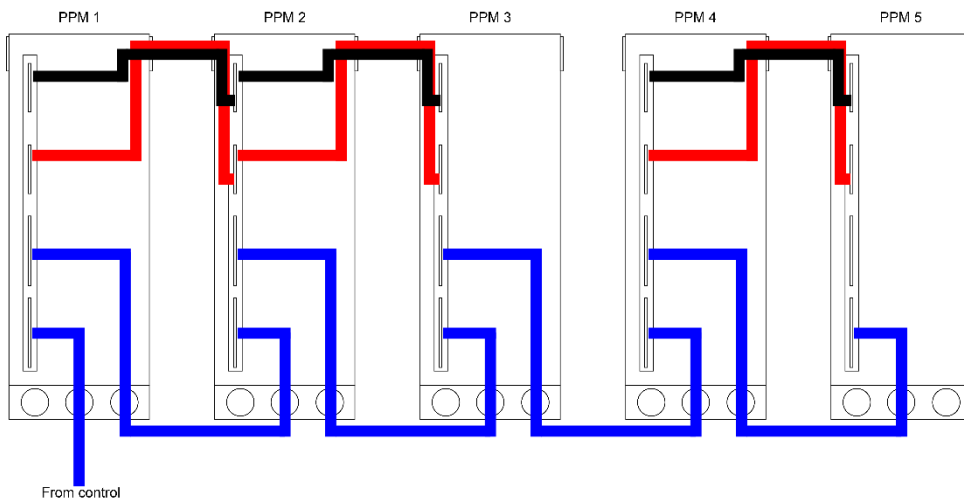
Figure 17: Interconnection with five modules
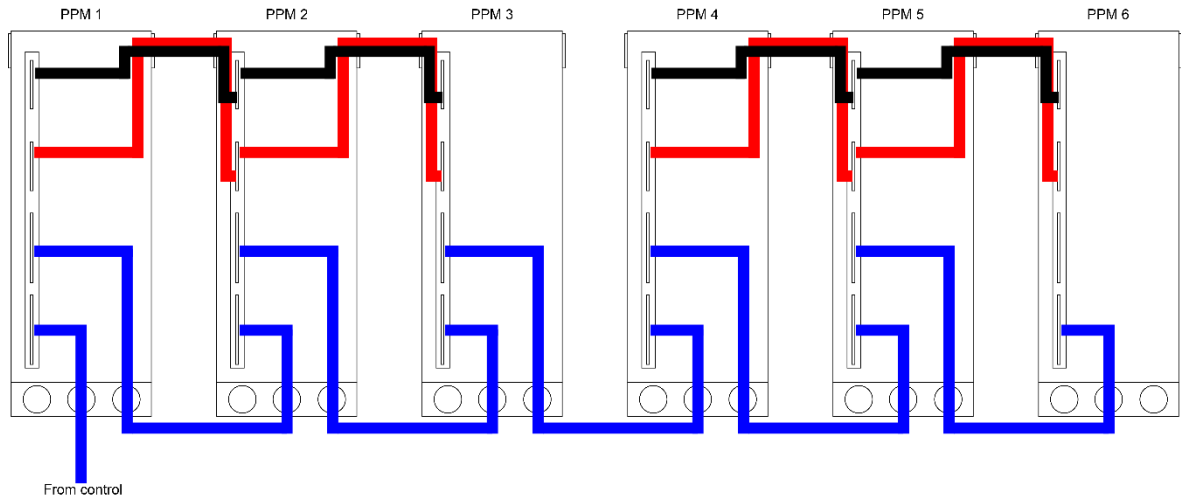
Figure 18: Interconnection with six modules

4.2 SCC2 – Control Computer

4.2.1 Technical Drawings
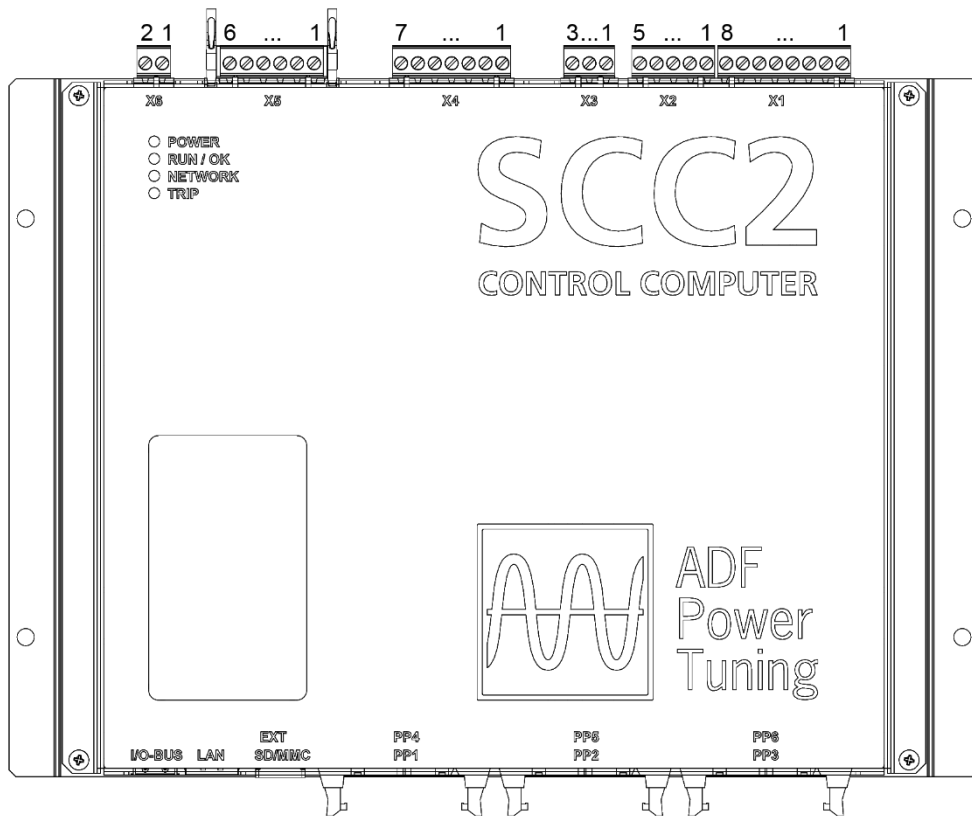
Figure 19: SCC2 Overview
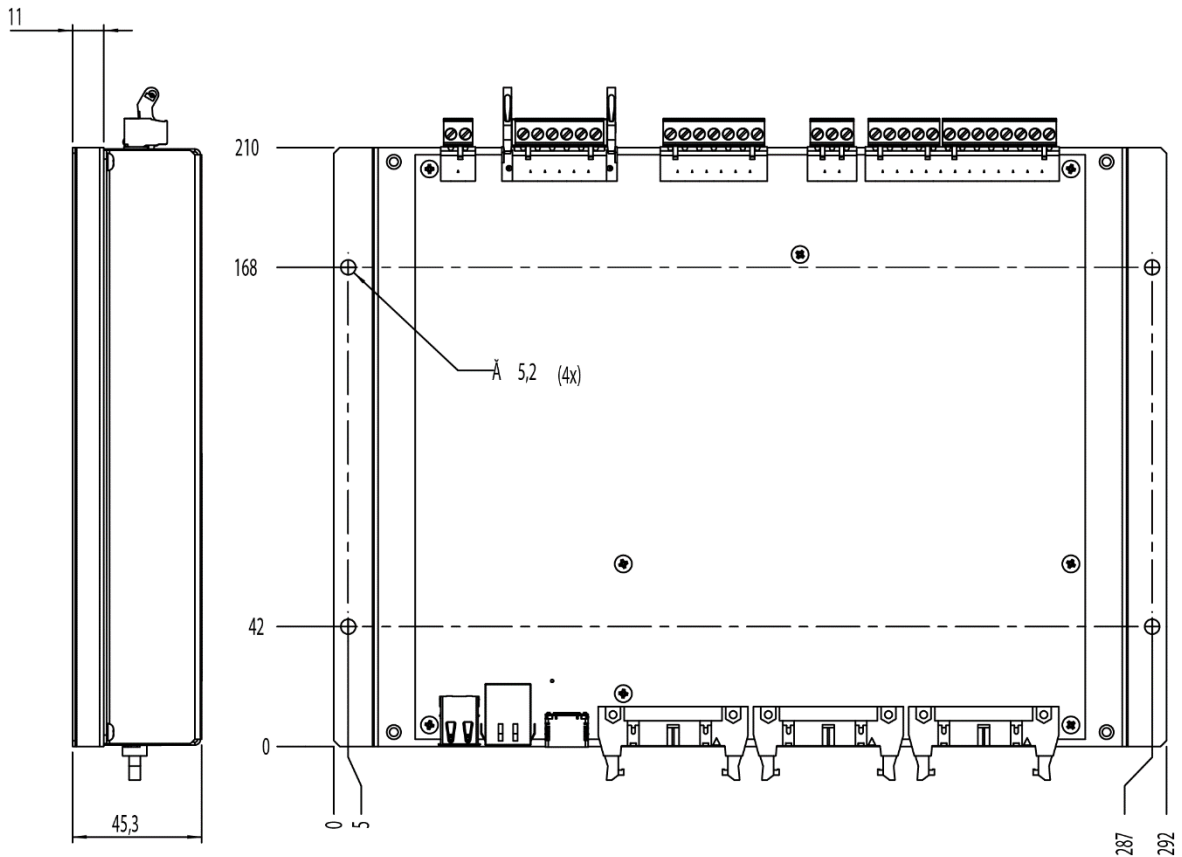
Figure 20: SCC2 dimensions (all dimensions in mm)

4.2.2 Auxiliary circuits

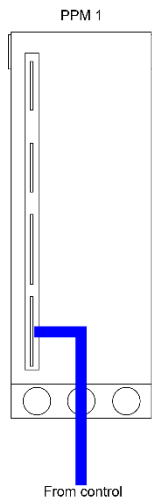The SCC2 control computer controls the system by measuring input values (current, voltage, temperature, etc.) and gives control signals to the inverter modules. In the reference implementation, the SCC2 is mounted on the CM300 module.

The SCC2 contains the following connections:

- X1: Digital Outputs
- X2: Digital Inputs
- X3: MCB
- X4: Voltage Measurements
- X5: Current Measurements
- X6: Supply
- I/O Bus (2x): I^{2}C bus
- LAN
- EXT: Multi Master connection
- PP1-3: Module connection 1 – 3
- PP4-6: Module connection 4 – 6

4.2.2.1 X1 – Digital Output

This connector contains general digital outputs. Some of these have fixed functions and some are free configurable.

X1 is an 8-pin connector type Phoenix MSTB 2,5/8-G-5,08. The corresponding plug MSTB 2,5/8-ST-5,08 is part of the SCC2 delivery.

Table 26: X1 – Digital output (250 V$_{AC}$, 5 A Relay)

Pin	Description	
1	Relay 1	NO
2		COM
3	Relay 2	NO
4		COM
5	Relay 3	NO
6		COM
7	Relay 4	NO
8		COM

4.2.2.1.1   X1:1&2 / Relay 1

Relay 1 is a general-purpose output. It is mapped to the OUT1 in the ADF software and can be configured via the Web User Interface.

4.2.2.1.2   X1:3&4 / Relay 2

Relay 2 is used to activate the pre-charge circuit. This signal can be used to activate the PPMs pre-charging on a signal from the SCC2.

To implement this function, there must be a MCB in front of the pre-charge input (section 4.1.6.3.3) to be able to switch these signals. Comsys uses a Siemens 3RT2015-1JB41 in the ADF P100 setup. The ADF P300 does not use relay 2.

The relay is closing when pre-charging is needed. This function is not required to be used in an application.
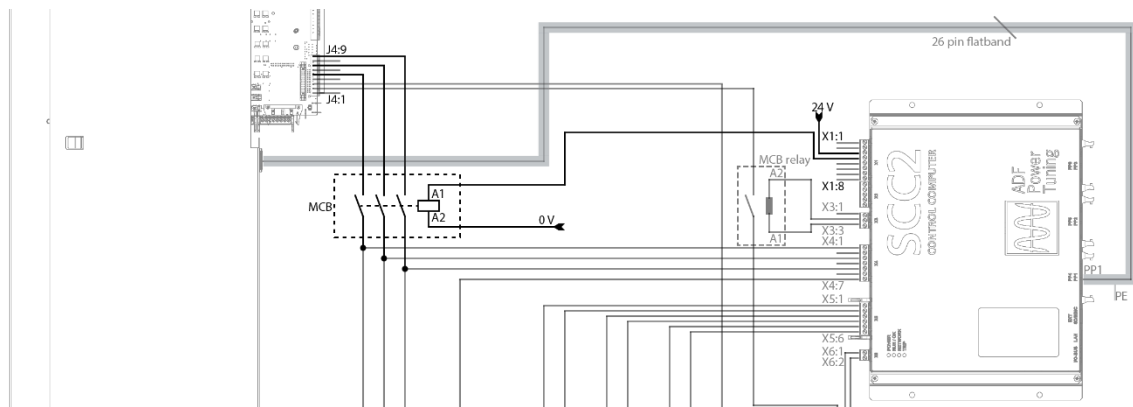
Figure 21: Pre-charge MCB wiring (PPM300 and SCC2 are not to scale)

4.2.2.1.3   X1:5&6 / Relay 3

Relay 3 is used to start the pump unit in the ADF P300W and for the top fan in the ADF P100N. The function is fixed set to "operation". The relay will close when the ADF is in operation mode. It can be used for any other function that is needed when the ADF is running.

4.2.2.1.4   X1:7&8 / Relay 4

Relay 4 is used as the ALARM output.

4.2.2.2   X2 – Digital Inputs

This connector contains general digital inputs. Some of these have fixed functions and some are free configurable.

X2 is a 5-pin connector type Phoenix MSTB 2,5/5-G-5,08. The corresponding plug MSTB 2,5/5-ST-5,08 is part of the SCC2 delivery.

Table 27: X2 – Digital in (24 V_{DC} logic)

Pin	Description
1	Digital IN1, 24 V_{DC}
2	Digital IN2, 24 V_{DC}
3	Digital IN3, 24 V_{DC}
4	Digital IN4, 24 V_{DC}
5	Common Ground for all digital in

4.2.2.2.1   IN1

Digital IN1 is a general-purpose input. It is mapped to the IN1 in the ADF software and can be configured via the Web User Interface.

4.2.2.2.2   IN2

Digital IN2 is a general-purpose input. It is mapped to the IN2 in the ADF software and can be configured via the Web User Interface.

4.2.2.2.3   IN3

Digital IN3 is a general-purpose input. It is mapped to the IN3 in the ADF software and can be configured via the Web User Interface.

4.2.2.2.4   IN4

Digital IN4 is deactivated. Comsys suggest leaving this pin open.

4.2.2.3   X3 – PPM MCB and Fan

This connector contains functions for the MCB.

X3 is a 3-pin connector type Phoenix MSTB 2,5/3-G-5,08. The corresponding plug MSTB 2,5/3-ST-5,08 is part of the SCC2 delivery.

Table 28: X3 - Main Circuit Breaker (MCB)

Pin	Description
1	Digital in – Position of the MCB (24 V_{DC}, active high) (not in use anymore)
2	Open collector output for the MCB relay (max 2 W)
3	24 V_{DC} – Power supply for the MCB relay (max 2.5 A)

4.2.2.3.1   Pin 1 – MCB Digital IN (not in use anymore)

This signal is not in use anymore. Make sure to use software 2.0.0 or later.

4.2.2.3.2   Pin 2 – Output for MCB and fan relay

The MCB and fan cannot be controlled by the SCC2 directly. It has to go through a relay providing the needed power. Pin 2 of X3 is the signal switching the relay.

The needed relay is not part of the delivery. Comsys uses an Omron G2R-1-SNI 24DC in the ADF P100 and ADF P300. The relay has a coil voltage of 24 VDC and a contact current of 10 A. Contact configuration is SPDT. The relay is used to close a 230 V circuit to be able to provide this voltage to the PPM modules.
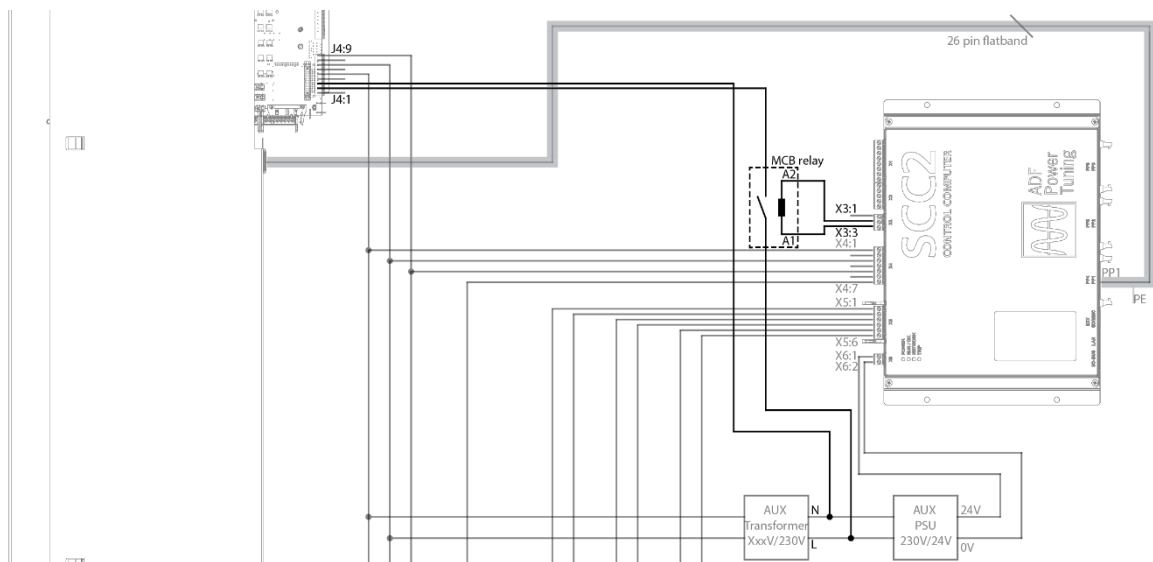
Figure 22: MCB relay circuit diagram (PPM300 and SCC2 are not to scale)

4.2.2.3.3   Pin 3 – 24 V for MCB relay

Pin 3 of X3 offers the 24 V_{DC} for the MCB relay with a maximum current of 2.5 A.

4.2.2.4   X4 – Voltage Measurement

This connector contains the voltage measurements.

X4 is a 7-pin connector type Phoenix MSTB 2,5/7-G-5,08. The corresponding plug MSTB 2,5/7-ST-5,08 is part of the SCC2 delivery.

Table 29: X4 - Line Voltage terminal block (max 690 V_{RMS})

Pin	Description
1	Line voltage phase 1, 208 – 690 V_{AC}
3	Line voltage phase 2, 208 – 690 V_{AC}
5	Line voltage phase 3, 208 – 690 V_{AC}
7	Protective earth (PE)

4.2.2.4.1   Line voltages

Pin 1, 3 and 5 is reserved for the line voltage measurements. The phase order is very important on these pins.

4.2.2.4.2   Pin 7 – Protective Earth

Pin 7 is the reference point for the voltage. In usual cases this is PE. It can however also be left empty if "IT (IEC 60364)" is used in the Setup Dialogs Grounding system.

4.2.2.4.3   Increased impedance

It might be needed to use increased impedance on the Voltage measurements. In this case voltage transformer can be used in conjunction with the measurement pins. The transformer can be provided by Comsys, see section 2.7 for more information.

Figure 23: Increased impedance VT circuit diagram (PPM300 and SCC2 are not to scale)

A setup like that will change the measurement from a Delta to a Y setup. This has to be changed in the software. A dedicated license key is n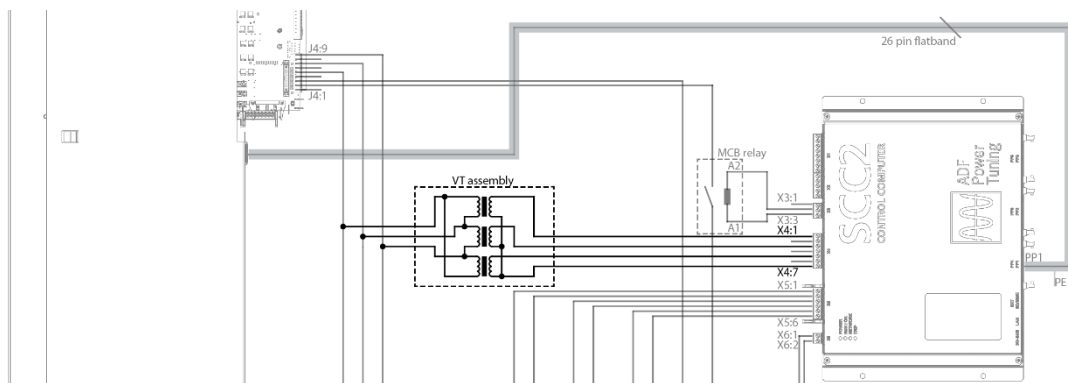eeded for every control computer that uses this setup. Please get in contact with your Comsys representative to get such a key.

4.2.2.5   X5 – Current Measurement

This connector contains the current measurements.

X5 is a 6-pin connector type Phoenix MSTB 2,5/6-GF-5,08. Please notice, this is the only SCC2 connector with a GF type connector. This is needed to have a better fixation of the plug. The corresponding plug MSTB 2,5/6-ST-5,08-LR is part of the SCC2 delivery.

Table 30: X5 - Load current terminal block (max 5 A_{RMS})

Pin	Description	
1	Load current phase 1 (0-5 A_{RMS})	S1
2		S2
3	Load current phase 2 (0-5 A_{RMS})	S1
4		S2
5	Load current phase 3 (0-5 A_{RMS})	S1
6		S2

Table 31: Current transformer (CT) specification

Current transformer specification	
Class	1.0 or better
Primary ratio	Exceeding the maximum load current including harmonics, reactive power, and transients
Secondary ratio	5 A maximum
ADF total CT burden	1.25 VA (CM300) 0.2 VA (SCC2)
Symmetry	Three identical CTs must be used

4.2.2.6   X6 – Supply

This connector contains the supply for the SCC2.

X6 is a 2-pin connector type Phoenix MSTB 2,5/2-G-5,08. The corresponding plug MSTB 2,5/2-ST-5,08 is part of the SCC2 delivery.

Table 32: X6 – SCC2 supply input terminal block

Pin	Description
1	24 V_{DC}
2	0 V (GND)

The SCC2 consumes about 1 A on idle plus 0.5 A for every ADF PPM300 running.

4.2.2.7   I/O-Bus

This I/O-Bus is a digital I^2C interface that is used for communicating with temperature sensors and with the HMI. The bus exists twice and is using a USB-A connector.

4.2.2.8   LAN

This LAN interface is used to connect the ADF to a network. The Web-User-Interface can be used via this, as well as the Modbus TCP (Option 416 059).

A shielded CAT5 or better should be used.

4.2.2.9   EXT: Multi Master connection

This interface is to connect multiple ADF systems in a Multi Master operation. This is needed when multiple ADFs are running in Closed-Loop operation.

A special, optional cable has to be used for the Multi-Master connection.

Find more information about the multi-master connection in section 2.11.

4.2.2.10   PP1-3: Module connection 1 – 3

PP1 to PP3 are connections for the flat cable of the power module. If one module is connected, it has to be on PP1, two modules have to be connected on PP1 and PP2.

Each PP cable also includes a 60 mm long PE cable with a 6.3 x 0.8 mm faston receptacle that needs to be grounded outside of the SCC2.

4.2.2.11   PP4-6: Module connection 4 – 6 (Optional)

PP4 to PP6 are connections for the flat cable of the power module. PP4-6 only exists on the SCC2-P6 control computer. It allows the connection of up to 6 modules to one SCC2. The modules must be connected to the lowest number on each bank *and* spread as equally between the banks as possible. For example, with four modules, use PP1, PP2, PP4 and PP5. This is illustrated in the table below:

#PPMs	DC bank 1: Positive polarity			DC bank 2: Negative polarity		
	PP1	PP2	PP3	PP4	PP5	PP6
1	x					
2	x			x		
3	x	x		x		
4	x	x		x	x	
5	x	x	x	x	x	
6	x	x	x	x	x	x

Each PP cable also includes a 60 mm long PE cable with a 6.3 x 0.8 mm faston receptacle that needs to be grounded outside of the SCC2.

> **ATTENTION:** When using SCC2-P6, always connect modules on the lowest position on every bank. For example, with 4 modules, connect them to PP1, PP2, PP4 and PP5; do **not** connect them to PP1, PP2, PP3 and PP4!
>
> Also make sure to separate the DC-buses as explained in 4.1.7.
>
> The reason is that the banks PP1…3 and PP4…6 are counter-switching. This means the modules must be distributed as equally among the banks as possible.

4.3 HMI-B – Basic HMI

4.3.1 Technical Drawings

Figure 24 shows the technical drawing of the basic HMI. Figure 25 shows a cut-out template to be used for the HMI-B.
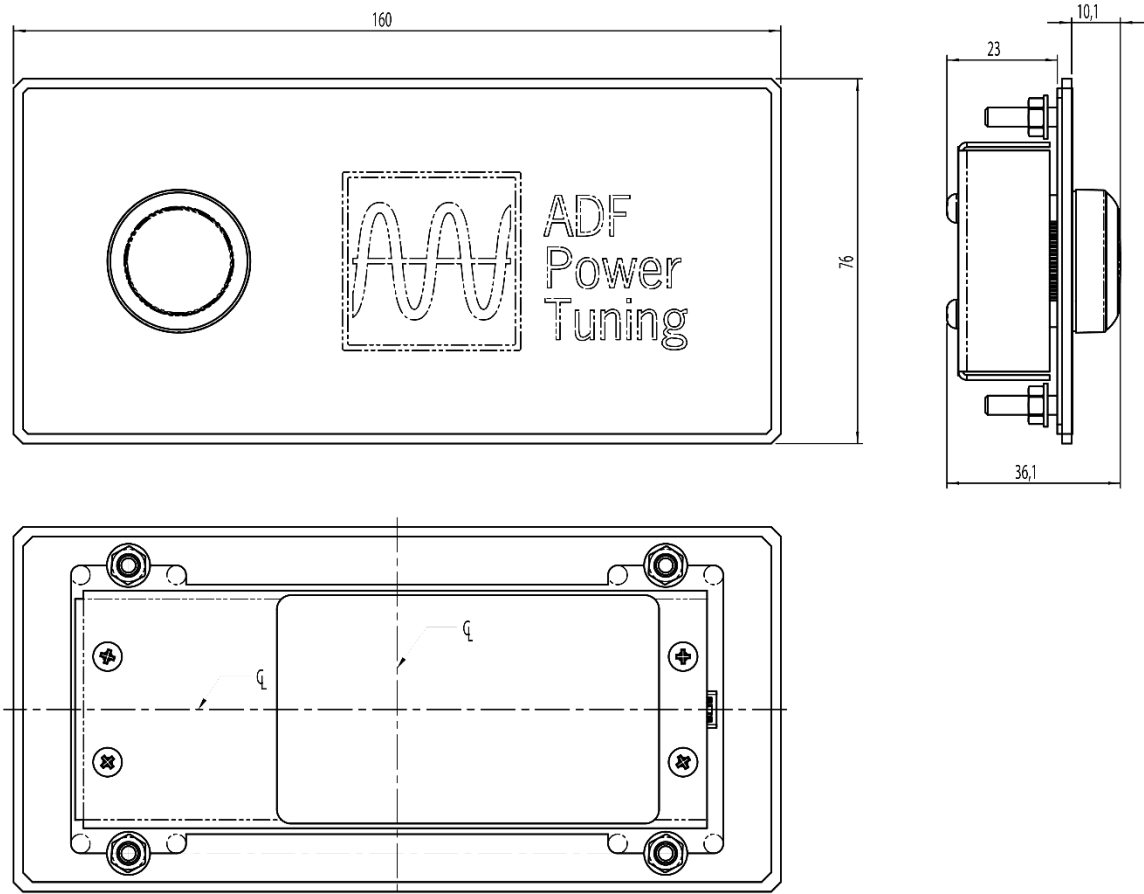
Figure 24: HMI-B dimensions (all dimensions in mm)

Figure 25: Panel cut-out for HMI-B; Scale 1:1 if printed on A4 (all dimensions in mm)
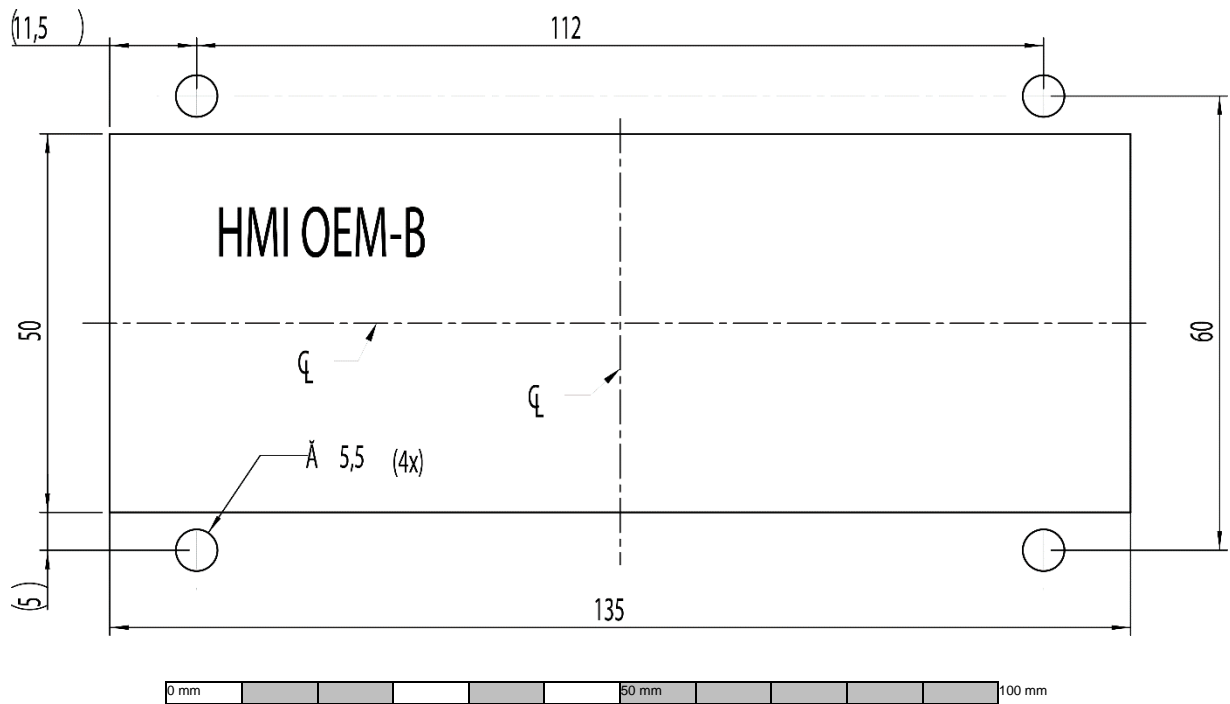
4.3.2 Auxiliary circuits

Dedicated OEM versions of the Basic HMI (Art no. 100923) as well as the Extended HMI (Art no. 100924) are available. The HMI-B also feeds the SCC2 with 24 V_{DC}. It is possible to use the SCC2 without the HMI, however then the 24 V_{DC} must be supplied directly to the SCC2 and another means controlling the system must be established.

The Basic HMI has a current consumption of 60 mA at 24 V_{DC}. The Extended HMI has a power consumption of 100 mA at 24 V_{DC}.

The figure below illustrates the principle of the HMI connection.

Figure 26: HMI-3 wiring
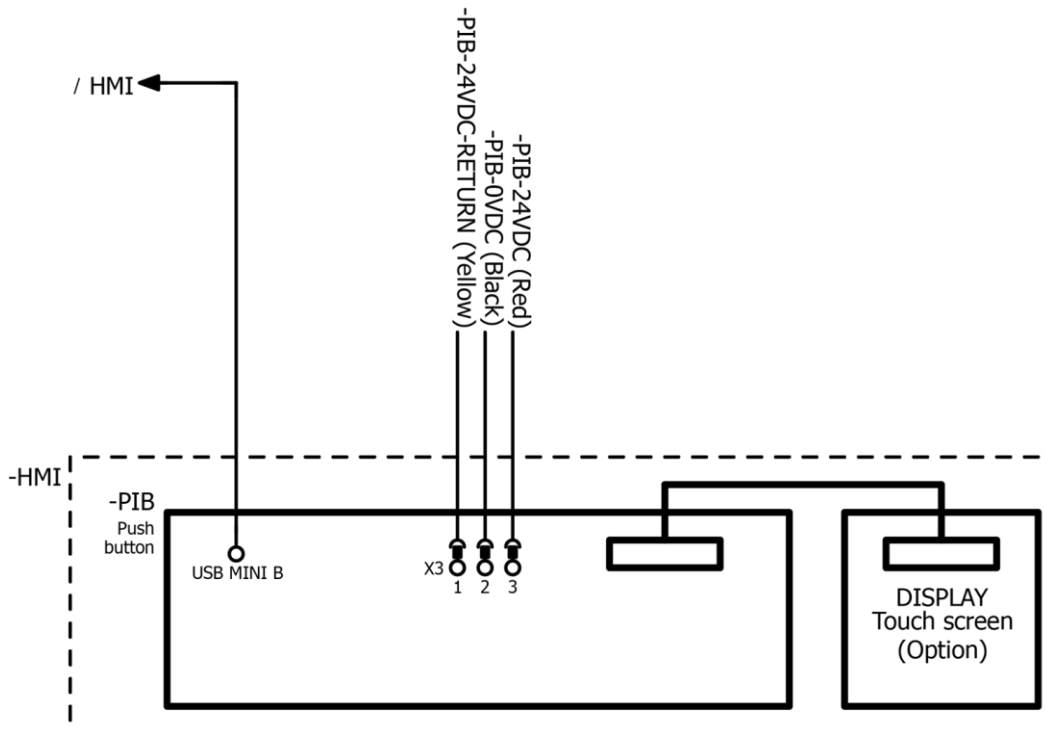
4.3.2.1   USB mini B

This USB mini B-Bus is a digital I²C interface that is used for communicating with the SCC2.

The I/O-bus uses a USB Mini-B connector on the HMI side and a USB-A connector on the SCC2 side.

4.3.2.2   X3 – HMI

X3 is the power supply going to the HMI-B as well as switched output supply from the HMI-B. The entire current going to the SCC2 – X6 needs to be routed through the HMI-B and therefor through this plug.

Table 33: **X3 – HMI supply output terminal block**

Pin	Description
1	Switched 24 V_{DC} (Yellow)
2	0 V (GND) (Black)
3	24 V_{DC} (Red)

When HMI-B is switched ON, the 24 V_{DC} is available. When HMI-B is switched OFF, 24 V is not available.

The HMI-E is supplied in the same way.

The connector is a MicroFit 3x1 RA MALE 43650-0300

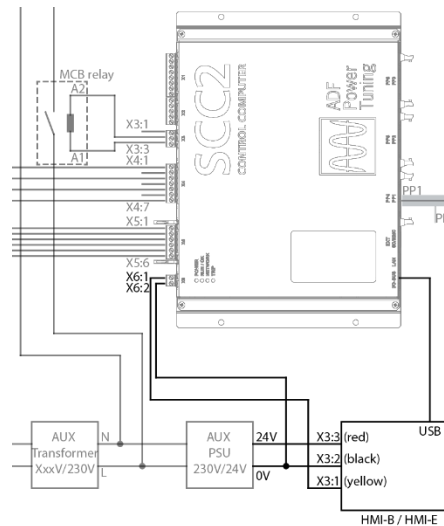Figure 27: HMI integration into the system

4.4 HMI-E – Extended HMI

4.4.1 Technical drawings

Figure 28: HMI-E dimensions (all dimensions in mm)

144

(11,5)

112

(4,5)

HMI OEM-E

160

120

80

Ă 5,5 (6x)
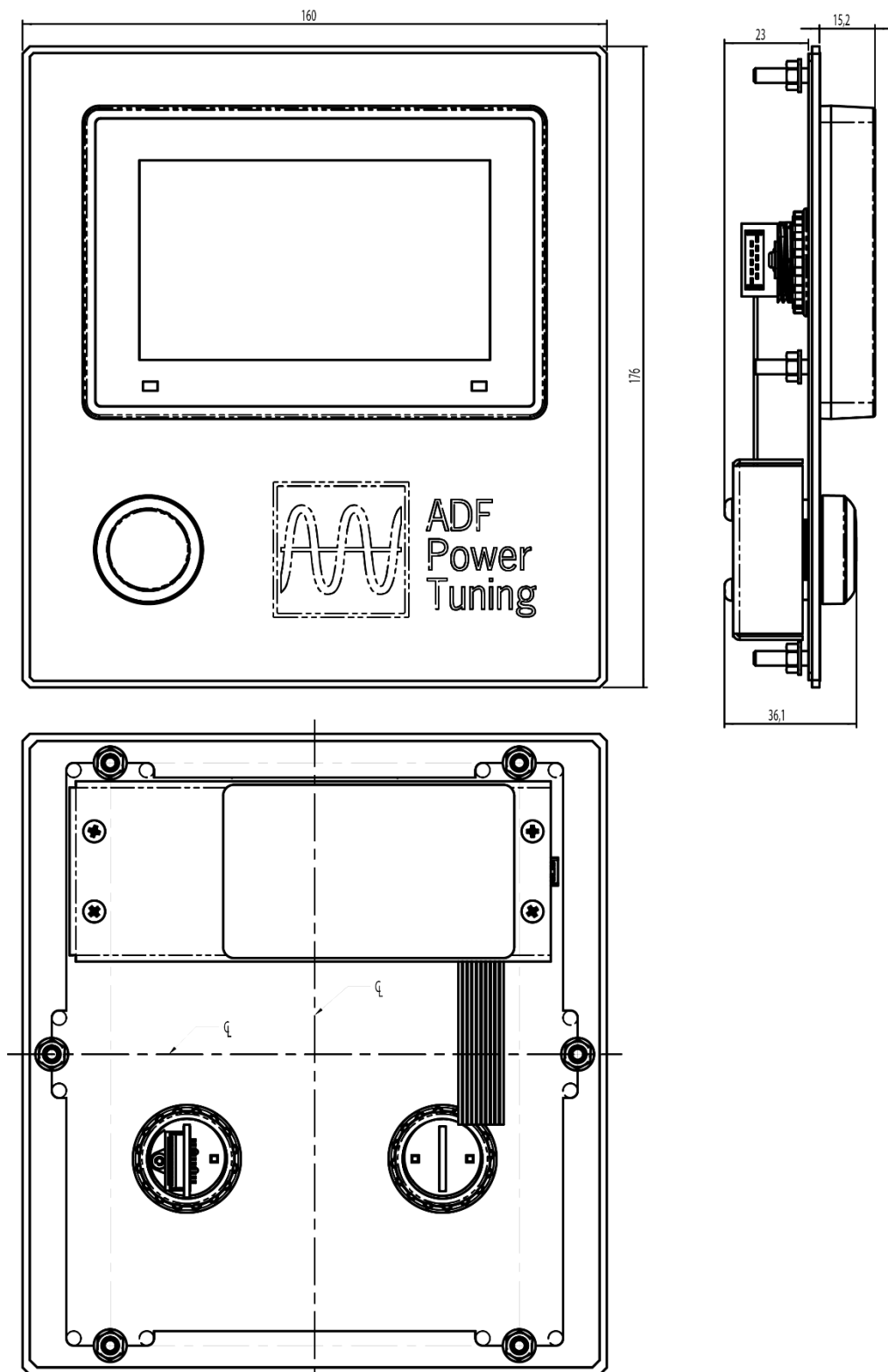
5

135

0 mm   50 mm   100 mm
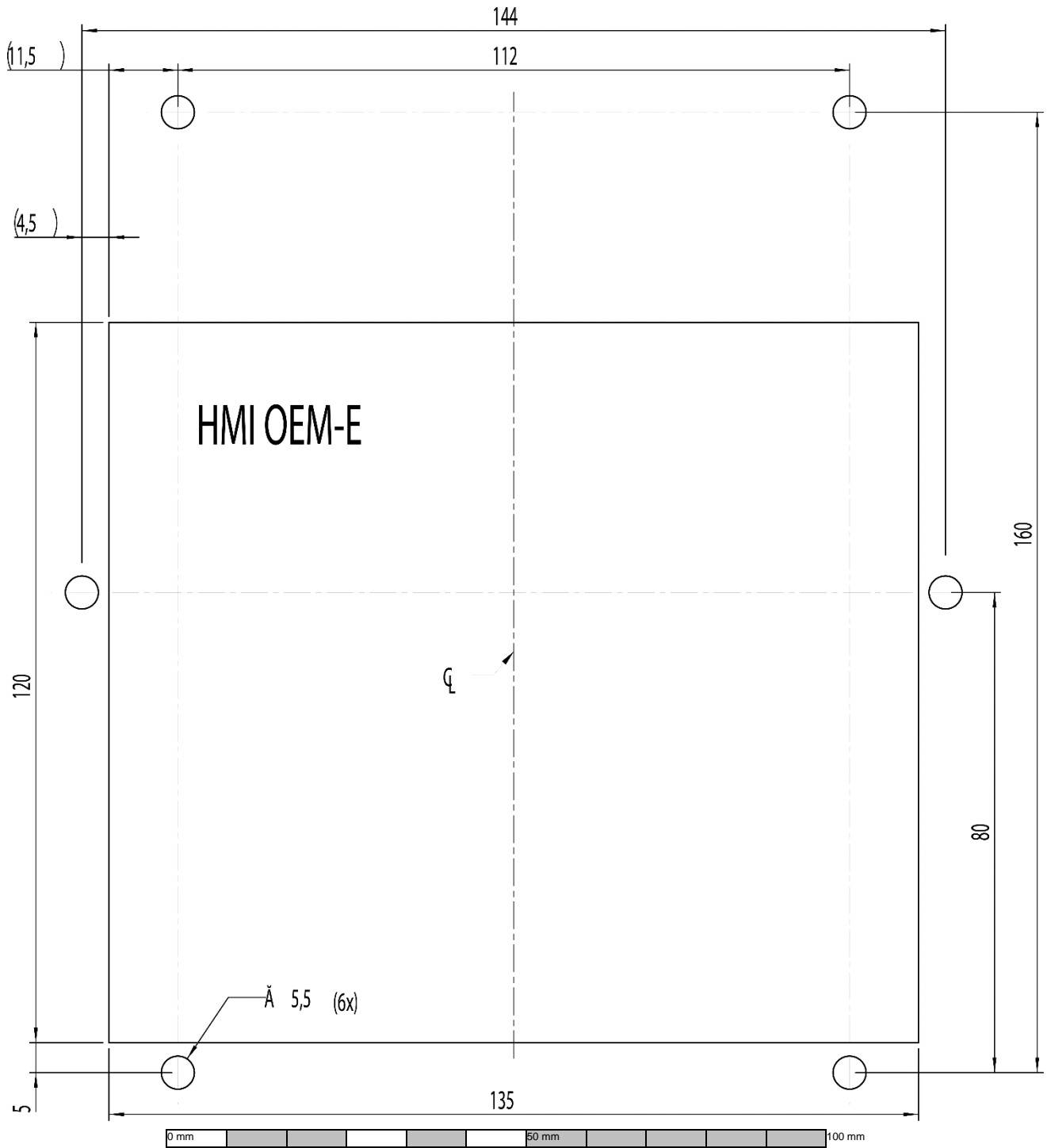
Figure 29: Panel cut-out for HMI-E; Scale 1:1 if printed on A4 (dimensions in mm)

5   Handling of power module

5.1   Unpacking

Each component is delivered in packaging suitable for transportation. Upon reception of the component visually inspect that the packaging is in good condition.

> **ATTENTION:** Before unpacking and installation the Active Filter please read through the following pages THOROUGHLY to make sure that it's handled in the right way.
>
> The unit is heavy and contains sensitive equipment.
>
> Do not attempt to move the unit before reading the lifting instruction and acting accordingly.
>
> Attempt to move the equipment without proper equipment and not according to instructions may result in damage of the equipment and injury.

5.1.1   Before unpacking and Installation/Commissioning

Before moving the PPM module without its protective packaging please pay extra attention to the section in this document that handles lifting.

> **ATTENTION:** Make sure the cabinet is closed at all time, even when installing it since it contains very sensitive power electronics.

5.1.2 Lifting the PPM module

If the Active Filter is to be moved when not in its protective packaging, please do it according to this document. Always handle the Active Filter with care since it consists of sensitive power electronics.

The Active Filter may only be lifted in the lifting lugs on top of the Active Filter. Also the angle between the lifting wire and the top of the Active Filter must be minimum 60 degrees according to Figure 30.
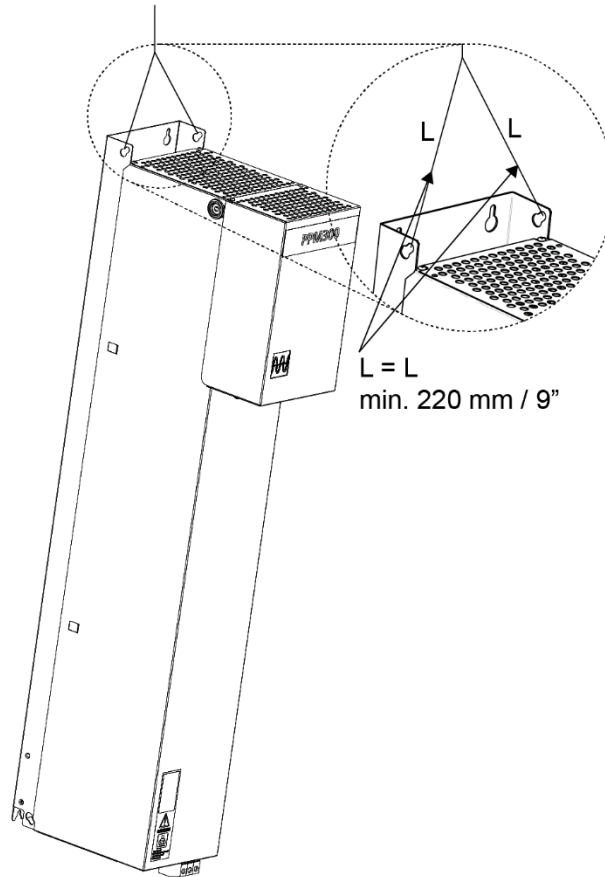
Figure 30: Correct lifting points on PPM300

The PPM300 must be lifted only in its eyelets using a suitable and approved crane.

5.1.2.1 Comsys lifting tool

Comsys offers a lifting tool specially designed for PPM300 modules and Rittal TS8 800 mm cabinets. The tool can be modified to be used on other cabinets.

Art No	Article Name	Description
101 215	ADF PPM-H Lifting Tool	Lifting tool for PPM300 on Rittal TS8 800 mm

Figure 31: ADF PPM-H Lifting Tool

5.1.3 Storage conditions

During storage of the unit, the unit should be kept within the following conditions. The conditions are acceptable only when the unit is kept in its shipping packaging.

Table 34: Maximum storage conditions

Maximum storage conditions (in protective shipment package)	
Temperature	-25 °C to 70 °C (-13 °F to 158 °F)
Relative humidity	Less than 95 %, non-condensing
Environmental conditions	Chemical class 3C3 Mechanical class 3S3

Table 35: Long term storage conditions

Maximum storage conditions (in protective shipment package)	
Temperature	-25 °C to 35 °C (-13 °F to 95 °F)
Relative humidity	Less than 75 %, non-condensing
Environmental conditions	Chemical class 3C3 Mechanical class 3S3

5.1.4 Transport conditions

During transport of the unit, the unit should be kept within the following conditions. The conditions are acceptable only when the unit is kept in its shipping packaging.

Table 36: Maximum transport conditions

Maximum transport conditions (in protective shipment package)	
Temperature	-25 °C to 70 °C (-13 °F to 158 °F)
Relative humidity	Less than 95 %, non-condensing
Environmental conditions	Chemical class 3C3 Mechanical class 3S3

6 Installation Environment

6.1.1 Operating conditions

The unit is suitable for indoor operation only. If the unit is operated within the below limits, full power may be utilized. During more demanding conditions, the unit will be derated when approaching full power.

The unit must be placed in a well-ventilated area. For cooling requirements, see section 6.1.2 "Air cooling media flow requirements" below.

Table 37: Maximum operating environmental conditions

Maximum operating environmental conditions	
Temperature	0 °C to 50 °C, up to 40 °C without derating 32 °F to 122 °F, up to 104 °F without derating
Relative humidity	Less than 95 %, non-condensing
Altitude	1000 m (3300 ft) without derating Liquid cooled modules can be placed at higher altitude without derating.

> ⚠ **ATTENTION:** In case of an air-cooled unit, make sure that the unit is installed in an environment without conductive or corrosive dust. If conductive or corrosive dust is present extra precautions must be taken. Contact your COMSYS representative.

6.1.2 Air cooling media flow requirements

Air cooled PPM300 modules must be mounted with at least 250mm / 10" clearance below it for air intake. The air exiting the top of the module must be disposed to the exterior of the cabinet where the module is mounted. If the outlet air is turned at a 90 degree angle, at least 100mm / 4" must be provided from outlet above the PPM300.

Inlet air must be filtered using filter mats.

The cooling air flow requirements are dependent of the amount of Power Processors present in the Active Filter, operating conditions and load cycles. The following table states the maximum demanded air flow from each ADF PPM300 type:

Table 38: Minimum air flow requirements

Model	Maximum air flow Per Module	Maximum losses
ADF PPM300v2-3-A-90/690(-IT)	600 m³/h	< 2969 W
ADF PPM300v2-3-A-90/600-UL	600 m³/h	< 2836 W
ADF PPM300v2-3-A-120/480(-IT)	600 m³/h	< 2725 W
ADF PPM300v2-3-A-110/480-UL	600 m³/h	< 2480 W

It is crucial that the Active Filter can utilize the needed air flow during maximum operating conditions. The cooling air may not exceed 50 °C / 122 °F under any circumstances.

> ⚠ **ATTENTION:** Make sure that the ambient temperature is below 50 °C / 122 °F under all circumstances.
>
> Make sure that the air drawn into the unit does not contain corrosive or conductive gases of any kind. Make sure that the physical mounting guidelines are followed and that no obstruction lower the air flow. Take care of the hot air emitted from the unit in a proper way.
>
> Failure to observe these guidelines may result in premature aging or failure of the equipment.

6.1.3 Liquid cooling media requirements

The table below summarizes worst case conditions for the liquid cooled modules.

- 10l/min
- Tm = 45˚ C
- Cooling Media: pure water

If a mix of glycol and water is used, the maximum media temperature must be adjusted accordingly as the effective thermal resistance of the heat sinks are increased when the specific heat capacity is reduced. As a rule of thumb, 50% glycol reduced specific heat capacity from 4.18 kJ/(kg*K) to 3.4 kJ/(kg*K).

If media flow of 10 liters per minute is maintained, the new maximum temperature can be calculated from the new specific heat capacity c_m by using the below formula:

$$T_{m,max} = 80 - \frac{146.6}{c_{new}}$$

For example, 50% glycol and 50% water will give a maximum media temperature of 37˚ C.

Model	Maximum pressure	Water flow Per Module	Media
Liquid cooled modules			
ADF PPM300v2-3-W-140/690	10 bar	10 l/min	Water, T_m = 45 ˚ C

ATTENTION: In case of adding an inhibitor (such as Glycol or Antifrogen N), be sure to adjust the cooling flow or media temperature accordingly.

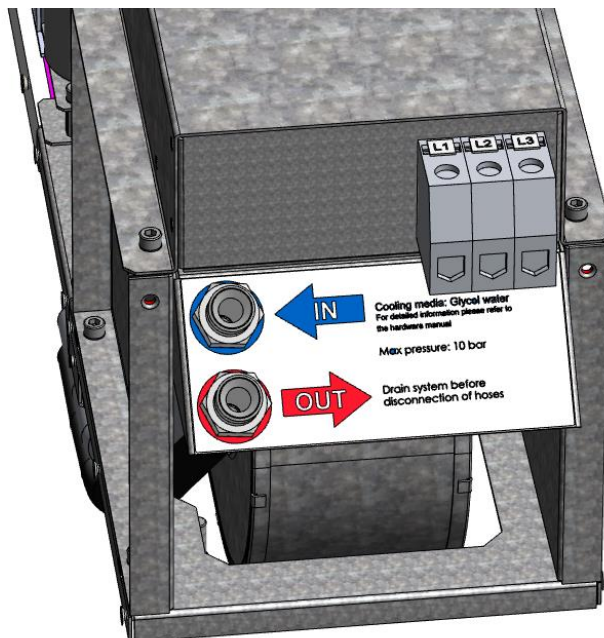Liquid connection: G ½" M BSPP connectors

Figure 32: Liquid cooling connection

7 Mechanical design

7.1 Air evacuation

The Active Filter contains internal fans that will ensure that the air flow reaches the needed capacity during maximum operating conditions. In order for the cooling to work properly, the PPM300 must be able to suck fresh air in close to the bottom of the enclosure.

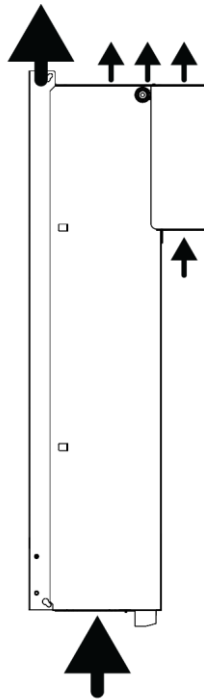The emitted hot air must be taken care of by the room housing the unit. Hot air is emitted from the top of the PPM300.

Figure 33: PPM300 air flow

Make sure to not create additional pressure drop by restricting air flow.

7.1.1 Prevent air circulation

In order to ensure proper cooling, the system must be prevented from reusing hot air.

> ⚠ **ATTENTION:** In case of an air-cooled unit, make sure that outlet air from the PPM300 cannot be returned directly to the inlet. If hot air from the outlet is "reused", cooling will not work as designed and the PPM-module will run hot.

In order to prevent direct reuse of hot air, a barrier needs to be installed in the cabinet. There are several ways of installing a barrier. The reference implementation is shown in the figures below:
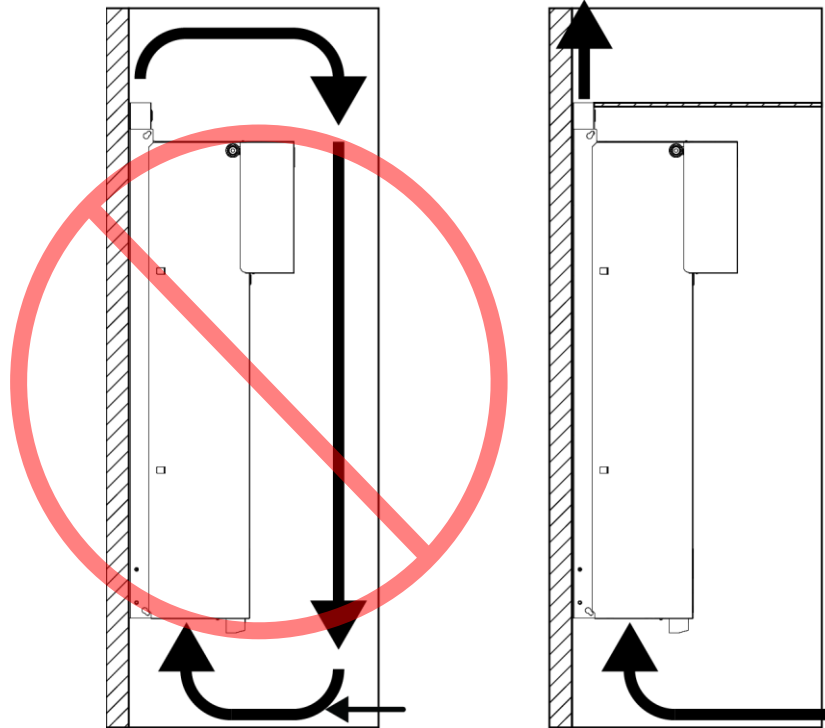

Figure 34: Air flow circulation prevention

On the left, there is no barrier in the cabinet. Due to the pressure drop from the air exiting the cabinet through a vent or similar device, the "easiest path" for the air is to recirculate back to the main fan of the PPM300. This will result in a significant portion of the air sucked in to the module being hot exhaust air, which in turn degrades cooling performance. In the figure to the right, a barrier prevents the exhaust air from recirculating into the main fan.

In the reference implementation, the barrier used is the TS8 special roof see section 2.13.1.

PPM-modules mounted freely (outside a cabinet) are not in need of any recirculation barrier.

7.1.2   Air exhaust chimney

In the reference implementations, chimneys are used to steer the hot exhaust air from the module towards the roof. These chimneys are part of the PPM300 delivery.
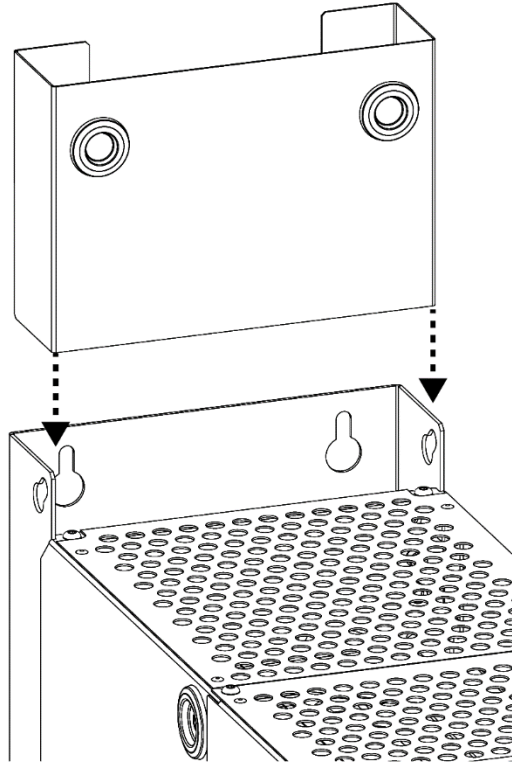

Figure 35: Optional air cooling chimney 100127

In the final ADF P300 product, configured with three PPM300 modules, the air exhaust chimneys will look like in the image below. In addition to the chimneys, there will be an inner ceiling that controls the air outlet and prevents recirculation.
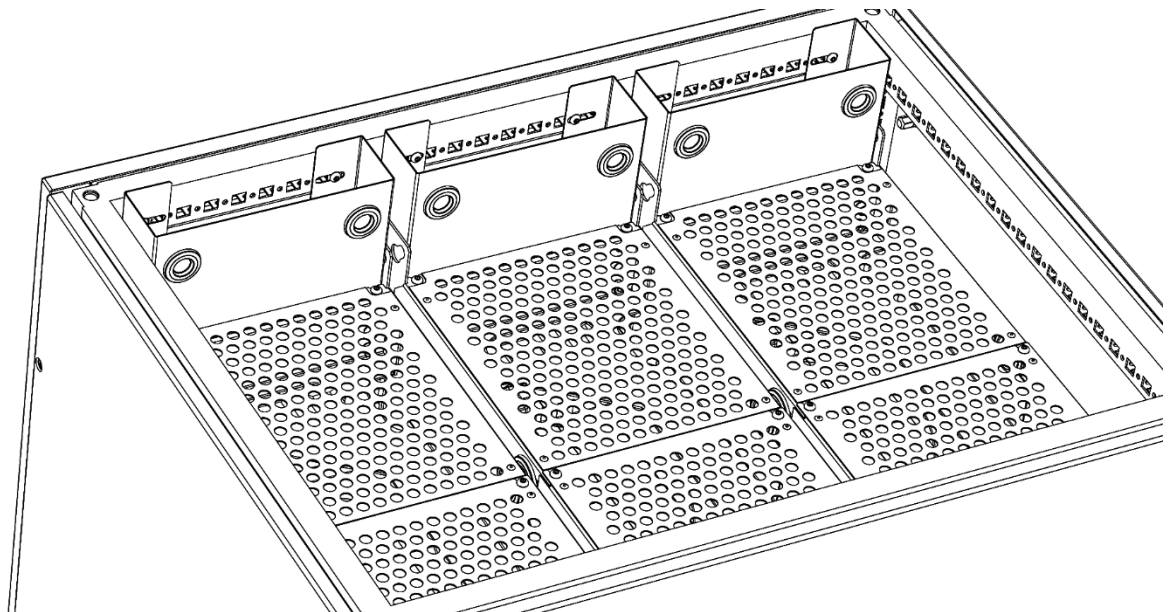

Figure 36: Air chimneys in reference implementation

An alternative part is also available, to steer air out to through the back plane, called "Air guiding PEM to Back plane-v2", art no 100149, shown in the figure below.
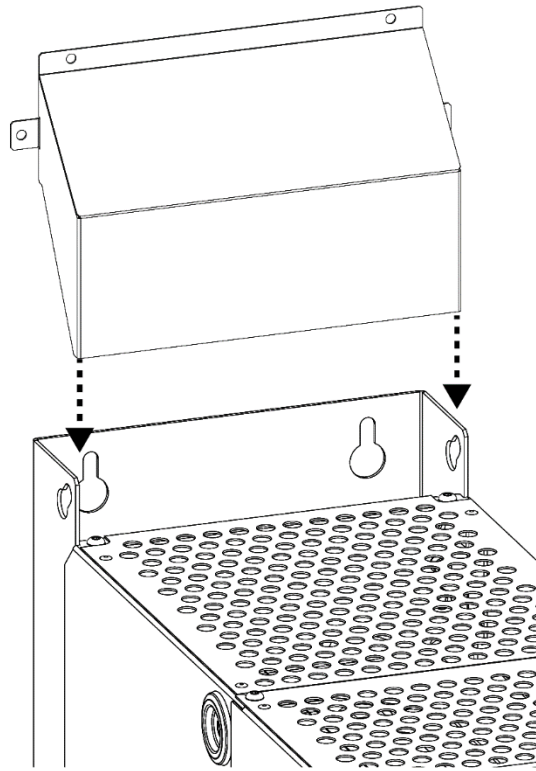

Figure 37: Optional back plane exhaust 100149

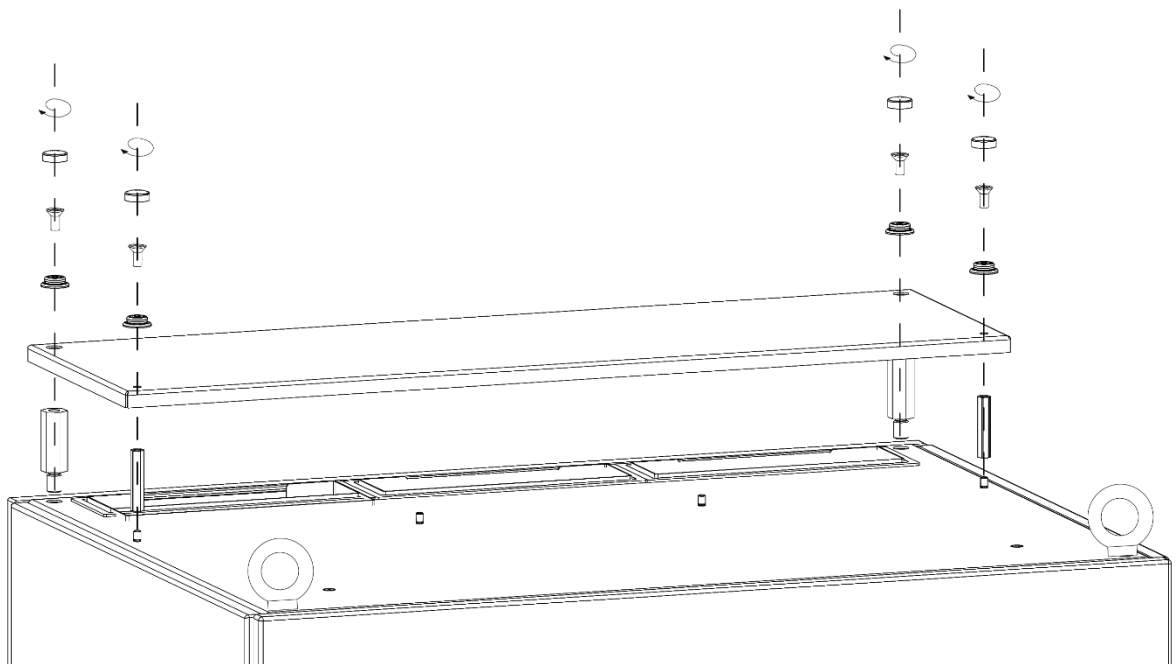### 7.1.3 Roof options for Rittal TS8
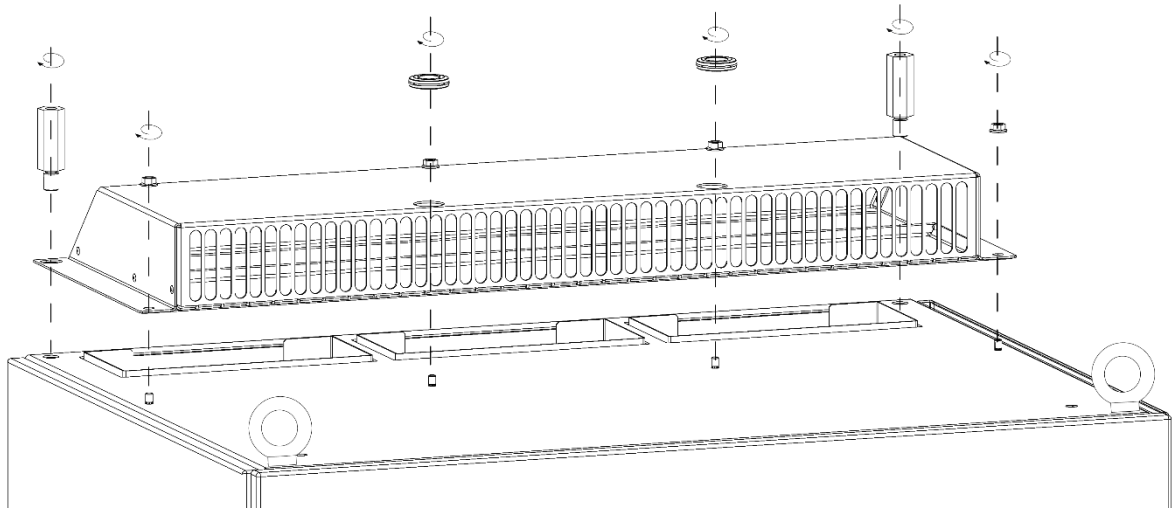

Figure 38: IP21 roof

Figure 39: IP43 roof

8   System Design

For proper sizing of PPM300 modules to the loads to be compensated, it is necessary to take the grid and some load properties into account. The best way to establish the needed filter size is by simulation, however this is time consuming. A different route is to use the drive sizing tool (currently support 6-pulse diode rectifiers). For more information on this tool, please refer to the Drives sizing manual, doc no 1199358.

The below plot shows the TDD as function of short circuit ratio and equivalent choke impedance, valid only for 6-pulse self-commutated diode rectifiers.
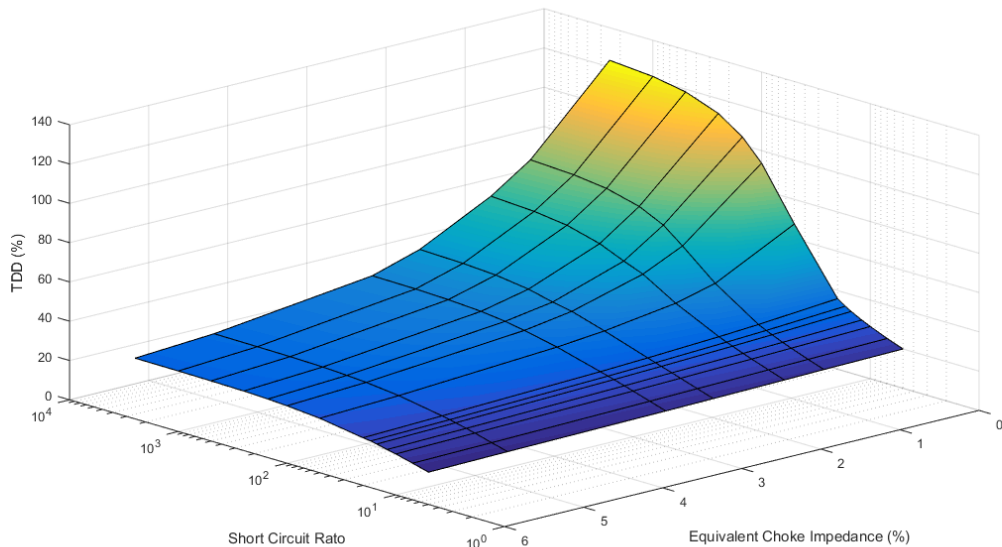

Figure 40: TDD as function of short circuit ratio and choke size

The short circuit ratio is the available short circuit current divided by the maximum drawn current from the grid. A small drive on a stiff network can easily reach short circuit current ratios of 1000; a large drive (several 100 kW) will usually not see ratios above 150.

In the graph, it can be seen that the stiffer the grid, the higher the current distortion, if all else is equal. It can also be seen that the equivalent series inductance has a profound effect on the distortion. With a 6% choke in series with the line rectifier, the distortion never exceeds 31% even on a very stiff grid. With 0% choke in series, the distortion may rise above 100% (meaning that the harmonic currents are larger than the fundamental current).

8.1   AC Choke Size

The above discussion shows that the AC Choke will fundamentally affect the uncompensated distortion level of the 6-pulse rectifier. The harmonic spectrum will also be slightly affected by the selection of an AC choke or DC choke. Largely the trend is similar no matter the choke type.

When the ADF is added to equation, the commutation of the 6-pulse rectifier will be affected by the addition of a harmonic current source with low source impedance (the active filter). To some extent, a larger AC choke will mitigate this effect. If no AC choke is present at all, simulation or calculation of the filter size is necessary as the commutation will be changed significantly, meaning higher harmonic currents.

In our findings, an AC choke size 2% seem to be optimal. Larger choke sizes tend to have a very limited effect on the harmonic current going to the rectifier, however smaller choke size will rapidly increase harmonic current interaction.

Use of a sizing tool is necessary to properly size the ADF.

— COMSYS —

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