RELIANCE ELECTRIC

AutoMax DPS DC Power Module

Instruction Manual

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Rockwell Automation

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Safety Instructions

DANGER, WARNING, and CAUTION point out potential trouble areas.

- A **DANGER** alerts a person that high voltage is present which could result in severe bodily injury or loss of life.
- A **WARNING** alerts a person to potential bodily injury if procedures are not followed.
- A **CAUTION** alerts a person that, if procedures are not followed, damage to, or destruction of equipment could result.

DANGER*:* Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, and/or service this equipment. Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in bodily injury.

WARNING*:* Earth fault detection devices must not be used on this converter as the sole protection measure against unintentional touching. The DC-component in the earth fault current may inhibit the correct function of the fault detector.

WARNING*:* The function of this electronic device, if not mounted in a metal control cabinet, can be disturbed by electromagnetic radiation of nearby radio transceivers (walkie-talkies).

CAUTION*:* Electronic power converters cause disturbances to the supply network. The basic version of this converter does not include any harmonic filters and may not fulfill the limits of the national recommendations. The harmonic voltage disturbances produced by the converter are dependent on the supply network impedance.

Machinery Directive

CAUTION*:* This converter device is a component intended for implementation in machines or systems for the capital goods industry.

The start-up of the converter in the European market is not permitted until it has been confirmed that the machine into which the converters are built is in conformance with the regulations of the Council Directive Machinery 98/37/EWG.

WARNING*:* To inhibit uncontrolled machine operation in case of the malfunction of the drive, the user must provide an external emergency stop circuit, which ensures disconnection of the power source from the motor.
This circuit must be hardwired with electro-mechanic components and shall not depend on electronic logic or software. The stopping device (e.g. mushroom head pushbutton with lock) must be accessible to the operator.
Failure to observe this precaution could result in bodily injury or loss of life.

Electromagnetic Compatibility (EMC-Directive)

CAUTION *:*

The operating of power converters in the European market is only permitted if the Council Directive Electromagnetic Compatibility 89/336/EWG has been observed.

It is the responsibility of the manufacturer of the machine or system to observe the immunity and emission limits, requested by the Council Directive EMC in the European market. Guidelines for the installation according EMC-regulations - for shielding, grounding, filter arrangement as well as wiring instructions - are summarized in Appendix A, 'CE-Conformance' of this Instruction manual.

Features

RELIANCE ELECTRIC DC Power Modules are 3 phase AC/DC converters and are used for the step less regulation of DC-motors. They are available in two variants:

For single-quadrant operation S-6

Controlled rectifier bridge with two directions. Clockwise rotation (I. Quadrant) or CCW rotation (III. Quadrant) motoring.

For four-quadrant operation S-6R

This converter works as rectifier and inverter and allows operation in both directions of rotation in motoring and regenerative mode (driving and braking).

AC-line reactors and super fast acting fuses are not included in the device and have to be mounted separately.

The DC Power Modules are designed as power units for DC-drives in **A**uto**M**a**x** **D**istributed **P**ower **S**ystems (AMX DPS).

They contain in addition to the power stack PC-boards with the following functions:

- Firing pulse transmission
- Line synchronization signals
- Line voltage feedback
- Armature current feedback
- Armature voltage feedback
- Snubber circuit

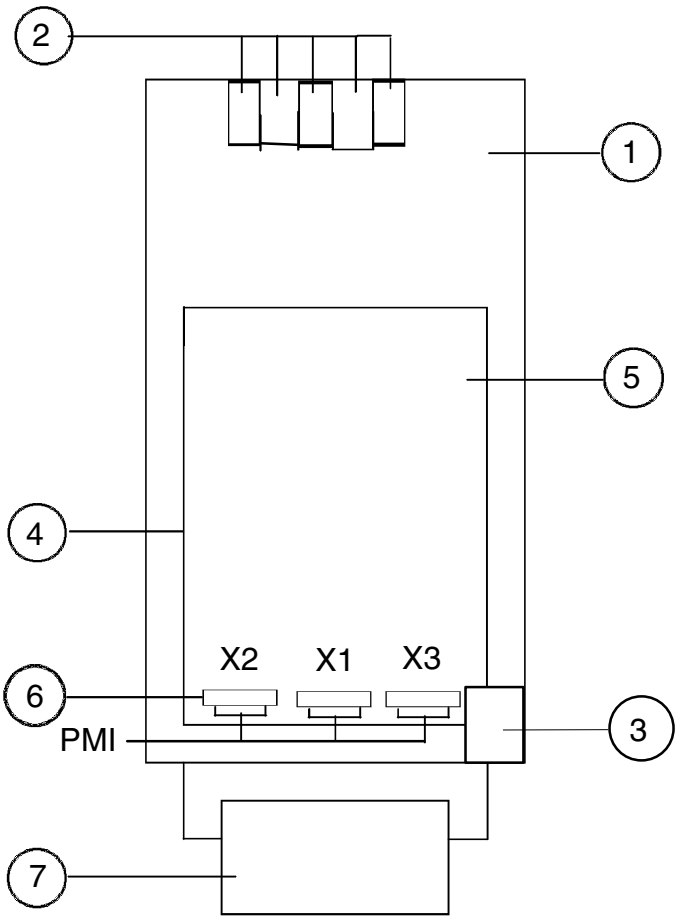
All control and regulator functions of the converter are executed fully digital in the Universal Drive Controller Module (UDC) mounted in an AutoMax rack and in the Power Module Interface Rack (PMI).

Protective measures

A balanced protective concept ensures a high degree of reliability.

- On single-quadrant drives fast acting fuses must be provided on the mains supply side to protect the thyristors against short circuits.
- On four-quadrant drives fuses are also required in the armature circuit.
- Instantaneous electronic trip (IET) protects the device against overcurrent and over-voltage peaks.
- Summing RC-networks limit the voltage at the thyristors.
- Converters with cooling fan (>=120A) are protected against excessive temperatures from overload or fan loss by thermostats on the heatsink.
- The controller is electrically isolated from the power unit.
- Regulator blocking on undervoltage or phase loss.
- Mains connection with optional phase sequence .
- Automatic adaptation to line frequency 50 Hz or 60 Hz (on units <=1500A).
- The DPS checks the drive before power up and during operation by the means of extensive diagnostic-routines. The following faults are detected:
  * Instantaneous overcurrent
  * Loss of line synchronization
  * Loss of speed feedback
  * Software detected overspeed /overvoltage
  * External IET(Instantaneous electronic trip)
  * Incorrect phase detection
  * Shorted thyristor

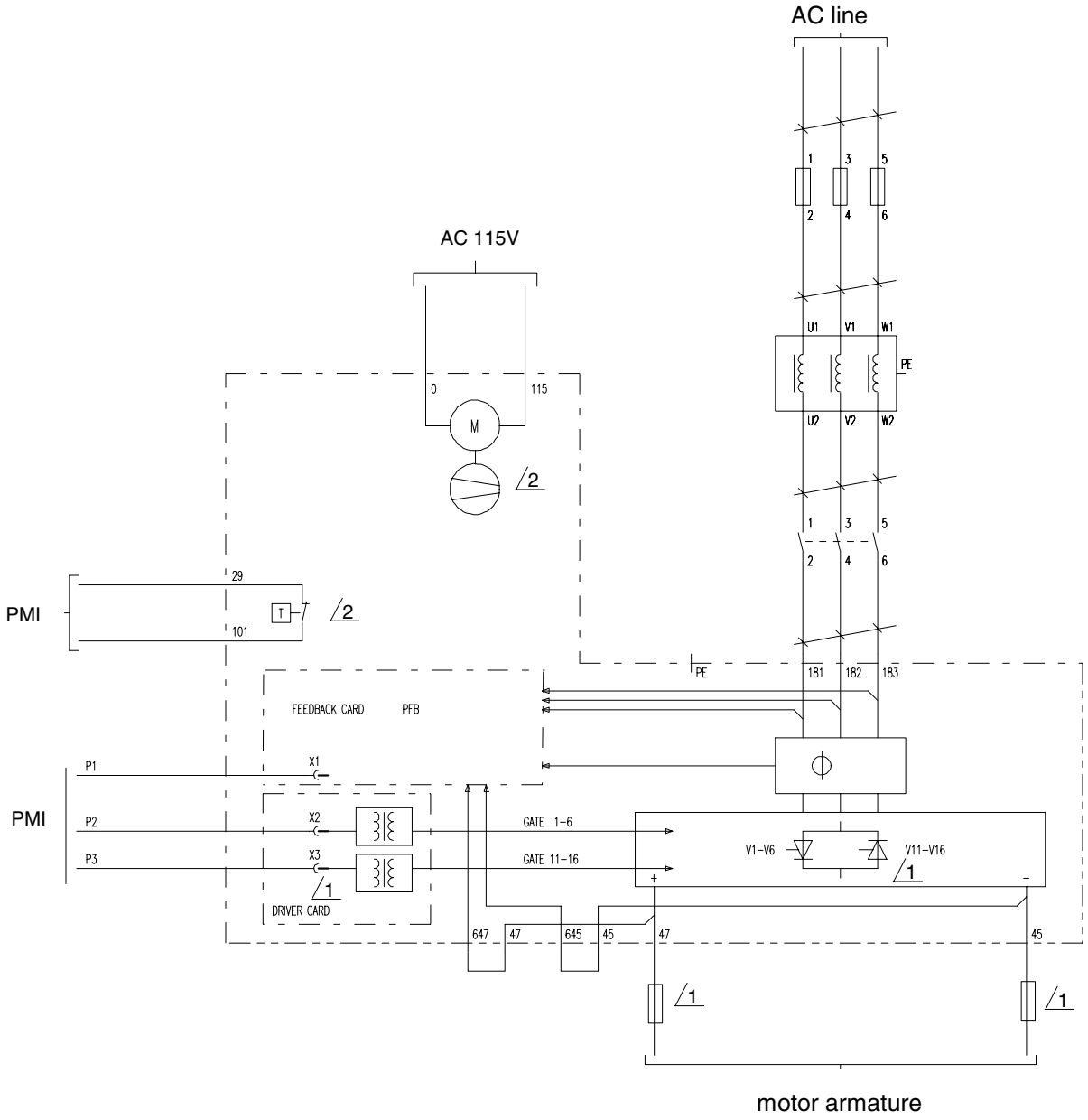
Configuration



(1) Power stack with heatsink
(2) Motor- and line input connections
(3) Control terminals
(4) PC-board PDA (behind PFA)
(5) PC-board PFA (front)
(6) Connector
(7) Cooling fan

Fig. 1-1: Configuration of the controller 120 A (simplified layout S-6R)

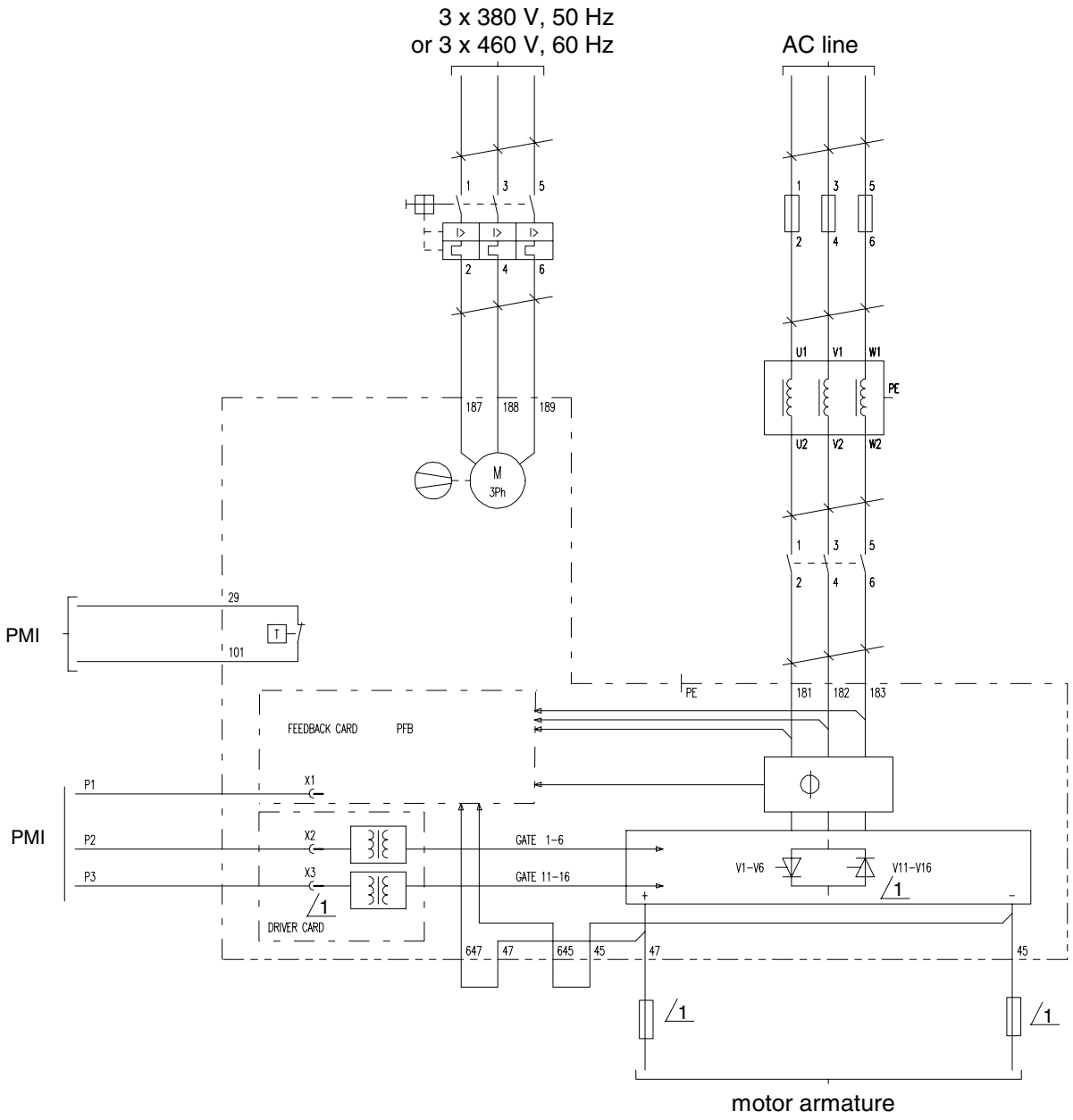
Schematic Diagram



/1 On single quadrant units S-6 the thyristors V11-V16 and the firing pulse transformers are not fitted, and armature fuses are not needed

/2 On Types < = 60 A cooling fan and thermostat F3 are not fitted.

Fig. 1-2: Schematic diagram Types < = 800 A



/1 On single quadrant units S-6 the thyristors V11-V16 and the firing pulse transformers are not fitted, and armature fuses are not needed

Fig. 1-3: Block diagram of the units 1500 A - 2000 A

Connection	Function	Remarks
181, 182, 183	- Converter AC-line supply input	- for supply voltages
PE	- Protecting earth connection	see Chapter 2
45, 47	- Converter output	
0, 115	- Cooling fan supply for type 120-800 A	- 1-phase
187, 188, 189	- Cooling fan supply for type 1500-2000 A	- 3-phase on 1500-2000 A units
29, 101	- Thermostat contact output	- from 120 A on

- The power unit for single-quadrant operation consists of a fully controlled, three-phase bridge rectifier, the four-quadrant variant comprising two antiparallel connected 3-phase bridges.

WARNING:
The output voltage of the converter is not limited. In case of a fault the output voltage (armature voltage) may reach the following value: $U_a = 1.35 \times U_N$ (observe the line voltage tolerance)

Functions of the PC-Boards

As already mentioned are all converter control and regulation functions executed in the AutoMax and Power Module Interface Rack outside the power unit. This covers also the functions for firing pulse generation including the pulse amplification (final stage) and functions for analogue to digital signal conversion and the measuring signals for line voltage, line synchronization, armature current and armature voltage from the power stack.
The only function of the cards on the power unit is to detect, calibrate and transfer the measuring and feedback signals. In addition the firing pulses are transferred to the power unit. The cards contain also the snubber circuits for the power unit.

The functions are distributed on the cards as follows:

Driver Card

The firing pulse transformers are placed on the card:

PDA for 4Q drives S-6R, or

PDB for 1Q drives S-6

The driver signals are distributed through series resistors to the adjacent transformers. The secondary side of the firing pulse transformers is connected via twisted pairs to the thyristors.

Feedback Card

Synchronization

For the synchronization of the firing pulses the DPS-System needs a 3-phase-AC voltage signal. These signals are generated from the secondary windings of the transformers T1-T3.
The transformers, on the primary side in delta connection, are linked to the mains through input fuses F1-F3.
The circuit calibrates the line voltage to the required signal amplitude and isolates the signals from the line voltage. The transformer secondary windings in star-connection are linked through resistive voltage dividers to connector X1.
The signal amplitude is adapted for different line voltages by means of jumper setting according to Table 3-1 in Chapter 3.

Line Voltage and Armature Voltage Feedback

5 high resistance voltage dividers are provided for 3 line voltage and 2 armature voltage feedback signals. The signal amplitude is adapted for different line voltages by means of jumper setting accord. to Table 3-1 in Chapter 3.

Current Feedback

The current feedback signal originates from 2 current transformers (CT1 and CT3) monitoring the AC line current to the SCR bridge. The CT connections are directly linked to connector X1 and then rectified and summed on a burden resistor in the PMI. The voltage across the burden resistor is fed back to the feedback card in the power module and there available at test points ARM CT and GND.

Voltage Limitation (Snubber) Circuit

For power modules up to type 800 A the feedback card also includes the snubber circuit.

SBA card

This card contains the voltage limitation (snubber) circuit for 1500 –2000 A units.

Converter input voltages:

- 3-phase line input voltage (terminals 181, 182, 183)

  Type < = 250 A..... 3 AC 200-500 V

  Type 450 A - 2000 A..... 3 AC 200-500 V and 3 AC 525-690 V

- Line voltage tolerance for the converter..... ..... ±10 %

  for the max. armature voltage according to Table 2-2

- Line frequency Type < = 1500 A..... 50 Hz or 60 Hz ±2 Hz

  Type 1600 A and 2000 A.....standard 50 Hz ±2 Hz

  on request 60 Hz ±2 Hz

Fan supply

Table 2-1

Unit Type	Terminal	Phases	Volts	Freq.	Amps	External Protection
120 A	0,115	2	115	50/60	0.20	
250 A	0,115	2	115	50/60	0.26	Fuse
450 A	0,115	2	115	50/60	0.26	< 6 A
800 A	0,115	2	115	50/60	0.52	
1500 A	187, 188, 189	3	400 460 *	50 60 *	1.1	Thermal Magnetic Circuit Breaker
1600 A 2000 A	187, 188, 189	3	400 460 *	50 60 *	1.1	

* Units with 460V / 60 Hz blower are available on request.

Armature Voltages

Table 2-2: Armature Voltages for different Line Voltages

Line Voltage Un	Negative Line Voltage Tolerance Ut	Standard Motor Armature Voltage			
		Motoring Operation		Regenerating Operation	
		Ua nom	Ua max	Ua nom	Ua max
200 V	10%	200 V	230 V	200 V	214 V
400 V	10%	460 V	490 V	400 V	440 V
415 V	10%	460 V	490 V	400 V	440 V
460 V	10%	520 V	570 V	500 V	500 V
500 V	5%	600 V	620 V	520 V	535 V
575 V	5%	700 V	710 V	600 V	615 V
660 V	5%	800 V	810 V	700 V	706 V
690 V	10%	800 V	850 V	700 V	738 V

Use of Standard Motor Armature Voltages implies:

- Inductive Voltage Drop Uk < = 4% per phase
- Max. Negative Line Voltage Tolerance Ut as stated

Max. permissible Motor Armature Voltage:

1-Quadrant Operation: Ua = Un *1.35* (100-Ut)/100* (100-Uk)/100

4-Quadrant Operation: Ua = Un *1.17* (100-Ut)/100* (100-Uk)/100

Armature current

The current ratings stated in Table 2-3 are valid for the service conditions (next sheet) concerning ambient temperature (45 degrees C) and installation altitude (1000 m).
On deviations the derating factors must be taken into account.

Table 2-3: Armature current, current transformers

Unit type	Max. Input Voltage		Armature current			Current Transformer-Ratio
			$I_{a\ nom}$	$I_{a\ d}$	$I_{a\ max}$	ü
60 A	500		50 A	60 A	75 A	833:2
120 A	500		100 A	120 A	150 A	833:1
250 A	500		208 A	250 A	312 A	2000:1
450 A	500		375 A	450 A	562 A	3000:1
450 A		690	315 A	380 A	472 A	3000:1
800 A	500		666 A	800 A	1000 A	5230:1
800 A		690	500 A	600 A	750 A	5230:1
1500 A	500		1250 A	1500 A	1875 A	10500:1
1500 A		690	1170 A	1400 A	1750 A	10500:1
1600 A		690	1334 A	1600 A	2000 A	10500:1
2000 A	500		1667 A	2000 A	2500 A	10500:1

$I_{a\ nom}$: Permanent rated current with 50% overload during one minute every 10 minutes

$I_{a\ d}$: Permanent rated current without overload ($I_{a\ d} = 1.2 \cdot I_{a\ nom}$)

$I_{a\ max}$: Maximum current during one minute after 9 minutes with $I_{a\ nom}$ ($I_{a\ max} = 1.5 \cdot I_{a\ nom}$)

Current transformer ratio: ü = Motor current / Burden current

Heat dissipation

Heat dissipation in watts may be expressed by the following formula

Dissipation $Pv = K + 3 . I_{anom}$

where K = 100 for units Type < = 120 A

K = 200 for units Type 250 and 450 A

K = 400 for units Type 800 A

K = 800 for units Type 1500 – 2000 A

Line impedance considerations

So that the maximum permissible short circuit current capacity of the converter is not exceeded, minimum supply network inductance is a mandatory requirement. Therefore a three phase iron core reactor should be incorporated in the mains supply to terminals 181, 182, 183. The line impedance of this reactor should be between 2 and 4%. Refer to Table 8-4 for selection.
No reactor is required when a matched line input transformer is provided.

Service Conditions

Ambient temperature	
- Operation:	0 degree C ... +55 degree C For temperatures higher than 45 degree the max. currents must be derated by 1.5% per degree C.
- Storage:	-25 degree C ... +55 degree C
- Transportation:	-25 degree C ... +70 degree C (+70 degree C during max. 24 hours)
Ambient relative humidity:	max. 50% at 40 degree C unlimited max. 90% at 20 degree C during max. 30 days/year 75% average (Class F, DIN 40 040) NOTE: Condensation is not allowed!
Air pollution:	The ambient air may contain some dry dust but must not contain excessive dirt, chemical fumes, oil, vapor etc.
Installation altitude:	max. 1000 m above sea level. Above derate max. current by 1% for every 100 m.
Degree of protection (enclosure):	IP00

Standard Equipment

The Power Modules are to be adapted to the nominal line voltage by setting a total of 8 jumpers on the Feedback Board.

In addition the two parameters *Phasing Transformer Voltage* and *AC Line Voltage* in the drive section AutoMax or ControlLogix 1756-DMD30 Software must be set as shown in the following Table:

Table 3-1:

For Rated AC Volts	**Set** Jumpers between Fastons	**Set** The *Phasing Transformer Voltage* Parameter to	**Set** The *AC Line Voltage* Parameter to the rated AC Line voltage 1)
100 - 230	690 - 230	**230**	**116** =< AC Line Voltage Param. <= **240**
231 - 380	690 - 380	**380**	**241** =< AC Line Voltage Param. <= **390**
381 - 460	690 - 460	**460**	**391** =< AC Line Voltage Param. <= **480**
461 - 575	690 - 575	**575**	**481** =< AC Line Voltage Param. <= **615**
576 - 690	no	**690**	**616** =< AC Line Voltage Param. <= **750**

1) The set value must be **inside** the chosen range in this column **regardless** of the actual measured voltage.

Example: For Rated AC Volts = 400V (381 – 460) and actual measured voltage = 385V
the *AC Line Voltage* Parameter may be set to 400V or any other value between 391 and 480 but **not to 385**.

Assembly

Always observe the following requirements when installing the Power Module in control cabinets:

- Comply with mandatory protection standards to prevent contact with live components (covers) and shock when a fault occurs (safe ground), e.g. as per EN60204; Therefore the installation should be done by instructed and qualified electrical personnel only.

- Provide studs accord. to dimension sheets Fig. 4-3 - 4-7.

- Leave space for hinge down the driver unit

- Leave a gap of at least 100 mm for the free circulation of cooling air and to eliminate the possibility of internal hot spots.

Ventilation

The cabinet ventilation must be designed so that the air entry temperature in the heatsink does not exceed 45 degree C (nominal operating temperature) under maximum permissible continuous current loading. If these temperature limits cannot be maintained, a reduction in power must be taken into account (1.5% per degree C above 45 degree C).

CAUTION: The maximum permissible ambient operating temperature of 55 deg. C must never be exceeded

Resulting heat dissipated must be exhausted by suitably dimensioned fans. Power dissipation values depending on controller output current can be calculated according to chapter 2.

Connection

Refer to the schematic diagrams Figures 1-2 and 1-3.

Transient suppression of contactor and relay coils:

Switching of contactor and relay coils (also valves, fan motors etc) causes transient voltages of high frequency (bursts), which can disturb electronic circuits.

NOTE:
A proved measure, to avoid potential problems, is to provide suppression networks on all contactor and relay coils of the drive equipment: AC-coils with RC-units, DC-coils with diodes in non conducting direction. In any case such coils, which contacts are connected to the drive, or which are actuated by contacts from the drive, must be suppressed. If cabinet blowers or power unit fans are switched, the RC-unit (part No. 215.02.00) must be connected across the contact.

Fig. 4-1: Connection Cables between PMI-Rack and Power Module Types 60A and 120A

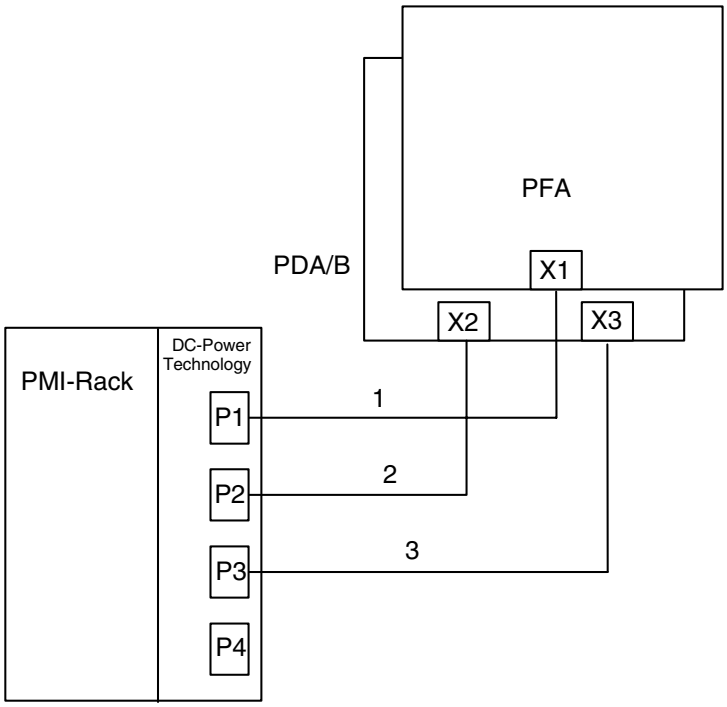
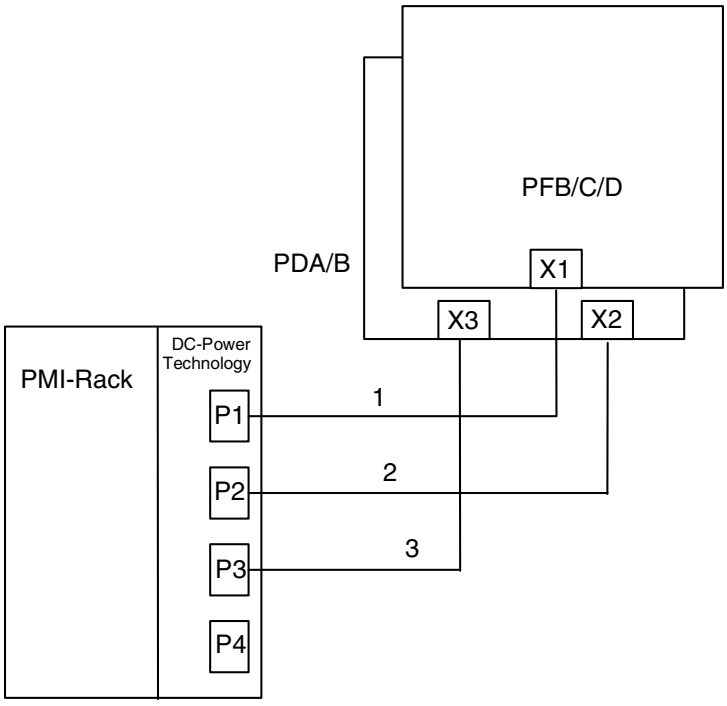
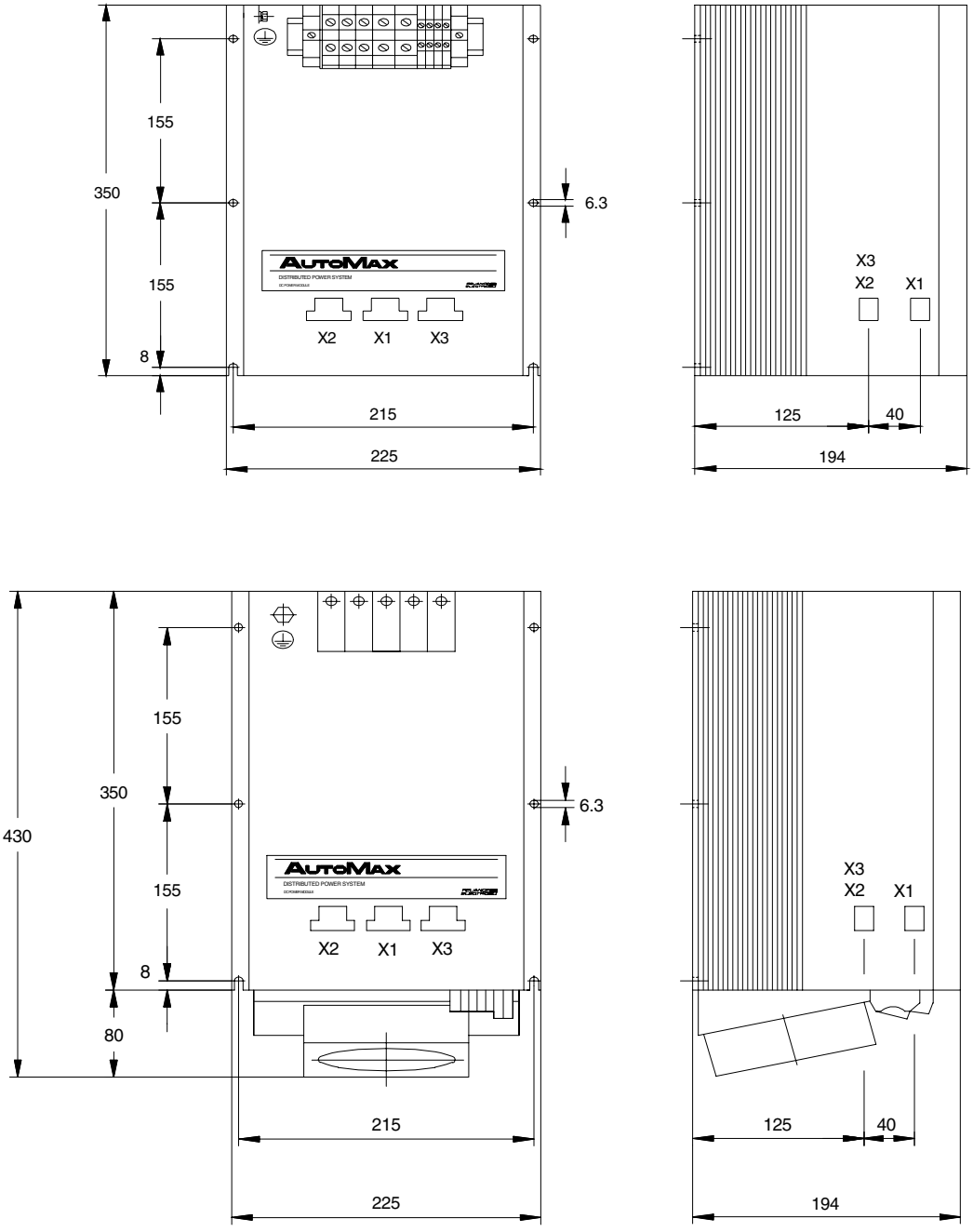


Fig. 4-2: Connection Cables between PMI-Rack and Power Module Types 250A - 2000A



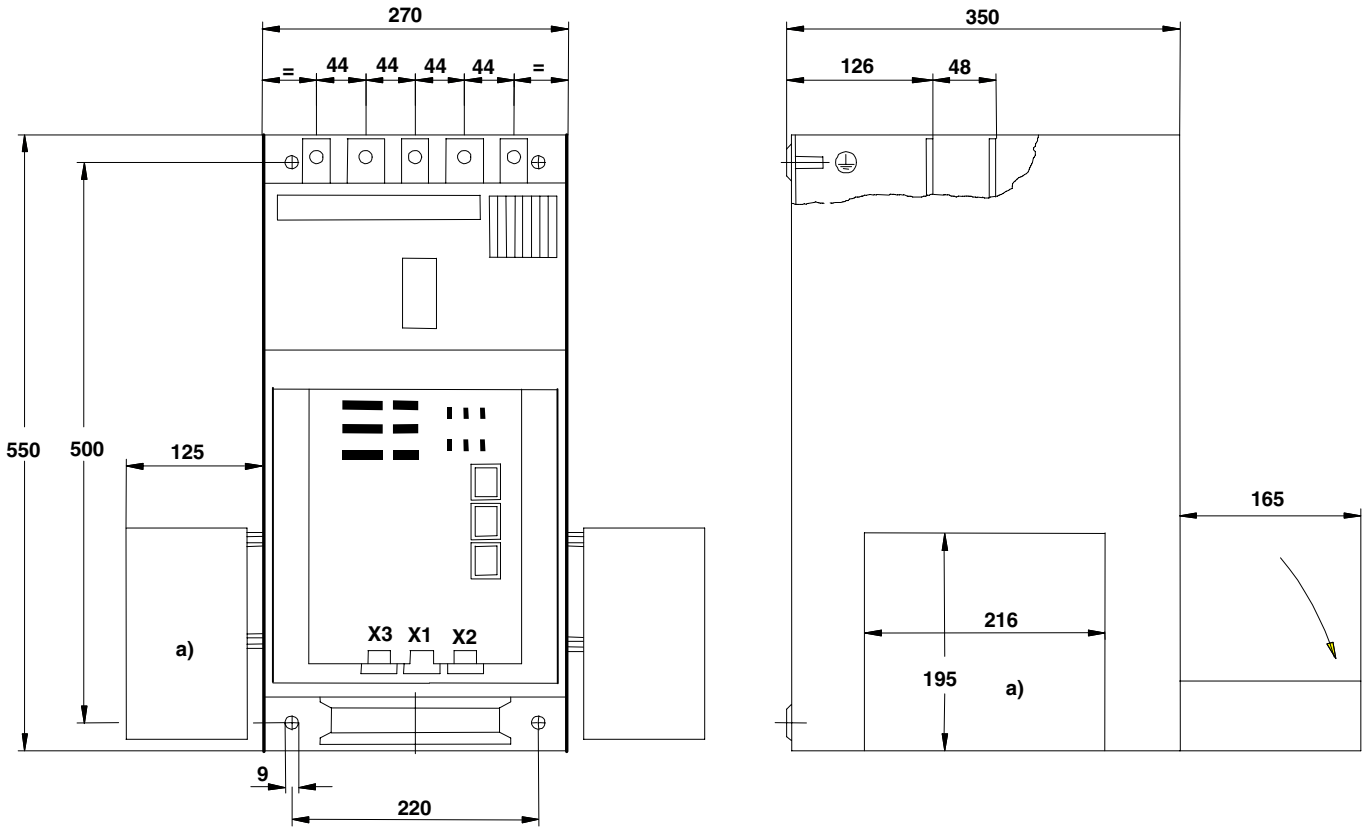
Cable	Function	Part No.
1	Armature Feedback	840.30.07
2	Armature Forward Gates	840.31.07
3	Armature Reverse Gates	840.32.07

Dimensions



	60A Unit (top)	120A Unit
Weight:	8.8 kg	12.0 kg
Cooling air:		187 m^3/h
Air flow direction:		from bottom to top
Minimum clearances for air circulation:		100 mm
Power connections		
181-183 (U,V,W)	terminals $16mm^2$	bolts M8
45(D),47(C)	terminals $35mm^2$	bolts M8
Protection earth PE1	bolt M5	bolt M8
Control connections	terminals $4mm^2$	$4mm^2$

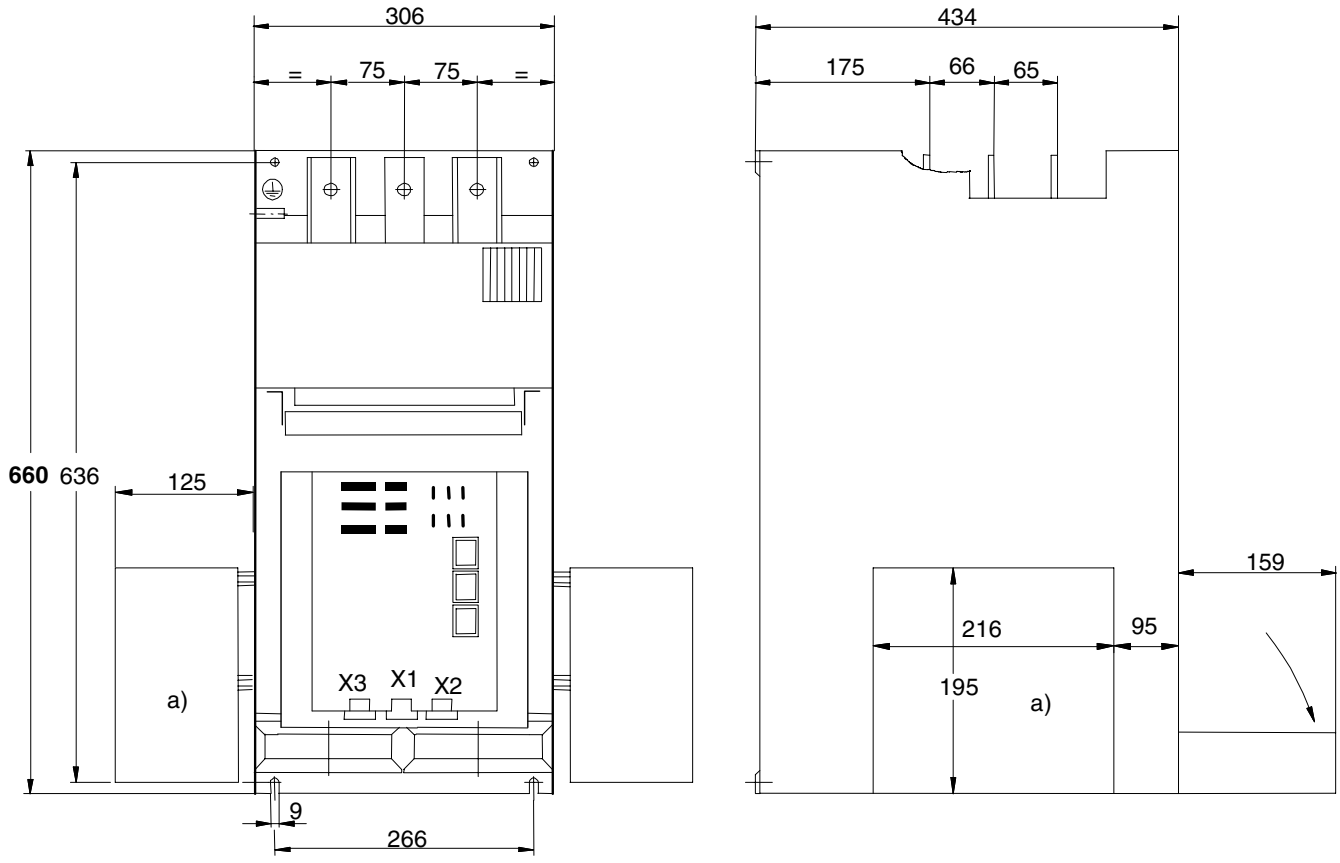
Fig. 4-3: Dimensions, weight and drilling plan for Type **60A and 120A**



a) The RC-Snubber module for thyristor protection (Part No. 922.58.10) is mounted on 690 V S-6R units only (on the left or right side of the U-frame)

Weight:	40 kg	
Cooling air:	407 m^3/h	
Air flow direction:	from bottom to top	
Minimum clearances for air circulation:	100 mm	
Power connections:	250A Unit	450A Unit
Motor 45(D), 47(C)	bus bars 25x5, drilling 11 mm	bus bars 40x5, drilling 14 mm
AC-Line 181(U), 182(V), 183(W)	bus bars 20x5, drilling 11 mm	bus bars 30x5, drilling 14 mm
Prot. earth PE1	bolt M10	bolt M10

Fig. 4-4: Dimensions, weight and drilling plan for Type **250/450A**



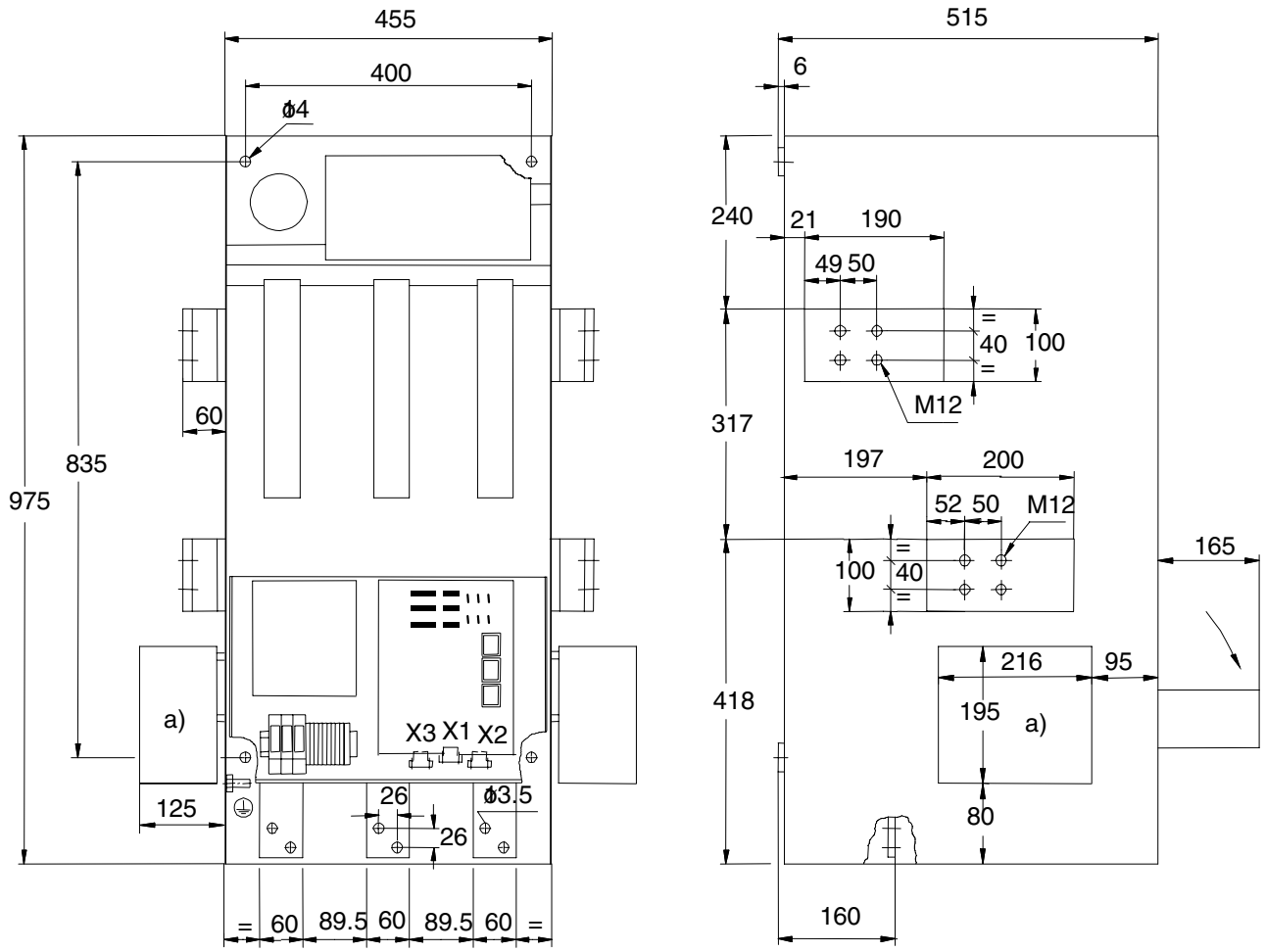
a) The RC-Snubber module for thyristor protection (Part No. 922.58.10) is mounted on 690V S-6R units only (on the left or right side of the U-frame)

Weight:	83 kg
Cooling air:	814 m^3/h
Air flow direction:	from bottom to top (2 fans)
Minimum clearances for air circulation:	100 mm

Power connections:

Motor 45(D), 47(C)	bus bars 50x10, drilling 13.5 mm
AC-Line 181(U), 182(V), 183(W)	bus bars 40x10, drilling 13.5 mm
Prot. earth PE1	bolt M12

Fig. 4-5: Dimensions, weight and drilling plan for Type **800A**



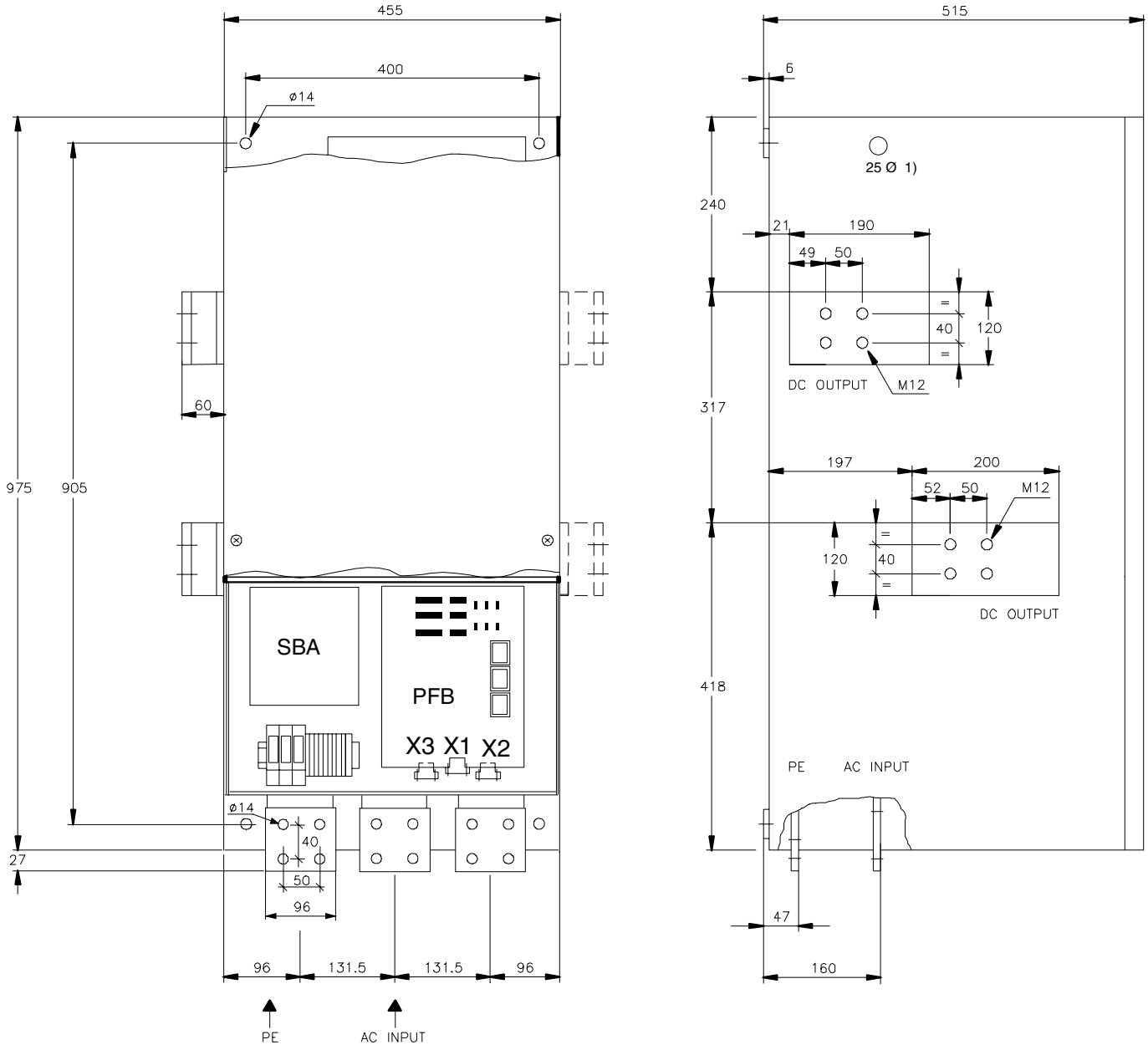
a) The RC-Snubber module for thyristor protection (Part No. 922.58.10) is mounted on 1500A, 690V S-6R units only (on the left or right side of the U-frame)

Weight:	195 kg
Cooling air:	2000 m^3/h
Air flow direction:	from bottom to top
Minimum clearances for air circulation:	100 mm

Power connections:

Motor 45(D), 47(C)	bus bars 100x10, drilling 4xM12
AC-Line 181(U), 182(V), 183(W)	bus bars 60x10, drilling 13.5 mm
Prot. earth PE1	bolt M12

Fig. 4-6: Dimensions, weight and drilling plan for units **1500A**



1) Holes for lifting hooks

Weight:	195 kg
Cooling air:	2000 m^3/h
Air flow direction:	from bottom to top
Minimum clearances for air circulation:	100 mm

Power connections:

Motor 45(D), 47(C)	Bus bars 120 x 10, Drilling 4 x M12 Torque 25 Nm
AC-Line 181(U), 182(V), 183(W)	Bus bars 96 x 10, Drilling 4 x 14 mm
Prot. earth PE	Bus bar 60 x 10, Drilling 2 x 14 mm,

Fig. 4-7: Dimensions, weight and drilling plan for units **1600A, 690V** and **2000A, 500V**.

General

The variable jumpers according to Chapter 3 for Diagnostics and Troubleshooting must be set and checked before the drive is ready for start-up.

As the converters are delivered fully tested, problems during start-up are caused in most cases by faults outside the power module (see chapter 6).

WARNING! This equipment should only be installed, adjusted and serviced by qualified personnel familiar with the drive functions and operation and the hazards involved. Wrong handling may cause damage to the machine or injury to personnel.

NOTE: For measuring voltage and current in the armature circuit different meters are required.

a) mean values ($I_a \cong M$; $U_a \cong EMF + RI$), e.g. Digital meter FLUKE 8022B

b) RMS values ($I_{a\ rms} \cong$ thermal loading of cables), e.g. real RMS-meter

General pre-operation checks with power off

- Visual check of electronic circuits and of motor for mechanical defects.
- Check of external connections according to interconnection diagram (cross section, earth fault).
- Check of the externally mounted semiconductor protection fuses

General checks with mains voltage applied

NOTE: For each intervention, the unit must be separated from mains!

Check sense of rotation on DC-motor blower and power unit fan (units 1500 - 2000A)

Safety Precautions

WARNING: Whenever work is done on the unit ac-input power must be disconnected and the voltage at terminals 45-47 checked with a voltmeter.

WARNING: Static sensitive PC-boards. Handle without touching components, connectors or leads.

Test Instruments for Trouble Shooting

The following meters or their equivalent are recommended:
An analog multimeter having a sensitivity of minimum 100 kohm/Volt or
a digital multimeter with a 10 megaOhm input impedance on all ranges (e.g. FLUKE)

For trouble shooting inside the power unit a short circuit tester and an oscilloscope will be required.

NOTE: The scope must not be **grounded** and should be connected to mains by means of an isolation transformer. The scope impedance must be min. 8 megaOhm (probe 1:10). This is required for all measuring instruments with mains supply. When checking the driver, care must be taken, that the scope case is connected to zero potential.
Never connect the scope while the drive is switched on.

Cooling Fan Check

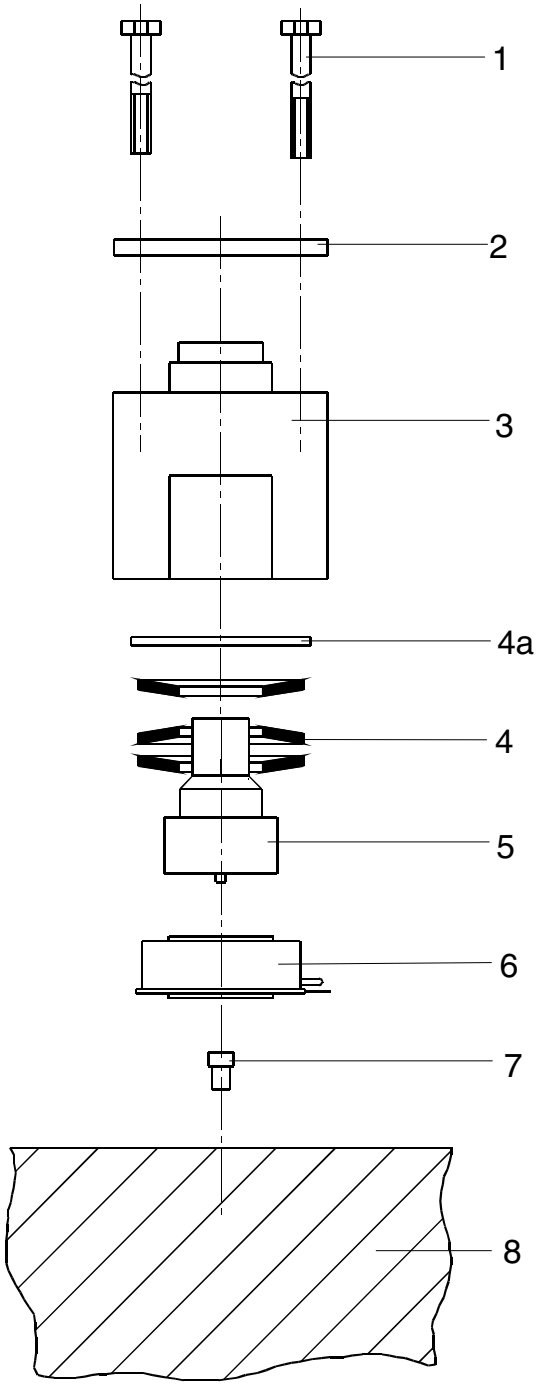
Normally the Power Modules will work without any maintenance. One exception are the cooling fans on power units and control cubicles. Their bearings should be visually checked from time to time, because the lifetime is limited. (they are designed to operate in continuous service for about 20.000 hours.) It is recommended to replace the fans (or bearings if possible) before the end of the lifetime to prevent breakdowns on the machine.
NOTE: Rockwell Automation delivers only the complete fan as renewal part. (See Table 7-1, 7-2)

Trouble Shooting

As the Units are delivered fully tested, problems during start-up are caused in most cases by faults outside the controller such as - Engineering errors, wrong connections, operating faults or wrong adaptations.

Replacement of Thyristors

Use original spare parts only. Selection according to Tables 7-1 and 7-2.
The location of the parts is shown in Fig. 1-1 and on the layout label inside the U-frame.



(1) Screws
(2) Steel plate
(3) Housing
(4a) Flat washer
(4) Plate springs
(5) Stamp
(6) Semiconductor
(7) Centering bolt
(8) Heatsink

Replacement of a thyristor or thyristor module Type 60 - 800A

- Loosen and swing out pc boards assembly
- Remove bus bars above the thyristors
- Remove gate leads of the thyristor concerned
- Unscrew thyristor or thyristor module
- Before mounting the new thyristor or thyristor module, coat the side, which is in contact with the heat sink, with a thin layer of heat conducting paste.

For units 800A:

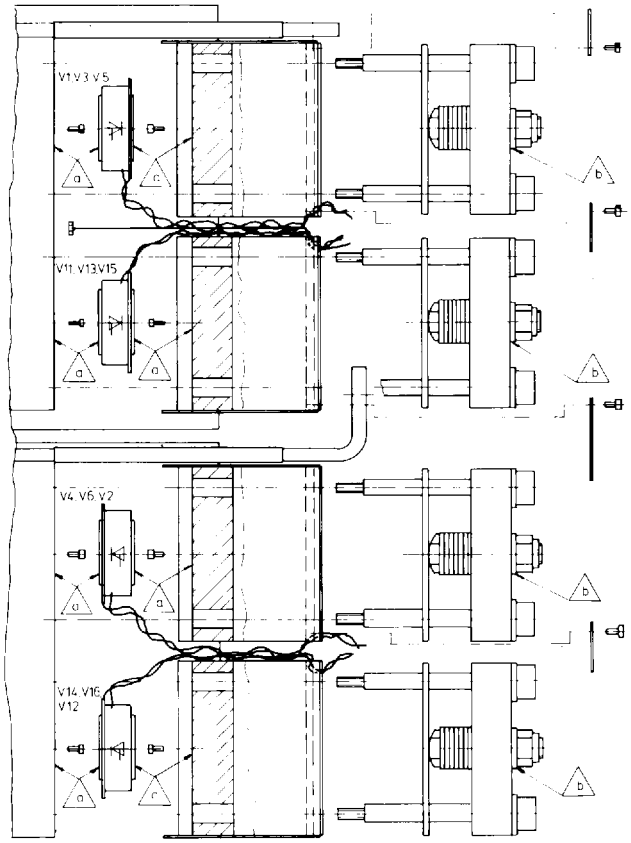
NOTE: for safe and easy mounting of thyristors on 800A units we recommend the tool PN 50.00.00

- Insert thyristor into box-clamp and put the package on the centering bolt on the heatsink
- Fasten the four hexagon bolts by hand until all slack is taken out and take care that the clamp housing stays parallel to the heatsink.
- Tighten each bolt by half a revolution at one time with hexagonal torque socket spanner 8 mm (10 mm), diagonally.

NOTE: Observe recommended torque!

- Repeat the procedure until the clamp is held down firmly to the heatsink on each side.
- Re-connect gate leads
- Screw on bus bars.

NOTE: Before replacing a thyristor or thyristor module the gate and cathode faston connectors must be checked for conductivity.



Replacement of a thyristor on power unit Types 1500 – 2000A

- Write protocol about the following procedure

- Open controller and protection unit by tilting forwards. Layout of thyristor assembly is visible now on side wall.

- Remove bus bars on front heat sink

- Unscrew the upper cooling air deflector. Unscrew the hexagon screws for the bus bar mounting.

- Unscrew the lower cooling air deflector

- Loosen the two screws (13 mm) on the clamp by quarter turns.(Caution: the center clamp screw 24 mm must not be turned)

- Withdraw clamp and heat sink.

- Clean heat sink from thermo conductive paste.

- Coat both sides of the new thyristor with an thin film of thermo conductive paste /a.

- Mount the thyristor on the centering pin in the rear heatsink. Observe correct polarity of cathode and anode according to layout.

- Insert clamp in front heatsink and attach to thyristor with centering pin.

NOTE /b

- Tighten the two clamp screws (13 mm) alternately by one quarter turn until the control ring under the center clamp nut can be turned through 360 degree by hand. Keep clearance to a minimum.

- Proceed installation in the reverse order of removal.

Spare Parts

Table 7-1 : Urgent Recommended Spare Parts for 1-Quadrant Units S-6 (800 – 2000A)

Unit Type	Max. Input Volt	Fan Supply Frequ.	Unit S-6 Part No.	Thyristor 6 pieces		Fan	Driver Board	Feedback Board	Snubber Board	Fuses F1,F2,F3 10 pieces
800A	500V	50 or 60Hz	840.55.11	122.04.02		921.90.01 (2 pieces)	PDB-1	PFD 813.91.11		4 AF 550.56.04
1500A	500V	50Hz	840.57.11	122.93.02		921.91.00	813.90.11	PFB 813.91.01	SBA 803.56.00	12 AFF 553.00.09
		60Hz	On request			921.91.10				
	690V	50Hz	840.57.21	122.93.04		921.91.00				
		60Hz	On request			921.91.10				
1600A	690V	50Hz	840.59.21	122.93.04		921.91.00				
		60Hz	On request			921.91.10				
2000A	500V	50Hz	840.59.11	122.93.02		921.91.00				
		60Hz	On request			921.91.10				

Table 7-2: Urgent Recommended Spare Parts for 4-Quadrant Units S-6R (60 – 2000A)

Unit Type	Max. Input Volt	Fan Supply Frequ.	Unit S-6R Part No.	Thyristor Module 6 pieces	Thyristor 12 pieces	Fan	Driver Board	Feedback Board	Snubber Board	Fuses F1,F2,F3 10 pieces
60A	500V		840.51.11	135.04.01		-		PFA 813.91.00		2.5 AT 550.06.20
120A	500V	50Hz	840.52.11	135.03.01		921.22.00				
250A	500V	or	840.53.11	135.11.02						
450A	500V	60Hz	840.54.11	135.12.02		921.90.01	PDA 813.90.10	PFC 813.91.10		
	690V		840.54.21	135.12.69				PFE 813.91.20		4 AF 550.56.04
800A	500V		840.56.11		122.04.02	921.90.01 (2 pieces)		PFD 813.91.11		
	690V		840.56.21		122.05.01			PFF 813.91.21		
1500A	500V	50Hz	840.58.11		122.93.02	921.91.00		PFB 813.91.01	SBA 803.56.00	12 AFF 553.00.09
		60Hz	On request			921.91.10				
	690V	50Hz	840.58.21		122.93.04	921.91.00				
		60Hz	On request			921.91.10				
1600A	690V	50Hz	840.60.21		122.93.04	921.91.00				
		60Hz	On request			921.91.10				
2000A	500V	50Hz	840.60.11		122.93.02	921.91.00				
		60Hz	On request			921.91.10				

Semiconductor Protecting Fuses

AC-Line Input and Motor Armature Circuit Protecting Fuses

Protecting fuses in the AC-line input and in case of four-quadrant operation in the motor armature circuit are to be selected from the following tables. The fuses are externally mounted and not supplied with the power module.

Table 8-1: Fuses for Line Voltage <= 500V

	Motor Armature Circuit						AC-Line Input		
Power Unit Type	Ia nom [A]	Iad [A]	Fuse Rating [A]	Fuse Part No. (2 piece)	Trip Indicator Part No. (2 pieces)	Fuse Holder Part No. (2 pieces)	Fuse Rating [A]	Fuse Part No. (3 pieces)	Fuse Holder Part No. (3 pieces)
60A	15	18	32	553.28.02	553.29.00	511.23.00	32	553.28.02	511.23.00
60A	25	30	40	553.28.04	553.29.00	511.23.00	32	553.28.02	511.23.00
60A	37	44	80	553.28.07	553.29.00	511.23.00	63	553.28.06	511.23.00
60A	50	60	80	553.28.07	553.29.00	511.23.00	63	553.28.06	511.23.00
120A	67	80	125	553.28.09	553.29.00	511.23.00	100	553.28.08	511.23.00
120A	100	120	160	553.30.04	553.26.29	511.24.00	125	553.28.09	511.23.00
250A	123	148	200	553.30.05	553.26.29	511.24.00	160	553.30.04	511.24.00
250A	176	210	315	553.31.13	553.26.29	511.24.00	250	553.30.06	511.24.00
250A	208	250	315	553.31.13	553.26.29	511.24.00	250	553.30.06	511.24.00
450A	294	350	450	553.32.16	553.26.29	511.24.00	450	553.32.16	511.24.00
450A	375	450	550	553.32.18	553.26.29	511.24.00	450	553.32.16	511.24.00
800A	458	550	630	553.33.19	553.26.29	511.25.00	630	553.33.19	511.25.00
800A	580	700	800	553.33.21	553.26.29	511.25.00	630	553.33.19	511.25.00
800A	666	800	1000	553.33.22	553.26.29	511.25.00	800	553.33.21	511.25.00
1500A	800	960	1250	553.33.23	553.26.29	511.25.00	1000	553.33.22	511.25.00
1500A	1000	1200	2x800	2x553.33.21	2x553.26.29	2x511.25.00	1250	553.33.23	511.25.00
1500A	1250	1500	2x1000	2x553.33.22	2x553.26.29	2x511.25.00	2x900	2x553.33.24	2x511.25.00
2000A	1667	2000	2500	553.72.01	553.26.30	-	2000	553.72.00	-

Table 8-2: Alternative Fuses (Tube Type) for Units <= 120A, Line Voltage <= 500V

Power Unit Type	Motor Armature Circuit					AC-Line Input		
	Ianom [A]	Iad [A]	Fuse Rating [A]	Fuse Part No. (2 pieces)	Double Fuse Holder with Trip Indicator Part No. (1 piece)	Fuse Rating [A]	Fuse Part No. (3 pieces)	Triple Fuse Holder without Trip Indicator Part No. (1 piece)
60A	15	18	32	553.11.02	511.14.00, 553.07.00 and .01	32	553.11.02	511.11.00
60A	25	30	40	553.12.02	511.14.00, 553.07.00 and .01	32	553.11.02	511.11.00
60A	37	44	80	553.44.01	512.32.02	63	553.44.00	512.32.01
60A	50	60	80	553.44.01	512.32.02	63	553.44.00	512.32.01
120A	67	80	125	553.44.03	512.32.02	100	553.44.02	512.32.01
120A	100	120	160	553.44.04	512.32.02	125	553.44.03	512.32.01

Table 8-3: Fuses for Line Voltage <= 690V

Power Unit Type	Motor Armature Circuit						AC-Line Input		
	Ia nom. [A]	Iad [A]	Fuse Rating [A]	Fuse Part No. (2 pieces)	Trip Indicator Part No. (2 pieces)	Fuse Holder Part No. (2 pieces)	Fuse Rating [A]	Fuse Part No. (3 pieces)	Fuse Holder Part No. (3 pieces)
450A	315	380	500	553.34.34	553.26.30	511.26.03	450	553.34.31	511.26.03
800A	500	600	800	553.34.36	553.26.30	511.26.03	630	553.34.34	511.26.03
1500A	800	960	2x700	2x553.34.35	2x553.26.30	2x511.26.03	2x630	2x553.34.34	2x511.26.03
1500A	1000	1200	2x800	2x553.34.36	2x553.26.30	2x511.26.03	2x700	2x553.34.35	2x511.26.03
1500A	1170	1400	2x800	2x553.34.36	2x553.26.30	2x511.26.03	2x700	2x553.34.35	2x511.26.03
1600A	833	1000	2x700	2x553.34.35	2x553.26.30	2x511.26.03	2x630	2x553.34.34	2x511.26.03
	1000	1200	2x800	2x553.34.36	2x553.26.30	2x511.26.03	2x700	2x553.34.35	2x511.26.03
	1167	1400	2x800	2x553.34.36	2x553.26.30	2x511.26.03	2x700	2x553.34.35	2x511.26.03
	1334	1600	2x900	2x553.34.37	2x553.26.30	2x511.26.03	2x800	2x553.34.36	2x511.26.03

AC-Line Reactors

Table 8-4: Iron Core Choke Selection

The AC-line input chokes 252.40.xx produce **2% voltage drop at 400V** and rated current.
The AC-line input chokes 252.44.xx produce **2% voltage drop at 690V** and rated current.

Drive Type	Motor I_{nom}	Current I_{ad}	AC- Line Input 3-Phase Rating I_{nom}	AC- Line Input 3-Phase Choke 1) Part No.	Field AC-Input 1-Phase Rating I_{nom}	Field AC-Input 1-Phase Choke Part No.
60A	21A	25A	25A	252.40.01	6A	252.42.05
	33A	40A	40A	252.40.02		
	50A	60A	62A	252.40.03		
120A	75A	90A	85A	252.40.04		
	108A	130A	115A	252.40.05	6A	252.42.05
	120A	150A	160A	252.40.06		
250A	158A	190A	160A	252.40.06	12A	252.42.06
	208A	250A	210A	252.40.07		
450A 500V	294A	350A	290A	252.40.08	12A	252.42.06
	375A	450A	392A	252.40.09		
450A 690V	215A	258A	220A	252.44.07	12A	252.42.06
	315A	380A	340A	252.44.08		
800A 500V	525A	630A	530A	252.40.10	12A	252.42.06
	666A	800A	660A	252.40.11		
800A 690V	330A	400A	340A	252.44.08	12A	252.42.06
	480A	575A	490A	252.44.09		
	500A	600A	660A	252.44.11		
1500A 500V	833A	1000A	850A	252.40.12	20A	252.42.01
	1000A	1200A	1100A	252.40.13		
	1334A	1600A	1360A	252.40.15		
2000A 500V	1350A	1620A	1360A	252.40.15		
	1667A	2000A	1700A	252.40.16		
1500A 1600A 690V	800A	1000A	850A	252.44.12	20A	252.42.01
	1000A	1200A	1100A	252.44.13		
	1334A	1600A	1360A	252.44.15		

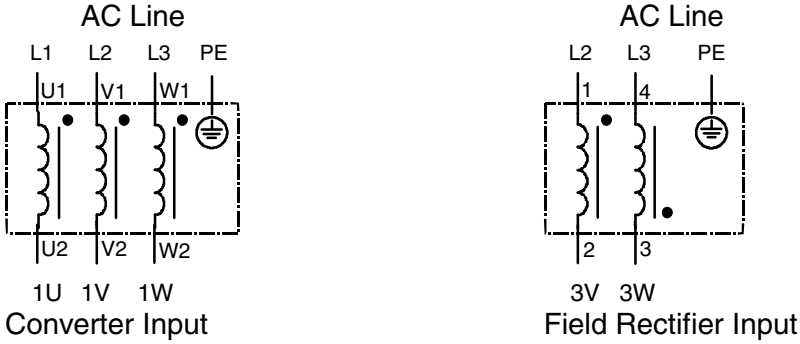
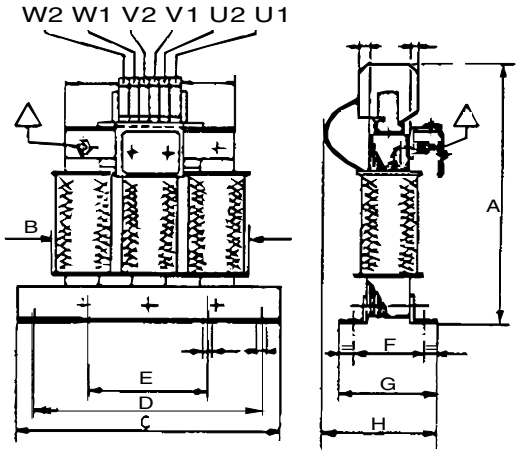


Figure 8-1: Line Reactor Wiring Diagram



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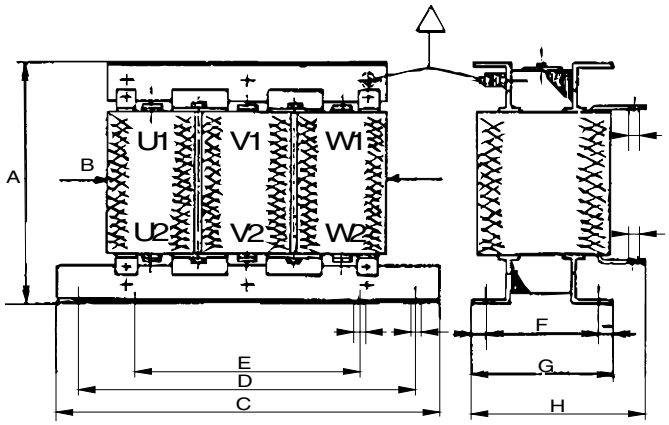


(2)

Δ Protection earth connection stud

Line Reactor Part No.	A	B	C	D	E	F	G	H	[kg]	P_v [W]	Fig.	Used for
252.40.01	190	150	190	170	75	45	67	80	4.7	50	1	Converter
252.40.02	185	150	190	170	75	60	72	85	6.5	60	1	Input
252.40.03	210	180	240	210	90	52	72	90	7.8	70	1	
252.40.04	160	180	240	210	90	52	72	95	7.8	80	2	
252.40.05	160	180	240	210	120	72	93	115	11	90	2	
252.40.06	240	260	260	--	240	75	97	170	18	130	2	
252.40.07	240	260	260	--	240	75	96	170	26	150	2	
252.40.08	240	290	260	--	240	100	116	190	26	170	2	
252.40.09	290	320	320	--	300	80	116	220	35	225	2	
252.40.10	280	270	320	300		108	123	180	50	365	2	
252.40.11	310	320	320	--	200	93	120	220	40	370	2	
252.40.12	330	350	350	--	240	110	140	250	55	590	2	
252.40.13	475	--	390	--	355	95	135	250	70	580	2	
252.40.15	450		410					280	95	800	2	
252.40.16	460	380	450	410		150	190	290	105	950	2	
252.44.07	223	260	270	240		95	120	155	20	200	2	
252.44.08	280	315	270	240		112	132	155	38	310	2	
252.44.09	290	325	350	240		100	125	235	40	410	2	
252.44.12	510	450	450	395		117	142	250	88	790	2	
252.44.13	510	450	450	395		125	165	310	100	900	2	
252.44.15	460	385	450	410		150	190	280	105	1100	2	
252.42.05	110		60	44		38	50		0.48		1	Field
252.42.06	124		78	56		47	60		1.2		1	Rectifier
252.42.01	150		105	84		70	89		3.8		1	Input

Figure 8-2: Line Reactor Dimensions (mm), Power Losses (W) and Weight (kg):

EMC Filters for AutoMax DPS DC-Converters

General Description

Power converters in general cause line disturbances over a wide frequency range.
Through the correct connection of the adapted filters (HF filter or Radio Frequency Interference (RFI) filter), the conducted emissions in the frequency range 150 kHz to 30 MHz can be kept below the limits stated in product standard EN 61800-3.

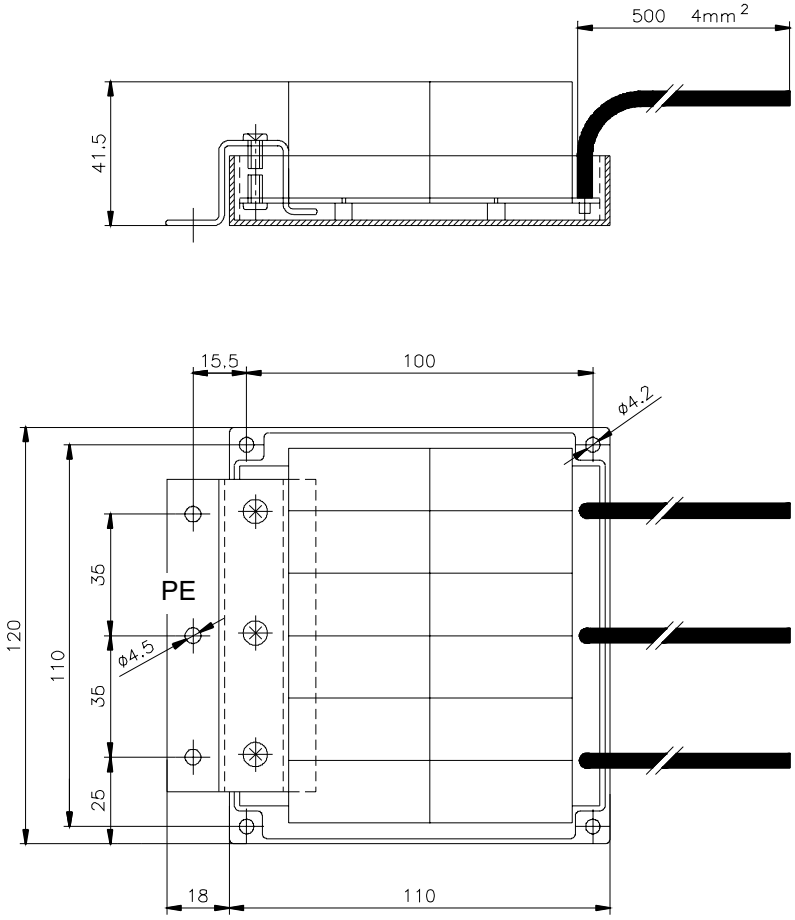
The radiated emissions in the frequency range 30 -1000 MHz will stay below the limits, if for the installation the same EMC measures are taken into account as for the conducted HF emissions.

NOTE: On all AutoMax DPS drives a line input reactor must be connected between filter output and converter input. This line reactor should be rated for minimum 2% voltage drop on drives up to 500V and 4% for 690V drives (selection according to Table 8-4). The drives AC-line input semiconductor protection fuses as per Table 8-1 to 8-3 must be mounted between filter output and line reactor. Otherwise the filter inrush current may damage the fuses.

HF Filter

If this filter is used on AutoMax DPS converters with AC line input currents **above 100A** the HF emission limits for class A, group 2* (EN 55011) in the **2nd environment** (industrial supply network) according to the **product standard EN 61800-3** are met and the drive fulfills CE conformity.

The HF filter is connected in front of the AC line reactor between the three AC line input phases and the protection earth conductor PE.



Filter part no.:	839.52.20
Nominal voltage L-L:	690V

Figure 8-3: HF-Filter dimensions (mm)

Radio Frequency Interference Filter

a) AutoMax DPS converters with AC line input currents **below 100A:**
If the RFI filter is connected, the HF emission limits for class A, group 1 (EN 55011) according to the **product standard EN 61800-3** are met and the drive is CE conform. This applies for the **1st environment** (residential) as well as for the **2nd environment** (industrial supply network).

b) AutoMax DPS converters with AC line input currents **above 100A:**
If the RFI filter is connected, the HF emission limits of class A, group 1 (EN 55011) in the **2nd environment** (industrial supply network) are met, as required in the past for the Generic Standard EN 50081-2. This is recommended if e.g. in industrial estates high power converters and offices with sensitive consumers are connected to the same supply transformer.

The filter must be connected into the three AC line input phases L1 - L3 of the AutoMax DPS in front of the AC line reactor, as shown in figure A-1.

RFI Filter Selection

The RFI-Filters can be selected from Tab. 8-5 according to the permitted filter current and the maximum operating voltage.
The permitted filter current is dependent on the application specific maximum continuous DC-current I_{ad} of the drive, the DC-current form factor (FF) and the ambient temperature T.

> The ambient temperature T is the max. temperature around the filter (typical 50°C inside cabinets for a standard max. cooling air temperature of 40°C). Typical DC-current form factor FF = 1.05

For cabinet mounting with T = 50°C and FF = 1.05:

Filter current = maximum continuous DC-current I_{ad}

For other ambient temperatures (T) and form factors (FF) the continuous current of the filter can be calculated as follows:

$$I_{FILTER} = I_{Line(rms)} \times \sqrt{\frac{45°C}{85°C - T}} = \sqrt{\frac{2}{3}} \times FF \times I_{ad} \times \sqrt{\frac{45°C}{85°C - T}}$$

Table 8-5: RFI Filter Selection

Filter Current	RFI-Filter 380 - 440 V Part No.	RFI-Filter 460 - 500 V Part No.	RFI-Filter 690 V Part No.	Application
25A	839.72.05	on request		according to a)
36A	839.72.06	on request		
50A	839.72.07	on request		
80A	839.72.09	on request		
100A	839.71.53	839.71.53		
150A	839.70.20			according to b)
180A	839.74.22	on request		
250A	839.73.25	on request		
270A	839.70.66	839.70.66		
280A	839.72.67	839.72.67		
340A	839.71.68	839.71.68		
500A	839.73.31	on request		
600A	-	839.73.92	839.73.92	
1000A	839.73.35	839.73.95	839.73.95	
1600A	839.73.38	839.73.98	839.73.98	

For RFI-Filter dimensions refer to the FlexPak3000 Instruction Manual Public. No.: FP3OIM-UMxxxx-EN

EMC Directive

This converter device is a component intended for implementation in machines or systems for the capital goods industry. It has been built to meet Council Directive 89/336 Electromagnetic Compatibility (EMC) and all applicable standards.

With the specified EMC filters and the measures as described in this guidelines the Converter can be operated CE-conform according to **product standard EN 61800-3**.

CAUTION:	The conformity of the drive and filter to any standard does not guarantee that the entire installation will conform. Many other factors can influence the total installation and only direct measurements can verify total conformity. It is therefore the responsibility of the machine manufacturer, to ensure, that the EC-conformity is met.

Disturbances

Conducted, High Frequency Disturbances (0.15 – 30 MHz)

Depending on location - first environment (residential or public low voltage supply network), second environment (industrial supply network) - and converter rating different limits are permitted, whereas the practical limit for the first environment is 100 A. For converters with AC line input current below 100 A, which are located in the first, as well as in the second environment, lower limits are required than for converters above 100 A in the second environment.

Radiated, High Frequency Disturbances (30 – 1000 MHz)

The radiated disturbances of the converter will be kept below the limits, if for the installation the same EMV-Measures are taken into account as for the conducted disturbances.

Conducted, Low Frequency Disturbances (Harmonics 0.1 – 2.5 kHz)

Converters with non sinusoidal AC line input current always generate current harmonics. The degree of disturbances, caused by harmonics, depends not only on the supply network (total Impedance), but also on the relative converter power.

Voltage harmonics may cause disturbances e.g. in centralized telecontrol systems or other electrical consumers. If high power converters are connected to low voltage distribution networks with low fault levels, the resulting voltage harmonic content could be claimed by the power supply authority to exceed the permitted values, stated in their regulations.
If the limits of the individual harmonic voltage portions are exceeded, the harmonic currents must be reduced in the supply network e.g. by means of active or passive harmonic filters.

On request Rockwell Automation will provide the harmonics current spectrum generated by each Converter or perform a harmonics analysis for the complete installation based on delivered data.

Immunity

Immunity against Conducted and Radiated, High Frequency Disturbances

The AutoMax DPS DC-converters fulfill the immunity requirement in the first, as well as in the second environment.

Essential Requirements for Conforming Installation

The following items are required for CE conformance:

1. Connection of EMC filter (RFI-Filter on drives <100A or HF filter on drives >100A) as specified in Chapter 8, Accessories.
2. Because Converter and filter have protection class IP00 they must be built in a cabinet. Both units must be mounted on a blank (not painted) panel with good conductivity.
3. Correct grounding of the equipment and the cable screens as shown in example Figure A-1.
4. Output power wiring (drive to motor) must be screened cable or run in a separate steel conduit.
5. All control (I/O) and signal wiring must be screened cable.
6. The braid of screened cables must be connected to the terminal box of the motor by the use of suitable, EMC-tested cable glands.
7. For all DC-converters a minimum line reactor of 2% voltage drop will be required. The line reactors must be linked between filter (Output) and DC-Converter (Input). For line reactor selection refer to Table 8-4.

Mounting Instructions

(Refer to Figure A-1)

- The filters must be screwed directly to the panel with the largest possible contact area.
- The support panel for the converters and filters must be a conducting steel sheet, with a common ground busbar at the bottom. This ground busbar, mounted in front of the terminals, must be solidly connected to the panel, ensuring good conductivity.
- All cable screens, entering the cabinet, must be connected to the control cabinets ground busbar. To ensure that the screen of the individual cable is connected solidly and with good conductivity to the ground busbar, galvanized cable brackets as shown in Figure A-1 are recommended. This applies also for coaxial cable, at which only the outer insulation should be removed.

Cable Glands

- Use suitable EMC-tested cable glands only
- The conductivity of the screen ground connection is ensured by laying the braid over a plastic cone which will press it to the inner side of the gland when mounted. It is important that the connection area is 360 degree around the cone. The cable glands provide pull-relief through the cable jacket.

Configuration

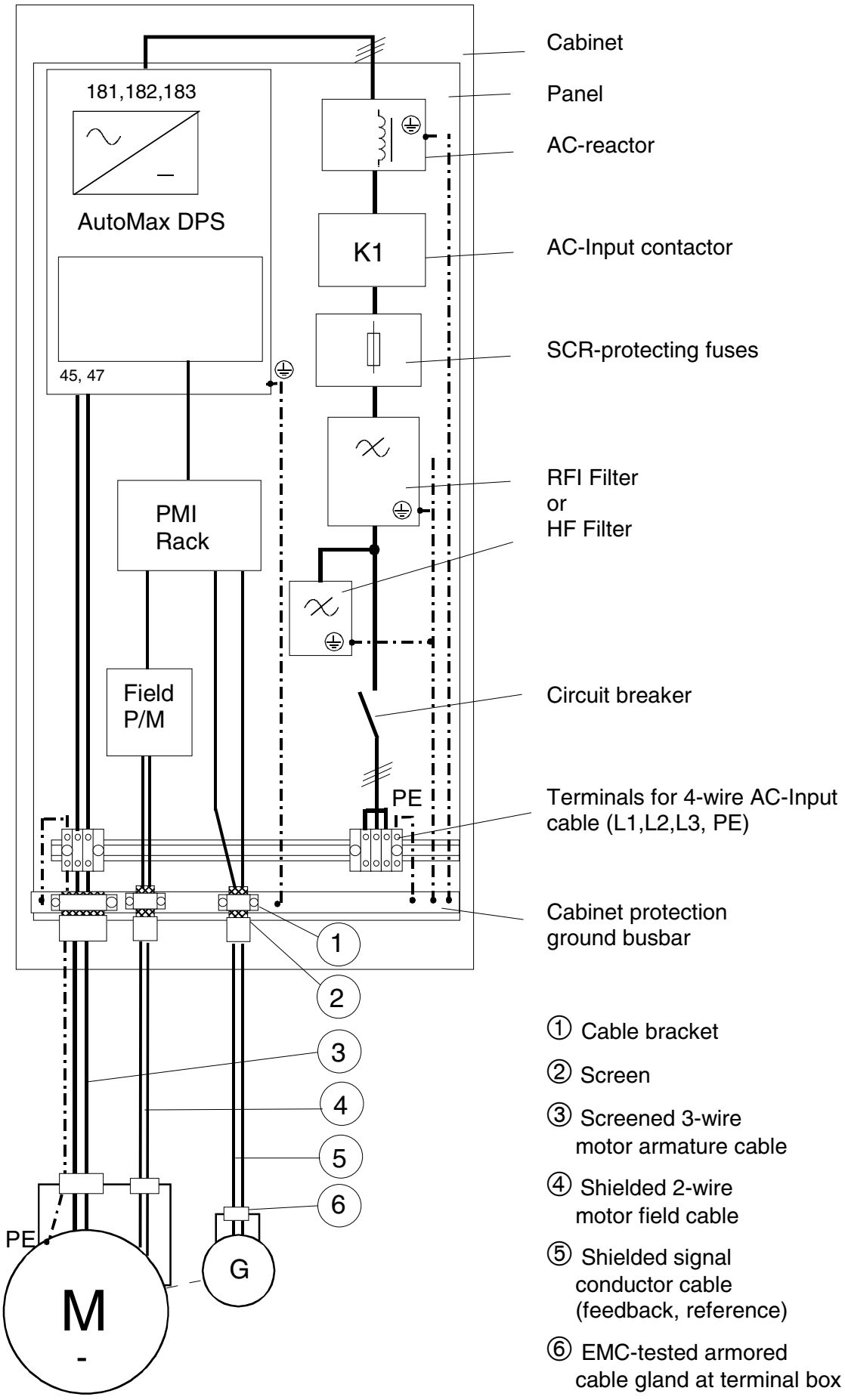
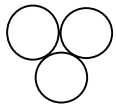


Figure A-1: Example for control cabinet configuration

Wiring Instruction

Motor Cable

- The cables between cabinet / armature output and DC-motor armature shall be 3-wire screened cable (+, - and earth conductor green/yellow) as specified in Figure A-2.
- The cables between field supply output and DC-motor field shall be 2-wire screened cable.
- The screen must be tinned copper braid or tinned steel braid. It must be solidly connected to the control cabinet ground busbar or ground stud of the converter with large connection area and good conductivity.
- The screen on the motor side must be solidly connected to the motor housing providing large connection area with good conductivity.
- If screened cables are not available (limited by the obtainable cross sections) the individual conductors and protective conductors must be run in steel conduits or enclosed metal cable ducts also connected to ground at both ends.
- All leads shall have the same cross section
  (earth conductors with cross section. $>16^2$: min. 16^2 or 50% of armature lead)
- The connections between filter and converter should be as short as possible!!
  These conductors must be bound together (with tie wrap) forming a triangle in cross section.



- Power and signal leads inside the cabinet must be distanced.

Analog or Digital Signals (e.g. reference, feedback signals), Control Signals (Relays)

These signal leads must be screened cable as specified in Figure A-2.
The individual conductors must be stranded, but twisted pairs are not required.
The screen must be grounded at both ends.

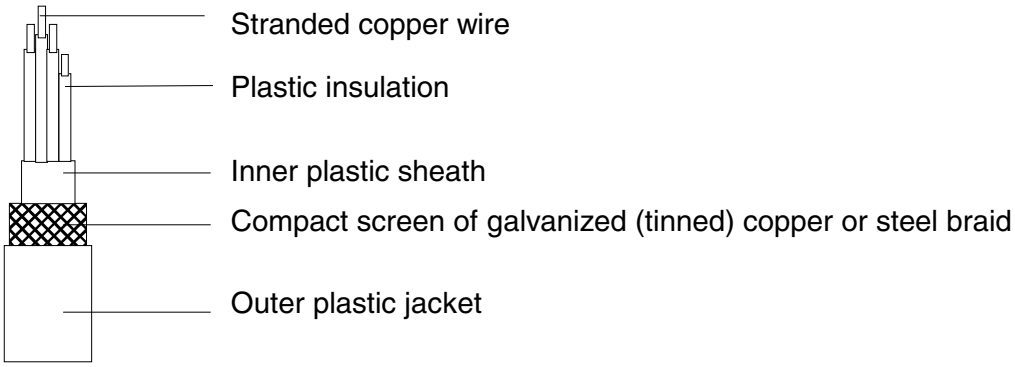


Figure A-2: Specification for screened cable

This appendix provides a cross reference list for part numbers of the AMX DPS DC-Power Module in numeric order and associated Rockwell Automation catalogue numbers.
Part numbers without catalogue numbers are spare parts. (Refer to Tables 7-1 to 8-5).

Table B.1 - Cross Reference List

Part Number	Catalogue Number
122.04.02	-
122.05.01	-
122.93.02	-
122.93.04	-
135.03.01	-
135.04.01	-
135.04.02	-
135.05.01	-
135.11.02	-
135.12.02	-
135.12.69	-
252.40.01	LL-25
252.40.02	LL-40
252.40.03	LL-62
252.40.04	LL-85
252.40.05	LL-115
252.40.06	LL-160
252.40.07	LL-210
252.40.08	LL-290
252.40.09	LL-392
252.40.10	LL-530
252.40.11	LL-660
252.40.12	LL-850
252.40.13	LL-1100
252.40.15	LL-1360
252.40.16	LL-1700
252.42.01	LF-15
252.42.05	LF-6
252.42.06	LF-12
252.44.07	LL-258-A
252.44.08	LL-340-A
252.44.09	LL-490-A
252.44.11	LL-660-A
252.44.12	LL-850-A
252.44.13	LL-1100-A
252.44.15	LL-1360-A
511.23.00	F-H1
511.24.00	F-H2
511.25.00	F-H3
511.26.03	F-H5
550.06.20	-
550.56.04	-
553.11.02	F-32R
553.12.02	F-40R
553.00.09	F-F6
553.00.10	F-F12
553.00.11	F-F15
553.28.02	F-25
553.28.04	F-40
553.28.06	F-60
553.28.07	F-60A
553.28.08	F-150S
553.28.09	F-150AS
553.30.04	F-150L
553.30.05	F-150AL
553.30.06	F-250
553.31.13	F-250A
553.32.16	F-450L
553.32.18	F-450AL
553.33.19	F-800S
553.33.20	F-700L
553.33.21	F-800L
553.33.22	F-16S
553.33.24	F-16XL
553.34.34	F-14S
553.34.35	F-14M
553.34.36	F-14L
553.34.37	F-14AL
553.44.00	F-63R
553.44.01	F-80R
553.44.02	F-100R
553.44.03	F-125R
553.44.04	F-160R
553.72.01	F-2500
803.56.00	-
813.90.10	-
813.90.11	-
813.91.00	-
813.91.01	-
813.91.10	-
813.91.11	-
813.91.20	-
813.91.21	-
840.51.11	SD3000-S6R-60
840.52.11	SD3000-S6R-120
840.53.11	SD3000-S6R-250
840.54.11	SD3000-S6R-450
840.54.21	SD3000-S6R-450-690
840.55.11	SD3000-S6-800
840.56.11	SD3000-S6R-800
840.56.21	SD3000-S6R-800-690
840.57.11	SD3000-S6-1500
840.57.21	SD3000-S6-1500-690
840.58.11	SD3000-S6R-1500
840.58.21	SD3000-S6R-1500-690
840.59.11	SD3000-S6-2000
840.59.21	SD3000-S6-1600-690
840.60.11	SD3000-S6R-2000
840.60.21	SD3000-S6R-1600-690
921.22.00	-
921.90.01	-
921.91.00	-
921.91.10	-
922.58.10	-

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