

6 Connections



WARNING

The converters are operated at high voltages.

Disconnect the power supply before making any connections!

Only qualified personnel who are thoroughly familiar with all safety notices contained in the operating instructions as well as erection, installation, operating and maintenance instructions should be allowed to work on these devices.

Non-observance of the safety instructions can result in death, severe personal injury or substantial property damage.

Failure to make the correct connections may result in irreparable damage to the unit.

Voltage may be present at the power and control terminals even when the motor is stopped.



The snubber capacitors might still be carrying hazardous voltage after isolation from the supply. For this reason, the converter must not be opened for at least two minutes after switch-off.

When working on the open converter, remember that live parts are exposed. The unit must always be operated with the standard front covers in place.

The user is responsible for ensuring that the motor, SIMOREG converter and other devices are installed and connected up in accordance with the approved codes of practice of the country concerned and any other regional or local codes that may apply. Special attention must be paid to proper conductor sizing, fusing, grounding, isolation and disconnection measures and to overcurrent protection.

These converters contain hazardous rotating machinery (fans) and control rotating mechanical components (drives). Death, serious bodily injury or substantial property damage may occur if the instructions in the relevant operating manuals are not observed.

The successful and safe operation of this equipment is dependent on careful transportation, proper storage and installation as well as correct operation and maintenance.

6.1 Installation instructions for proper EMC installation of drives

NOTE

These installation instructions do not purport to handle or take into account all of the equipment details or versions or to cover every conceivable operating situation or application. If you require more detailed information, or if special problems occur, which are not handled in enough detail in this document, please contact your local Siemens office.

The contents of these installation instructions are not part of an earlier or existing agreement or legal contract and neither do they change it. The actual purchase contract represents the complete liability of the A&D Variable-Speed Drives Group of Siemens AG. The warranty conditions, specified in the contract between the two parties, is the only warranty which will be accepted by the A&D Variable-Speed Drives Group. The warranty conditions specified in the contract are neither expanded nor changed by the information provided in the installation instructions.

6.1.1 Fundamental principles of EMC

6.1.1.1 What is EMC

EMC stands for "electromagnetic compatibility" and defines the capability of a piece of equipment to operate satisfactorily in an electromagnetic environment without itself causing electromagnetic disturbances that would adversely affect other items of equipment in its vicinity.

Thus, different items of equipment must not adversely affect one another.

6.1.1.2 Noise radiation and noise immunity

EMC is dependent on two characteristics of the equipment/units involved, i.e. radiated noise and noise immunity. Items of electrical equipment can either be fault sources (transmitters) and/or noise receivers.

Electromagnetic compatibility exists if the fault sources do not adversely affect the function of the noise receivers.

An item of equipment can be both a fault source and a fault receiver. For example, the power section of a converter must be regarded as a fault source and the control section as a noise receiver.

6.1.1.3 Limit values

Electrical drives are governed by Product Standard EN 61800-3. According to this standard, it is not necessary to implement all EMC measures for industrial supply networks. Instead, a solution adapted specifically to the relevant environment can be applied. Accordingly, it may be more economical to increase the interference immunity of a sensitive device rather than implementing noise suppression measures for the converter. Thus, solutions are selected depending on their cost-effectiveness.

SIMOREG DC Master converters are designed for industrial applications (industrial low-voltage supply system, i.e. a system that does not supply domestic households).

Noise immunity defines the behaviour of a piece of equipment when subjected to electromagnetic disturbance. The Product Standard regulates the requirements and assessment criteria for the behaviour of equipment in industrial environments. The converters in this description comply with this Standard (Section 6.1.2.3).

6.1.1.4 SIMOREG converters in industrial applications

In an industrial environment, equipment must have a high level of noise immunity whereas lower demands are placed on noise radiation.

SIMOREG DC Master converters are components of an electrical drive system in the same way as contactors and switches. Properly qualified personnel must integrate them into a drive system consisting, at least, of the converter, motor cables and motor. Commutating reactors and fuses are also required in most cases. Limit values can only be maintained if these components are installed and mounted in the correct way. In order to limit the radiated noise according to limit value "A1", the appropriate radio interference suppression filter and a commutating reactor are required in addition to the converter itself. Without an RI suppression filter, the noise radiated by a SIMOREG DC Master converters exceeds limit value "A1" as defined by EN55011.

If the drive forms part of a complete installation, it does not initially have to fulfil any requirements regarding radiated noise. However, EMC legislation requires the installation as a whole to be electromagnetically compatible with its environment.

If all control components in the installation (e.g. PLCs) have noise immunity for industrial environments, it is not necessary for each drive to meet limit value "A1" in its own right.

6.1.1.5 Non-grounded supply systems

Non-grounded supply systems (IT systems) are used in a number of industrial sectors in order to increase plant availability. In the event of a ground fault, no fault current flows so that the plant can still produce. When RI suppression filters are installed, however, a ground fault does cause a fault current to flow, resulting in shutdown of the drives and, in some cases, destruction of the suppression filter. For this reason, the Product Standard does not define limit values for these supply systems. From the economic viewpoint, RI suppression should, if required, be implemented on the grounded primary side of the supply transformer.

6.1.1.6 EMC planning

If two units are not electromagnetically compatible, you can either reduce the noise radiated by the noise source, or increase the noise immunity of the noise receiver. Noise sources are generally power electronics units with a high power consumption. To reduce the radiated noise from these units, complex, costly filters are required. Noise receivers are predominantly control equipment and sensors including evaluation circuitry. Increasing the noise immunity of less powerful equipment is generally easier and cheaper. In an industrial environment, therefore, it is often more cost-effective to increase noise immunity rather than reduce radiated noise. For example, in order to adhere to limit value class A1 of EN 55011, the noise suppression voltage at the mains connection may be max. 79 dB(μ V) between 150 kHz and 500 kHz and max. 73 dB (μ V) (9 mV or 4.5 mV) between 500 kHz and 30 MHz.

In industrial environments, the EMC of the equipment used must be based on a well-balanced mixture of noise radiation and noise immunity.

The most cost-effective RI suppression measure is the physical separation of noise sources and noise receivers, assuming that it has already been taken into account when designing the machine/plant. The first step is to define whether each unit is a potential noise source (noise radiator or noise receiver). Noise sources are, for example, PLCs, transmitters and sensors. Components in the control cabinet (noise sources and receivers) must be physically separated, if necessary through the use of metal partitions or metal enclosures for individual components. Figure 1 shows an example component layout in a control cabinet.

6.1.2 Proper EMC installation of drives (installation instructions)

6.1.2.1 General

Since drives can be operated in a wide range of differing environments and the electrical components used (controls, switched-mode power supplies, etc.) can widely differ with respect to noise immunity and radiation, any mounting/installation guideline can only represent a practical compromise. For this reason, EMC regulations do not need to be implemented to the letter, provided that measures are checked out on a case by case basis.

In order to guarantee electromagnetic compatibility in your cabinets in rugged electrical environments and fulfil the standards specified by the relevant regulatory bodies, the following EMC regulations must be observed when designing and installing cabinets.

Rules 1 to 10 generally apply. Rules 11 to 15 must be followed to fulfil standards governing radiated noise.

6.1.2.2 Rules for proper EMC installation

Rule 1

All the metal components in the cabinet must be conductively connected over a large surface area with one another (not paint on paint!). Serrated or contact washers must be used where necessary. The cabinet door should be connected to the cabinet through the shortest possible grounding straps (top, center, bottom)..

Rule 2

Contactors, relays, solenoid valves, electromechanical hours counters, etc. in the cabinet, and, if applicable, in adjacent cabinets, must be provided with quenching elements, for example, RC elements, varistors, diodes. These devices must be connected directly at the coil.

Rule 3

Signal cables ¹⁾ should enter the cabinet at only one level wherever possible.

Rule 4

Unshielded cables in the same circuit (incoming and outgoing conductors) must be twisted where possible, or the area between them kept as small as possible in order to prevent unnecessary coupling effects.

Rule 5

Connect spare conductors to the cabinet ground (ground ²⁾) at both ends to obtain an additional shielding effect.

Rule 6

Avoid any unnecessary cable lengths in order to reduce coupling capacitances and inductances.

Rule 7

Crosstalk is kept low if cables are routed close to the cabinet ground. For this reason, wiring should not be routed freely in the cabinet, but as close as possible to the cabinet frame and mounting panels. This applies equally to spare cables.

Rule 8

Signal and power cables must be routed separately from one another (to prevent noise from being coupled in). A minimum 20 cm clearance should be maintained.

If the encoder cables and motor cables cannot be routed separately, then the encoder cable must be decoupled by means of a metal partition or installation in a metal pipe or duct. The partition or metal duct must be grounded at several points.

Rule 9

The shields of digital signal cables must be connected to ground at both ends (source and destination). If there is poor potential bonding between the shield connections, an additional potential bonding cable of at least 10 mm² must be connected in parallel to the shield to reduce the shield current. Generally speaking, the shields can be connected to the cabinet housing (ground ²⁾) at several points. The shields may also be connected at several locations outside the cabinet.

Foil-type shields should be avoided. Their shielding effect is poorer by a factor of 5 as compared to braided shields.

Rule 10

The shields of analog signal cables may be connected to ground at both ends (conductively over a large area) if potential bonding is good. Potential bonding can be assumed to be good if all metal parts are well connected and all the electronic components involved are supplied from the same source.

The single-ended shield connection prevents low-frequency, capacitive noise from being coupled in (e.g. 50 Hz hum). The shield connection should then be made in the cabinet. In this case, the shield may be connected by means of a sheath wire.

Rule 11

The RI suppression filter must always be mounted close to the suspected noise source. The filter must be mounted over the largest possible area with the cabinet housing, mounting plate, etc. Incoming and outgoing cables must be routed separately.

Rule 12

To ensure adherence to limit value class A1, the use of RI suppression filters is obligatory. Additional loads must be connected on the line side of the filter.

The control system used and the other wiring in the cubicle determines whether an additional line filter needs to be installed.

Rule 13

A commutating reactor must be installed in the field circuit for controlled field supplies.

Rule 14

A commutating reactor must be installed in the converter armature circuit.

Rule 15

Unshielded motor cables may be used in SIMOREG drive systems.

The line supply cable must be routed at a distance of at least 20 cm from the motor cables (field, armature). Use a metal partition if necessary.

Footnotes:

1) Signal cables are defined as:

Digital signal cable:	Analog signal cable.:
Pulse encoder cables	e.g. ± 10 V setpoint cable
Serial interfaces, e.g. PROFIBUS-DP	

2) The term "Ground" generally refers to all metallic, conductive components which can be connected to a protective conductor, e.g. cabinet housing, motor housing, foundation grounder, etc.

Cabinet design and shielding:

The cabinet design illustrated in **Figure 1** is intended to make the user aware of EMC-critical components. The example does not claim to include all possible cabinet components and their respective mounting possibilities.

Details which influence the noise immunity/radiation of the cabinet and are not absolutely clear in the overview diagram are described in **Figures 1a - 1d**.

Figures 2a -2d show details of different shield connection techniques with ordering source information.

Arrangement of RI suppression filters and commutating reactors:

Section 6.1.2.3 shows how RI suppression filters and commutating reactors are arranged in the SIMOREG DC Master system. The specified sequence for mounting reactors and filters must be observed. Fuses for semiconductor protection are selected according to Section 6.6.2.

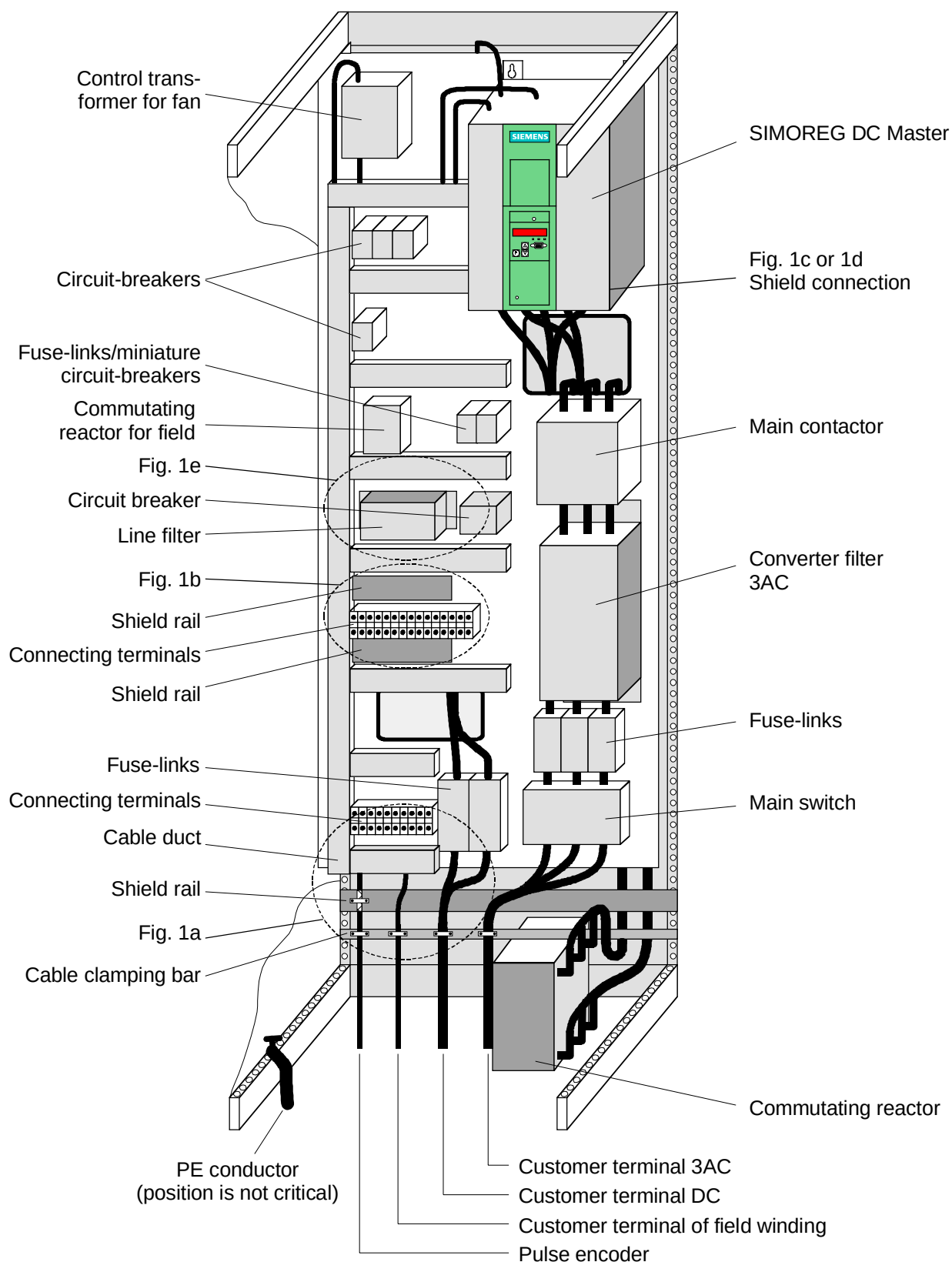


Fig. 1: Example of a cabinet design with a SIMOREG DC Master 15 A to 850 A

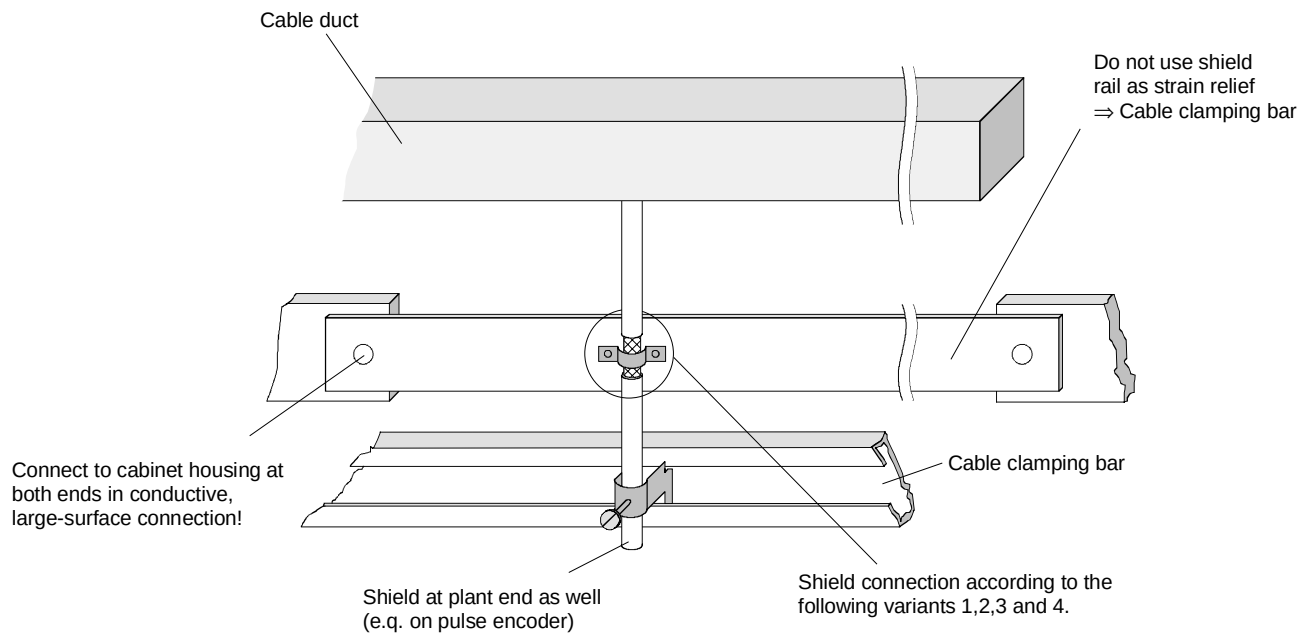


Fig. 1a: Shield at cable entry point to cabinet

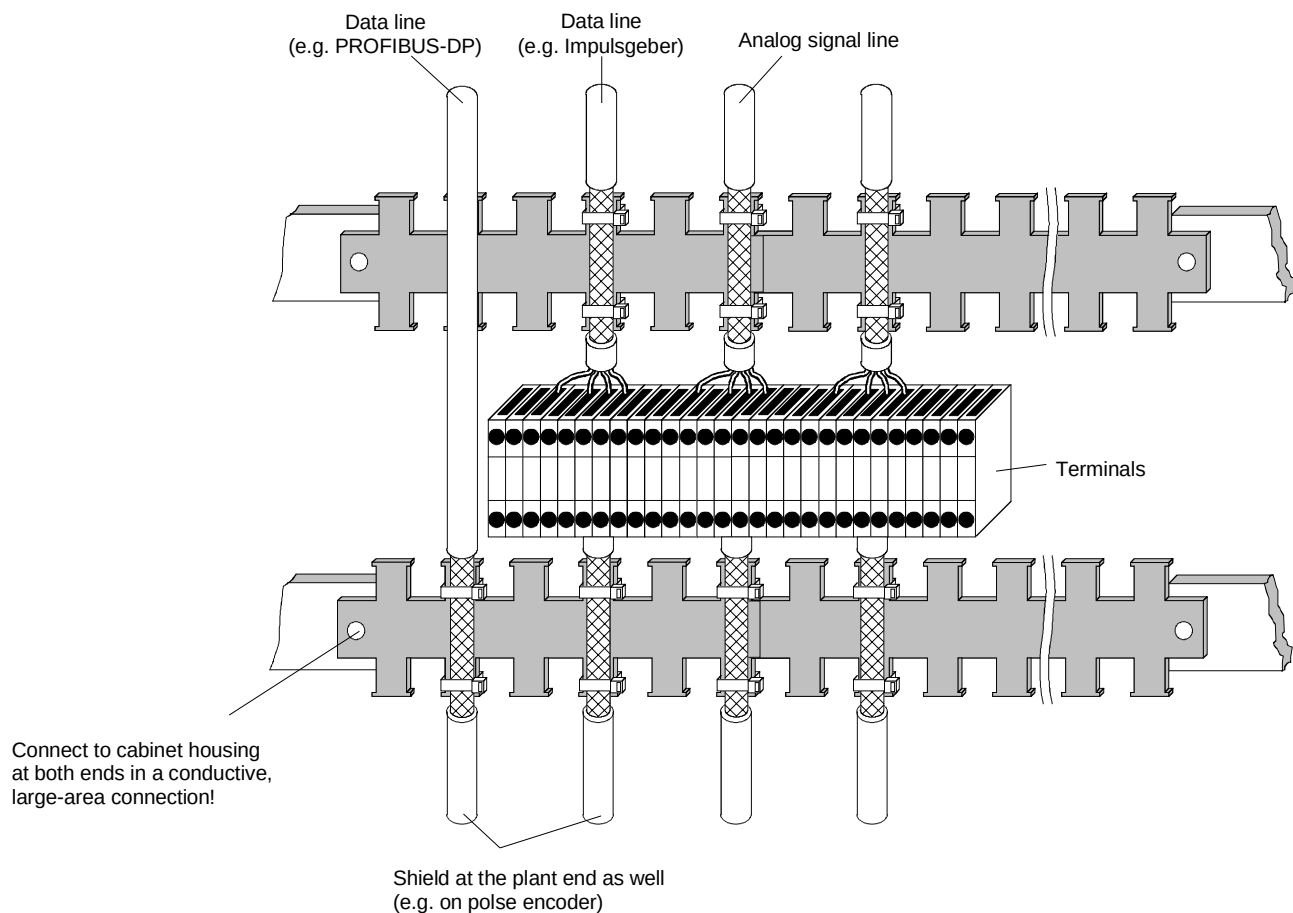
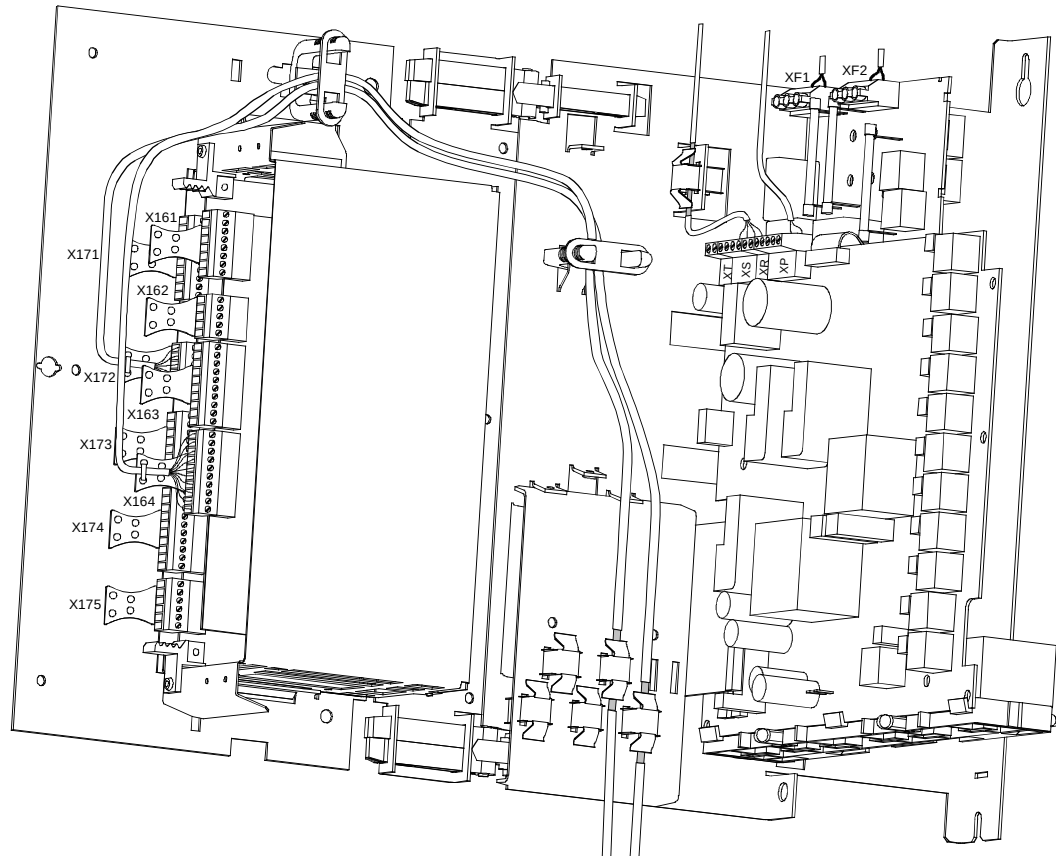


Fig. 1b: Shielding in the cabinet



The customer connections must be routed above the electronics box.

Fig. 1c: Connecting shields on SIMOREG DC Master converters up to 850A

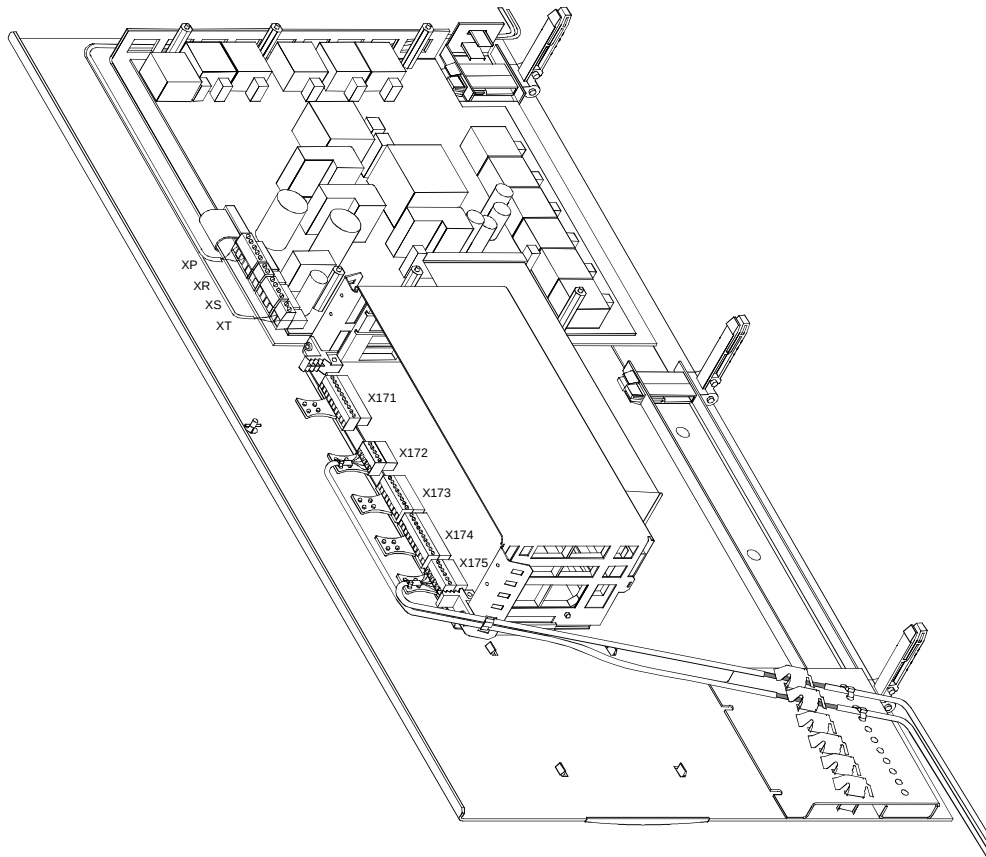


Fig. 1d: Connecting shields on SIMOREG DC Master >850A

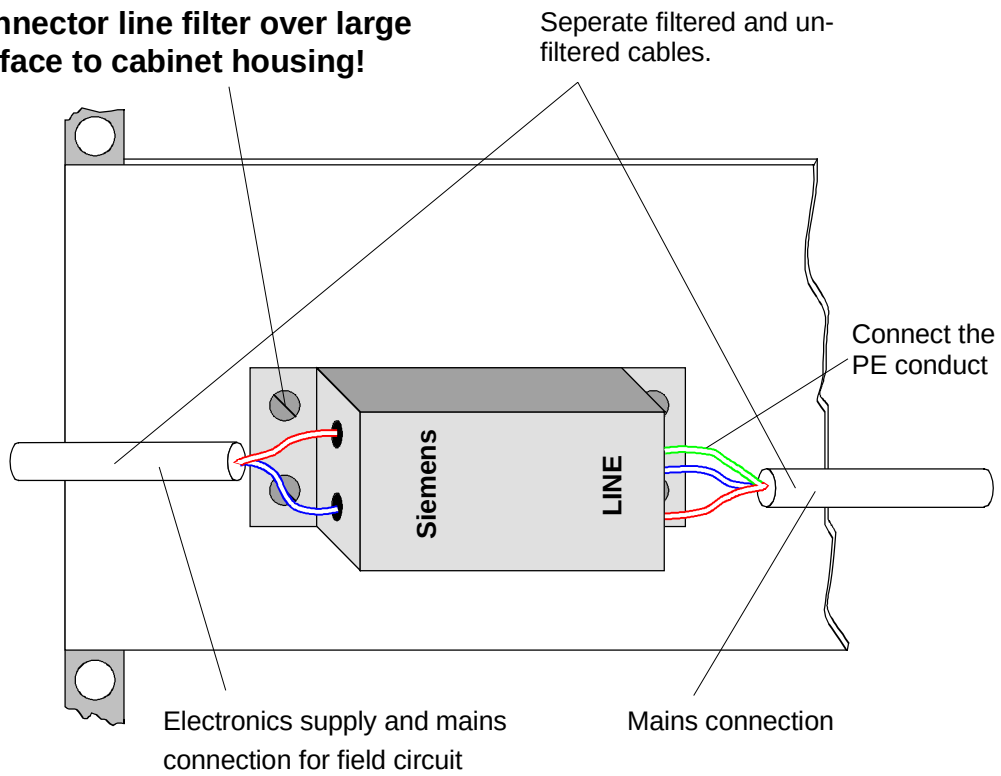
Connector line filter over large surface to cabinet housing!

Fig. 1e: Line filter for SIMOREG DC Master 6RA70 electronics power supply

Shield connections:

Variant 1:

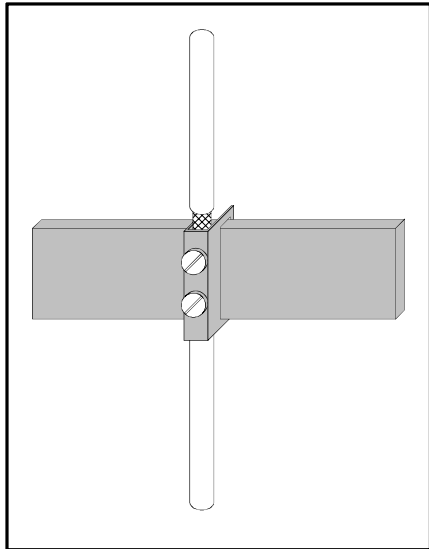


Fig. 2a: Terminal on a copper busbar, max. cable diameter 15 mm

Variant 2:

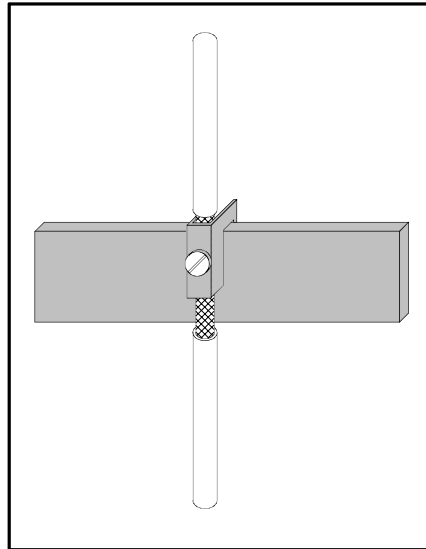


Fig. 2b: Terminal on copper busbar, max. cable diameter 10 mm

Caution!

The conductor might be damaged if the terminal screw is over-tightened.

Note:

Terminals:
 5 mm busbar thickness
 Order No. 8US1921-2AC00
 10 mm busbar thickness
 Order No. 8US1921-2BC00

Note:

Terminals:
 Order No. 8HS7104,
 8HS7104, 8HS7174, 8HS7164

Variant 3:

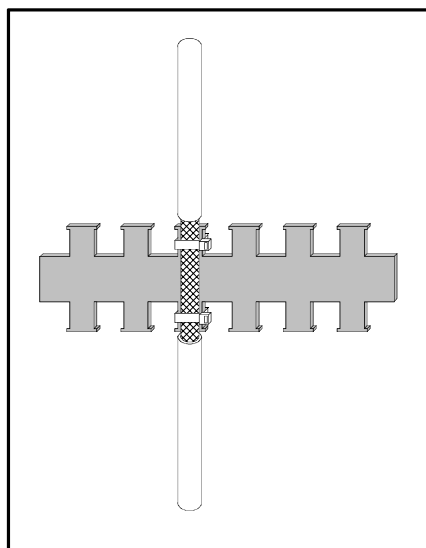


Fig. 2c: Metallized tubing or cable ties on a bare metal comb-type/serrated rail

Variant 4:

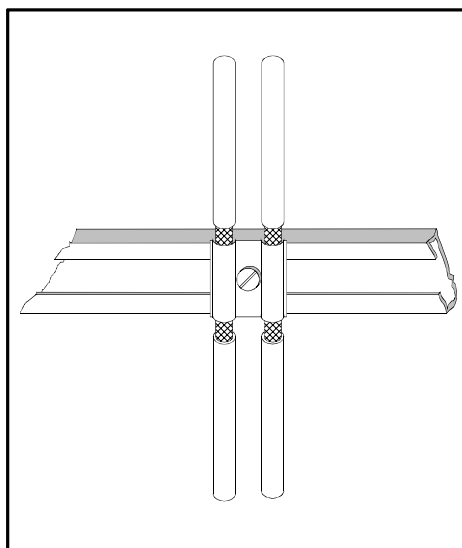


Fig. 2d: Clamp and metallic mating piece on a cable clamping rail

Note:

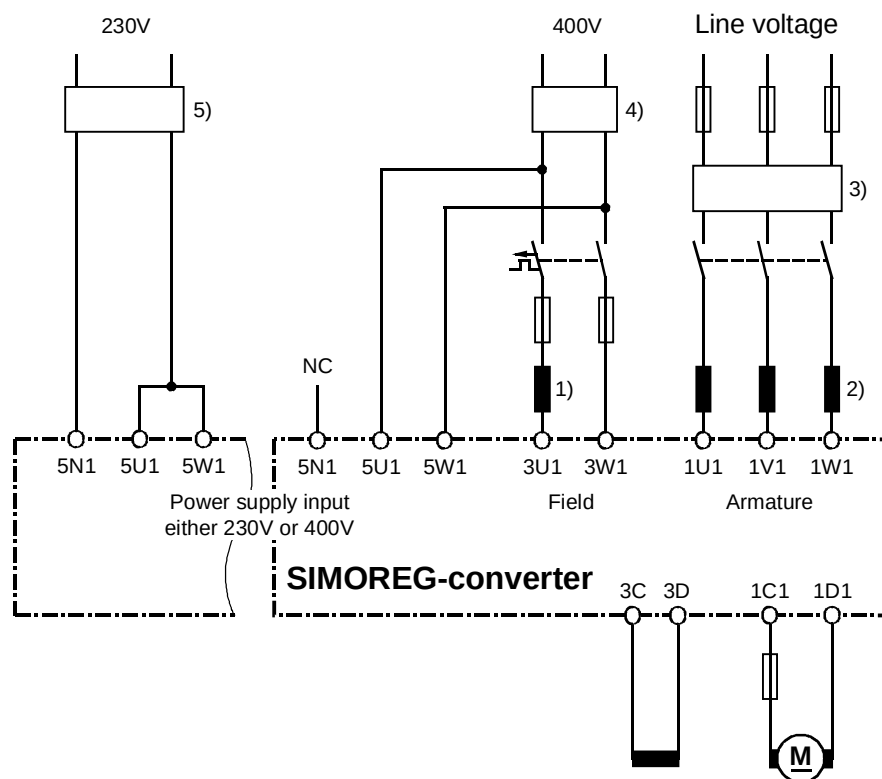
Comb-type rail:
Item No. J48028

Note:

Siemens 5VC55... cable clamps;
Clamping rails in various sizes:
Item No. K48001 to 48005

6.1.2.3 Arrangement of components for converters

Arrangement of reactors and RI suppression filter



- 1) The commutating reactor in the field circuit is dimensioned for the rated motor field current.
- 2) The commutating reactor in the armature circuit is dimensioned for the rated motor current in the armature. The line current equals DC current x 0.82.
- 3) The RI suppression filter for the armature circuit is dimensioned for the rated motor current in the armature. The line current equals DC current x 0.82.
- 4) The RI suppression filter for the field circuit and the electronics power supply is dimensioned for the rated motor field current plus 1 A.
- 5) The RI suppression filter for the electronics power supply is dimensioned for 2 A.

Note:

When RI suppression filters are used, commutating reactors are always required at the converter input to decouple the snubber circuitry.

Commutating reactors are selected according to information in Catalog DA93.1.

6.1.2.4 List of recommended RI suppression filters

Rated current RI suppression filter (A)	RI suppression filter Order number	Terminal cross- section (mm ²)	Weight (kg)	Dimensions HxWxD (mm)
12	6SE7021-0ES87-0FB0	10*)	2.2	215x90x81
18	6SE7021-8ES87-0FB0	10*)	2.2	215x90x81
36	6SE7023-4ES87-0FB0	25	3.7	245x101x86
80	6SE7027-2ES87-0FB0	50	9.5	308x141x141
120	6SE7031-0ES87-0FA0	50	10	348x171x141
180	6SE7031-8ES87-0FA0	95	13	404x171x141
500	6SE7033-7ES87-0FA0	Connecting lug	49	590x305x154
1000	6SE7041-0ES87-0FA0	Connecting lug	90	840x465x204
1600	6SE7041-6ES87-0FA0	Connecting lug	130	870x465x204

*) RI suppression filters generate discharge currents. VDE 0160 specifies a PE connection with 10 mm².

In the case of converters with 3-phase connection, the line current (filter current) equals the DC current x 0.82.

In the case of converters with 2-phase connection, two phase are connected to the three-phase RI suppression filter. In this instance, the line current is equal to the DC current.

Important technical data of RI suppression filters:

Rated supply voltage	3AC 380-460 V (± 15%)
Rated frequency	50/60 Hz (± 6%)
Operating temperature	0° C to +40° C
Degree of protection	IP20 (EN60529) IP00 with 500 A and above

For further technical data about RI suppression filters, please refer to the Operating Instructions:

SIMOVER Master Drives RI Suppression Filters EMC Filters, Order number: 6SE7087-6CX87-0FB0.

6.1.3 Information on line-side harmonics generated by converters in a fully-controlled three-phase bridge circuit configuration B6C and (B6)A(B6)C

Converters for the medium power range usually consist of fully-controlled three-phase bridge circuit configurations. An example of the harmonics generated by a typical system configuration for two firing angles ($\alpha = 20^\circ$ and $\alpha = 60^\circ$) is given below.

The values have been taken from an earlier publication entitled "Harmonics in the Line-Side Current of Six-Pulse Line-Commutated Converters" written by H. Arremann and G. Möltgen, Siemens Research and Development Dept., Volume 7 (1978) No. 2, © Springer-Verlag 1978.

Formulae have been specified with which the short circuit power S_K and armature inductance L_a of the motor to which the specified harmonics spectrum applies can be calculated depending on the applicable operating data [line voltage (no-load voltage U_{V0}), line frequency f_N and DC current I_d]. A dedicated calculation must be performed if the actual system short circuit power and/or actual armature reactance deviate from the values determined by this method.

The spectrum of harmonics listed below is obtained if the values for short circuit power S_K at the converter supply connection point and the armature inductance L_a of the motor calculated by the following formulae correspond to the actual plant data. If the calculated values differ, the harmonics must be calculated separately.

a.) $\alpha = 20^\circ$

b.) $\alpha = 60^\circ$

Fundamental factor $g = 0.962$

Fundamental factor $g = 0.953$

v	I_v/I_1	v	I_v/I_1
5	0.235	29	0.018
7	0.100	31	0.016
11	0.083	35	0.011
13	0.056	37	0.010
17	0.046	41	0.006
19	0.035	43	0.006
23	0.028	47	0.003
25	0.024	49	0.003

v	I_v/I_1	v	I_v/I_1
5	0.283	29	0.026
7	0.050	31	0.019
11	0.089	35	0.020
13	0.038	37	0.016
17	0.050	41	0.016
19	0.029	43	0.013
23	0.034	47	0.013
25	0.023	49	0.011

The fundamental-frequency current I_1 as a reference quantity is calculated by the following equation:

$$I_1 = g \times 0.817 \times I_d$$

where I_d DC current of operating point under investigation

where g Fundamental factor (see above)

The harmonic currents calculated from the above tables are valid **only** for

I.) Short-circuit power S_K at converter supply connection point

$$S_K = \frac{U_{V0}^2}{X_N} \quad (\text{VA})$$

where

$$X_N = X_K - X_D = 0.03536 \times \frac{U_{v0}}{I_d} - 2\pi f_N \times L_D \quad (\Omega)$$

and

U_{v0} No-load voltage in V at the converter supply connection point

I_d DC current in A of operating point under investigation

f_N Line frequency in Hz

L_D Inductance in H of commutating reactor used

X_D Impedance of the commutating reactor

X_N Impedance of the network

X_K Impedance at the converter terminals

II.) Armature inductance L_a

$$L_a = 0.0488 \times \frac{U_{v0}}{f_N \times I_d} \text{ (H)}$$

A separate calculation must be performed if the actual values for short-circuit power S_K and/or armature inductance L_a deviate from the values calculated on the basis of the above equations.

Example

Let us assume that a drive has the following data:

$$U_{v0} = 400 \text{ V}$$

$$I_d = 150 \text{ A}$$

$$f_N = 50 \text{ Hz}$$

$$L_D = 0.169 \text{ mH (4EU2421-7AA10 where } I_{LN} = 125 \text{ A)}$$

When

$$X_N = 0.03536 \times \frac{400}{150} - 2\pi \times 50 \times 0.169 \times 10^{-3} = 0.0412 \Omega$$

the required system short-circuit power at the converter supply connection point is as follows:

$$S_K = \frac{400^2}{0.0412} = 3.88 \text{ MVA}$$

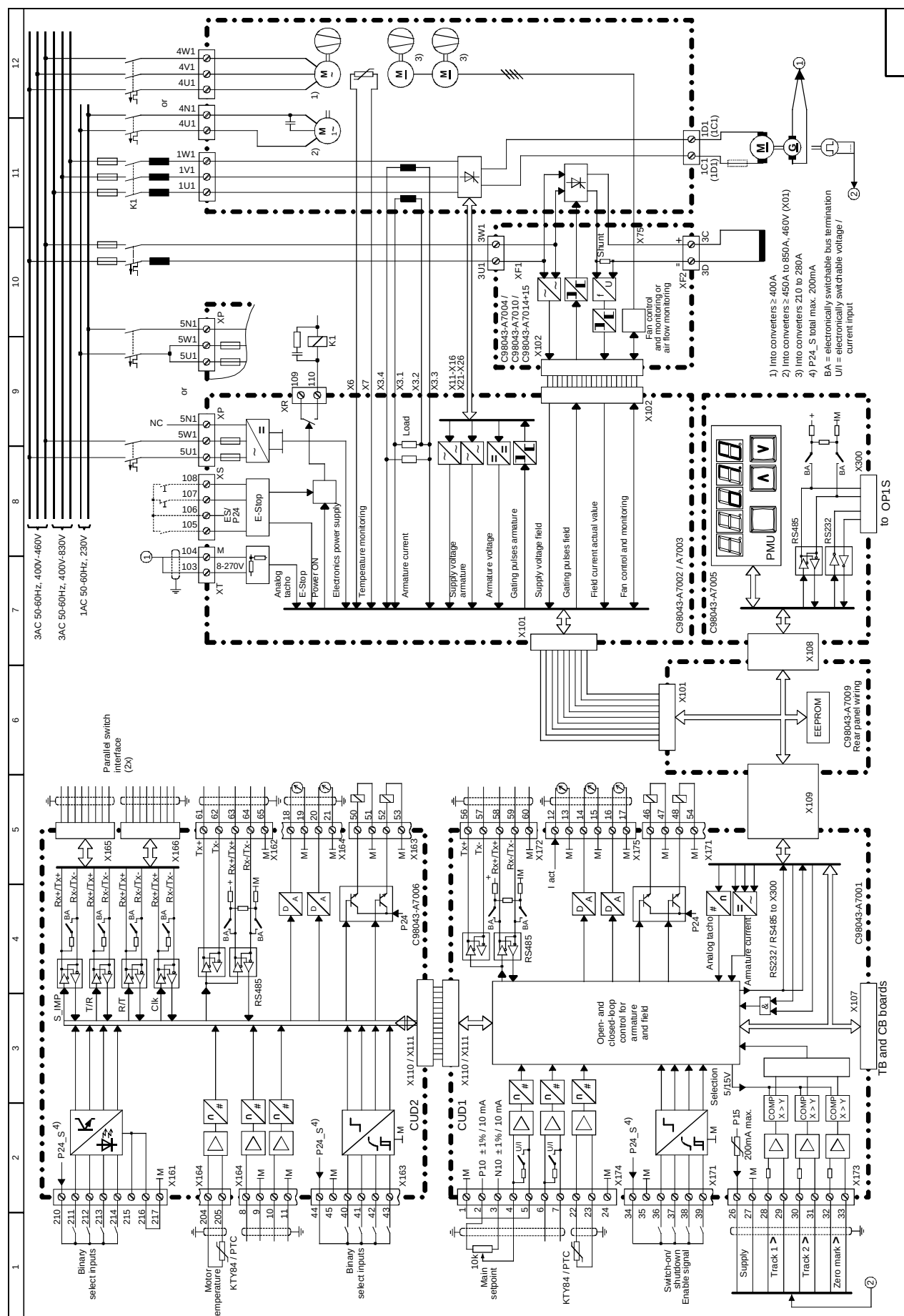
and the required motor armature inductance as follows:

$$L_a = 0.0488 \times \frac{400}{50 \times 150} = 2.60 \text{ mH}$$

The harmonic currents I_v listed in the tables above (where $I_1 = g \times 0.817 \times I_d$ for firing angles $\alpha = 20^\circ$ and $\alpha = 60^\circ$) apply only to the values S_K and L_a calculated by the above method. If the calculated and actual values are not the same, the harmonics must be calculated separately.

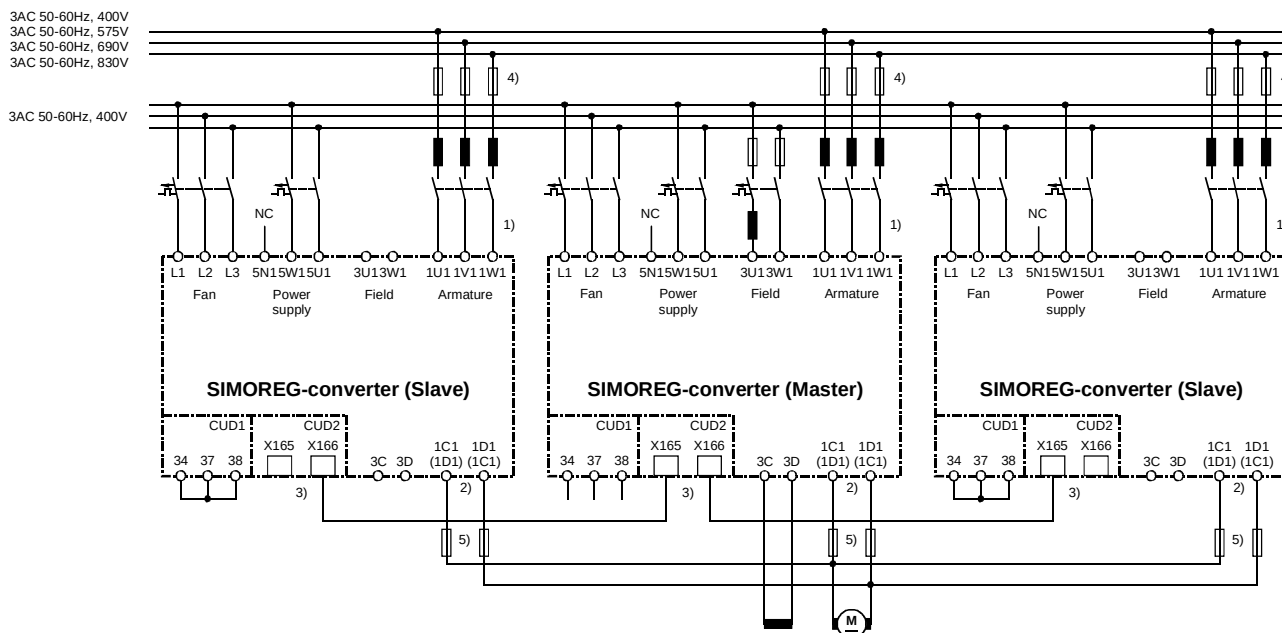
For the purpose of dimensioning filters and compensation circuits with reactors, the harmonic values calculated by these equations can be applied only if the values calculated for S_K and L_a tally with the actual values of the drive. If they do not, they must be calculated separately (this is especially true when using compensated motors as these have a very low armature inductance).

6.2 Block diagram with recommended connection



6.3 Parallel connection of converters

6.3.1 Circuit diagram showing parallel connection of SIMOREG converters



- 1) The same phase sequence is required between 1U1 /1V1 /1W1.
- 2) The same phase sequence is required between 1C1 / 1D1.
- 3) The converters are connected by means of an (8-pin) shielded Patch cable of type UTP CAT5 according to ANSI/EIA/TIA 568, such as those used in PC networking.
A standard 5 m cable can be ordered directly from Siemens (order number: 6RY1707-0AA08).
(n-1) cables are needed to connect n converters in parallel.
The bus terminator must be activated (U805=1) on the converter at each end of the bus.
- 4) These fuses may only be used on converters up to 850A.
- 5) For converters up to 850A in 4Q operation only

The terminal expansion option (CUD2) is required for each converter in a parallel connection.

A maximum of 6 converters can be connected in parallel.

When several converters are connected in parallel, the master unit should be positioned in the center to allow for signal transit times. Maximum length of paralleling interface cable between master and slave converters at each end of bus: 15m.

For the purpose of current distribution, separate commutating reactors of the same type are required for each SIMOREG converter. Current distribution is determined by the differential reactor tolerance. A tolerance of 5% or higher is recommended for operation without derating (reduced current).

Caution:

Parallel connections may only be made between converters with the same DC current rating!

6.3.2 Parameterization of SIMOREG converters for parallel connection

6.3.2.1 Standard operating mode

Master		Slaves	
U800 = 1	Paralleling interface active	U800 = 2	Paralleling interface active Use master firing pulses
U803 = 0	"N+1 mode" not active		
U804.01 = 30	control word 1	U804.01 = 32	status word 1
U804.02 = 31	control word 2		
U804.03 = 167	Actual speed value		
U805 = 1	(bus termination)	on the two end units (at both physical ends of the bus cable)	
0	(no bus termination)	on all other units	
U806 = 12	master for one slave	U806 = 2	1 slave
13	master for 2 slaves	U806 = 2 and 3	2 slaves
14	master for 3 slaves	U806 = 2, 3 and 4	3 slaves
15	master for 4 slaves	U806 = 2,3,4 and 5	4 slaves
16	master for 5 slaves	U806 = 2,3,4,5 and 6	5 slaves
Set U806.02 like U806.01		Set U806.02 like U806.01	
P082 <> 0	operating mode for field	P082 = 0	internal field is not used
Set P083 depending on the source of the actual speed value		P083 = 4	Freely connected actual speed value
		P609 = 6023	Use actual speed value of master
$P100 = \frac{\text{Rated motor current}}{\text{Number of SIMOREG units}}$		$P100 = \frac{\text{Rated motor current}}{\text{Number of SIMOREG units}}$	
Set P648, P649 depending on the source of the control word		P648 = 6021	Use control word 1 from master
		P649 = 6022	Use control word 2 from master
		P821.01 = 31	Suppress alarm A031
P110 = Actual armature resistance x no. of SIMOREG converters		P110 = set as on master	
P111 = Actual armature inductance x no. of SIMOREG converters		P111 = set as on master	
The optimization run for current controller and precontrol (P021 = 25) sets these parameters correctly.			

For further details about the operating principle of parallel connections between SIMOREG converters, please refer to Section 8, Function Diagrams, Sheet 41 (paralleling interface).

Notes:

- Control commands "Switch-on/Shutdown", "Enable operation", "Emergency stop" etc. must be connected to a group of parallel-connected SIMOREG converters via the master device. Terminals 37 and 38 must be permanently connected to terminal 34 on the slave !
- Optimization runs must be started on the master device. All slaves must be connected and ready to run when optimization is started.

6.3.2.2 Operating mode "N+1 mode" (redundancy mode)

Master	Standby master	Slaves
U800 = 1 Paralleling interface active	U800 = 2 Paralleling interface active Use master firing pulses	
U803 = 1 "N+1 mode" active		
U804.01 = 30 control word 1 U804.02 = 31 control word 2 U804.03 = 167 actual speed value U804.04 = any U804.05 = any U804.06 = 32 status word 1 U804.07 = any U804.08 = any U804.09 = any U804.10 = any	U804.01 = 32 status word 1 U804.02 = any U804.03 = any U804.04 = any U804.05 = any U804.06 = 30 control word 1 U804.07 = 31 control word 2 U804.08 = 167 actual speed value U804.09 = any U804.10 = any	U804.01 = 32 status word 1 U804.02 = any U804.03 = any U804.04 = any U804.05 = any U804.06 = any U804.07 = any U804.08 = any U804.09 = any U804.10 = any
U805 = 1 (bus termination) 0 (no bus termination)	on the two end units (at both physical ends of the bus cable) on all other units	
U806.01 = 12 master + 1 slave 13 master + 2 slaves 14 master + 3 slaves 15 master + 4 slaves 16 master + 5 slaves U806.02 = 2 slave 2	U806.01 = 2 slave 2 U806.02 = 12 master + 1 slave 13 master + 2 slaves 14 master + 3 slaves 15 master + 4 slaves 16 master + 5 slaves	U806.01 = 3 2 slaves U806.01 = 3 and 4 3 slaves U806.01 = 3,4 and 5 4 slaves U806.01 = 3,4,5 and 6 5 slaves U806.02 = set like U601.01
P082 <> 0 operating mode for field	P082 = 0 internal field is not used	
P08, set according to source of the actual speed value		P083 = 4 Freely connected actual speed value P609 = 6023 Use actual speed value of master
$P100 = \frac{\text{Rated motor current}}{\text{Number of SIMOREG units}}$		
P648, P649, set according to source of the control word		P648 = 6021 Use control word 1 from master P649 = 6022 Use control word 2 from master
		P821.01 = 31 Suppress alarm A031
U807 = 0.000s telegram failure does not lead to a fault message		
P110 = Actual armature resistance x no. of SIMOREG converters P111 = Actual armature inductance x no. of SIMOREG converters The optimization run for current controller and precontrol (P021 = 25) sets these parameters correctly.	P110 = set as on master P111 = set as on master	

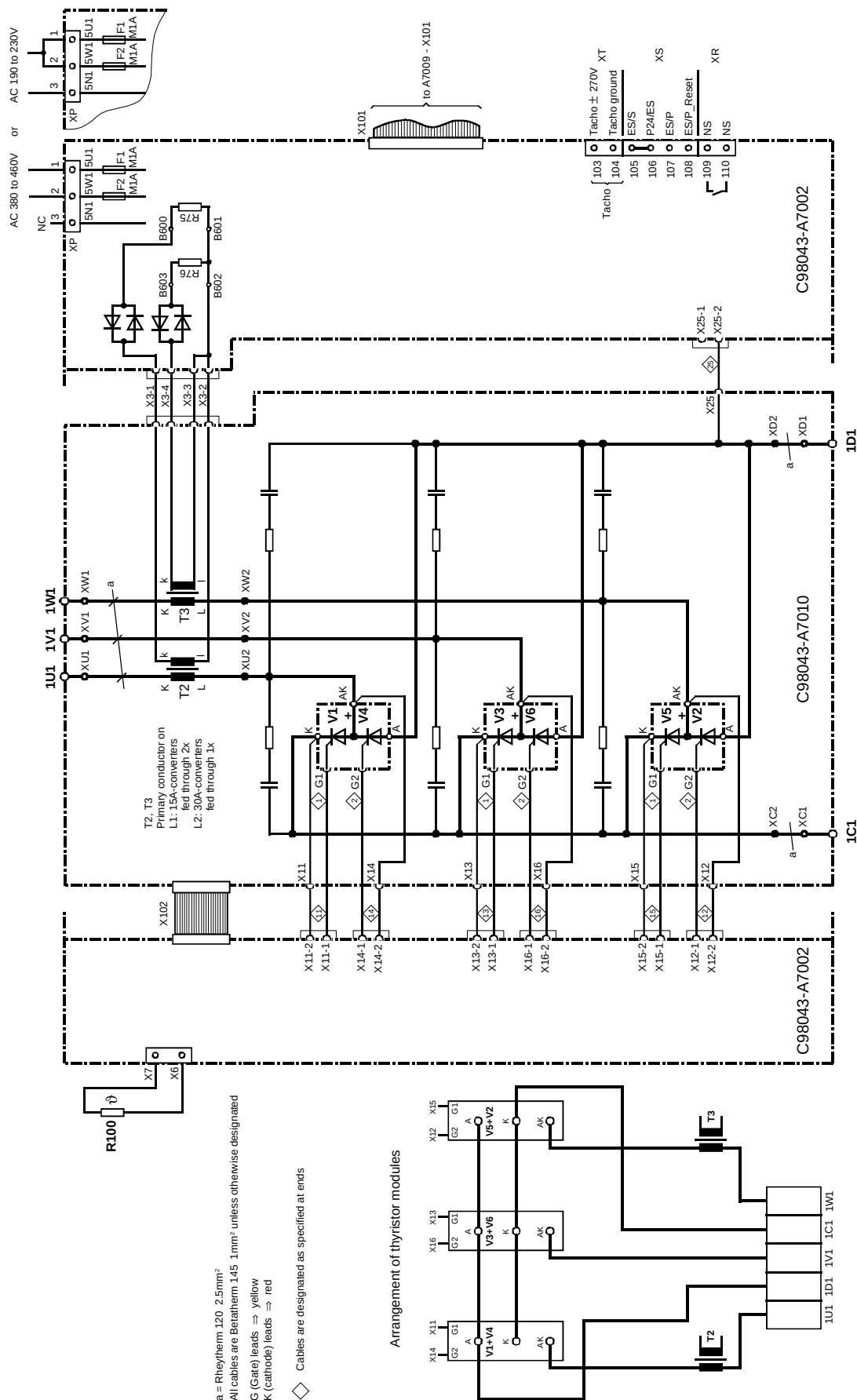
For further details about the operating principle of parallel connections between SIMOREG converters, please refer to Section 8, Function Diagrams, Sheet G45 (paralleling interface).

Notes:

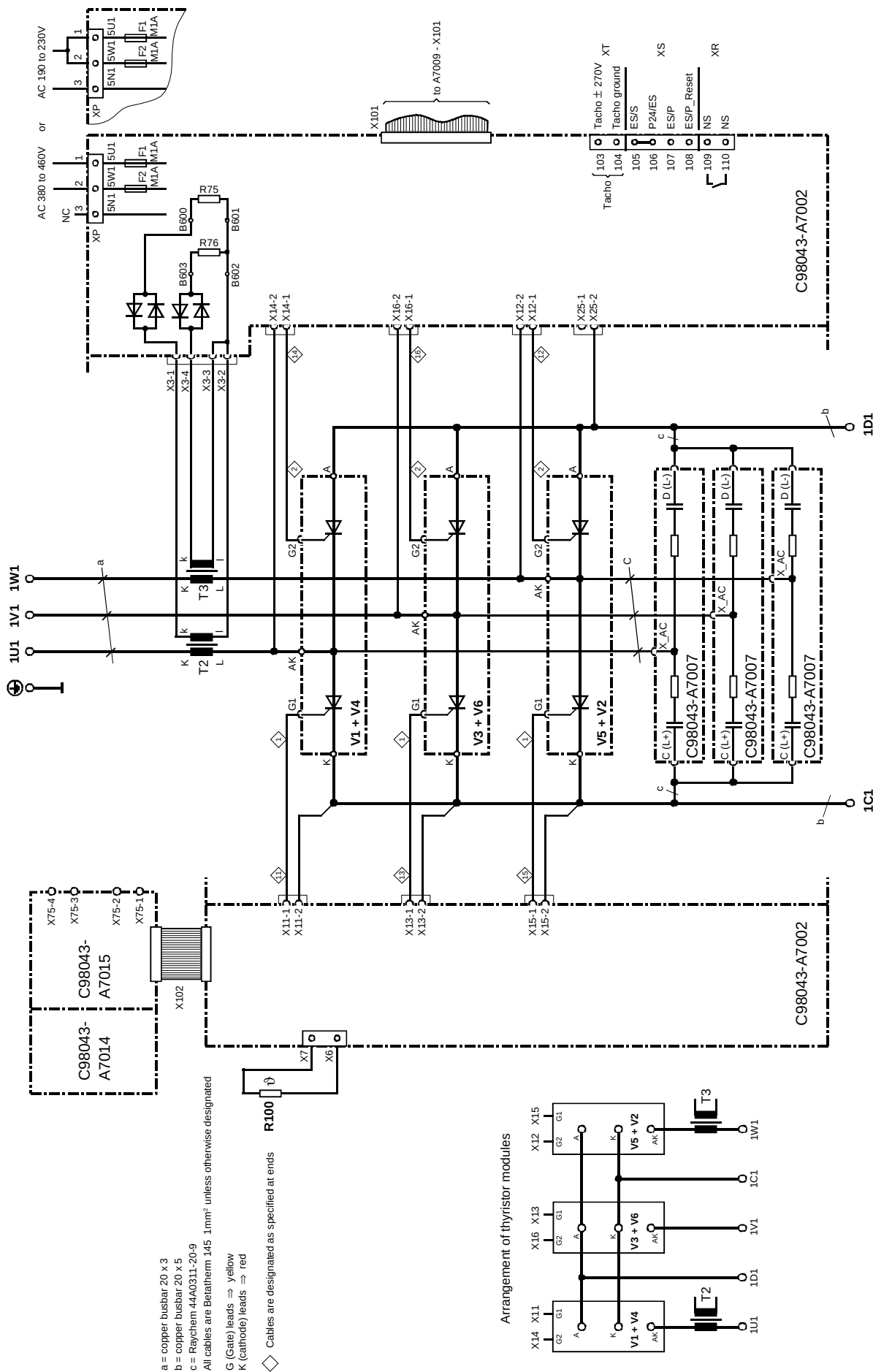
In this mode it is possible to maintain operation with the remaining SIMOREG units if one unit should fail (e.g. fuse blown in the power section). The functional SIMOREG units continue to run without interruption if one unit fails. During configuration, make sure that the power of only n units (instead of $n+1$ units) is sufficient for the application.

- Control commands "Switch-on/Shutdown", "Enable operation", "Emergency stop" etc. must be connected to a group of parallel-connected SIMOREG converters via the master device AND via the "standby" master device.
Terminals 37 and 38 must be permanently connected to terminal 34 on the slaves!
- The speed setpoint and the actual speed value must be connected to a group of parallel-connected SIMOREG converters via the master device AND via the "standby" master device. !
- All parameters except for those in the above list must be set identically on the master and the "standby" master.
- Optimization runs must be started on the master device. All slaves must be connected and ready to run when optimization is started.

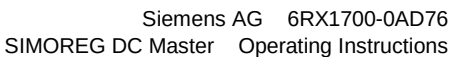
6.4.1 Converters: 30A, 1Q



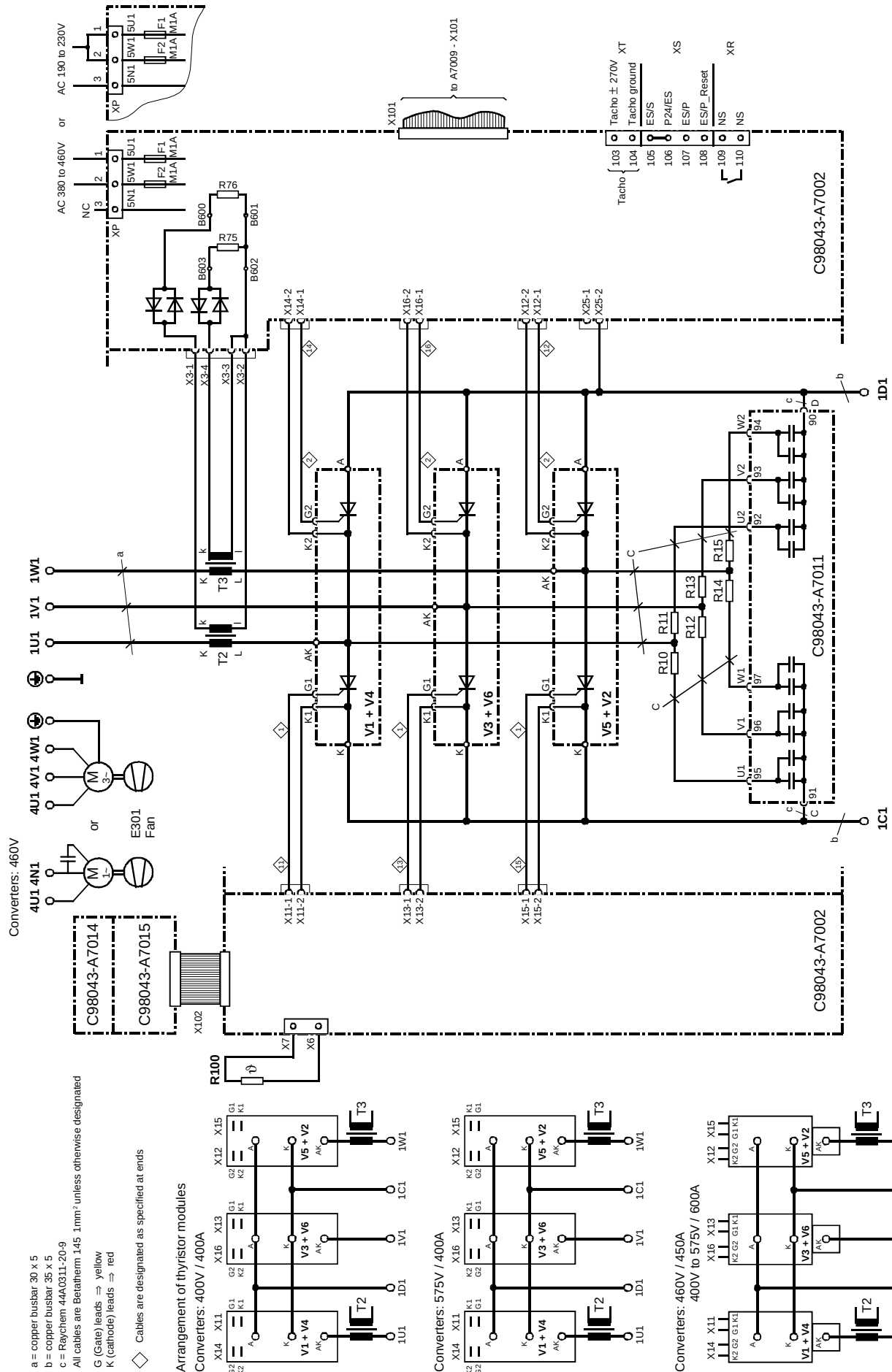
6.4.2 Converters: 60A, 1Q



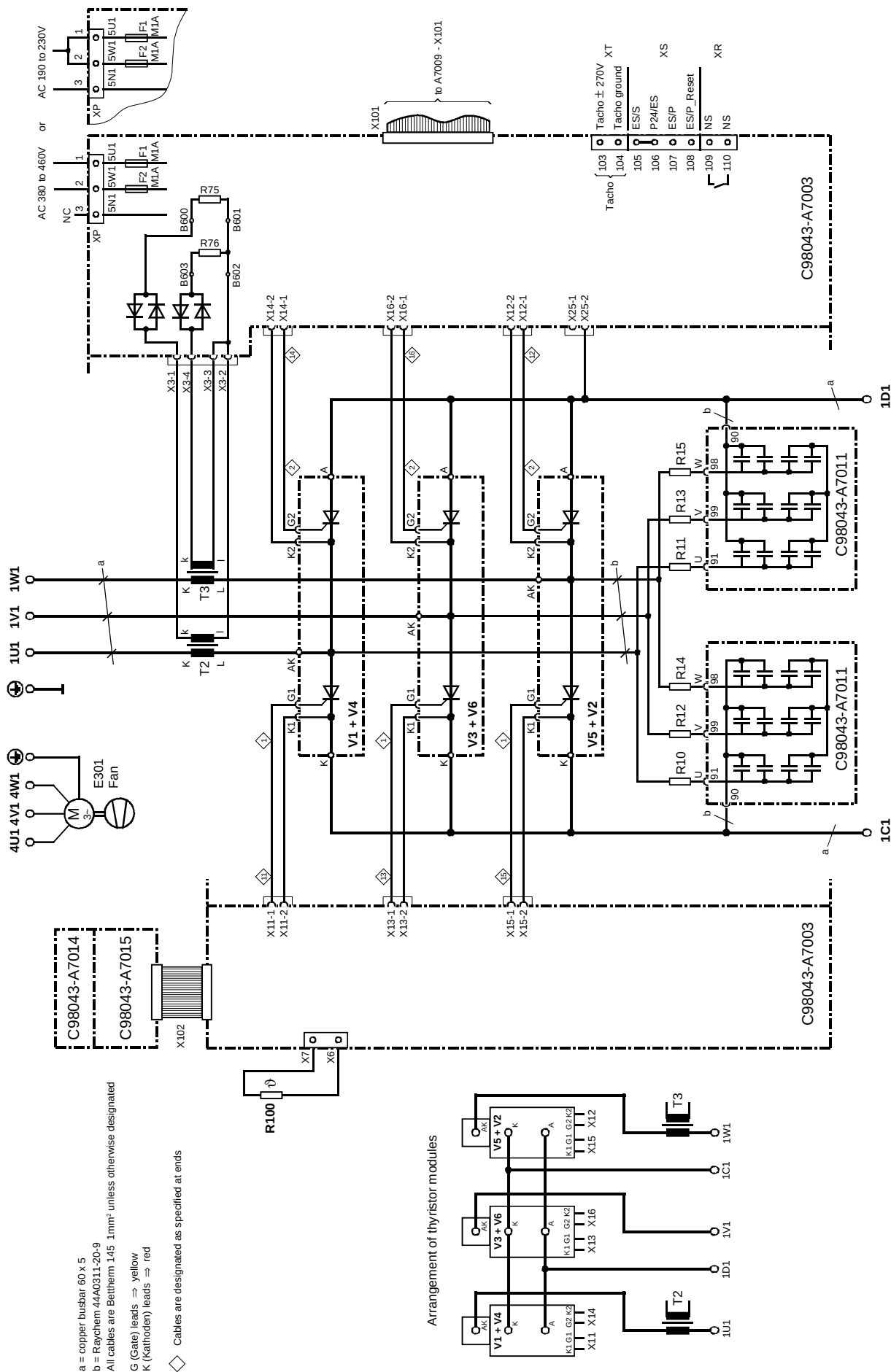
6-24



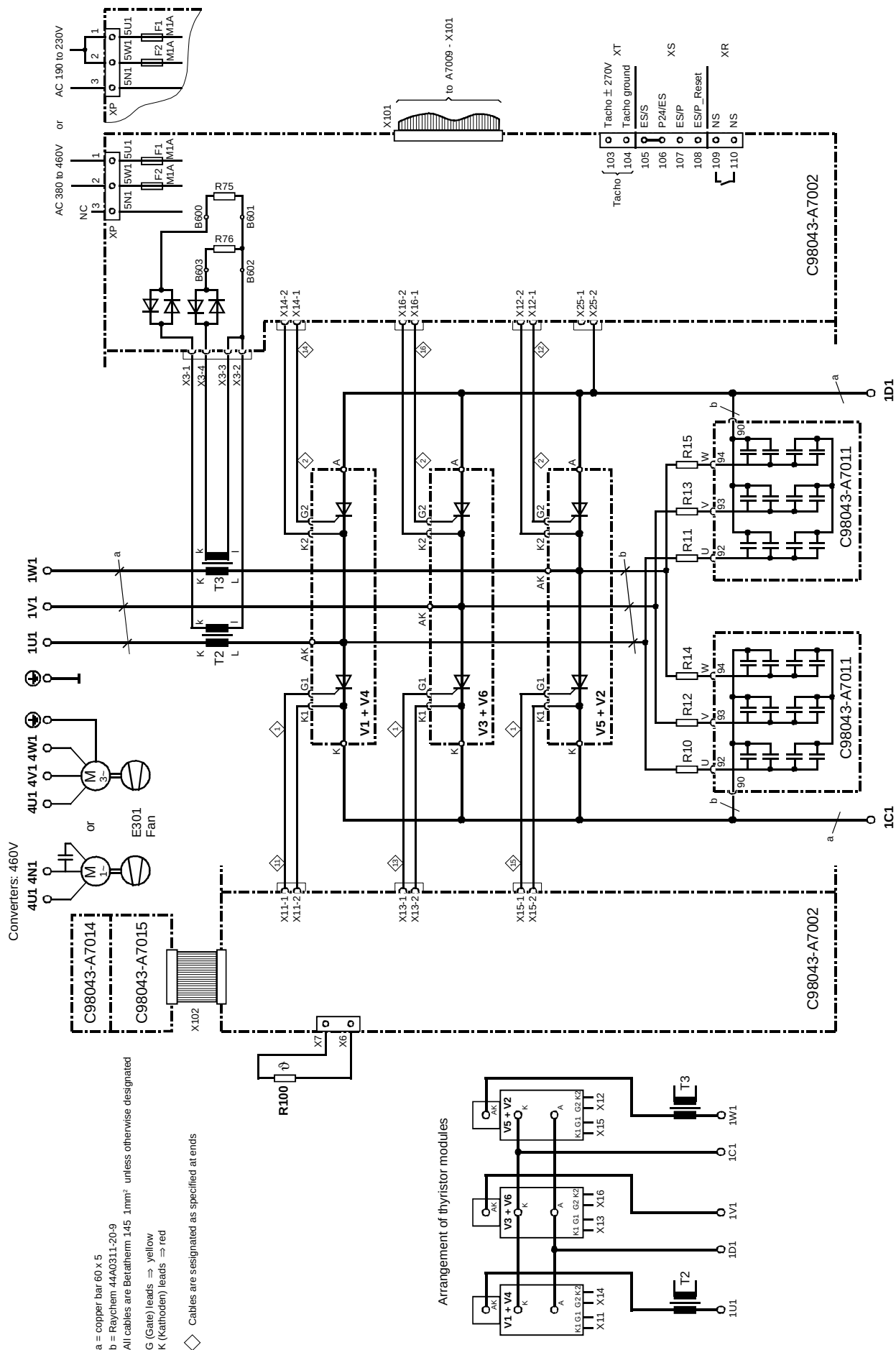
6.4.4 Converters: 400A to 600A, 1Q



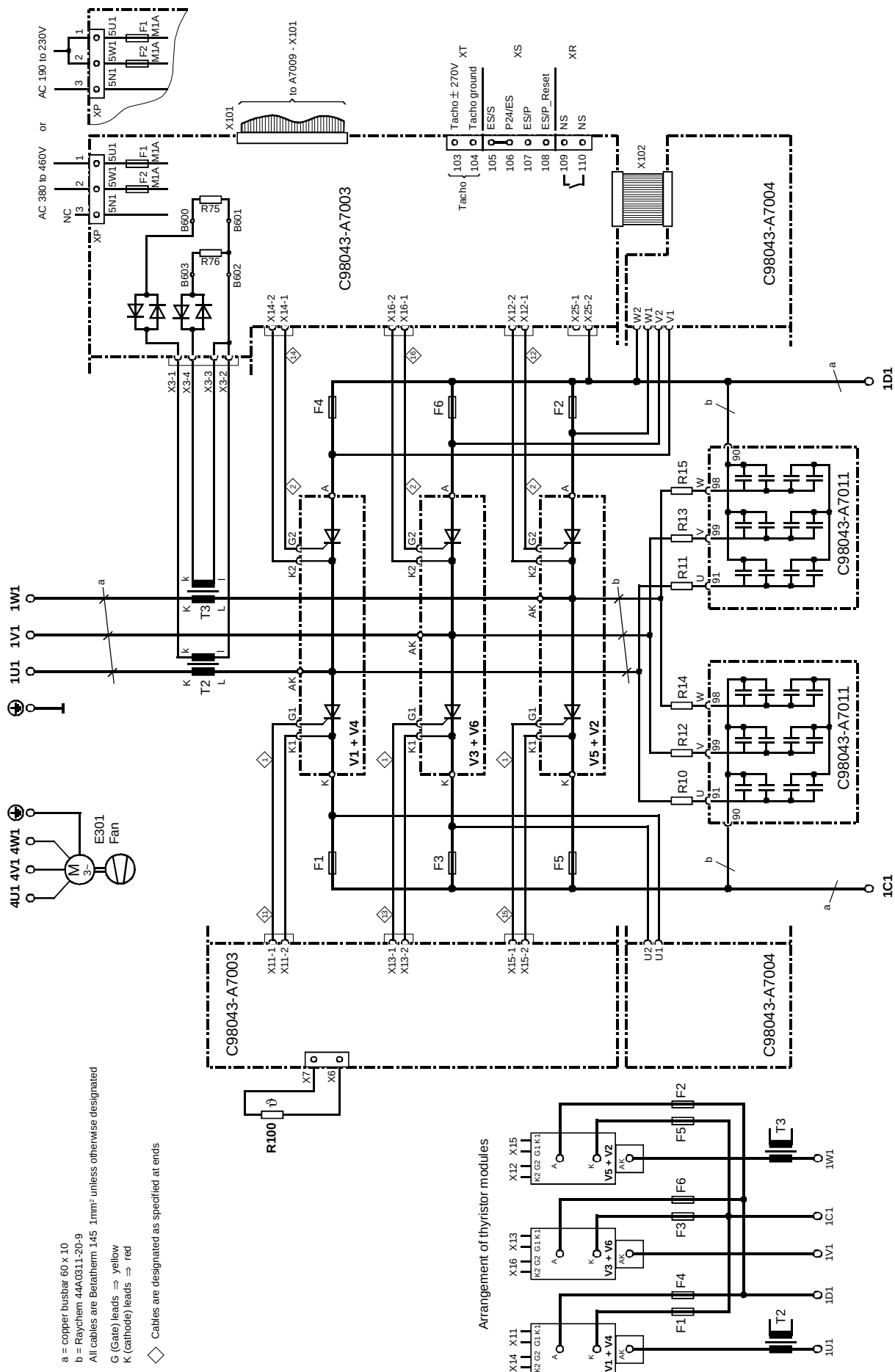
6.4.5 Converters: 720A, 1Q



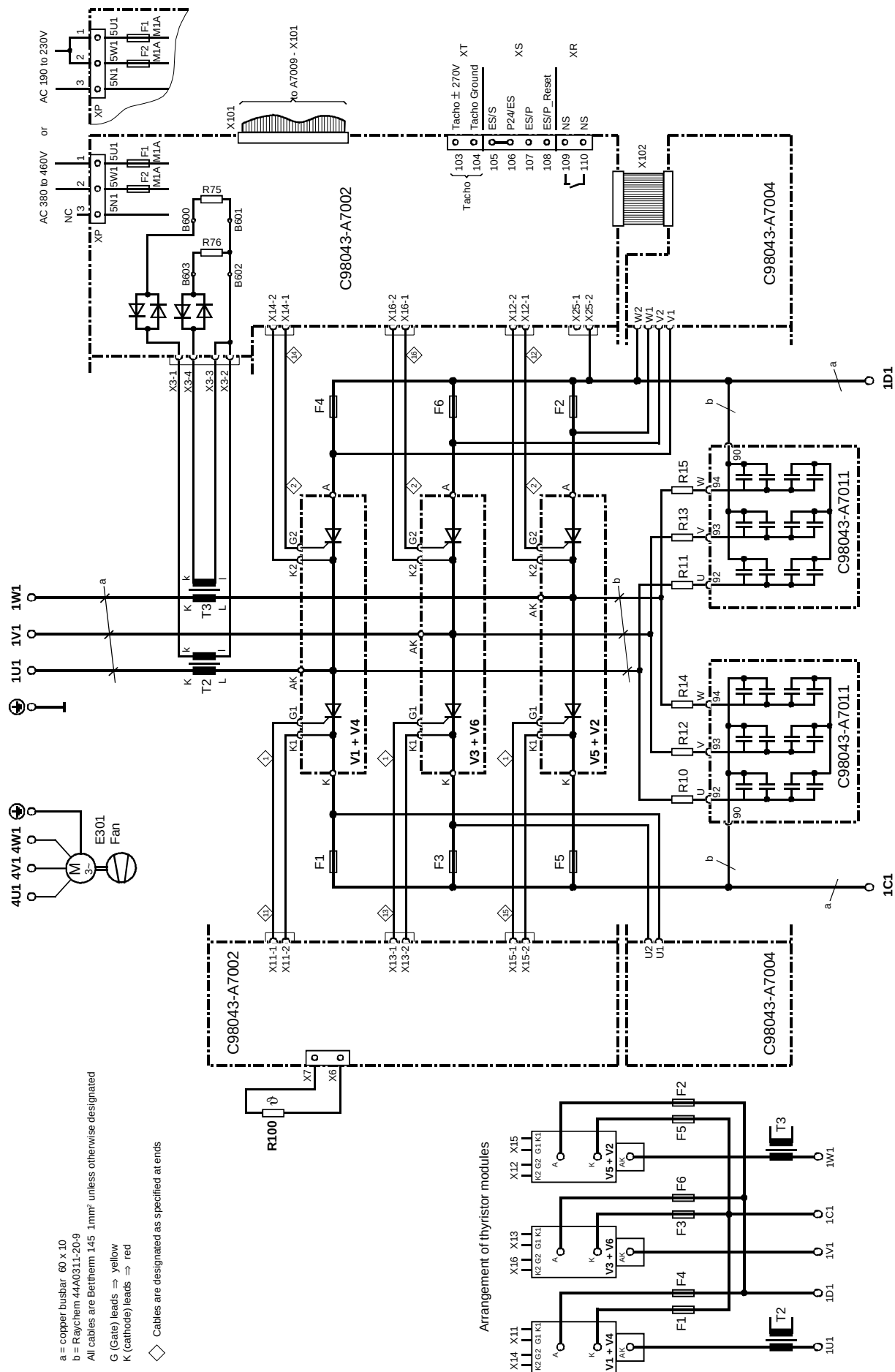
6.4.6 Converters: 800 to 850A, 1Q



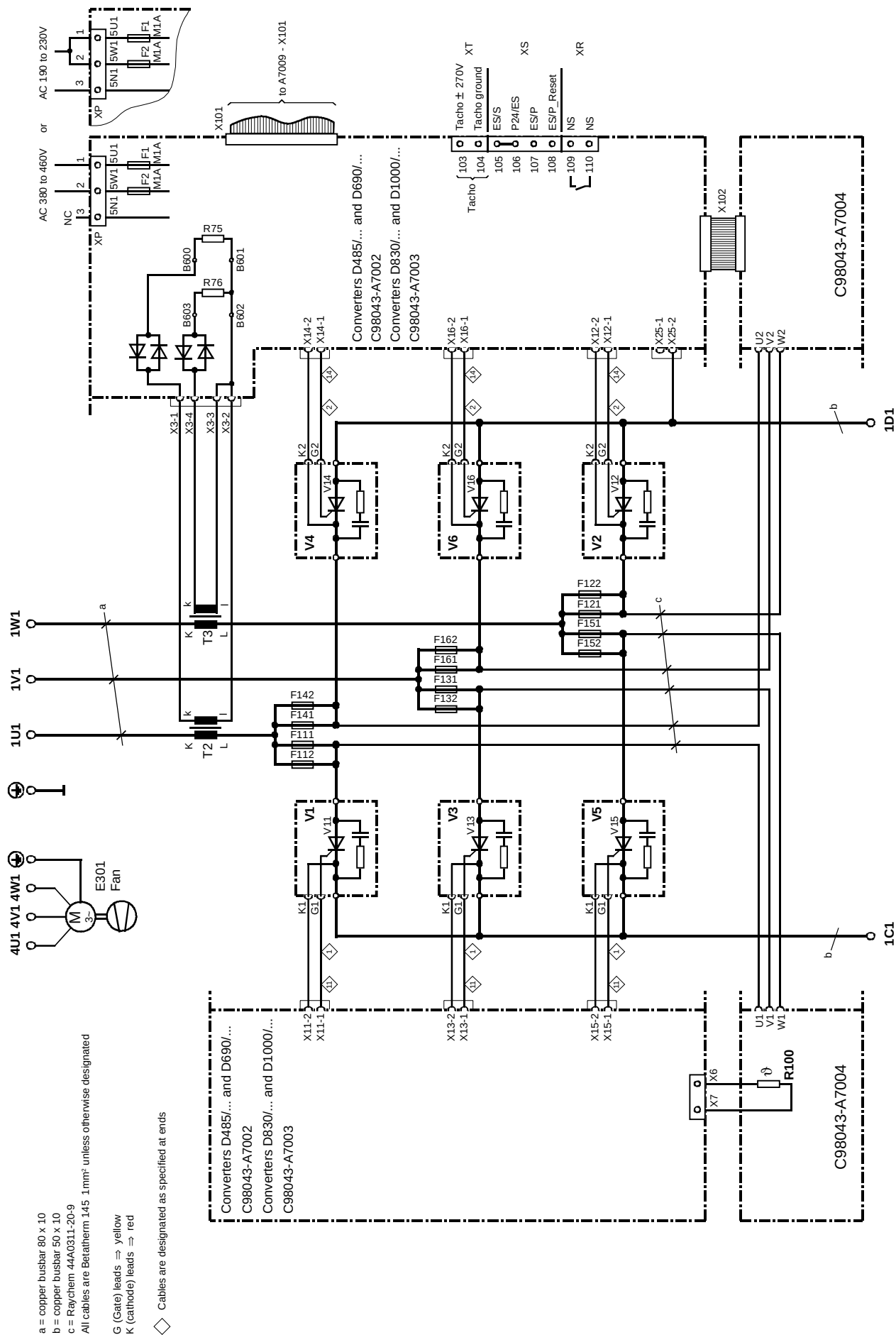
6.4.7 Converters: 900A to 950A, 1Q



6.4.8 Converters: 1000 to 1200A, 1Q

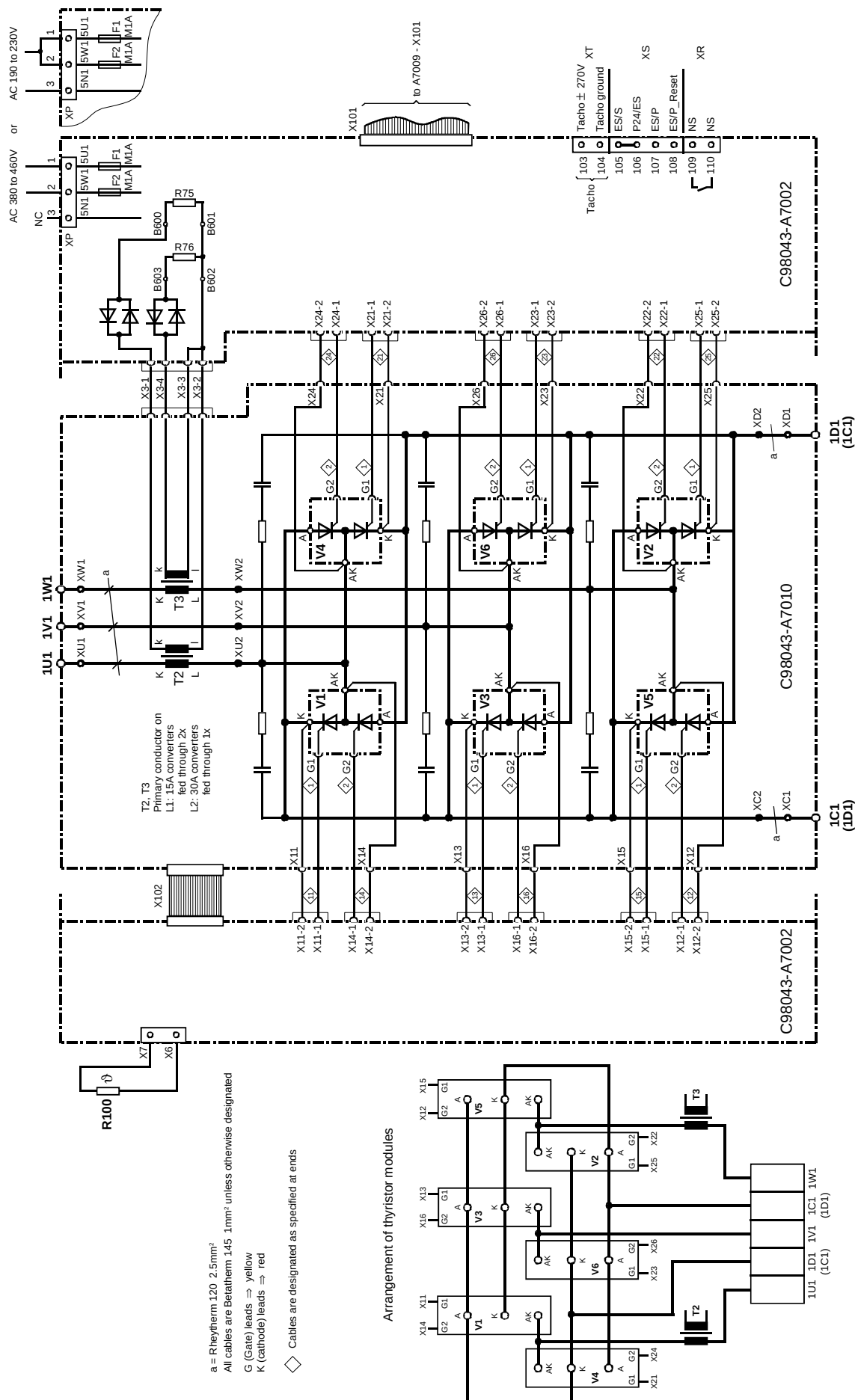


6.4.9 Converters: 1500 to 2000A, 1Q

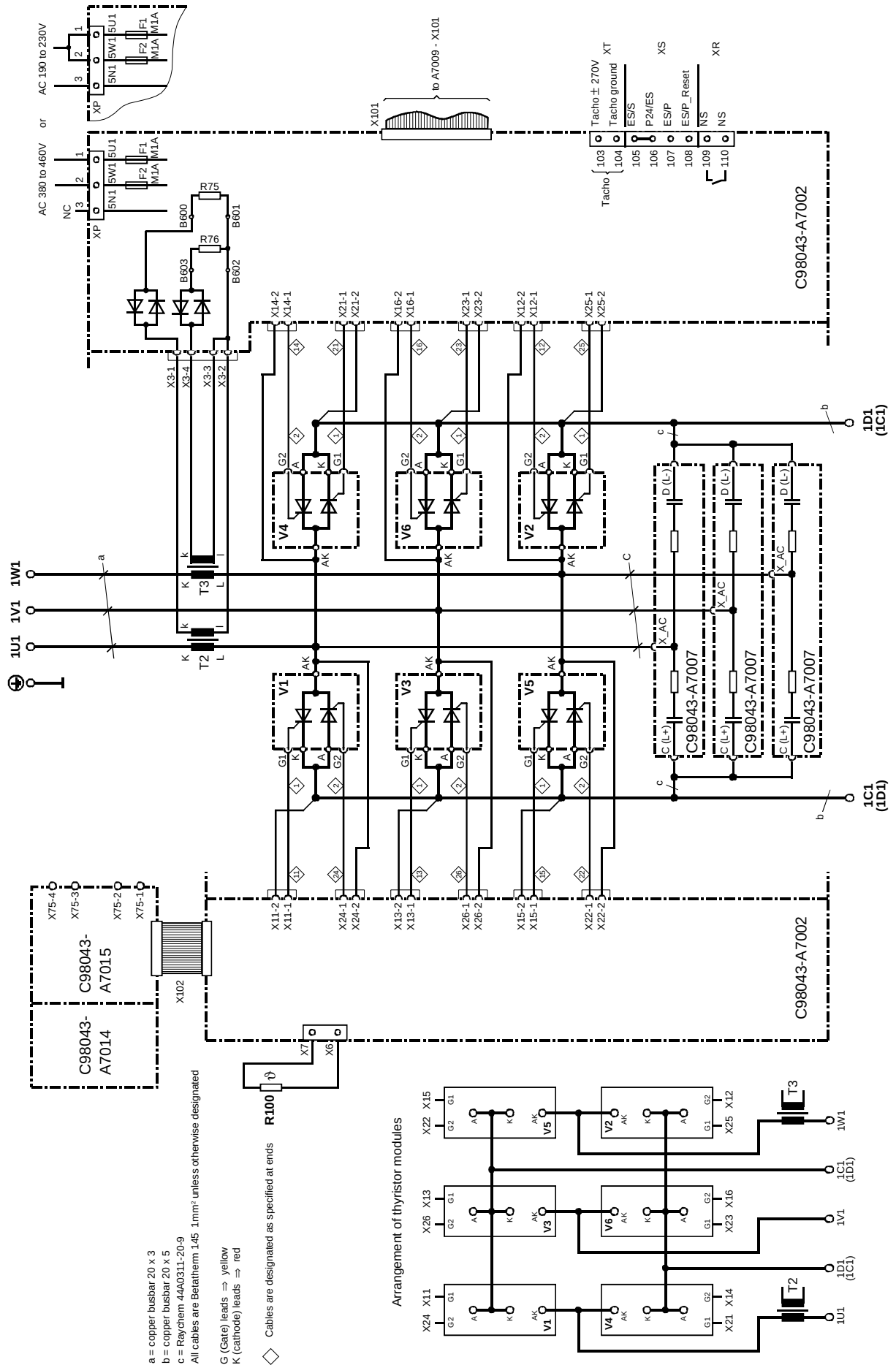


Arrangement of thyristor blocks

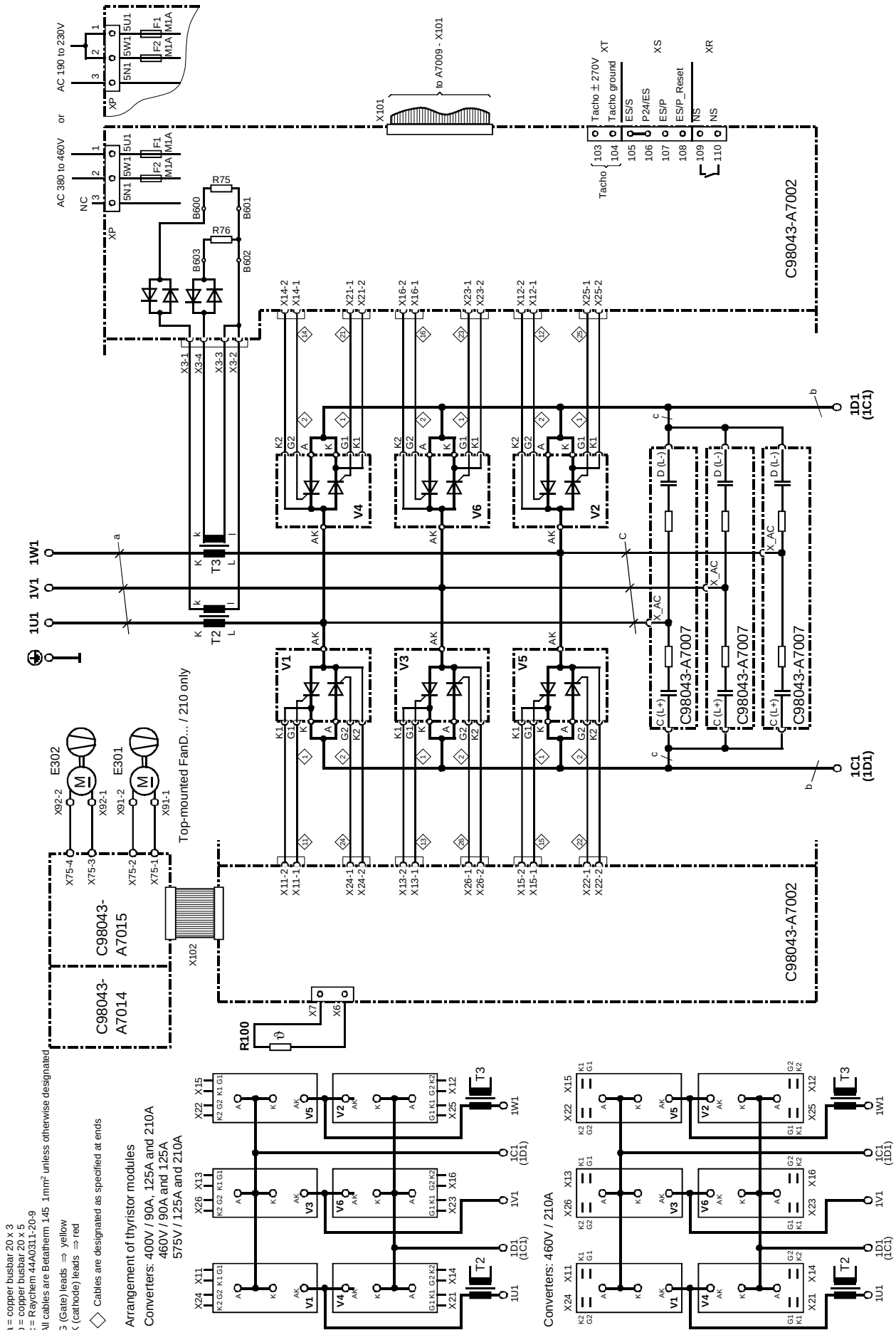
6.4.10 Converters: 15 to 30A, 4Q



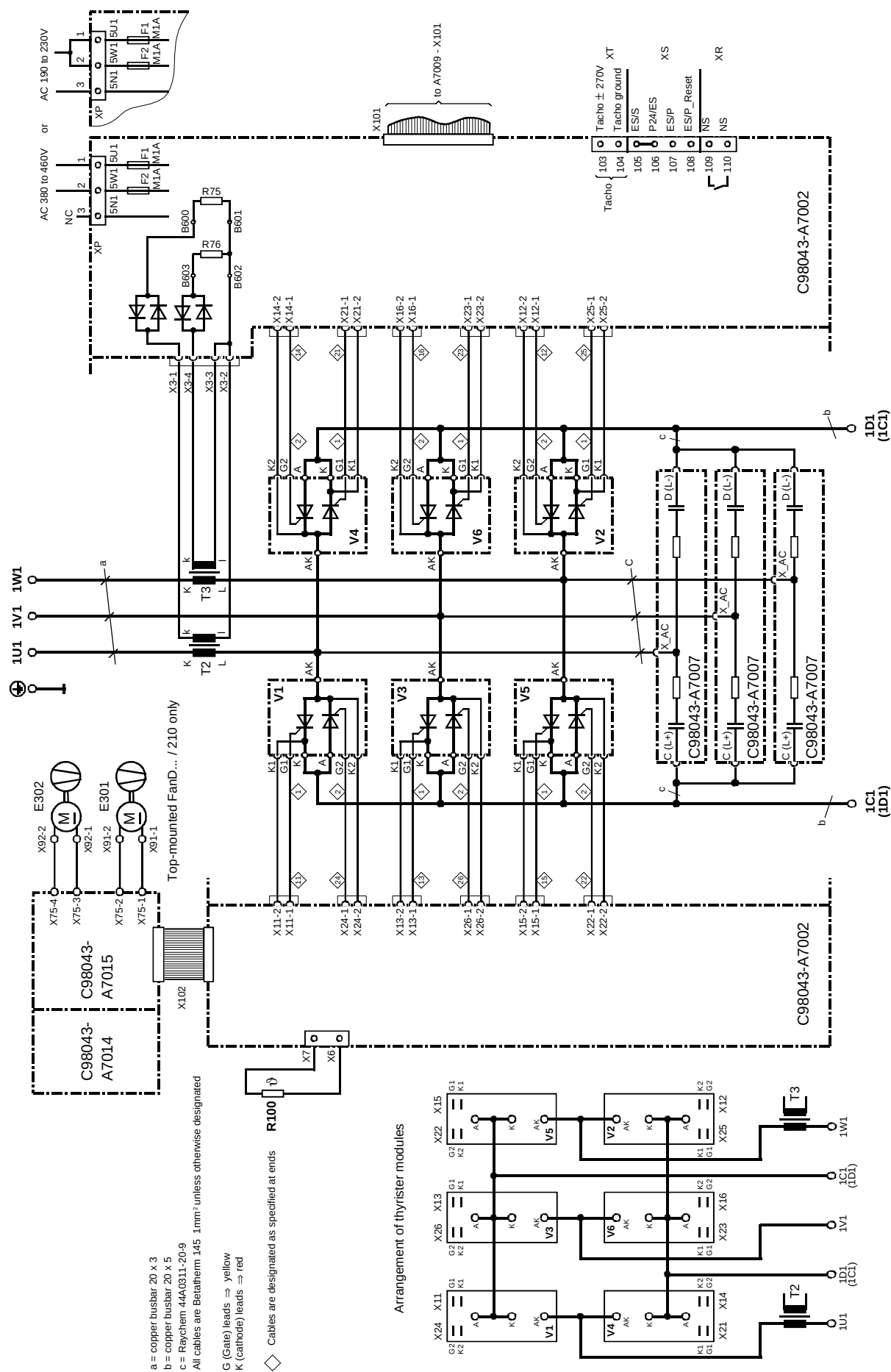
6.4.11 Converters: 60A, 4Q



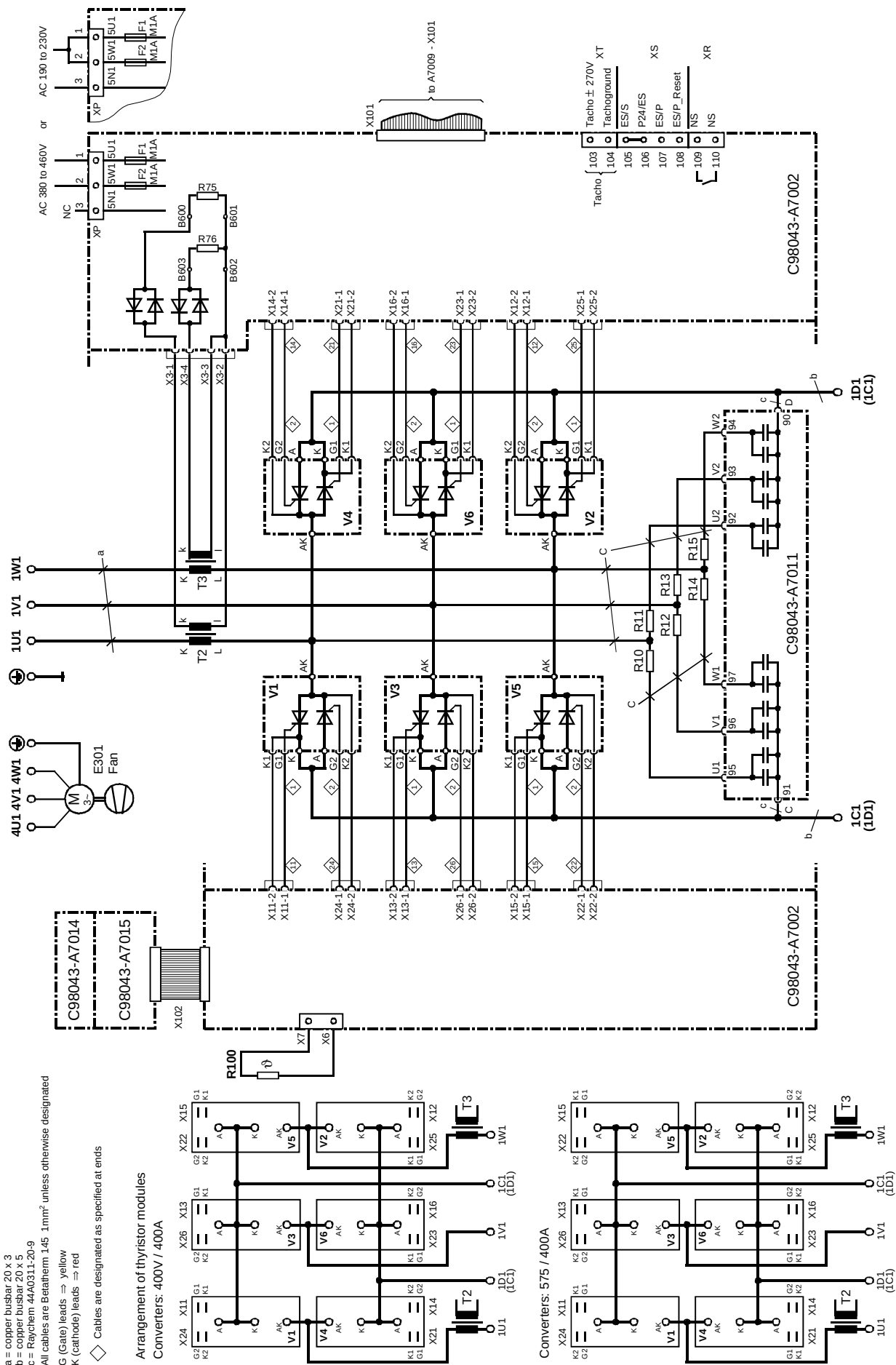
6.4.12 Converters: 90A to 210A, 4Q



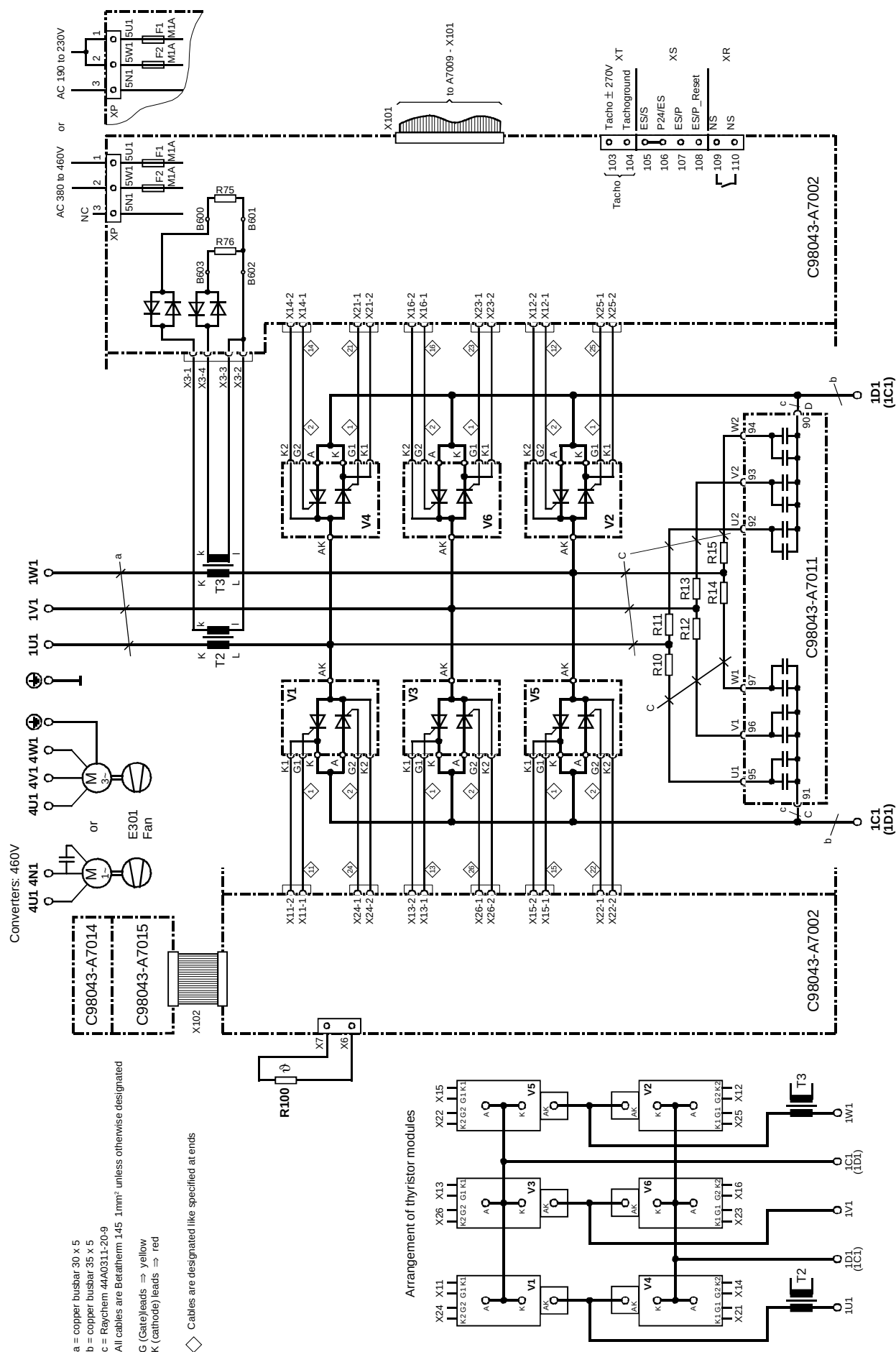
6.4.13 Converters: 280A, 4Q



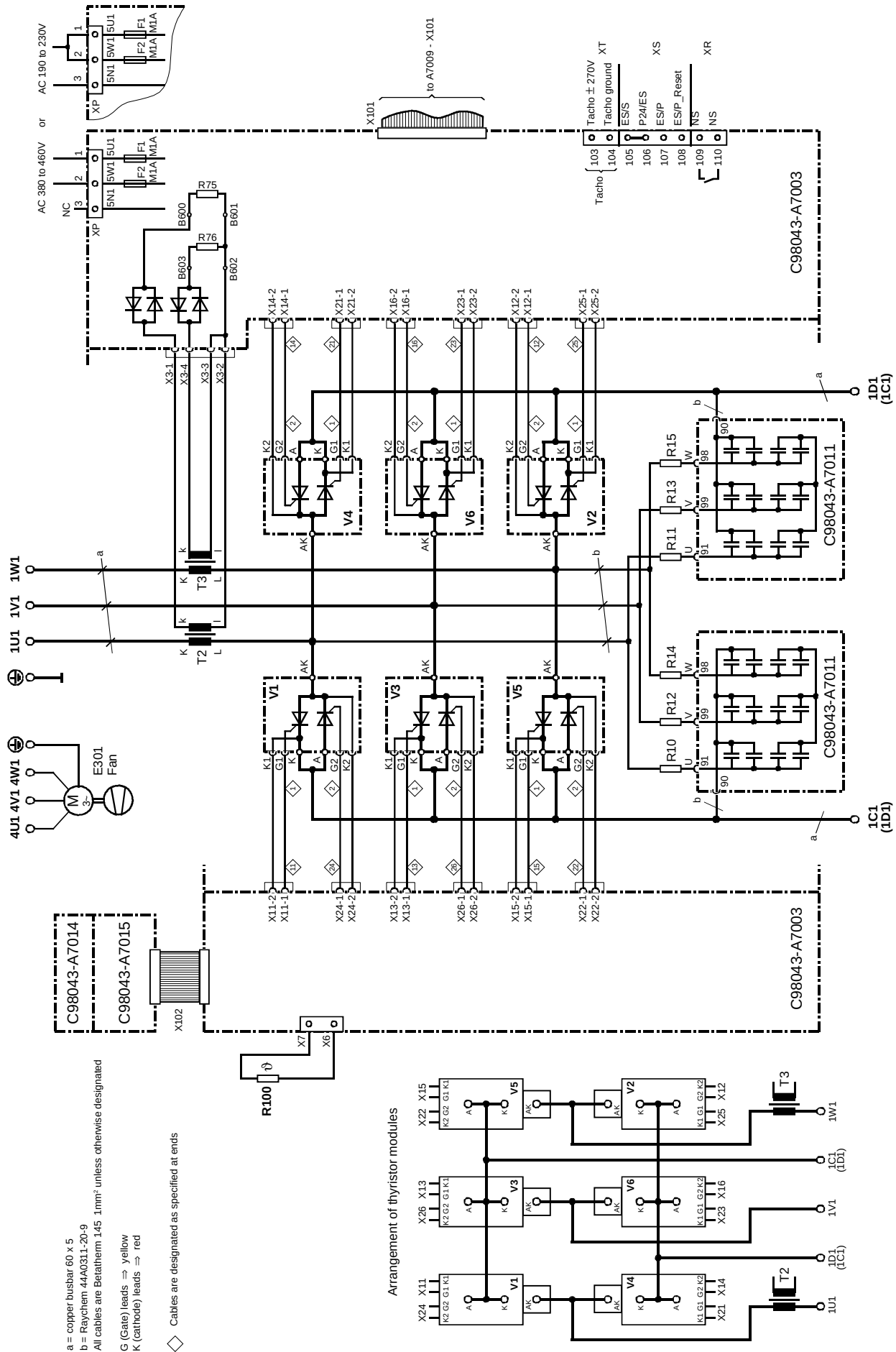
6-36



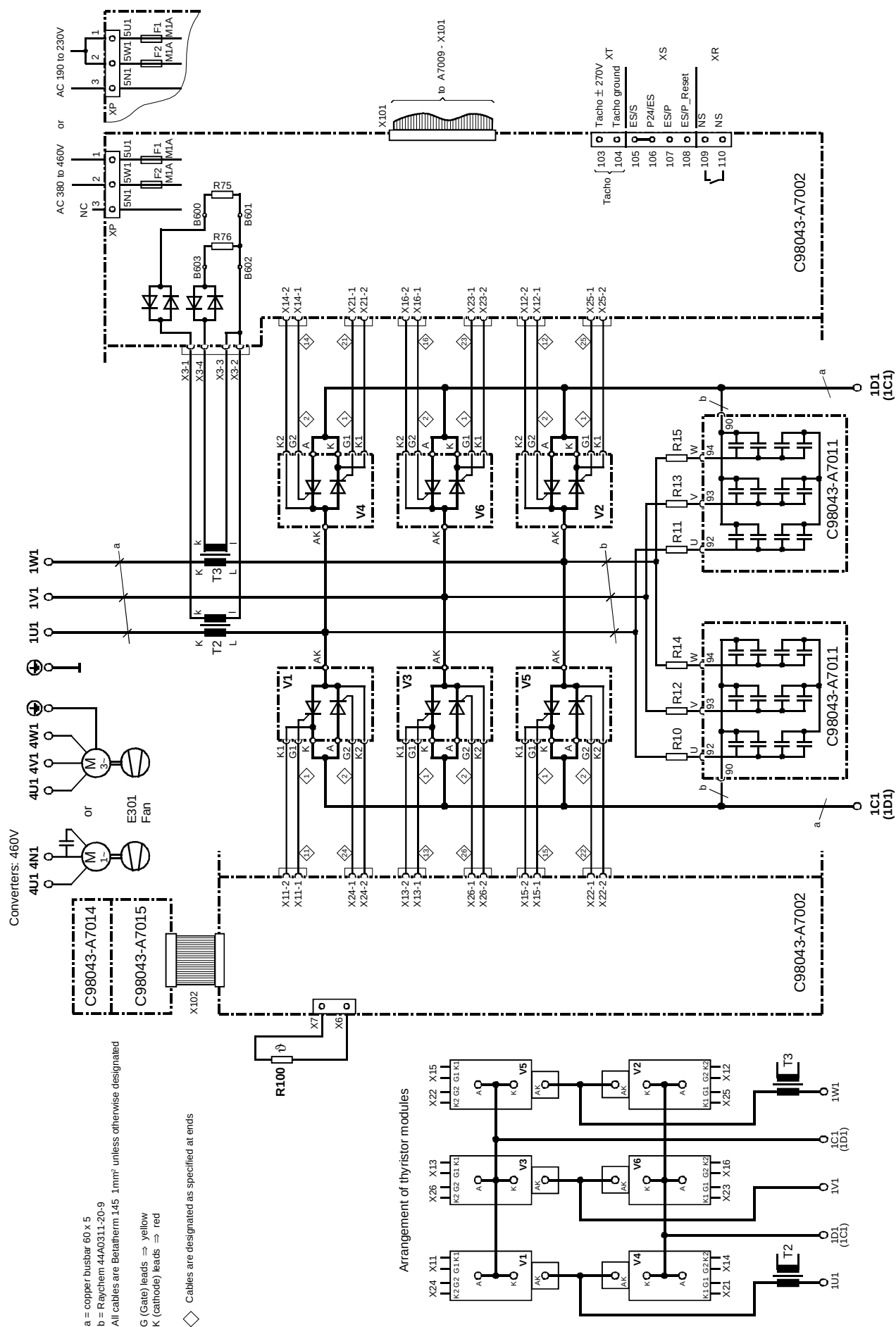
6.4.15 Converters: 450A to 600A, 4Q



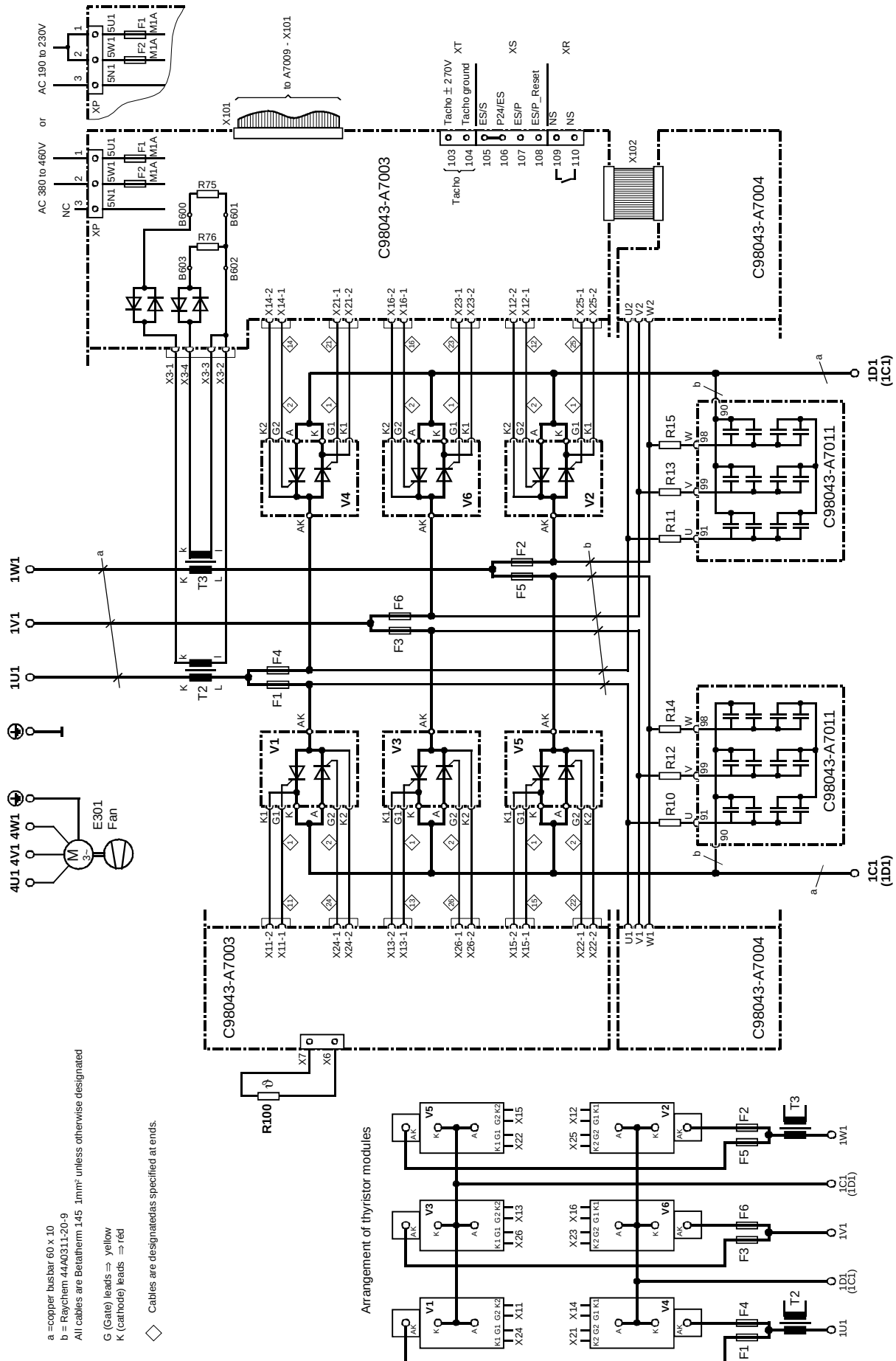
6.4.16 Converters: 760A, 4Q



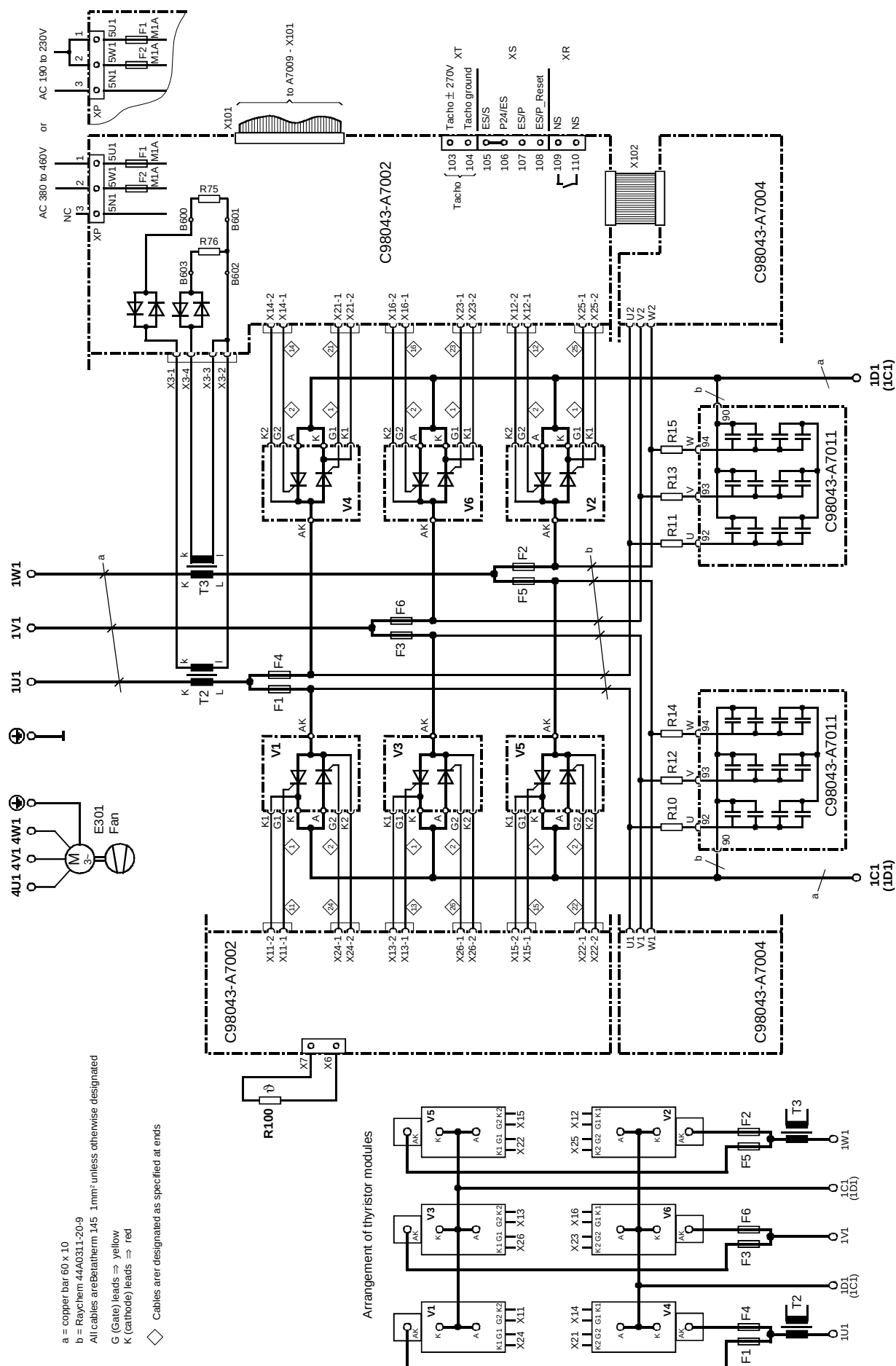
6.4.17 Converters: 850A, 4Q



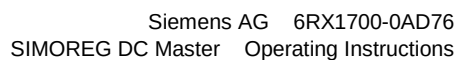
6.4.18 Converters: 950A to 1000A, 4Q



6.4.19 Converters: 1100 to 1200A, 4Q

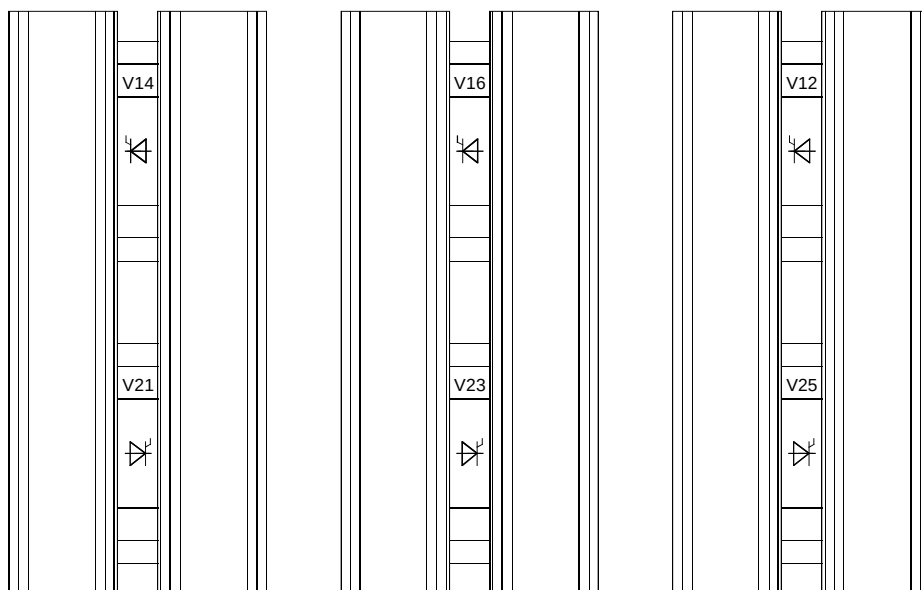


6-42

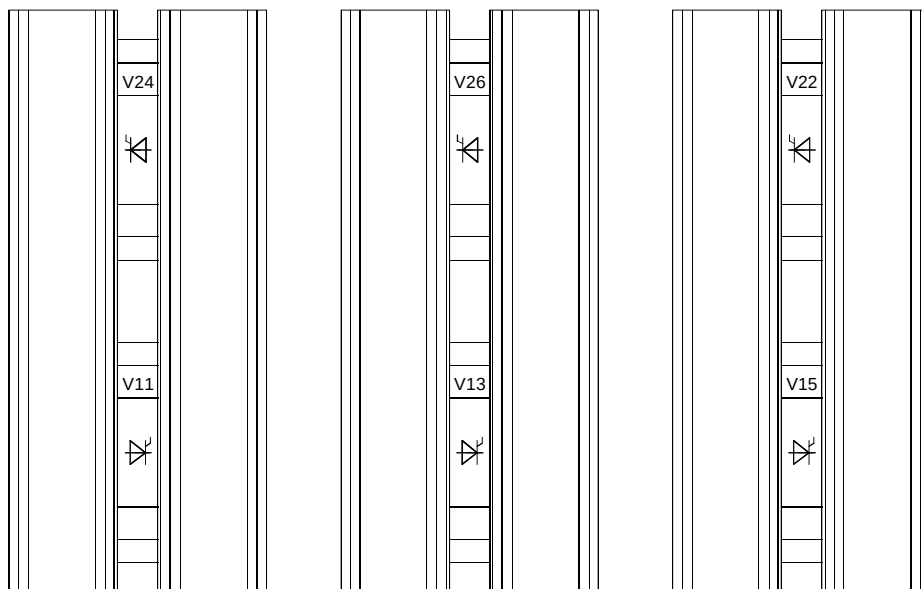


Arrangement of thyristor blocks

At rear

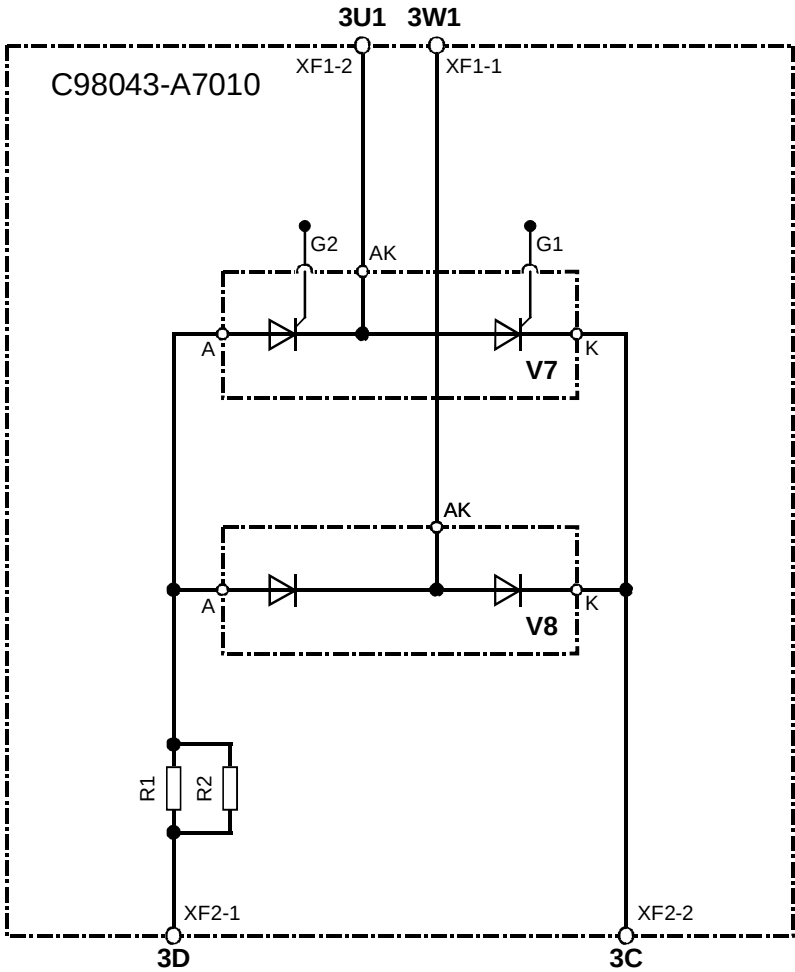


At front



6.5 Field supply

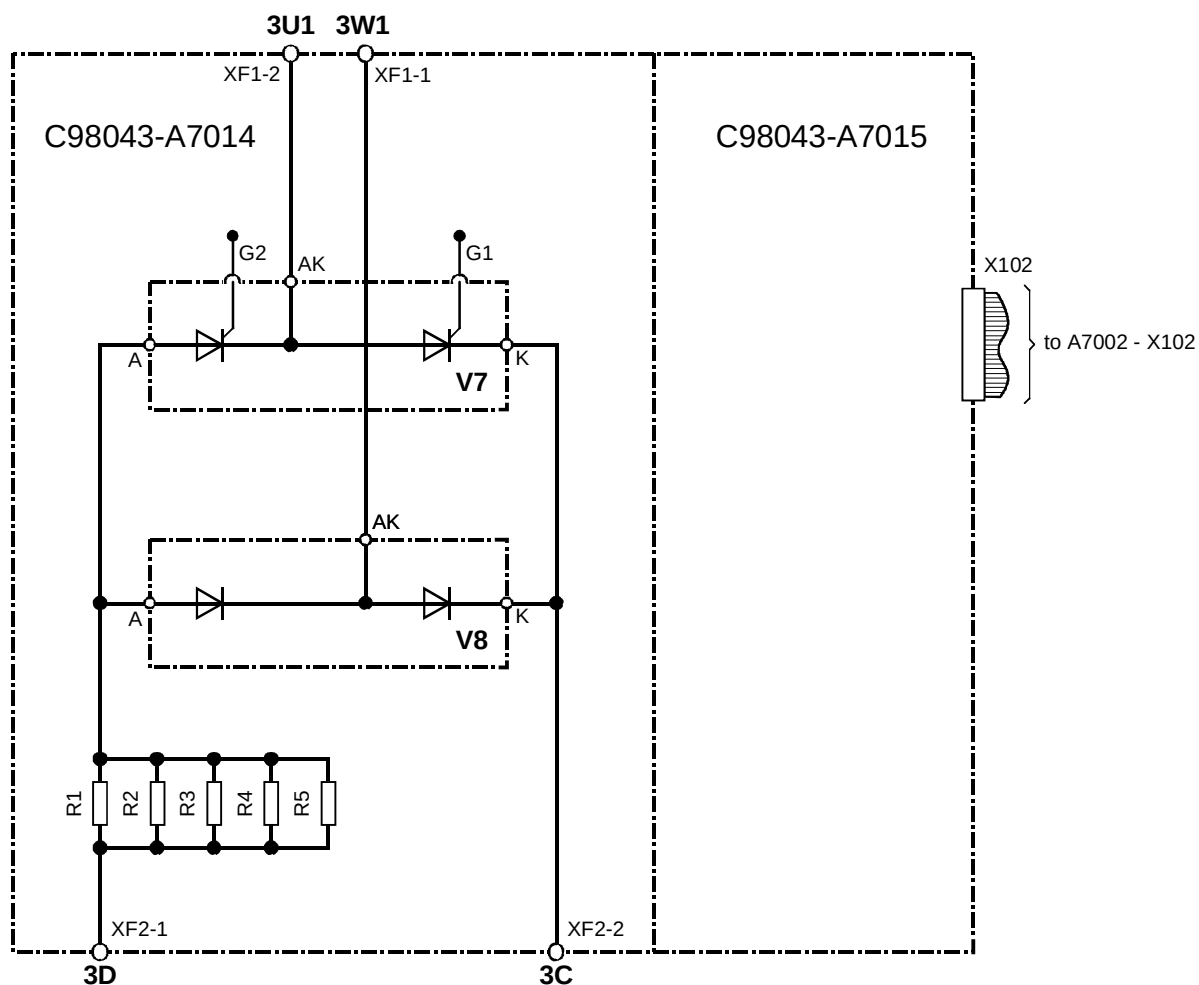
Converter type D . . . / 15 to 30



Gating leads are Betatherm 145 1mm²

Module	Rated DC current armature	Rated DC current fied	R1	R2
A7010-L1	15A	3A	0R1	0R1
A7010-L2	30A	5A	0R1	0R05

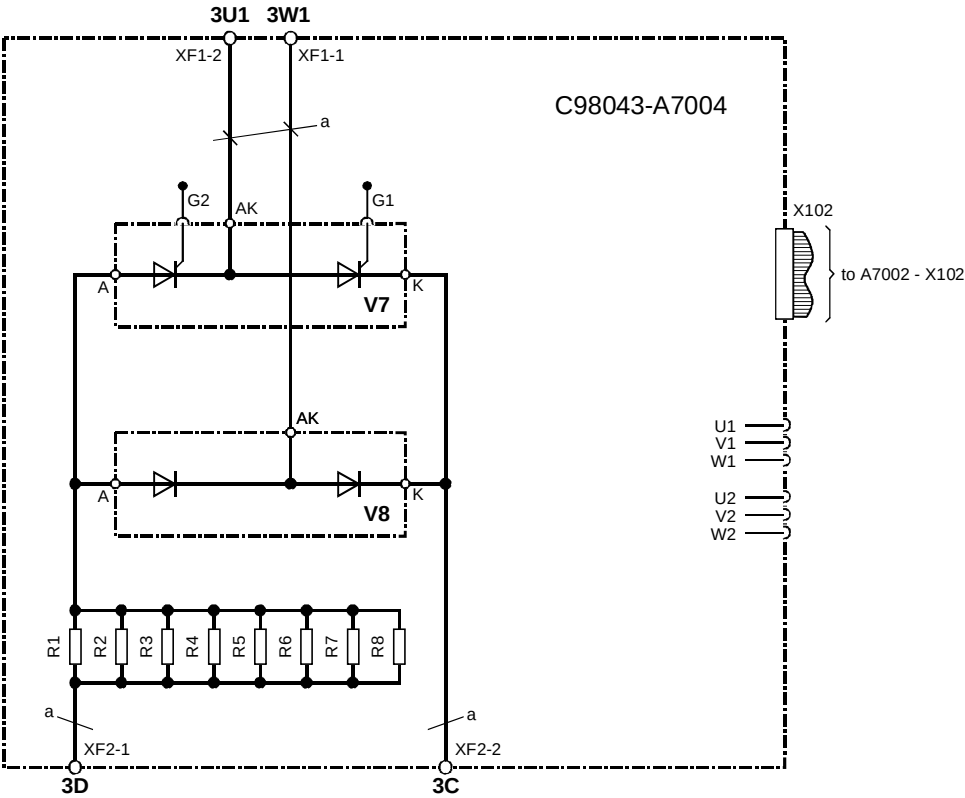
Converter type D . . . / 60 to 850



Gating leads are 145 1mm²

Module	Rated DC current armature	Rated DC current field	R1	R2	R3	R4	R5
A7014-L1	60A bis 125A	10A	0R04	0R04	—	—	—
A7014-L2	210A bis 280A	15A	0R04	0R04	0R04	0R04	0R04
A7014-L2	400A bis 600A	25A	0R04	0R04	0R04	0R04	0R04
A7014-L2	720A bis 850A	30A	0R04	0R04	0R04	0R04	0R04

Converter type D . . . / 900 to 2000



a = Betatherm 145 6mm²
Gating leads are Betatherm 145 1mm²

Module	Rated DC current armature	Rated DC current field	R1	R2	R3	R4	R5	R6	R7	R8
A7004	900A bis 1200A	30A	0R04	0R04	0R04	0R04	0R04	0R04	0R04	0R04
A7004	1500A bis 2000A	40A	0R04	0R04	0R04	0R04	0R04	0R04	0R04	0R04

6.6 Fuses and commutating reactors

6.6.1 Commutating reactors

Commutating reactors can be selected from Catalog DA93.1.

The line impedance including commutating reactors must be between 4% and 10% of short-circuit voltage. Commutating reactors must be provided by the customer to limit commutating voltage dips in the supply system (subject to local regulations).

6.6.2 Fuses

For technical data, configuring data and dimension drawings, please refer to Catalog DA94.1.

6.6.2.1 Recommended fuses for field circuit

Converter unit Rated DC current A	Max. permis- sible field current A	Fuse Order No.	Rated current of fuse A
15	3	5SD420	16
30	5	5SD420	16
60 to 125	10	5SD420	16
210 to 280	15	5SD440	25
400 to 600	25	5SD440	25
710 to 1200	30	5SD480	30
1500 to 2000	40	3NE1802-0	40

6.6.2.2 Fuses for armature circuit

6.6.2.2.1 Converters 1Q: 400V, 575V, 690V and 830V

Converter Order No.	C / V A / V	Line fuses 3 Siemens	
		Order No.	C / V A / V
6RA7018-6DS22	30 / 400	3NE1815-0	25 / 690
6RA7025-6DS22	60 / 400	3NE1817-0	50 / 690
6RA7025-6GS22	60 / 575	3NE1817-0	50 / 690
6RA7028-6DS22	90 / 400	3NE1820-0	80 / 690
6RA7031-6DS22	125 / 400	3NE1021-0	100 / 690
6RA7031-6GS22	125 / 575	3NE1021-0	100 / 690
6RA7075-6DS22	210 / 400	3NE3227	250 / 1000
6RA7075-6GS22	210 / 575	3NE3227	250 / 1000
6RA7078-6DS22	280 / 400	3NE3231	350 / 1000
6RA7081-6DS22	400 / 400	3NE3233	450 / 1000
6RA7081-6GS22	400 / 575	3NE3233	450 / 1000
6RA7085-6DS22	600 / 400	3NE3336	630 / 1000
6RA7085-6GS22	600 / 575	3NE3336	630 / 1000
6RA7087-6DS22	850 / 400	3NE3338-8	800 / 800
6RA7087-6GS22	800 / 575	3NE3338-8	800 / 800
6RA7086-6KS22	720 / 690	3NE3337-8	710 / 900

Converter Order No.	C / V	Branch fuses Siemens		
	A / V	Qty.	Order No.	C / V A / V
6RA7091-6DS22	1200 / 400	6	3NE3338-8	800 / 800
6RA7090-6GS22	1000 / 575	6	3NE3337-8	710 / 900
6RA7088-6KS22	950 / 690	6	3NE3337-8	710 / 900
6RA7088-6LS22	900 / 830	6	3NE3337-8	710 / 900
6RA7093-4DS22	1600 / 400	6	6RY1702-0BA02	1000 / 660
6RA7093-4GS22	1600 / 575	6	6RY1702-0BA02	1000 / 660
6RA7093-4KS22	1500 / 690	6	6RY1702-0BA03	1000 / 1000
6RA7093-4LS22	1500 / 830	6	6RY1702-0BA03	1000 / 1000
6RA7095-4DS22	2000 / 400	6	6RY1702-0BA01	1250 / 660
6RA7095-4GS22	2000 / 575	6	6RY1702-0BA01	1250 / 660
6RA7095-4KS22	2000 / 690	12	6RY1702-0BA04	630 / 1000
6RA7095-4LS22	1900 / 830	12	6RY1702-0BA04	630 / 1000

Branch fuses are included in converter, external semiconductor fuses are not needed.

6.6.2.2.2 Converters 1Q: 460V

Converter Order No.	C / V	Line fuses 3 Siemens		Line fuses 3 Bussmann		Line fuses 3 Bussmann	
	A / V	Order No.	C / V A / V	Order No.	C / V A / V	Order No.	C / V A / V
6RA7018-6FS22	30 / 460	3NE1815-0	25 / 690	170M1562	32 / 660	FWH-35B	35 / 500
6RA7025-6FS22	60 / 460	3NE1817-0	50 / 690	170M1565	63 / 660	FWH-60B	60 / 500
6RA7028-6FS22	90 / 460	3NE1820-0	80 / 690	170M1567	100 / 660	FWH-100B	100 / 500
6RA7031-6FS22	125 / 460	3NE1021-0	100 / 690	170M1568	125 / 660	FWH-125B	125 / 500
6RA7075-6FS22	210 / 460	3NE3227	250 / 1000	170M3166	250 / 660	FWH-225B	225 / 500
6RA7078-6FS22	280 / 460	3NE3231	350 / 1000	170M3167	315 / 660	FWH-275B	275 / 500
6RA7082-6FS22	450 / 460	3NE3233	450 / 1000	170M3170	450 / 660	FWH-450B	450 / 500
6RA7085-6FS22	600 / 460	3NE3336	630 / 1000	170M4167	700 / 660	FWH-600B	600 / 500
6RA7087-6FS22	850 / 460	3NE3338-8	800 / 800	170M5165	900 / 660	FWH-800B	800 / 500

FWH-... and FWP-... fuses are not mechanically compatible with the 3NE... or 170M... fuses.

Converter Order No.	C / V	Branch fuses Siemens		
	A / V	Qty.	Order No.	C / V A / V
6RA7091-6FS22	1200 / 460	6	3NE3338-8	800 / 800

Branch fuses are included in converter, external semiconductor fuses are not needed.

6.6.2.2.3 Converters 4Q: 400V, 575V, 690V and 830V

Converter Order No.	C / V	Line fuses 3 Siemens		DC fuse 1 Siemens	
	A / V	Order No.	I / U A / V	Order No.	C / V A / V
6RA7013-6DV62	15 / 400	3NE1814-0	20 / 690	3NE1814-0	20 / 690
6RA7018-6DV62	30 / 400	3NE1815-0	25 / 690	3NE4102	40 / 1000
6RA7025-6DV62	60 / 400	3NE1817-0	50 / 690	3NE4120	80 / 1000
6RA7025-6GV62	60 / 575	3NE1817-0	50 / 690	3NE4120	80 / 1000
6RA7028-6DV62	90 / 400	3NE1820-0	80 / 690	3NE4122	125 / 1000
6RA7031-6DV62	125 / 400	3NE1021-0	100 / 690	3NE4124	160 / 1000
6RA7031-6GV62	125 / 575	3NE1021-0	100 / 690	3NE4124	160 / 1000
6RA7075-6DV62	210 / 400	3NE3227	250 / 1000	3NE3227	250 / 1000
6RA7075-6GV62	210 / 575	3NE3227	250 / 1000	3NE3227	250 / 1000
6RA7078-6DV62	280 / 400	3NE3231	350 / 1000	3NE3231	350 / 1000
6RA7081-6DV62	400 / 400	3NE3233	450 / 1000	3NE3233	450 / 1000
6RA7081-6GV62	400 / 575	3NE3233	450 / 1000	3NE3233	450 / 1000
6RA7085-6DV62	600 / 400	3NE3336	630 / 1000	3NE3336	630 / 1000
6RA7085-6GV62	600 / 575	3NE3336	630 / 1000	3NE3336	630 / 1000
6RA7087-6DV62	850 / 400	3NE3338-8	800 / 800	3NE3334-OB ¹⁾	500 / 1000
6RA7087-6GV62	850 / 575	3NE3338-8	800 / 800	3NE3334-OB ¹⁾	500 / 1000
6RA7086-6KV62	760 / 690	3NE3337-8	710 / 900	3NE3334-OB ¹⁾	500 / 1000

1) Two fuses connected in parallel

Converter Order No.	C / V	Branch fuses Siemens		
	A / V	Qty.	Order No.	C / V A / V
6RA7091-6DV62	1200 / 400	6	3NE3338-8	800 / 800
6RA7090-6GV62	1100 / 575	6	3NE3338-8	800 / 800
6RA7090-6KV62	1000 / 690	6	3NE3337-8	710 / 900
6RA7088-6LV62	950 / 830	6	3NE3337-8	710 / 900
6RA7093-4DV62	1600 / 400	6	6RY1702-0BA02	1000 / 660
6RA7093-4GV62	1600 / 575	6	6RY1702-0BA02	1000 / 660
6RA7093-4KV62	1500 / 690	6	6RY1702-0BA03	1000 / 1000
6RA7093-4LV62	1500 / 830	6	6RY1702-0BA03	1000 / 1000
6RA7095-4DV62	2000 / 400	6	6RY1702-0BA01	1250 / 660
6RA7095-4GV62	2000 / 575	6	6RY1702-0BA01	1250 / 660
6RA7095-4KV62	2000 / 690	12	6RY1702-0BA04	630 / 1000
6RA7095-4LV62	1900 / 830	12	6RY1702-0BA04	630 / 1000

Branch fuses are included in converter, external semiconductor fuses are not needed.

6.6.2.2.4 Converters 4Q: 460V

Converter Order No.	C / V	Line fuses 3 Siemens		Line fuses 3 Bussmann		Line fuses 3 Bussmann	
		Order No.	C / V	Order No.	C / V	Order No.	C / V
	A / V		A / V		A / V		A / V
6RA7018-6FV62	30 / 460	3NE1815-0	25 / 690	170M1562	32 / 660	FWH-35B	35 / 500
6RA7025-6FV62	60 / 460	3NE1817-0	50 / 690	170M1565	63 / 660	FWH-60B	60 / 500
6RA7028-6FV62	90 / 460	3NE1820-0	80 / 690	170M1567	100 / 660	FWH-100B	100 / 500
6RA7031-6FV62	125 / 460	3NE1021-0	100 / 690	170M1568	125 / 660	FWH-125B	125 / 500
6RA7075-6FV62	210 / 460	3NE3227	250 / 1000	170M3166	250 / 660	FWH-225B	225 / 500
6RA7078-6FV62	280 / 460	3NE3231	350 / 1000	170M3167	315 / 660	FWH-275B	275 / 500
6RA7082-6FV62	450 / 460	3NE3233	450 / 1000	170M3170	450 / 660	FWH-450B	450 / 500
6RA7085-6FV62	600 / 460	3NE3336	630 / 1000	170M4167	700 / 660	FWH-600B	600 / 500
6RA7087-6FV62	850 / 460	3NE3338-8	800 / 800	170M5165	900 / 660	FWH-800B	800 / 500

Converter Order No.	C / V	DC fuse 1 Siemens		DC fuse 1 Bussmann	
		Order No.	C / V	Order No.	C / V
	A / V		A / V		A / V
6RA7018-6FV62	30 / 460	3NE4102	40 / 1000	FWP-35B	35 / 660
6RA7025-6FV62	60 / 460	3NE4120	80 / 1000	FWP-70B	70 / 660
6RA7028-6FV62	90 / 460	3NE4122	125 / 1000	FWP-125A	125 / 660
6RA7031-6FV62	125 / 460	3NE4124	160 / 1000	FWP-150A	150 / 660
6RA7075-6FV62	210 / 460	3NE3227	250 / 1000	FWP-250A	250 / 660
6RA7078-6FV62	280 / 460	3NE3231	350 / 1000	FWP-350A	350 / 660
6RA7082-6FV62	450 / 460	3NE3334-OB	500 / 1000	FWP-500A	500 / 660
6RA7085-6FV62	600 / 460	3NE3336	630 / 1000	FWP-700A	700 / 660
6RA7087-6FV62	850 / 460	3NE3334-OB 1)	500 / 1000	FWP-1000A	1000 / 660

FWH-... and FWP-... fuses are not mechanically compatible with the 3NE... or 170M... fuses.

1) Two fuses connected in parallel

Converter Order No.	C / V	Branch fuses Siemens		
		Qty.	Order No.	C / V
	A / V			A / V
6RA7091-6FV62	1200 / 460	6	3NE3338-8	800 / 800

Branch fuses are included in converter, external semiconductor fuses are not needed.

6.6.2.3 F1 and F2 fuses in the power interface

Only UL listed or UL recognized fuses must be used for UL listed converters.

Wickmann 198 1A / 250 V 5 x 20 mm time lag

Wickmann 343 1A / 250 V 6,3 x 32 mm time lag

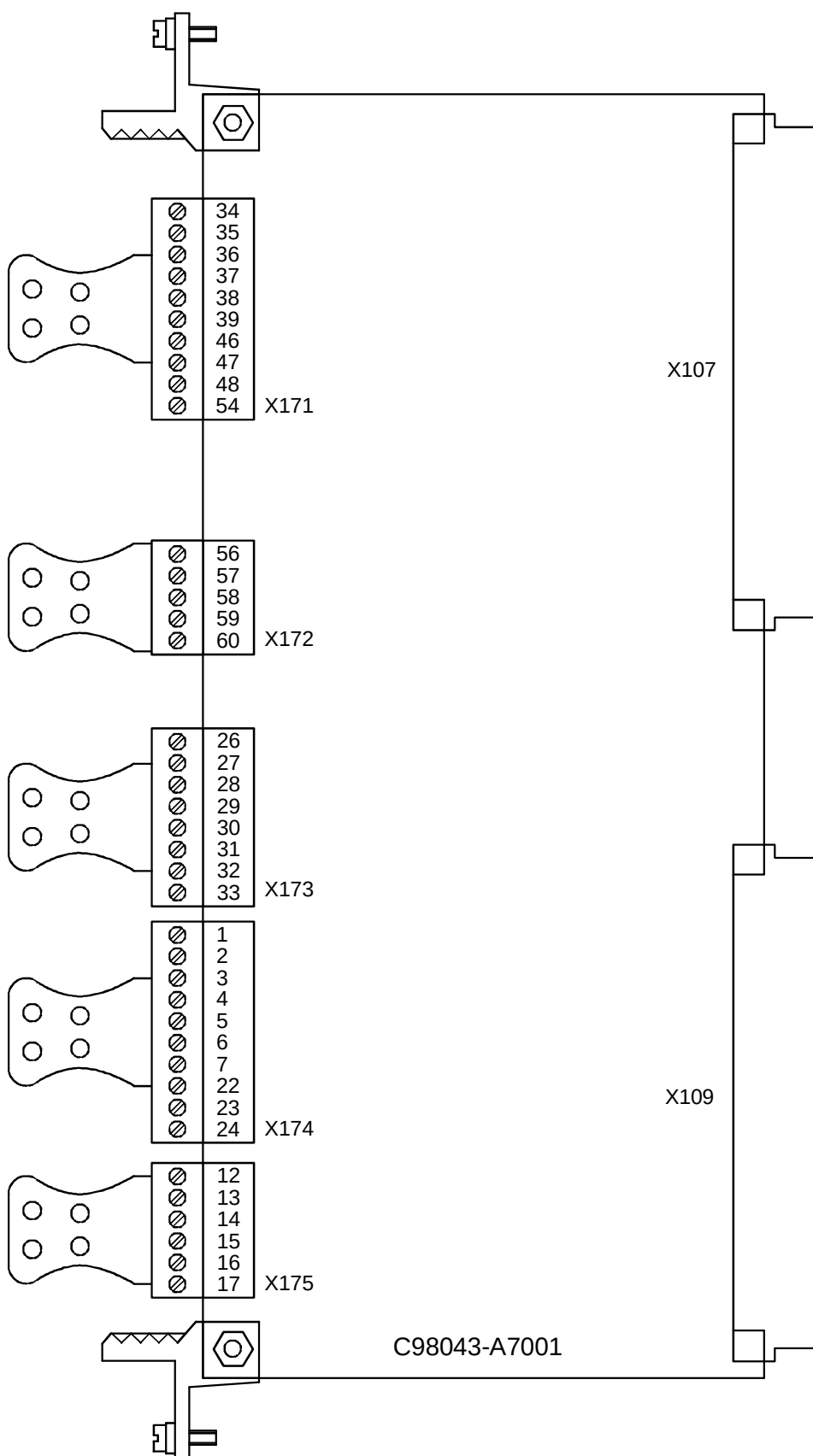
Schurter FSD 1A / 250 V 5 x 20 mm time lag Ordering Code 0034.3987

Schurter FST 1A / 250 V 5 x 20 mm time lag Ordering Code 0034.3117

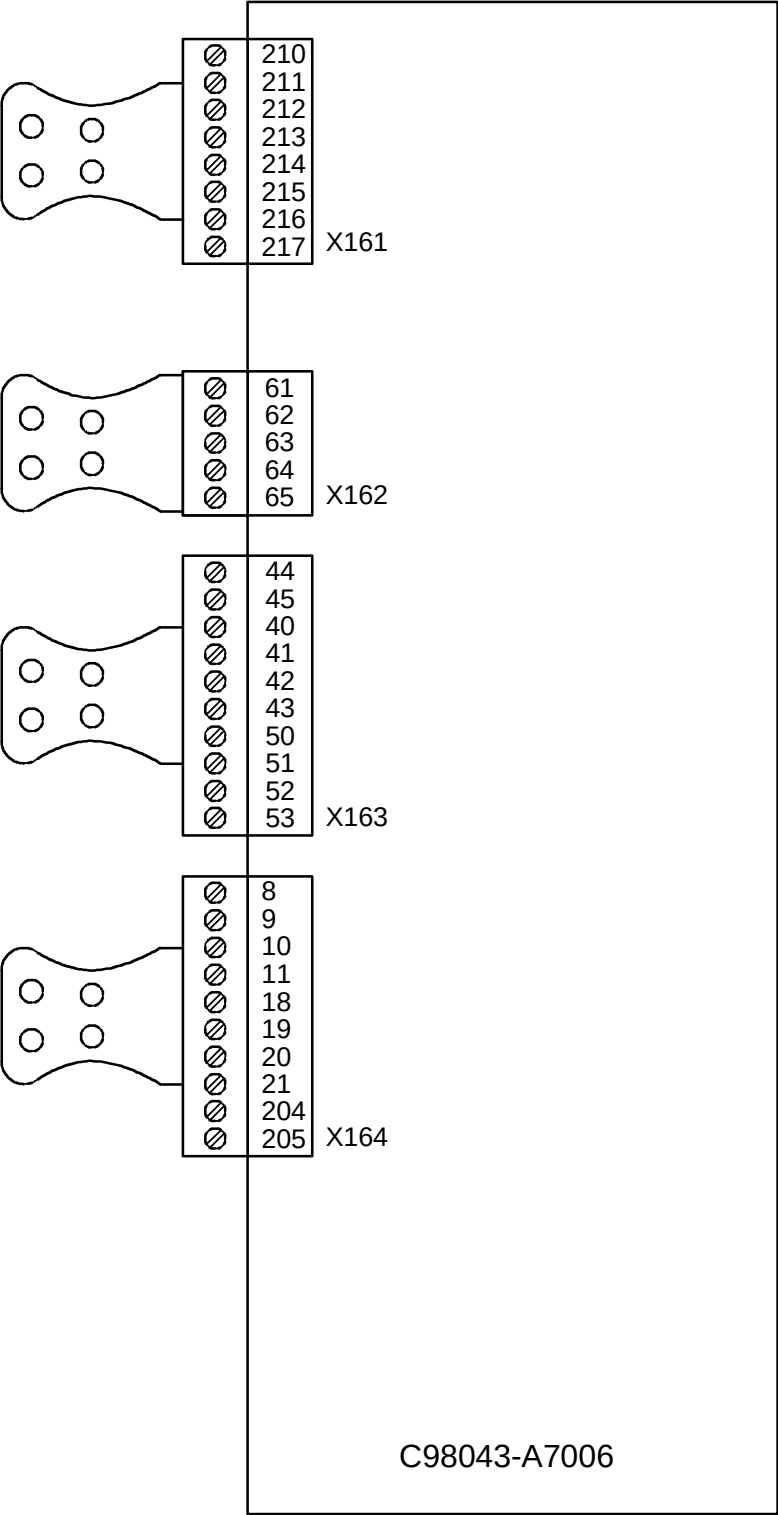
Schurter FSU 1A / 250 V 5 x 20 mm time lag Ordering Code 2010.0017

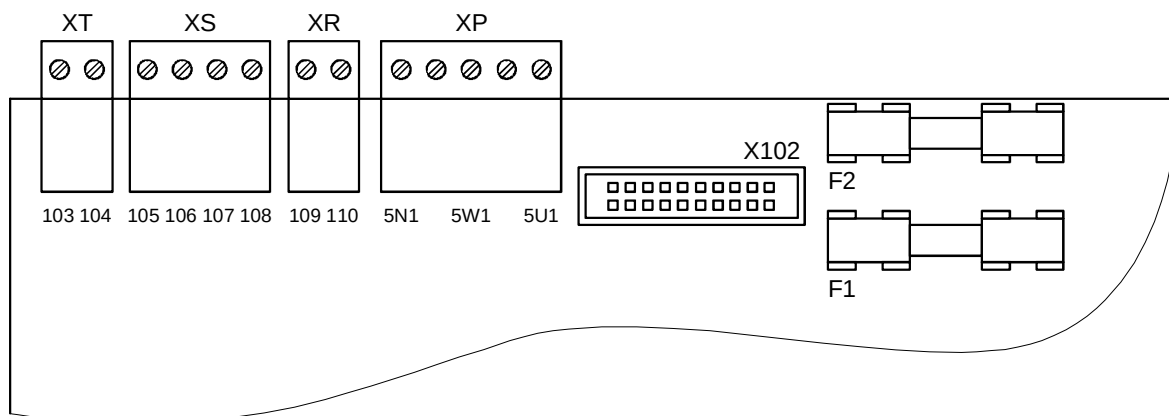
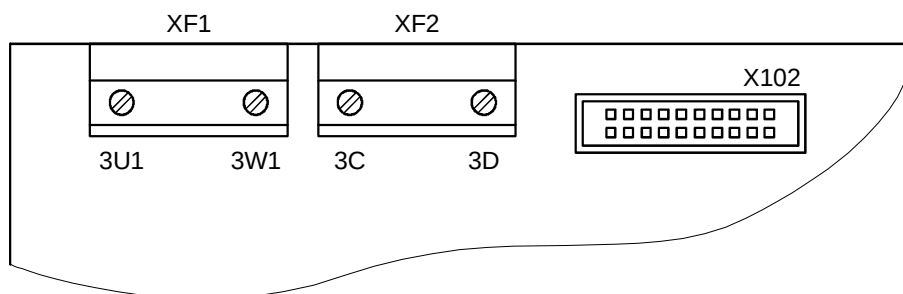
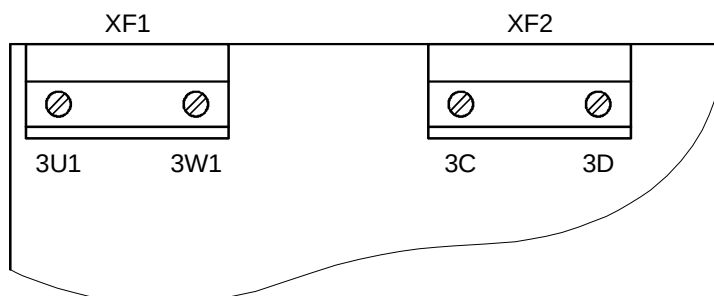
6.7 Terminal arrangement

Module C98043-A7001 (CUD1)



Module C98043-A7006 (CUD2)



Module C98043-A7002 or C98043-A7003**Module C98043-A7010****Module C98043-A7014**

6.8 Terminal assignments



WARNING



The converter might sustain serious or irreparable damage if connected incorrectly.
The power cables and/or busbars must be secured mechanically outside the converter.

Power section

Terminal type:

15A and 30A units	KDS10 PCB feed-through terminal (screw-type terminal) Maximum cross-section 10mm ² , finely stranded
60A to 280A units	1U1,1V1,1W1: Through-hole for M8 (3x20 copper bus) 1C1,1D1: Through-hole for M8 (5x20 copper bus)
400A and 600A units	1U1,1V1,1W1: Through-hole for M10 (5x30 copper bus) 1C1,1D1: Through-hole for M10 (5x35 copper bus)
710A to 850A units	Through-hole for M12 (5x60 copper bus)
950A to 1200A units	Through-hole for M12 (10x60 copper bus)
1500A to 2000A units	1U1,1V1,1W1: Through-hole for M12 (10x80 copper bus) 1C1,1D1: Through-hole for M12 (10x50 copper bus)

The converters are designed for a permanent power supply connection according to DIN VDE 0160 Section 6.5.2.1.

PE conductor connection: Minimum cross-section 10mm². (see Section 5.1 for connection options).

The connection cross-sections must be determined according to the applicable regulations, e.g. DIN VDE 100 Part 523, DIN VDE 0276 Part 1000.

Function	Terminal	Connection values/Remarks
Armature supply input	1U1 1V1 1W1	} see technical data in Section 3.4
PE conductor	⊕	
Armature circuit motor connection	1C1 (1D1) 1D1 (1C1)	

Field circuit

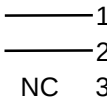
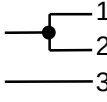
Terminal type:

15A to 850A units	MKDS terminal block (screw-type terminal) Maximum connection cross-section 4mm ² , finely stranded
1200A to 2000A units	G10/4 converter terminal (screw-type terminal) Maximum connection cross-section 10mm ² , finely stranded

Function	Terminal	Connection values/Remarks
Supply connection	XF1-2 3U1 XF1-1 3W1	2AC 400 (– 20%), 2AC 460 (+10%)
Field winding connection	XF2-2 3C XF2-1 3D	Rated DC voltage 325V / 373V For 2AC 400 / 460 supply connection

Electronics power supply

Terminal type: Type 49 plug-in terminal
Maximum cross-section 1.5mm², finely stranded

Function	Con- nection	Terminal XP	Connection values/Remarks
Incoming supply 400V		5U1 5W1 5N1	2AC 380 to 460 (+15% / – 25%); I _n =1A (– 35% for 1min) Internal fuse protection with F1, F2 on board C98043-A7002 or -A7003 external fuse protection 6A, characteristic C recommended
or			
Incoming supply 230V		5U1 5W1 5N1	1AC 190 (– 25%) to 230 (+15%); I _n =2A (– 35% for 1min) Internal fuse protection with F1, F2 on board C98043-A7002 or -A7003 external fuse protection 6A, characteristic C recommended

NOTE

In the case of line voltages which exceed the tolerance range specified in Section 3.4, the electronics supply voltage, field circuit mains supply connection and converter fan connection must be adjusted by means of transformers to the permissible value stated in Section 3.4. It is essential to use an isolating transformer for rated line voltages in excess of 460V.

The rated supply voltage for the armature circuit (index 001) and the field circuit (index 002) must be set in parameter P078.

Fan

(for forced-cooled converters ≥ 400A)

Terminal type: DFK-PC4 plug-in terminal (screw-type)
Maximum connection cross-section 4mm², finely stranded

The insulation on the supply cables must be taken up to the terminal housing.

Function	Terminal	Connection values/Remarks
Incoming supply 400V bis 460V	4U1 4V1 4W1	3AC 400 to 460 For further details, see technical data in Section 3.4
PE conductor		
or		
Incoming supply 230V	4U1 4N1	1AC 230 For further details, see technical data in Section 3.4



WARNING

The converter might overheat if the incorrect phase sequence is connected (incorrect direction of rotation of fan).

Check:



- On converters up to 850A (fan at bottom), check whether fan is rotating in direction of arrow
- On converters of > 850A (fan at top), check whether fan is rotating in counter-clockwise direction (to left) when viewed from above

Caution: Rotating parts can cause physical injuries!

Open-loop and closed-loop control sectionTerminal type: **X171 to X175**Plug-in terminal (screw-type)
Maximum connection cross-section 1.5mm²**XR, XS, XT**MSTB2.5 plug-in terminal
Maximum connection cross-section 2.5mm²**Analog inputs - setpoint inputs, reference voltage** (see also Section 8, sheet G113)

Function		Terminal X174	Connection values/Remarks
Reference	M	1	} ±1% at 25°C (stability 0.1% per 10°K); 10mA short-circuit-proof
	P10	2	
	N10	3	
Select input	main setpoint +	4	Differential input Parameter settings: ±10V; 150kΩ Resolution can be parameterized up to approx. 555µV (±14bits) Parameter settings: 0 - 20mA; 300Ω 4 - 20mA; 300Ω Common mode suppression: ±15V
	main setpoint –	5	
Select input	analog 1 +	6	
	analog 1 –	7	

Analog inputs - actual speed inputs, tacho inputs (see also Section 8, sheet G113)

Function	Terminal XT	Connection values/Remarks
Tacho connection 8V to 270V	103	±270V; >143kΩ
Ground analog M	104	

Pulse encoder input (see also Section 8, sheet G145)

Function	Terminal X173	Connection values/Remarks
Supply (+13,7V to +15,2V)	26	200mA; short-circuit-proof (electronic protection) Overload response: Fault message F018
Ground pulse encoder M	27	
Track 1 Positive terminal	28	Load: $\leq 5.25\text{mA}$ at 15V
Track 1 Negative terminal	29	(w/o switching losses, see below for cable, cable length, shield connection)
Track 2 Positive terminal	30	Switching hysteresis: See below
Track 2 Negative terminal	31	Pulse/pause ratio: 1:1
Zero marker Positive terminal	32	Level of input pulses: See below
Zero marker Negative terminal	33	Track offset: Table 1 see below Pulse frequency: Table 2 see below Cable length: See below

Characteristic data of pulse tacho evaluation electronics**Level of input pulses:**

Encoder signals (symmetrical and asymmetrical) up to a max. 27V differential voltage can be processed by the evaluated electronics.

Electronic adaptation of evaluation electronics to signal voltage of encoder:

- Rated input voltage range **5V** P142=0 (see also Section 8, sheet 17):
 - Low level: Differential voltage $< 0.8\text{V}$
 - High level: Differential voltage $> 2.0\text{V}$
 - Hysteresis: $> 0.2\text{V}$
 - Common-mode control range: $\pm 10\text{V}$
- Rated input voltage range **15V** P142=1 (see also Section 8, sheet 17):
 - Low level: Differential voltage $< 5.0\text{V}$
 - High level: Differential voltage $> 8.0\text{V}$ Restriction: See switching frequency
 - Hysteresis: $> 1\text{V}$
 - Common-mode control range: $\pm 10\text{V}$

If the pulse encoder does not supply symmetrical encoder signals, then its ground must be routed as a twisted-pair lead with every signal cable and connected to the negative terminals of track 1, track 2 and the zero marker.

Switching frequency:

The maximum frequency of the encoder pulses is 300kHz. To ensure correct evaluation of the encoder pulses, the minimum distance $T_{\min}$ between two encoder signal edges (tracks 1 and 2) specified in the table must be observed:

Table 1:

	Rated input voltage 5V		Rated input voltage 15V		
Differential voltage ¹⁾	2V	$> 2.5\text{V}$	8V	10V	$> 14\text{V}$
$T_{\min}$ ²⁾	630ns	380ns	630ns	430ns	380ns

1) Differential voltage at terminals of evaluation electronics

2) The phase error L_G (deviating from 90°), which may occur as the result of encoder and cable, can be calculated from $T_{\min}$:

$$L_G = \pm (90^\circ - f_p \cdot T_{\min} \cdot 360^\circ \cdot 10^{-6})$$

L_G [°] = phase error

f_p [kHz] = pulse frequency

$T_{\min}$ [ns] = minimum distance between edges

This formula applies only if the encoder pulse/pause ratio is 1:1.

If the pulse encoder is incorrectly matched to the encoder cable, disturbing cable reflections will be produced at the receive end. These reflections must be damped so that the encoder pulses can be correctly evaluated. The limit values listed in the table below must be maintained to ensure that the resultant power loss in the adapting element of the evaluation electronics is not exceeded.

Table 2:

$f_{\max}$	50kHz	100kHz	150kHz	200kHz	300kHz
Differential voltage ³⁾	Up to 27V	Up to 22V	Up to 18V	Up to 16V	Up to 14V

3) Differential voltage of encoder pulses at no load
(approximate encoder power supply voltage)

Cable, cable length, shield connection:

The encoder cable capacitance must be recharged at each encoder edge change. The RMS value of this current is proportional to the cable length and the pulse frequency and must exceed the current specified by the encoder manufacturer. A suitable cable as recommended by the encoder manufacturer must be used. The maximum cable length must not be exceeded. Generally, a twisted cable pair with common pair shield is sufficient for each track. Crosstalk between the cables is thus reduced. The shielding of all pairs protects against noise pulses. The shield must be connected to the shield bar of the SIMOREG converter over the largest possible surface area.

Temperature sensor inputs (motor interface 1) (see also Section 8, sheet G185)

Function	Terminal X174	Connection values/Remarks
Motor temperature	22	Sensor acc. to P490 index 1
Connection of the temperature sensor	23	
Ground analog M	24	

Analog outputs (see also Section 8, sheet G115)

Function	Terminal X175	Connection values/Remarks
Actual current	12	0...±10V corresponds to 0...±200% Converter rated DC current Max. load 2mA, short-circuit-proof
Ground analog M	13	
Select output analog 1	14	0...±10V, max. 2mA short-circuit-proof Resolution ±11bits
Ground analog M	15	
Select output analog 2	16	
Ground analog M	17	

Binary control inputs (see also Section 8, sheet G110)

Function	Terminal X171	Connection values/Remarks
Supply (output)	34	24V DC, internal short-circuit-proof supply referred to internal ground. The sum of the currents drawn from terminals 34, 44 and 210 must not exceed 200 mA. Overload response: Fault message F018
Ground digital M	35	
Select input binary 1	36	
Power On / Shutdown	37	
H signal: Power ON Line contactor CLOSED + (with H signal at terminal 38), acceleration along ramp-function generator ramp to operating speed. L signal: Shutdown Deceleration along ramp-function generator ramp to $n < n_{\min}$ (P370) + , controller disable + line contactor OPEN. See Section 9.3 for exact function description.		
Enable operation	38	H signal: +13V to +33V L signal: – 33V to +3V or terminal open 8.5mA at 24V
H signal: Controller enabled L signal: Controller disabled See Section 9.3.4 for exact function description		
Select input binary 2	39	

Safety shutdown (E-STOP, see also Section 9.8)

Function	Terminal XS	Connection values/Remarks
Supply for safety shutdown (output)	106	24V DC, max. load 50mA, short-circuit-proof Overload response: Fault message F018
Safety shutdown switch	105	$I_e = 20\text{mA}$
Safety shutdown pushbutton	107	NC contact $I_e = 30\text{mA}$
Safety shutdown Reset	108	NO contact $I_e = 10\text{mA}$

NOTE

Either terminal 105 or terminals 107 + 108 may be used!
 Terminal 105 is connected to terminal 106 in the delivery state.

Binary control outputs (see also Section 8, sheet G112)

Function	Terminal X171	Connection values/Remarks
Select output binary 1 Ground M	46 47	H signal: +20V to +26V L signal: 0 to +2V Short-circuit-proof 100mA Internal snubber circuit (free-wheeling diode) Overload response: Fault message F018
Select output binary 2 Ground M	48 54	

Binary control outputs (isolated relay outputs)

Function	Terminal XR	Connection values/Remarks
Relay for line contactor	109 110	Load capability: ≤250V AC, 4A; $\cos\Phi=1$ ≤250V AC, 2A; $\cos\Phi=0,4$ ≤30V DC, 2A External fuse protection 4A, characteristic C recommended

Serial interface 1 RS232 (9-pin SUBMIN D socket connector)**X300**

Use a shielded connecting cable! Ground shield at both ends!

Con. pin X300	Function
1	Housing earth
2	Receive cable to RS232 (V.24) standard
3	Send and receive cables to RS485, two-wire, positive differential input/output
4	Input: Reserved for later use
5	Ground
6	5 V voltage supply for OP1S
7	Send cable to RS232 (V.24) standard
8	Send and receive cables to RS485, two-wire, positive differential input/output
9	Ground

Cable length: Up to 15m according to EIA Standard RS232C
 Up to 30 m capacitive load, max. 2.5nF (cable and receiver)

A serial connection to a PLC or PC can be made using connector X300 on the PMU, allowing the converter to be controlled and operated from a central control centre or room.

Serial interface 2 RS485

Function	Terminal X172	Connection values/Remarks
TX+	56	RS485, 4-wire send cable, positive differential input
TX-	57	RS485, 4-wire send cable, negative differential input
RX+/TX+	58	RS485, 4-wire receive cable, positive differential input, 2-wire send/receive cable, positive differential input
RX-/TX-	59	RS485, 4-wire receive cable, negative differential input, 2-wire send/receive cable, negative differential input
M	60	Ground

Cable length: For transmission rate $\approx 187.5\text{kBd} \Rightarrow 600\text{m}$
 For transmission rate $\leq 93.75\text{kBd} \Rightarrow 1200\text{m}$

The following must be observed: DIN 19245 Part 1

The potential difference between the data reference potentials M of all interfaces must not exceed $-7\text{V} / +12\text{V}$. If this cannot be guaranteed, then equipotential bonding must be provided.

Activation of interface 1 or 2:

- Set the baud rate in parameter P783 or P793.
- Set the protocol in parameter P780 or P790.

Options:**Terminal expansion CUD2** (C98043-A7006)

Terminal type: Plug-in terminal (screw-type)
Max. connection cross-section 1.5mm²

Motor interface (see also function diagrams, Section 8, sheets G185 and G186)

Function		Terminal X164	Connection values/Remarks
Motor temp.	positive terminal	204	Sensor acc. to P490 index 2
Motor temp.	negative terminal	205	
		Terminal X161	
Supply (output)	binary inputs	210	24V DC, internal short-circuit-proof supply referred to internal ground. The sum of the currents drawn from terminals 34, 44 and 210 must not exceed 200 mA. Overload response: Fault message F018 H signal: +13V to +33V L signal: – 33V to +3V or terminal open Input resistance = 2.8k Ω
Binary input		211	
Binary input		212	
Binary input		213	
Binary input		214	
Ground for binary inputs		215	
Ground for binary inputs		216	
M		217	

Analog inputs (see also Section 8, sheet G114)

Function		Terminal X164	Connection values/Remarks
Select input	analog 2	8	$\pm 10V$, 52k Ω Resolution: ± 10 bit Common mode suppression: $\pm 15V$
Ground analog		9	
Select input	analog 3	10	
Ground analog		11	

Analog outputs (see also Section 8, sheet G116)

Function		Terminal X164	Connection values/Remarks
Select output	analog 3	18	0... $\pm 10V$, max. 2mA Short-circuit-proof Resolution ± 11 bit
Ground analog	M	19	
Select output	analog 4	20	
Ground analog	M	21	

Binary inputs (see also Section 8, sheet G111)

Function		Terminal X163	Connection values/Remarks
Supply		44	24V DC, internal short-circuit-proof supply referred to internal ground. The sum of the currents drawn from terminals 34, 44 and 210 must not exceed 200 mA.
Ground digital M		45	Overload response: Fault message F018
Select input	binary 3	40	H signal: +13V to +33V L signal: – 33V to +3V or terminal open 8.5mA at 24V
Select input	binary 4	41	
Select input	binary 5	42	
Select input	binary 6	43	

Binary outputs (see also Section 8, sheet G112)

Function		Terminal X163	Connection values/Remarks
Select output	binary 3	50	H signal: +20V to +26V
Ground M		51	L signal: 0 to +2V
Select output	binary 4	52	Short-circuit-proof 100mA Internal snubber circuit (free-wheeling diode) Overload response: Fault message F018
Ground M		53	

Serial interface 3 RS485

Function	Terminal X162	Connection values/Remarks
TX+	61	RS485, 4-wire send cable, positive differential input
TX-	61	RS485, 4-wire send cable, negative differential input
RX+/TX+	63	RS485, 4-wire receive cable, positive differential input, 2-wire send/receive cable, positive differential input
RX-/TX-	64	RS485, 4-wire receive cable, negative differential input, 2-wire send/receive cable, negative differential input
M	65	Ground

Cable length: For transmission rate $\approx 187.5\text{ kBd} \Rightarrow 600\text{ m}$
 For transmission rate $\leq 93.75\text{ kBd} \Rightarrow 1200\text{ m}$

The following must be observed: DIN 19245 Part 1

The potential difference between the data reference potentials M of all interfaces must not exceed -7V / +12V. If this cannot be guaranteed, then equipotential bonding must be provided.

Activate interface 3:

- Set the baud rate in parameter P803.
- Set the protocol in parameter P800.

