KOLLMORGEN
Seidel

Analog Servo Amplifier
Series 60WKS

CE

Assembly / Installation / Commissioning

Edition 12/99

Previous editions

Edition	Comments
10 / 87	First edition
12 / 87	Corrections
03 / 89	Corrections
08 / 89	New layout, completely produced with DTP, significant additions for Installation etc.
11 / 90	New layout, corrections, transformer specification added
04 / 92	Corrections
01 / 93	Improvements
06 / 94	Corrections
11 / 96	Corrections, CE-conform wiring diagrams, glossary, index, fault-finding, layout, new arrangement, valid for 60WKS amplifiers from serial number 0600270000
10 / 97	Seidel Servo Drives GmbH
12 / 99	KMS, Layout

Technical changes to improve the performance of the equipment may be made without prior notice !

Printed in the Federal Republic of Germany 12/99

Mat.No. 67769

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Safety instructions

Warning signs : you must observe the important instructions in the text, which are indicated by the following symbols :

hazard from electricity and its effects

general warning general instructions

- **Only properly qualified personnel are permitted to perform activities such as transport, installation, commissioning and maintenance. Properly qualified persons are those who are familiar with the transport, assembly, installation, commissioning and operation of the product and who have the appropriate qualifications for their job. The qualified personnel must know and observe the following standards and directives:**
  IEC 364 and CENELEC HD 384 or DIN VDE 0100
  IEC-Report 664 or DIN VDE 0110
  national accident prevention regulations or VBG 4

- **Read the available documentation before carrying out installation and commissioning. Incorrect handling of the servo amplifier can lead to injury to persons or material damage.**
  It is vital that you keep to the technical data and information on installation requirements (nameplate and documentation).

- **The servo amplifiers contain electrostatically sensitive components which can be damaged by incorrect handling. Discharge yourself before touching the servo amplifier. Avoid contact with highly insulating materials (artificial fabrics, plastic film etc.). Place the servo amplifier on a conductive surface.**

- **During operation, keep all covers and cabinet doors shut. Otherwise there are deadly hazards with the possibility of severe danger to health or material damage.**

- **In operation, depending on the degree of enclosure protection, servo amplifiers can have bare components which are live, and hot surfaces. Control and power cables can carry a high voltage even when the motor is not rotating.**

- **Never pull out or plug in the servo amplifier while the system is live. There is a danger of electric arcing and danger to persons and contacts.**

- **After disconnecting the servo amplifier, wait at least two minutes before touching live sections of the equipment or undoing connections (e.g. contacts, screwed connections). Capacitors can still carry dangerous voltages after the supply voltage has been switched off. To be safe, measure the DC-link voltage, and wait until it has fallen below 40 V.**

Directives and standards

Servo amplifiers are components which are intended to be incorporated into electrical machines and plant.

When the servo amplifiers are built into machines or plant, the intended operation is forbidden until it has been shown that the machine or plant fulfills the requirements of the EC Directive on Machines (89/392/EEC), the EC Directive on EMC (89/336/EEC) and the EC Low-Voltage Directive (73/23/EEC). EN 60204 and EN 292 must also be observed.

In connection with the Low-Voltage Directive 73/23/EEC, the harmonized standards of the EN 50178 series are applied to the servo amplifiers, together with EN 60439-1, EN 60146 and EN 60204.

The manufacturer of the plant or machine is responsible for ensuring that the plant or machine meets the limits which are laid down in the EMC regulations. Advice on the correct installation for EMC – such as shielding, grounding, filter arrangement, treatment of connectors and cable layout – can be found in this documentation.

CE - Conformance

Conformance to the following directives is mandatory for the supply of servo amplifiers within the European Community:

since 1 January 1996	:	EC EMC Directive 89/336/EEC
since 1 January 1997	:	EC Low-Voltage Directive 73/23/EEC

The servo amplifiers have been tested in an authorised testing laboratory, in a defined configuration with the components shown in Chapter II.

Any divergence from the assembly and installation described in the documentation means that you will be responsible for the performance of new measurements to ensure that the regulatory requirements are met.

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I General

I.1 Preface

This manual describes the installation, commissioning, adjustment and adaptation of the 60WKS-M240/xx-PB (abbeviated 60WKS) servo amplifiers.
The manual is divided into 6 chapters :

Chapter 1: General Information
Chapter 2: Installation and Commissioning
Chapter 3: Functions and Options
Chapter 4: Peripheral Equipment
Chapter 5: Drawings
Chapter 6: Appendix with Glossary, Index and Fault-Finding

Transport : only by personnel with knowledge of the handling of electrostatically-sensitive components
Installation : only by electrically qualified personnel
Commissioning : only by qualified personnel with extensive knowledge of electrical engineering and drive technology

We offer training and familiarisation courses on request.

We can only guarantee the functionality of the servo amplifier and servo motor if SM-series motors and our isolating transformers and accessories are used.

I.2 Prescribed usage of the servo amplifiers

The servo amplifiers are exclusively intended for driving brushless synchronous servo motors from the SM series under speed or torque control. The servo amplifiers are installed as components in electrical equipment or machines, and may only be operated as integral components of such equipment.
The 60WKS-M240/xx-PB series of servo amplifiers are supplied from the industrial 3-phase mains supply, via an isolating transformer. This isolating transformer must meet the specification in Chapter IV.1.
The servo amplifiers may only be operated in a closed steel switchgear cabinet, observing the ambient conditions defined in Chapter I.8.2. The notes on the ventilation of the servo amplifers are especially important.
The equipment must be plugged into a standard industrial 19"-casing (rack module) or into one of our compact housings, and connections must only be made via on of our module backplanes.

In accordance with the EC Directives on machines and the safety regulations, you must prepare a hazard analysis of the machine.

Only if the system components which are described in Chapter II are used, and the rules for installation in this documentation are followed, can we guarantee the conformance of the servo amplifiers with the following standards for industrial areas:

EC EMC Directive 89/336/EWG
EC Low-Voltage Directive 73/23/EWG

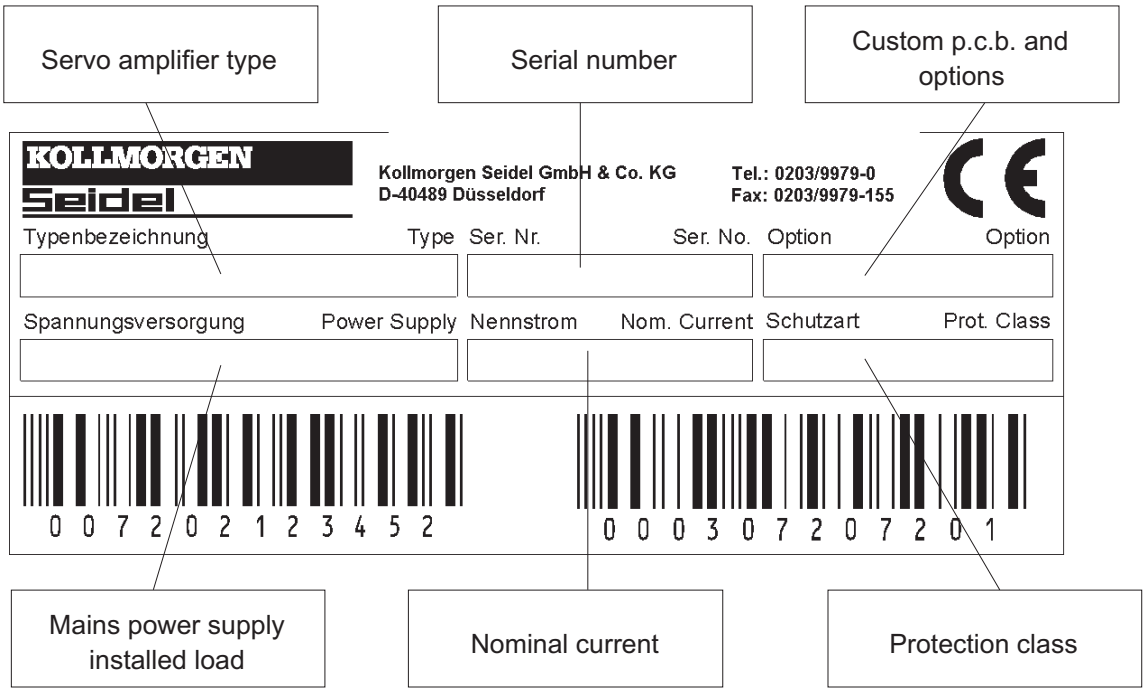
I.3 Abbreviations used in this manual

The abbreviations used in this manual are explained in the table below.

Abbrev.	Meaning	Abbrev.	Meaning
AGND	analog ground	PELV	protected low voltage
EMC	electromagnetic compatibility	PLC	programmable logic controller
BTB	system ready to operate	PSTOP	limit switch for CW rotation
		PSU	Power supply unit
CE	European Community	PWM	pulse-width modulation
DIN	Deutsches Institut für Normung	$R_{Ballast}$	ballast resistor
DGND	digital ground	RLG	rotor position sensor
EN	European standard	SW	setpoint
ESD	electrostatic discharge	V AC	AC voltage
IDC	analog current monitor	V DC	DC voltage
LED	light-emitting diode	VDE	Verein deutscher Elektrotechniker
NSTOP	limit switch for CCW rotation	VTA	analog speed monitor

I.4 Nameplate

The nameplate depicted below is mounted on the servo amplifier. The information shown below is printed in the individual fields.



I.5 Equipment description 60WKS

Design

Plug-in modules with an aluminium front panel, 19"-system, connections via module backplane

The following servo amplifiers must be operated with forced ventilation :
- ***all 60WKS servo amplifiers with a rated output current of 12 A and above***
- ***all 60WKS servo amplifiers with Option -24V-***
- ***all 60WKS servo amplifiers in an ambient temperature > 40 °C***

The ventilation is necessary as soon as the DC-link voltage, or even just the 24 V auxiliary supply, is switched on, i.e. even if the servo amplifier is unloaded or disabled.

Unit size

Unit	Format	Height	Width
60WKS (servo amp.)	double Eurocard	6HE (233.4 mm)	9 TE (approx. 61 mm)

Options

-24V- electronics supply from external 24 V supply
-01- limit-switch logic, 1:1-control and ramp generator

Function

The 60WKS series of servo amplifiers in 240 V technology are set up for driving the SM series of synchronous servo motors with RLG/tacho-feedback and trapezoidal commutation. The power section is implemented as a 3-phase, pulse-width modulated transistor stage.
The motor speed and the trapezoidal output currents are controlled by PI-controllers. The phase-switching of the motor and tacho windings are controlled by the electronic rotor-position sensor (RLG) of the motor.

Custom p.c.b.

All the adjustment and parameters which can be altered by the user are put onto a plug-in custom p.c.b. and are accessible from the front.
The potentiometers which are provided as standard can be replaced by fixed resistors for series production.

Variants

Amplifier 60WKS-CE240/xx-PB: - power feed via 3-phase isolating transformer
- PSU, ballast circuit and ballast resistor are integrated.

Accessories

Isolating transformers : Type 3TxxK-240 (see Chapter IV)

F-backplanes : Unit connections on the rear face: via plug-in terminals for the control signals and terminals/studs for the power connections

R-backplanes : Unit connections: plug-in terminals, accessible from the front, for control signals and terminals/studs for the power connections

19"-rack modules : 19"-base units in various widths, with assembled F- or R-backplanes (example 84TE, see Chapter V.6)

Compact housing : Type K1.1-L with fan and R-backplane (see Chapter V.4/5)

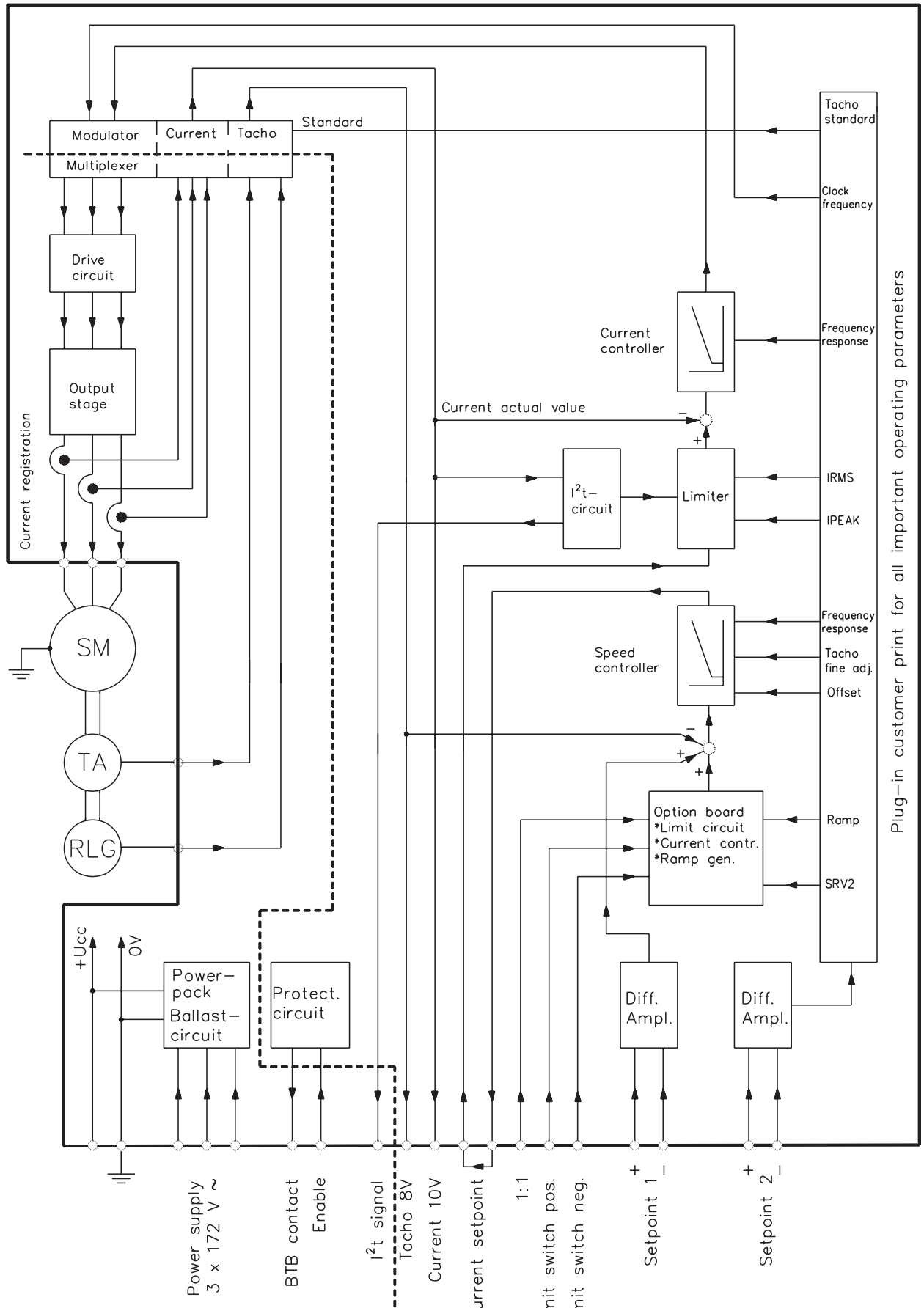
I.5.1 Function groups 60WKS

- 3-phase power supply unit with smoothing capacitors
- Ballast circuit with **-w-** characteristic
- Auxiliary supply, to generate the auxiliary voltages from the DC-link voltage (alternatively, an external 24V-supply, Option -24V-)
- 3-phase output stage for 4-Q operation
- 2 differential inputs for setpoints, setpoint 2 is adjustable
- Enable-input
- Limit-switch inputs (Option -01-)
- PI / current / speed controller
- Trimmer potentiometer and fixed components for all the important operating parameters – on the plug-in custom p.c.b.
- Expansion slot for Option p.c.b. -01- with limit-switch logic and ramp generator
- Input for **3-phase, brushless or DC-tacho**
- Input for rotor position sensor (RLG)
- Ready/standby relay with isolated contact for fault signalling
- 24 V logic with isolated optocouplers for control signals, PLC-compatible
- LEDs for all important operating states
- ±15 V auxiliary voltage outputs

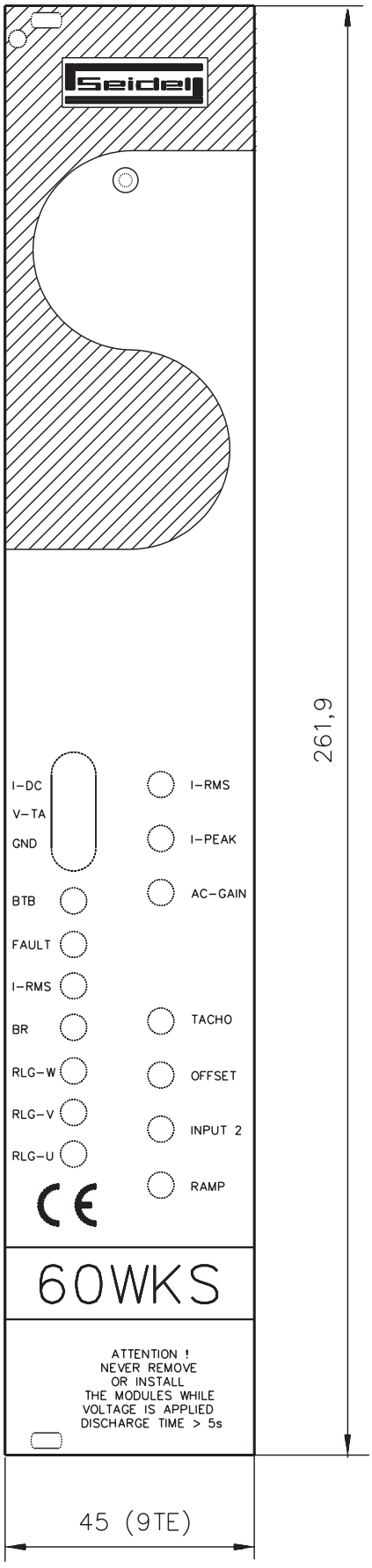
Protection and monitoring functions

- Fuses for the DC-link and auxiliary power supply
- Short-circuit / earth-fault protection at the motor connection terminals
- Short-circuit protection of the 15 V auxiliary supply
- Undervoltage monitoring
- Overvoltage monitoring
- I^2t effective current monitoring
- Temperature monitoring of the power output transistors
- RLG- and Tacho monitoring (cable break)

I.6 Block diagram



I.7 Frontal view 60WKS



I.8 Technical Data

I.8.1 Technical data for 60WKS-M240/xx-PB

		Transistorized inverter 60WKS-M240/				
Rated data	**DIM**	**3-PB**	**6-PB**	**12-PB**	**22-PB**	**26-PB**
Rated supply voltage	V~	3 x 60—172 / 50 ... 60Hz +max. 10%				
Installed load at rated current *	kVA	0.5	1	2	3.7	4.4
rated DC-link voltage	V=	240				
Rated output current for 4-Q operation, peak value at standstill	A	3	6	12	22	26
Peak output current (max. approx. 5 s)	A	7.5	15	30	50	50
AC fusing, maximum	AM	3 x 20				
Switch-on threshold of the ballast circuit	V	300				
Switch-off threshold of the ballast circuit	V	285				
Pulse power of the ballast circuit	kW	5.4				
Continuous power of the ballast circuit	W	135				
Overvoltage switch-off threshold	V	325				
Form-factor of the output current (rated conditions, with min. load inductance)	—	1.01				
Minimum motor inductance	mH	5	2.5	1.2	0.7	0.6
Bandwidth of the subordinate current control loop	kHz	1				
Clock frequency of the output stage	kHz	(2x) 8.5				
Voltage drop at rated current	V	5				
Quiescent dissipation, output stage disabled	W	12				
Dissipation at rated current (incl. PSU losses, without ballast dissipation)	W	30	45	85	140	170
Aux. voltage outputs (Ri=330 Ω)	V	±15				
	mA	±20				
Aux. voltage outputs for RLG/Tacho	V	±15				
	mA	±30				
Inputs						
Setpoint 1, fixed setting	V	±10				
Setpoint 2, adjustable 0 — 100 %	V	±10				
Common-mode voltage max.	V	±10				
Input resistance	kΩ	150				
Input drift max.	µV/K	±15				
24 V auxiliary supply(Option-24V-)	V	24 (20 ... 30)				
referred to 0V/GND	A	0.5				
Connections						
Servo amplifier	control signals	DIN 41612—C64 (plug connector)				
	power signals	DIN 41612—D32 (plug connector)				
Backplane board	RLG/tacho	SubD 9-pin (socket)				
	control signals	Combicon 5.08/20-pin (or 2x12-pin)				
	power signals	4 mm² terminals				
Mechanical						
Weight	kg	1.4				
Dimensions (double Eurocard, 9 TE-units)	mm	220 x 233.4 x 45				

* maximum value in operation with SM-series motors

I.8.2 Permissible ambient conditions, ventilation, mounting position

Transport temperature/humidity	see Chapter VI.1
Storage temp./humidity/time	see Chapter VI.1
Supply voltage tolerances **mains power** **aux. supply (Option -24V-)**	 min. 3 x 60 V AC / max. 3 x 172 V AC + 10 % min. 20 V DC / max. 30 V DC referred to 0V/GND
Ambient temperature $T_{AMB.}$ in operation	0 ... +45 °C at rated data +45 ... +55 °C with power derating 2,5% / °C **(forced ventilation)**
Humidity in operation	5...85 % rel. Feuchte, nicht kondensierend
Site altitude	up to 1000 m above mean sea level without restriction 1000 ... 2500 m a.m.s.l. with derating 1.5 % / 100m
Pollution level	pollution level 2 to EN60204 / EN50178
Protection class	IP 00 (protected against touching in the power connections area)
Mounting / position	in a closed switchgear cabinet / normally vertical
Ventilation **cont. current < 12A and no Option -24V- and $T_{AMB.}$ < 40°C**	**natural convection** with uninterrupted air flow (we always recommend forced ventilation at higher current or with cramped mounting conditions.
cont. current ≥ 12A or with Option -24V- or $T_{AMB.}$ > 40°C	**forced ventilation** Ensure that there is an adequate volume of cooling air entering the switching cabinet, and that it is as dust-free as possible.

I.8.3 Cable cross-sections

In accordance with EN 60204 and taking account of the operating conditions for multi-axis systems, we recommend the following cable cross-sections:

Amplifier type	**60WKS**		
Peak value I_{rated}	**3 / 6 A**	**12 A**	**22/26 A**
Dimension	**[mm²]**	**[mm²]**	**[mm²]**
AC supply	4i x 1.5	4i x 2.5	4i x 4
DC-link	3i x 1.5	3i x 2.5	3i x 4
Motor leads	4i x 1.5	4i x 2.5	4i x 4
RLG/tacho	6 x 2 x 0.25 (twisted pairs, shielded)		
Setpoints	2 x 0.14 (stranded, shielded)		
Control signals, BTB	0.5		
Brake (motor)	2 x 1.0		
Thermal cutout (motor)	2 x 0.5		
+24 V / GND	1.0 (Option -24V-)		

I.8.4 Fuse protection

60WKS			**3 A**	**6 A**	**12 A**	**22 A**	**26 A**
AC supply		external	power contactor for system protection, motor or transformer characteristic, set to 0.5 X rated amplifier current				
DC-link	(F1)	internal	10 AT	10 AT	15 AT	30 AT	30 AT
Aux. supply	(F2)	internal	1 AT (2AT with Option -24V-)				
Ballast board	(F3)	internal	3.15 AT				
Fan (V3,W3) compact housing			-	-	1 AT	1 AT	1 AT

I.9 Interference suppression

If interference occurs in the CNC or the analog or digital path measuring systems, the additional measured listed here may be applied:

- additional ferrite rings around the motor cables
- installation of armature chokes (please use the types supplied by us)
- HF filter in the setpoint output of the CNC (RC of 1 kΩ / 10 nF)

In each case, you will have to try out which measures suffice to eliminate the interference.

I.10 Ballast circuit

When the motor is braked, energy is fed back into the servo amplifier. This energy is dissipated as heat in the ballast resistor. The ballast resistor is switched into action by the ballast circuit.

The response of the circuit begins at a DC-link voltage of 285 V, and is indicated by a blinking of the internal **yellow** LED D83.

As the loading is repeated, the built-in **-w-** characteristic causes the threshold to rise to 300 V, so that there is power-sharing between more than one module, if they are **parallel-connected** on the same DC-bus.

You should make an estimate of the ballast power which is to be expected – especially for single axes – from the known drive data.
For normal servo applications, the following method has proved to be good:

$$\textit{peak ballast circuit power} > \frac{1}{3} \cdot \sum \textit{peak power of all the amplifiers}$$

$$\textit{continuous ballast circuit power} > 0.03 \cdot \sum \textit{continuous power of all motors}$$

You can receive further help on calculating the required ballast power for your system from our in-house applications department.

The ventilation is necessary as soon as the DC-link voltage, or even just the 24 V auxiliary supply, is switched on, i.e. even if the servo amplifier is unloaded or disabled.

<u>Permitted combinations of amplifier motherboarde / ballast board</u>
Before swapping a ballast board, check the labelling on the board !

Amplifiers up to serial no. 0600269999 :
motherboard 60 PC 8802-010
ballast board 60 WK-BAL

Amplifiers from serial no. 0600270000 (with CE sign) :
motherboard E.F.927.5/2
ballast board E.F.927.5/3

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II Installation and Commissioning

II.1 Important instructions

- Check the conformance of the servo amplifier and the motor. Compare the rated voltage and current of the equipment. Implement the wiring according to the wiring diagram in Chapter II.2.3 ff. For correct EMC wiring follow the connection diagrams in Chapter II.2.1.
- Lay out all cables which carry a high current with an adequate cross-section in accordance with EN 60204. A tabular summary of the recommended cross-sections can be found in Chapter I.8.3.
- Make sure that, even under worst-case conditions, the rated voltage on the terminals U1, V1, W1 resp. Ucc, 0V/GND is not exceeded by more than 10 %. An excessive voltage on these terminals can cause destruction of the ballast circuit. We recommend using the upper transformer tap.
- Make sure that the supply voltages and the ballast resistor are adequately protected by fusing. Use the values recommended in Chapter I.8.4 as a guide.
- Connect all shielding with large areas (low impedance), using metallized connector housings where possible (see Chapter II.2.1).
- Loop the BTB contact into the safety circuit of the system. Only so can the monitoring of the servo amplifier be assured.
- Loop the temperature monitoring of the motors into the safety circuit of the system. Overheating of the motors can lead to their destruction.
- The ±15V auxiliary voltages must not be brought out of the switchgear cabinet. This is to prevent capacitively and/or inductively induced interference.
- Ensure that there is an adequate supply of filtered cooling air in the switchgear cabinet, fed from below. Observe the rules for ventilation in Chapter I.8.2.
- At the front of the modules, protection against contact is only assured if the modules are inserted into a 19"-rack unit and secured with the screws which are provided.
  After inserting the modules, fix the front panel with the fixing screws. This is vital to ensure good contact in the plug connectors. Poor contact can burn out the connector contacts.

Caution
Never connect or remove the servo amplifier while it is live.
In unfavourable cases this could result in destruction of the electronics.
Residual charge in the capacitors can still have a dangerous level up to 120 seconds after switching off. Measure the voltage in the DC-link circuit, and wait until the voltage has dropped below 40 V.

Even when the motor is at standstill, control and power leads can still be live.

II.2 Installation

Only electrically qualified personnel are allowed to install the servo amplifier.

The installation procedure is described as an example. Depending on the application of the equipment, a different procedure may be appropriate or necessary.

More detailed knowledge can be acquired through our training courses (on request).

Warning !

Protect the servo amplifier from inadmissable loading.
In particular, components must not be bent or isolation clearances altered during transport and handling.
Avoid touching electronic components and contacts.

Caution !

Only install and wire up the equipment in a de-energized state,
i.e. neither the mains supply not the operating voltages of any other connected equipment may be switched on.
Make sure that the switchgear cabinet is safely disconnected (safety lock-out, warning signs etc.).
The individual voltages will only be switched on during commissioning.

Ground and PE-symbol

The ground symbol  ***, which is found in all the wiring diagrams, indicates that you must provide an electrically conductive connection with as large an area as possible between the designated unit and the mounting plate in your switchgear cabinet.***
This connection is for the suppression of HF interference, and must not be confused with the PE-symbol (which is a safety measure to EN 60204).

Grounding system and protective earth

Power and signal electronics have safely separate routing to EN 50178.
The DC-link circuit is grounded on one side, and supplied from the mains via an isolation transformer with a screen winding.
The reference potentials 0V/GND/PE (DC-link) and AGND (control electronics) are connected on the unit for functional reasons.
The central connection to the protective earth (PE) is made on the backplane.
The most favourable way of connecting the reference potentials for interference suppression is shown in Chapter II.3.6.

The following instructions should help you to follow a sensible installation sequence, without overlooking any important steps.

Location

19"-rack module or compact housing, in a closed switchgear cabinet. Observe Chapter I.8.2 .
The location must be free from conductive or corrosive substances.

Ventilation

Ensure the correct ventilation of the servo amplifier and observe the permitted ambient temperature, **Chapter I.8.2**.

Assembly

Install the 19"-module and the peripheral equipment close together on an **earthed** mounting plate in the switchgear cabinet (see II.2.1)

Cable selection

Select cables according to EN 60204 and our requirements, as in Chapter I.8.3 .

Grounding Shielding

See Chapter II.2.1 for correct EMC shielding and grounding.
Ground the mounting plate, motor casing, mains filter, isolating transformer and CNC-GND of the control (see Chapter II.2.1).

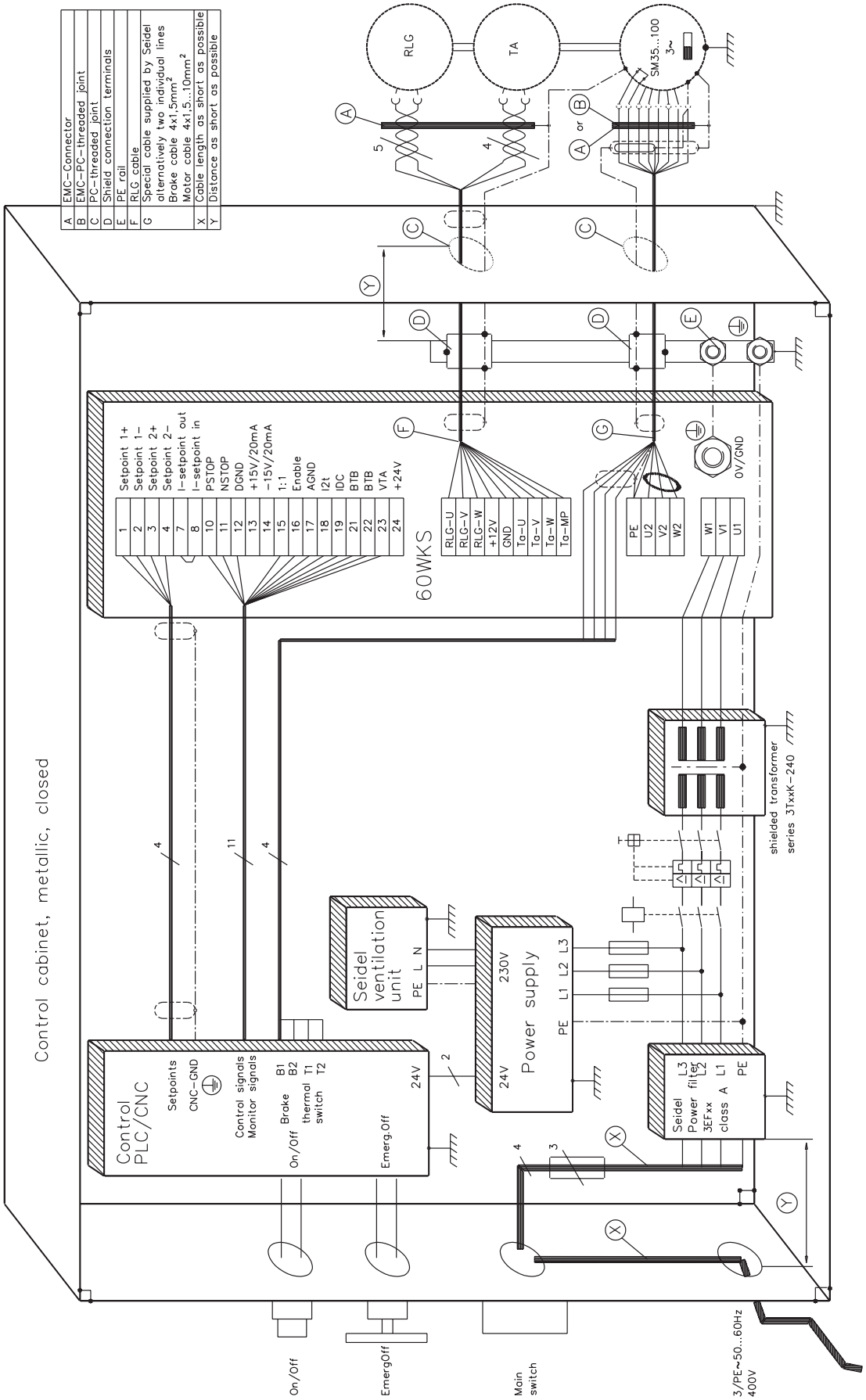
Wiring

— **Run power and control cables separately**
— **Wire the BTB-contact into the safety loop of the system**
— Connect the digital control inputs of the servo amplifier
— Connect the analog setpoint input and AGND
— Connect the RLG/tacho, shielding connected to shield-terminals or EMC-connectors at both ends
— Connect the motor leads, using ring cores close to the servo amp. Shielding to shield-terminals or EMC-connectors at both ends
— Connect the motor holding brake. Shielding to PE at both ends.
— Connect the mains supply (for max. permissible voltages see Chapter I.8.2, use Seidel isolating transformer 3Txx and Seidel mains filter 3EFxx)

Check

Final check of the wiring which has been installed, referring to the wiring diagrams which have been used.

II.2.1 CE - correct wiring for 60WKS, general diagram



II.2.2 Module backplanes F60WKSMB and R60WKSMB

Types: F60WKSMB for amplifier 60WKS, connections at back
R60WKSMB for amplifier 60WKS, connections at front

The module backplanes are fixed into the 19"-modules from behind. The amplifiers are pushed into the module casing and plugged into the module backpanels. The electrical signals are made accessible on the backplanes by means of terminals, studs, and plug connectors.

Chapter V.6 contains diagrams of the backplanes.

The table below show the signal assignments for the connectors.

II.2.2.1 Connector assignments for R60WKSMB

2 x 12-pin (XST404)
Combicon-conn.
Compact housing

(Terminal no.)		Signal designation	Signal-direction	Short designation (screen print)
1		Setpoint 1 + , ±10V	**I**nput	SW 1 +
2		Setpoint 1 – , ±10V	**I**nput	SW 1-
3		Setpoint 2 + , ±10V	**I**nput	SW 2 +
4		Setpoint 2 – , ±10V	**I**nput	SW 2-
x		Coding		
13	**upper**	+15 V aux. supply	**O**utput	+15
14	**connector**	–15 V aux. supply	**O**utput	-15
15		Integral off / 1:1	**I**nput	1:1
16		Enable	**I**nput	E
17		AGND joined to 0V	**I**nput	AGND
23		Tacho-monitor ±3V/1000min^{-1}	**O**utput	TA
PE		Shield connection		PE
7		Current setpoint ±10V out	**O**utput	ISA
8		Current setpoint ±10V in	**I**nput	ISE
10		Limit-switch positive	**I**nput	PSTOP
11		Limit-switch negative	**I**nput	NSTOP
12		Digital-GND (DGND)	**I**nput	DGND
18	**lower**	I²t-signal	**O**utput	I2T
19	**connector**	IDC-monitor ±10V/I_{PEAK}	**O**utput	IDC
x		Coding		
21		BTB-contact, floating	**I**nput	BTB
22		BTB-contact, floating	**O**utput	BTB
24		+24 V aux. supply	**I**nput	+24V
25		GND for +24 V (option)	**I**nput	0V

II.2.2.2 Connector assignments for F60WKSMB

XST404, 20-pin Combicon-conn.	DIN 41612 C64-conn.	Signal-designation	Signal-direction	screen print
1	14a	Setpoint 1+ , ±10 V	**I**nput	SW 1+
2	14c	Setpoint 1– , ±10 V	**I**nput	SW 1-
3	15a	Setpoint 2+ , ±10 V	**I**nput	SW 2+
4	15c	Setpoint 2– , ±10 V	**I**nput	SW 2-
7	12a	Current setpoint ±10 V out	**O**utput	ISA
8	12c	Current setpoint ±10 V in	**I**nput	ISE
10	17a	Limit-switch positive	**I**nput	PSTOP
11	17c	Limit-switch negative	**I**nput	NSTOP
12	4a,c	Digital-GND (DGND)	**I**nput	DGND
13	26a,c	+15 V - aux supply	**O**utput	+15
14	28a,c	–15 V - aux. supply	**O**utput	-15
15	16c	Integral off / 1:1	**I**nput	1 : 1
16	10a	Enable	**I**nput	E
17	2a,c	AGND joined to 0V	**I**nput	AGND
18	10c	I^2t-signal	**O**utput	I2T
19	19a	IDC-monitor ±10V / I_{PEAK}	**O**utput	IDC
21	7a,c	BTB-contact	**I**nput	BTB
22	8a,c	BTB-contact	**O**utput	BTB
23	22a	Tacho-monitor ±3V/1000min^{-1}	**O**utput	TA
24	30a,c	+24 V aux. supply, ref. to 0 V teminal (Option -24V-)	**I**nput	+24

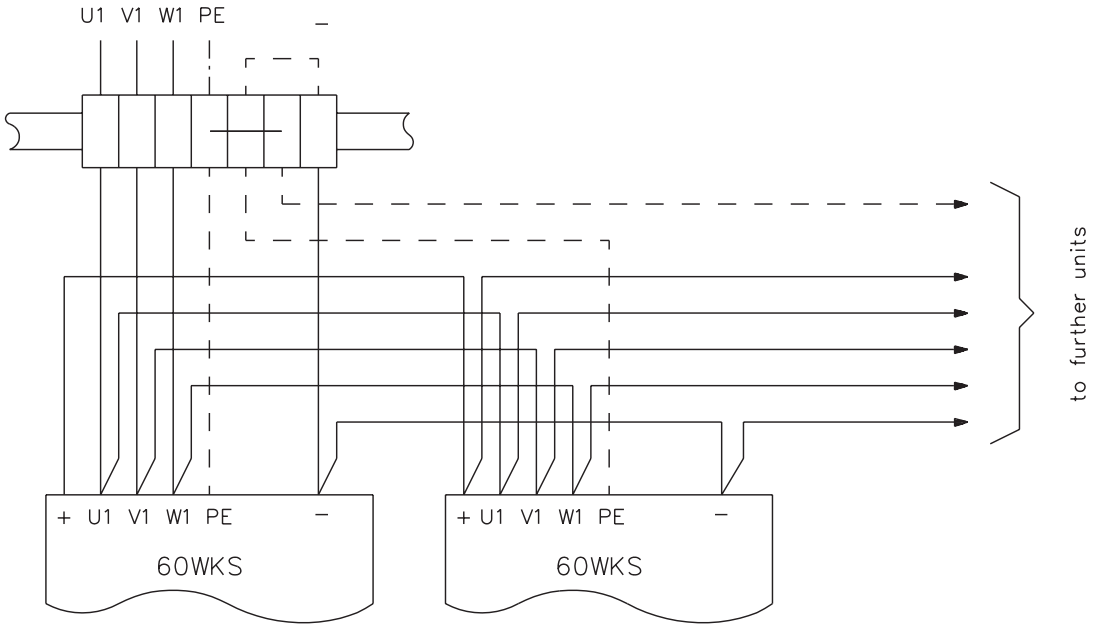
XST401 9-pin SubD	DIN 41612 C64-conn.	Signal desig. for AC-tacho	Signal desig. for DC-tacho *	Short desig.
1	18a,c	+15 V for RLG	+15 V for RLG + tacho	+15 V
2	24a,c	Tacho star point	GND for tacho	Ta-Mp
3	23c	Tacho phase W	Tacho - (0V)	Ta-W
4	23a	Tacho phase V	–15 V for tacho	Ta-V
5	22c	Tacho phase U	Tacho +	Ta-U
6	21a,c	GND für RLG	GND for RLG	GND
7	20c	RLG-phase W	RLG-phase W (X)	RLG-W
8	20a	RLG-phase V	RLG-phase V (Z)	RLG-V
9	19c	RLG-phase U	RLG-phase U (Y)	RLG-U

* When using a DC-tacho, the solder links LB10, 11 and 13 must be soldered in the “DC” position.

Power connections (Terminals, studs)	DIN 41612 Conn. D32	Signal designation	Short desig.
+Ucc	2a,c / 4a,c	DC-link +240 V	+Ucc
U1 (L1)	6a,c / 8a,c	AC connection 172 V	U1
V1 (L2)	10a,c / 12a,c	AC connection 172 V	V1
W1 (L3)	14a,c / 16a,c	AC connection 172 V	W1
–Ucc, 0V, PE	18a,c / 20a,c	DC-link –(0V/GND)	0V
U2 (U)	22a,c / 24a,c	Motor U	U2
V2 (V)	26a,c / 28a,c	Motor V	V2
W2 (W)	30a,c / 32a,c	Motor W	W2

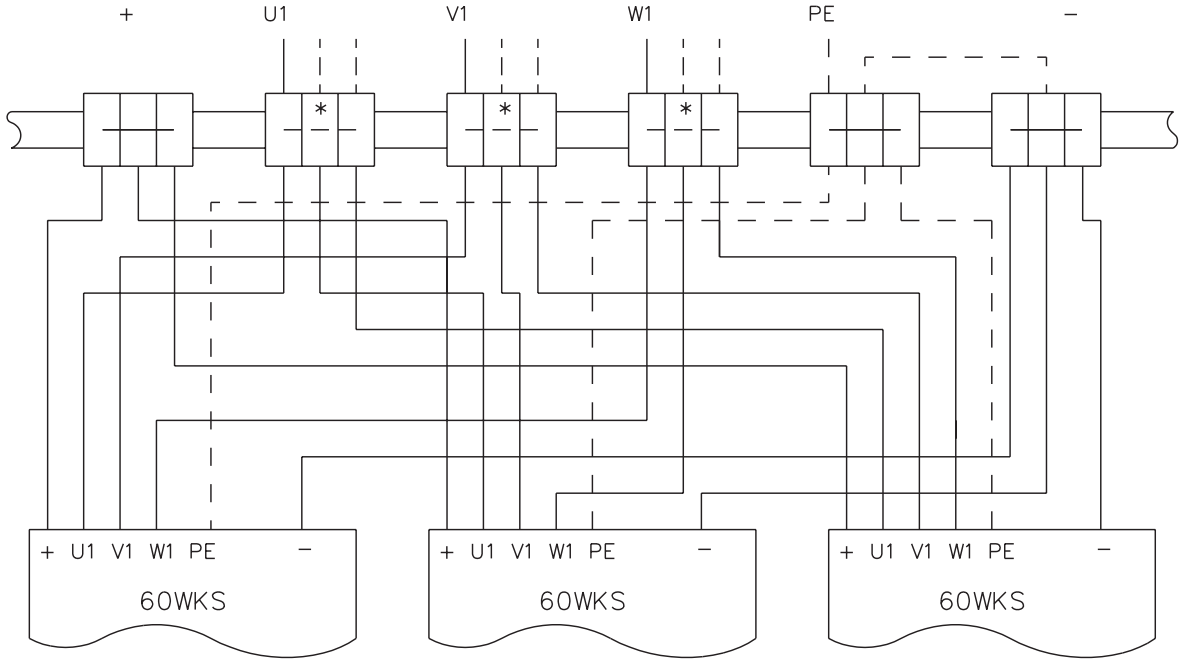
II.3 Wiring diagrams

II.3.1 Recommended wiring (power) for more than one compact housing



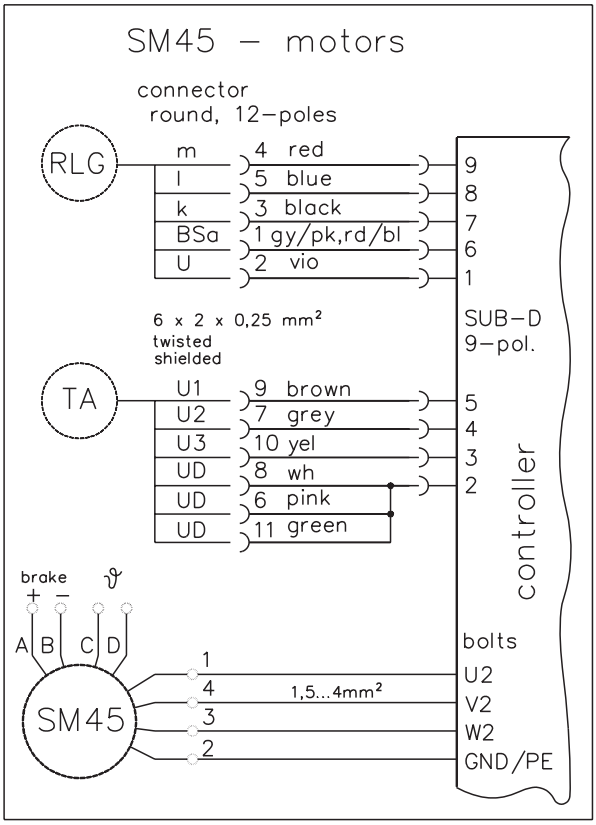
Connection of several 60WKS units in compact housings with bus wiring for line cross sections 1,5...2,5mm² (6/12A), fuse protection according to VDE regulations.

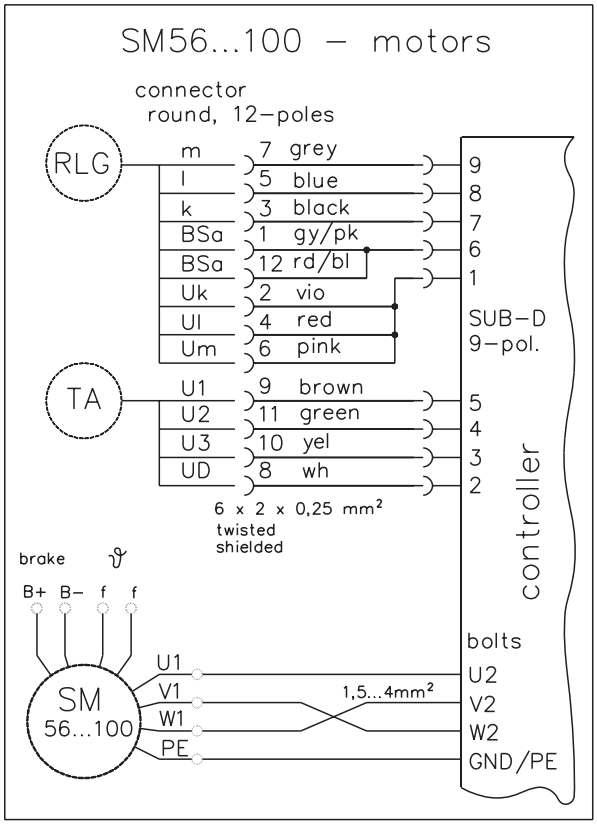
See CE-correct wiring for measures to improve EMC



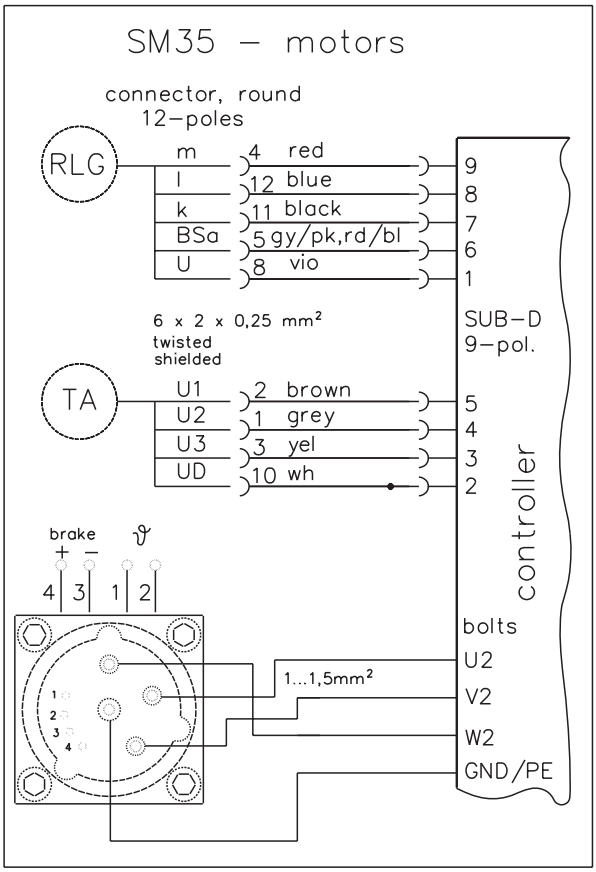
Connection of several 60WKS units in compact housings with distributor terminals for line cross sections 2,5...4mm² (12/22/26A)
* Single fuse protection depending on cross section according to VDE regulations

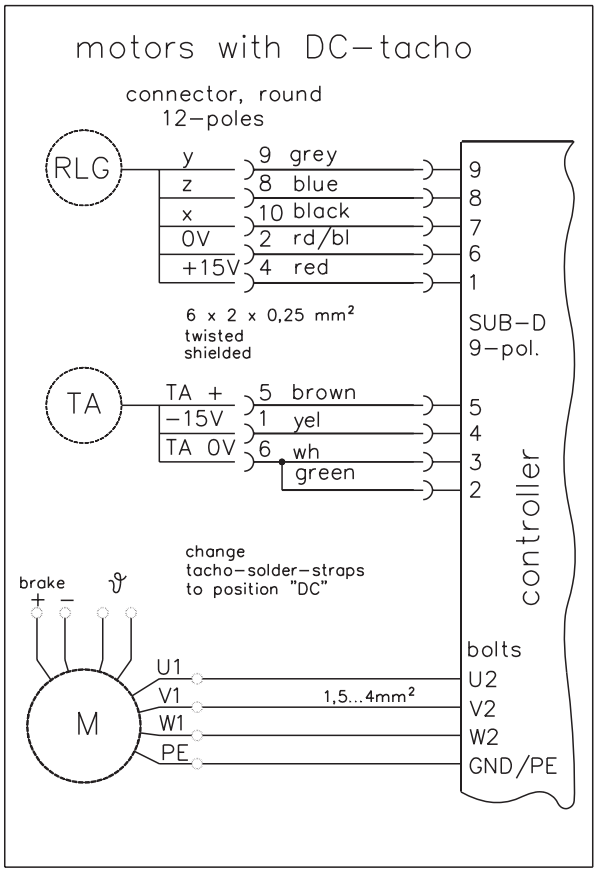
II.3.2 Motor connection





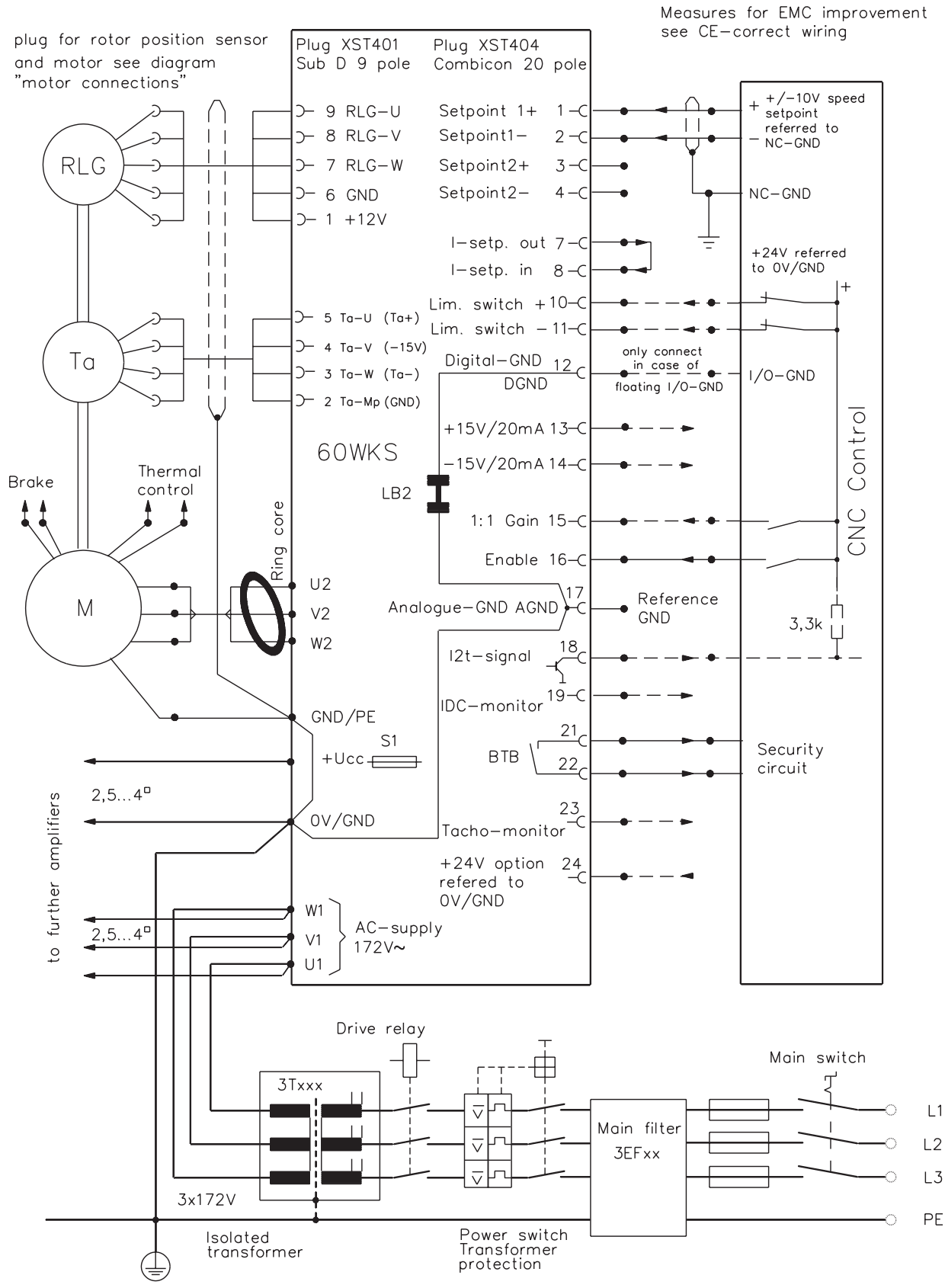
See CE-correct wiring for measures to improve EMC



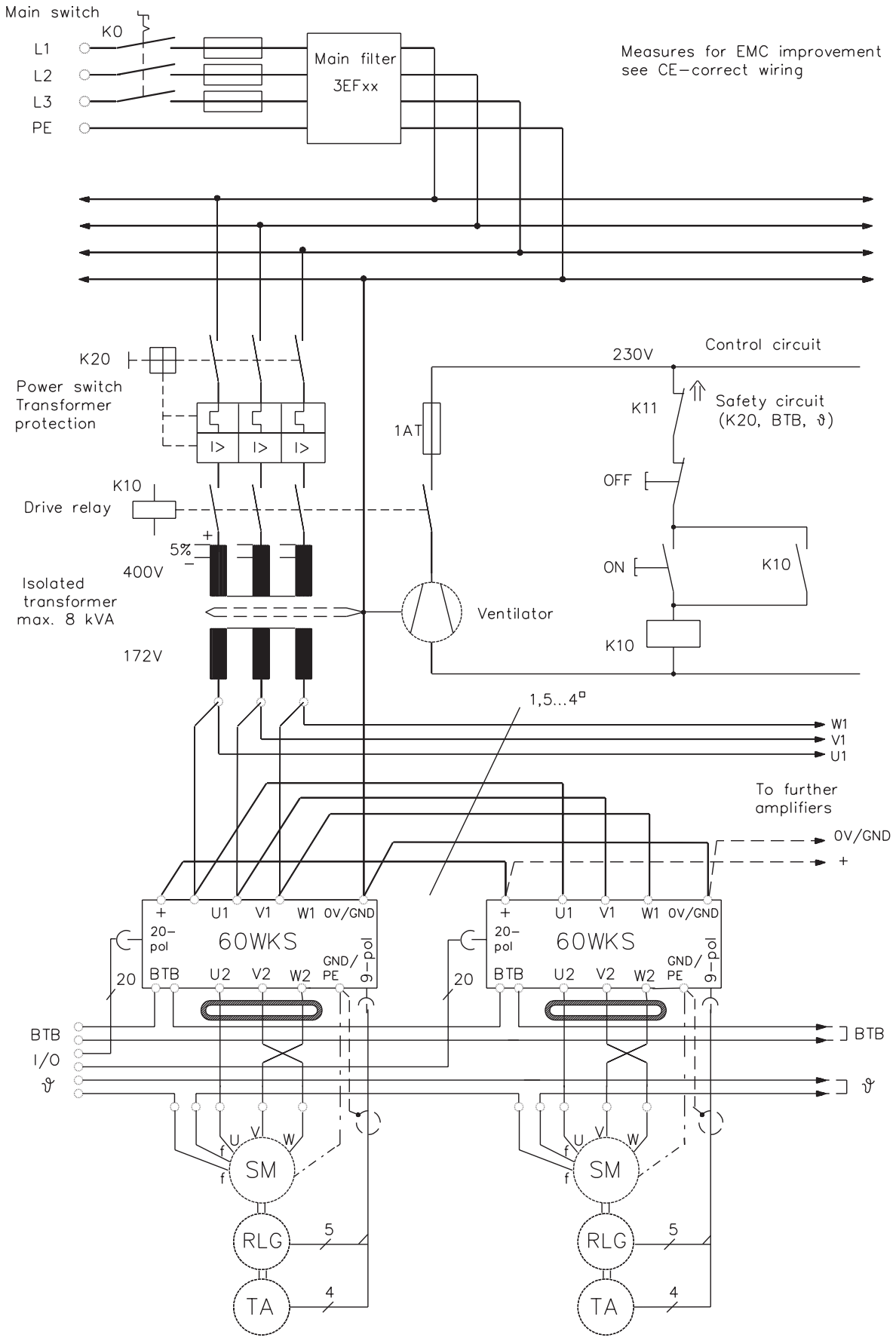


II.3.3 Wiring diagram for 60WKS

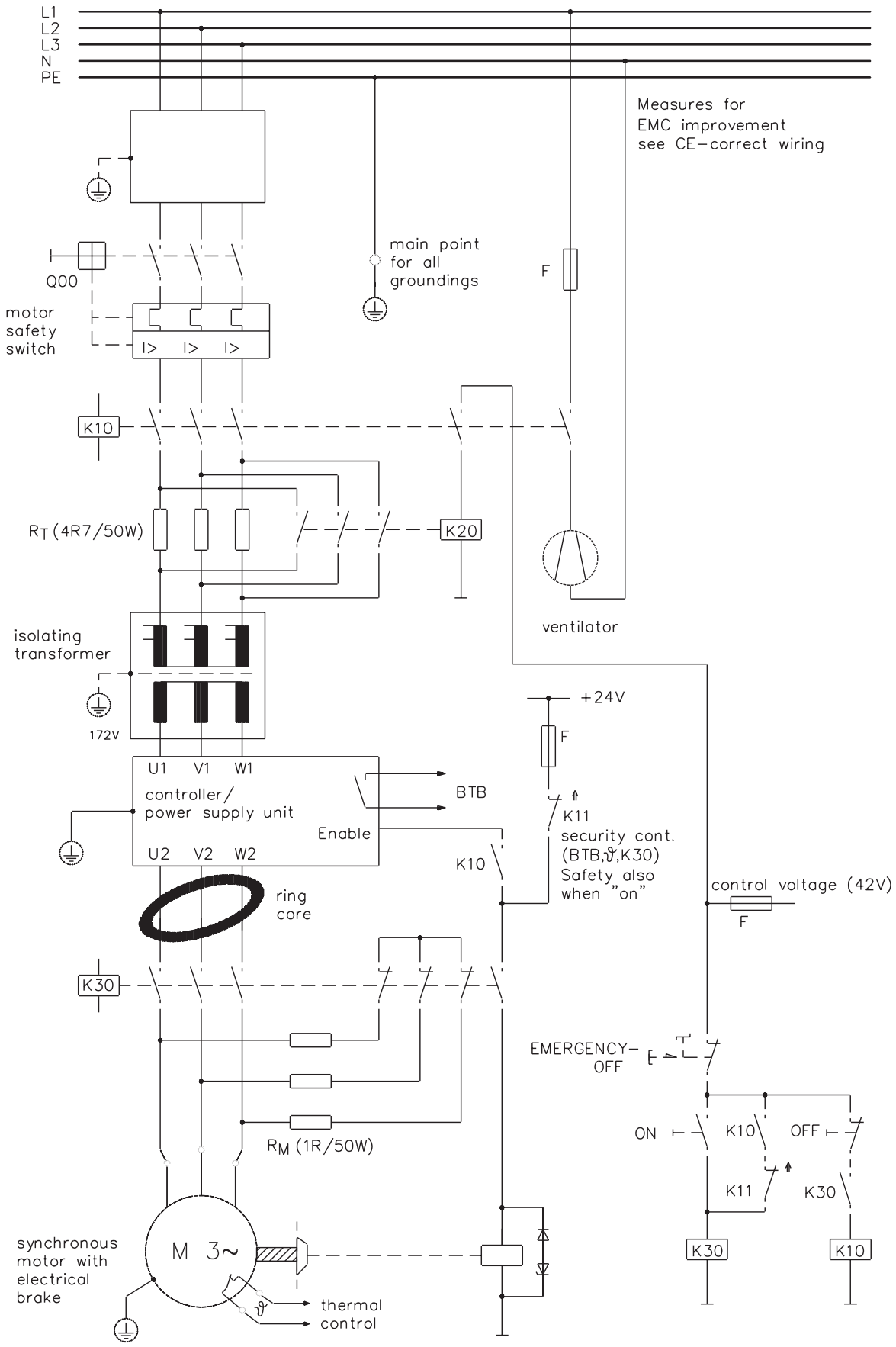
Caution ! Never remove or plug-in the controller when it is alive !



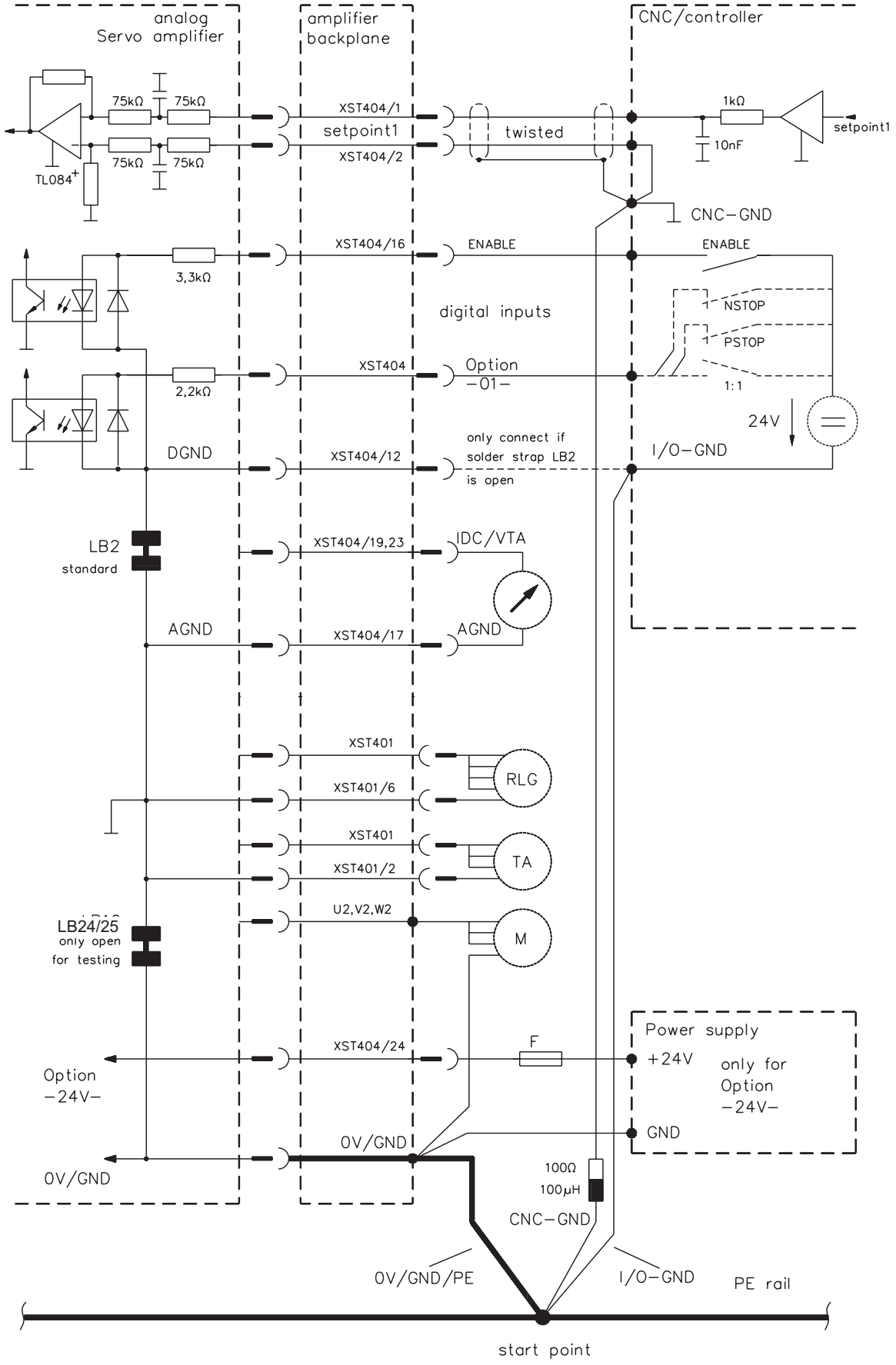
II.3.4 Recommended wiring for 2x60WKS with SM56 ... SM100



II.3.5 Recommended wiring for soft start and brake



II.3.6 Schematic representation of the GND and PE connections



II.4 Commissioning

II.4.1 Important notes

- Check that the instructions in Chapter II.1 have been followed
- A correct step-by-step sequence of commissioning helps you to avoid damage.
  If you require further information, please contact our applications department.
- Permitted are:
  adjustment of the servo amplifier settings on the custom p.c.b.,
  optimization and use of circuit blocks by means of the soldered links
  (LB2, 3, 10, 11, 12, 13).
  Any other alteration will invalidate the guarantee.
- **Never plug in or remove the modules when they are live**
  This is vital to avoid burnt-out connector contacts, the destruction of entire boards in the servo amplifier, and a danger to personnel from charged capacitors.
  Residual charges in the capacitors can still have dangerous levels more than 120 seconds after switching off the mains supply.
  Insert and remove the plug-in modules **only** when the voltage has fallen below the low-voltage limit.
  Measure the DC-link voltage with a voltmeter.
  Wait until the voltage has fallen below 40V.
  The plug-in modules can now be inserted or removed.
- After the plug-in modules have been inserted, fix them in position in the front panel, by using the screws previded, to ensure a good contact for the connectors.
  Poor contact causes the contacts to burn out.

II.4.2 Notes on commissioning

The commissioning procedure is only described briefly here. Further know-how can be provided in our **training courses** (on request).

In multi-axis systems, commission each servo amplifier individually.

Caution !

Check that all live connection components are protected against accidental contact. Dangerous voltages can occur up 325 V.

Never disconnect the electrical connections of a live servo amplifier. The residual charges in the capacitors can still have a dangerous level up to 2 min. after switching off the mains supply.

The heat sink temperature of the amplifier can reach 80 °C in operation. Check (measure) the temperature of the heat sink. Wait until it has cooled down to below 40 °C before touching it.

Warning !

If the servo amplifier has been stored for longer than one year, then the DC-link capacitors must first be re-formed. This is done by applying, at most, half the operating voltage to the units (possibly via a series resistor).

Please ask our applications department about the exact process of capacitor formation.

The following notes should help you to carry out the commissioning in a sensible sequence, without endangering personnel or machinery.

Check installation	Check the installed wiring against the wiring diagram (transformer and RLG connections, grounding, motor connection, control signals) Check the equipment – nameplates (rated voltage, rated current, special adjustments – if required). Test the emergency-stop switch before the first switch-on.
Set up safe values	Reduce the gain (AC-GAIN pot. hard left) and the peak current (IPEAK pot. near the left stop) for safety.
Start up the transformer	Remove all modules. Switch on the mains supply. Check the secondary AC voltage. Switch off the supply. Switch on the ventilation.
Secure the system	Insert and fix a servo amplifier in position. Inhibit the enable signal. and secure the emergency-stop function.
	***Caution !*** ***Make sure that any unintended movement of the drive cannot create a danger for persons or machinery.***
Switch on supply	Switch on the mains supply.
Apply setpoint, Enable	Move the axis by switching the enable signal while a low setpoint value is applied.
Optimize	Adjust the axis (AC-GAIN, OFFSET, TACHO – if not already preset).
Switch off supply	Switch off. Measure the voltage in the DC-link. Wait until the voltage has fallen below 40 V.
Secure the system	Plug in / fix and commission further servo amplifiers.

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III Functions and Options

III.1 Important notes

- Alterations to the servo amplifier may only be carried out by properly qualified personnel.
- The setting and optimization of the servo amplifier, and the use of circuit elements by means of the solder links are permitted.
  Any other alterations will invalidate the guarantee.
- After any alteration is carried out, the servo amplifier must be commissioned again, observing the commissioning and safety instructions.

III.2 Description of the functions

III.2.1 Input functions

III.2.1.1 Setpoint inputs SW1, SW2

The servo amplifier is equipped with two decoupled, additive differential inputs for the setpoint values.
Input 1 has a fixed setting for differential input voltages of max. ± 10 V.
Input 2 is equipped with an adjustable attenuator (P302):
Range of adjustment 0...100 %.

— Clockwise rotation increases the speed (effect increases)
— A positive voltage on terminal 1 compared to teminal 2, or terminal 3 compared to terminal 4, results in clockwise rotation of the motor shaft (looking toward the shaft end).

The common-mode voltage range (important in avoiding earth loops) is additionally ± 10 V for both inputs, the input resistance is 150 kΩ.

III.2.1.2 Tachometer input Ta

P304 is provided for fine adjustment of the tachometer, the range of adjustment is ±30 % .
The fixed resistors **R301...304** (0.5 % tolerance) determine the tachometer normalization.
The standard values fitted are dimensioned for tacho voltages of 10.8 V resp. 16.2V at the rated speeds of 2000 resp. 3000 min^{-1} (motors of the SM series) with P304 at the right resp. left stop.
If a DC-tacho is used, please see also Chapter III.2.3.4 .

III.2.1.3 Digital control inputs

All inputs are **isolated** and coupled by optocouplers. The ground reference is **Digital**-GND (DGND, terminal 12). The logic is designed for +24 V / 10 mA (**PLC-compatible**), with a logic-high level of +12...30 V.
If required, control from +15 V (terminal 13) is possible. In this case, Digital-GND (terminal 12) must be connected to Analog-GND (terminal 17).
As delivered, AGND and DGND are connected by the solder link LB2 on the amplifier board.

Enable input E

The output stage of the amplifier is enabled by the Enable signal (terminal 16, input 24 V, **active-high**, logic level 12 V...30 V / 10 mA referred to Digital-GND, terminal 12, floating).
In the inhibited state, the motor which is connected has no torque, and the integrator sections of the speed and current controllers are also inhibited.

When the Option board -01- is used the following functions are also available :

- **1:1 / -Integral-off** (1:1, terminal 15), **high level** to switch over the current controller to **speed control.**
- Limit switch positive/negative (**PSTOP / NSTOP**, terminals 10/11)**, high level in normal operation** (safe in the event of a cable break). If an input signal disappears (limit switch open) then the corresponding direction of rotation is blocked.

The digital input circuits PSTOP/NSTOP are mounted on the Option board -01- , and **can only be used when an Option board -01- is available.** In this case, the solder link **LB3 on the amplifier board** must also be opened.

A 1:1 connection of the servo amplifier can also be achieved without using an Option board -01- , by altering the custom board (see Chapter III.3.3).

III.2.2 Output functions

III.2.2.1 Armature current monitor output IDC, terminal 19

The output delivers ±10 V referred to AGND for ± **peak instrument current.**
The output is the average value DC of all three phases, which is approximately **proportional** to the **motor torque.**
The output resistance is 2kΩ.
This signal can also be utilized as a **current**-setpoint signal for a second, 1:1 connected (slave) servo amplifier in a tandem drive.
For operating the servo amplifier as a 1:1 current controller, see Chapter II.3.1.2 and III.3.3 .

III.2.2.2 Tachometer monitor output VTA, terminal 23

The output delivers ±3 V / 1000min^{-1} into 1 kΩ against AGND with the standard normalization for SM motors with rated speeds of 1000, 2000, 3000 min^{-1} and an AC tachometer (tachometer voltage approx. 5.4 V / 1000 min^{-1}).
The tachos of the SM motors with 4000 min^{-1} and 6000 min^{-1} deliver only half the voltage (2.7 V / 1000 min^{-1}).
When using motors with **DC** tachos (tacho voltage 2.5 V / 1000 min^{-1}) and the standard normalization on the custom board, the output delivers 2.25 V / 1000 min^{-1}.
The normalization is **not** affected by the tachometer pot. P304.

III.2.2.3 Ready/standby contact BTB

Operational readiness (**BTB**, terminals 21/22 , 24 V / 0.1 A DC) is signalled via a **floating** relay contact (max. 100 V / 0.1 A DC).

The contact is **closed** when the servo amplifier is ready for operation. The signal is **not** affected by the Enable signal or the I^2t limiting.

If the Option -24V- is used, then the BTB signal also appears when the mains supply is switched off (and the 24 V supply is switched on).

III.2.2.4 Measurement points

- **Armature current monitor (IDC)**, normalization ±10 V for ± **peak instrument current.**
  The measurement point provides the same signal as described under III.2.2.2
  Output impedance 2 kΩ, reference point is AGND.
- **Tachometer monitor (VTA)**, the voltage is the tachometer voltage, reference point is Analog-GND.
  The measurement point provides the same signal as described under III.2.2.2
  Output impedance 1 kΩ, reference point is AGND.

III.2.3 Setting functions

III.2.3.1 Ramp potentiometer P301

When the Option board -01- is plugged in, the desired rise time for a setpoint step can be adjusted by potentiometer P301 (effective only for setpoint input 2).
With the standard values fitted on the custom board (C306 = 10 nF) the hard left position of P301 corresponds to a rise time of approx. 100 ms.
When P301 is **hard right** the remaining delay time of **10 ms** is practically meaningless. If necessary, C306 can be reduced to a minimum of 1nF.
(adjustment range 1:10)

III.2.3.2 Setpoint potentiometer P302

Potentiometer P302 can be used to attenuate the setpoint input SW2.
Turning P302 clockwise increases the speed.
(adjustment range 0...100 %)

III.2.3.3 Offset potentiometer P303

The offset potentiometer P303 is used to compensate for error voltages of the operational amplifier or the setpoint voltage source (controller) which occur at setpoint = 0 V .
Make the adjustment while the amplifier is active (enabled) and the setpoint voltage = 0 V , so that the motor is at stillstand.
(adjustment range ±10 mV)

III.2.3.4 Tacho potentiometer P304, tacho adjustment R310

Potentiometer P304 is used for the fine adjustment of the tachometer.
The range of adjustment is ±30 %.

The standard fitting is for the AC tacho voltages of the SM motors

- 10.8V (for rated speed 2000 min^{-1} and 5.4 V / 1000 min^{-1})
- 16.2V (for rated speed 3000 min^{-1} and 5.4 V / 1000 min^{-1})
- 10.8V (for rated speed 4000 min^{-1} and 2.7 V / 1000 min^{-1})
- 16.2V (for rated speed 6000 min^{-1} and 2.7 V / 1000 min^{-1})

and

- right resp. left stop of the potentiometer is dimensioned for 10 V speed setpoint.

When using motors with a **DC tacho output** you should adjust the normalization on the custom board, because of the lower tacho voltage of about 6 V.

— Reduce R310 from 11.5 kΩ to 4.7 kΩ .
(Alternatively, you can reduce the four tacho resistors R301...R304 from 16.5 kΩ to 10 kΩ)

III.2.3.5 AC-gain potentiometer P305

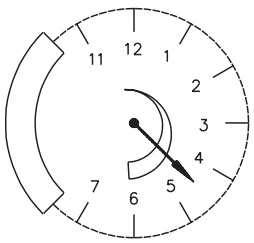
The proportion gain of the **PI** speed controller can be increased by turing P305 clockwise (the control becomes stiffer). When P305 is hard left, then R307 fixes the gain at about 10.
The integral component is fixed by C304 and R307 to 0.1 μF x 100 kΩ = 10 ms.
Reducing C304 improves the response speed of the amplifier, but increases the tendency to oscillation. There are very few cases where the standard values need to be changed.
Adjust P305 while the amplifier is active and the motor is at stillstand (setpoint voltage = 0 V) by turning it clockwise until oscillation begins (which is very easy to see on an oscilloscope connected to the current monitor) and then turning it back to a position clearly below the oscillation threshold.

R309 limits the gain of the I component to about 5000 at very low frequencies.

III.2.3.6 Peak current I_{PEAK}, P306

Turning P306 to the left reduces the peak instrument current I_{PEAK} .
The (linear) range of adjustment is 0...100 %.
Alternatively, the end value can be reduced by means of a fixed resistor.
As delivered, P306 ist set to the right stop (maximum) and covered.
The following **table** provides information for the **rough setting** of I_{PEAK} and I_{RMS} for commissioning. An **exact** setting – especially for low currents – is possible by using the method described in **Chapter III.2.3.7**

View:
front side of the installed controller



Potentiometer P306 and P307 I_{PEAK} and I_{RMS}

As delivered–state cw–stop (7h30)

60WKS–M240/3/6/12/22/26

	P306 IPEAK/A					P307 IRMS/A				
Position	3A	6A	12A	22A	26A	3A	6A	12A	22A	26A
right	7,5	15	30	50	50	3	6	12	22	26
7	7,4	14,5	29	49	49	2,8	5,5	11	19	23
6	7,0	13	26	43	43	2,6	5	10	17,5	21
5	6,2	11	22,5	37	37	2,4	4,5	9	16	19
4	5,5	9	19	31	31	2,2	4	8,5	14,5	17
3	4.4	7,5	15	25	25	2	3,5	7,5	13	15
2	3,2	5,5	11	19	19	1,8	3	6,5	11,5	13
1	2,2	3,5	7	13	13	1,5	2,5	6	10	11
12	1,2	2	3	7	7	1,2	2	5,5	8,5	9
11	(0,2)	(0,5)	(1)	(2)	(2)	(1)	(1,5)	(4,5)	(7)	(8)
left	0	0	0	0	0	0	0	0	0	0

III.2.3.7 Effective current I_{RMS}, I^2t limit, P307

The servo amplifiers have the capability to deliver the peak instrument current I_{PEAK} for a maximum of 5 sec., after which the current is limited to I_{RMS} , the preset rated current.

Counter-clockwise (left) rotation of P307 reduces I_{RMS} , the (square-law) setting range is 0...100 %. The centre position of the potentiometer corresponds to about 70 % of the rated current of the instrument.

The time t, during which the pulse current can be delivered, varies in accordance with the setting which is selected for I_{RMS} and I_{PEAK} :

$$t = \frac{(I_{RMS})^2 \cdot 20s}{(I_{PEAK})^2}$$

Alternatively, I_{RMS} can be set by two fixed resistors.

For an easy way to set the current, you can swap two motor phases. The motor will then take up a definite position (effectively stalling) as soon as the enable is switched on, even without any setpoint. Start the setting with a low I_{RMS} current (P307 near to the left stop). After switching on the enable signal the amplifier current will initially rise to the preset peak current I_{PEAK} and then, after reaching the I^2t limit, it will fall back to the I_{RMS} value. Set the desired current by turning P307 step by step to the right (clockwise).

Measure it by using an oscilloscope or voltmeter connected between the **IDC** measuring point (current setpoint monitor) and AGND. The table in Chapter III.2.3.6 can be used to make a simple (rough) setting.

As delivered, P307 is set hard right (maximum).

III.2.4 Other functions

III.2.4.1 Frequency response of the servo amplifier

The setting of the current controller has been adapted to match the intended type of motor. A change of this basic setting should only be contemplated in exceptional cases, and after consultation.

III.2.4.2 I²t monitoring

When the current reaches the preset limit for effective current (I_{RMS}, I²t limit, see Chapter III.2.3.7) the pulse current is limited until the effective load falls.
The BTB signal is not affected by this behaviour.

The response of the I²t limit is indicated by the yellow LED and signalled by a floating optocoupler output at the I²t signal output (terminal 18, referred to DGND, terminal 12).

In normal operation the output is actively held down to 0 V (Low level). If required, a pull-up resistor with a minimum value of 2.2 kΩ can be externally wired to +15...30(24) V.

III.2.4.3 Displays

Red/green LEDs for the DC-link voltage [BTB] and common fault [FAULT]
The **green** LED lights up when the DC-link voltage / auxiliary (±15 V) power supply are functioning properly. The controller is operational when the green LED is lit up **and** the red LED is not lit up.
The BTB contact (floating, normally open, **100 V / 0.1 A DC** , terminals 21,22) is closed when the servo amplifier is ready for operation.
The **red** LED lights up on

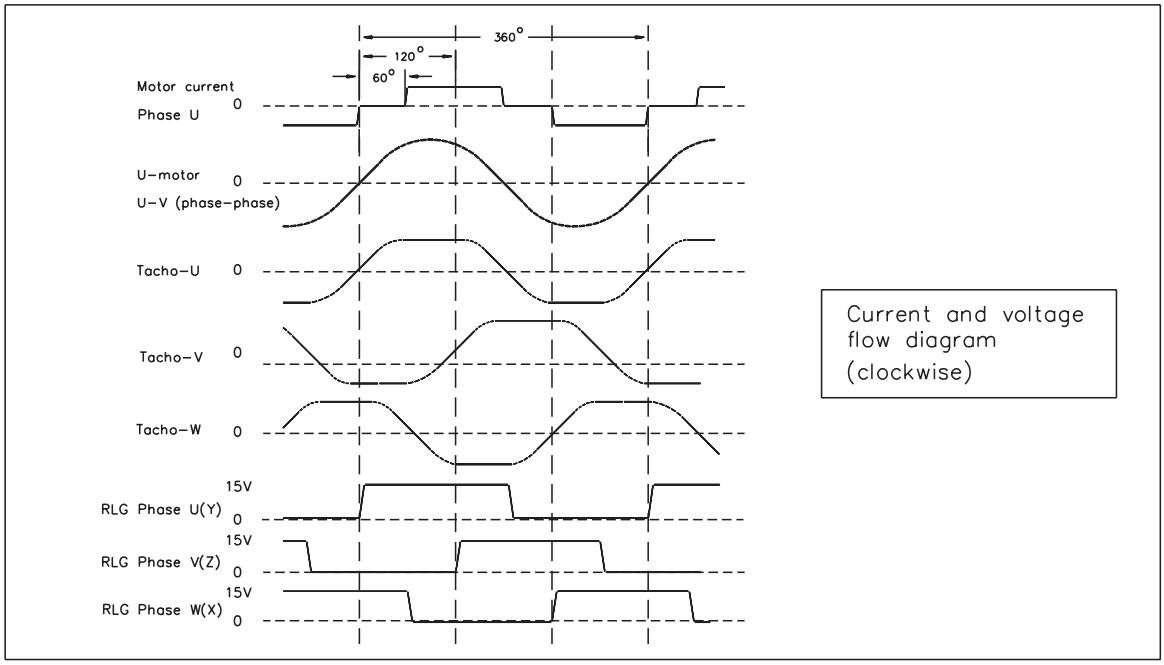
- overcurrent (short circuit)
- overvoltage (peak ballast power too high)
- undervoltage of the auxiliary supply
- overtemperature of the heat sink (output stage)

In all cases, when a red LED lights up the BTB signal is interrupted (fault signal). After the cause of the fault has been removed, you can clear the fault signal by switching the mains supply (or the 24 V auxiliary supply) off and on again. See Chapter III.3.1.4 for the arrangement of the LEDs.

Yellow LED for the I²t monitoring [I-RMS]
When the preset limit for the effective current has been reached, the upper **yellow** LED I_{RMS} lights up, and at the same time a signal is output (terminal 8). The **BTB** contact is **not** affected.

Internal yellow LED for the ballast circuit [BR]
When the ballast circuit is activated, the internal yellow LED indicates this by blinking.
A weak glowing of the yellow LED indicates that the ballast circuit is faulty (overload of the ballast circuit). If the LED flickers even when the connected motor is at **standstill** , this indicates that the mains supply voltage is too high.

Green LEDs for rotor position indicator [RLG-W, RLG-V, RLG-U]
Three green LEDs indicate the rotor position signals. If the instrument is properly connected the LEDs light up in sequence for a duration of 180° (electrical) with a phase shift of 120° between them. So one or two LEDs may be lit up at any instant, but never three or none. If the RLG signals (or the supply voltage to the rotor position indicator) are missing, then all three LEDs light up, and the controller does not deliver any current.



Current and voltage flow diagram (clockwise)

III.3 Options

III.3.1 Option board -01-

In order to activate the Option board -01- you **must open** the solder link **LB3** on the amplifier board (accessible from above when the option board is pulled out). The limit switch inputs must **always** be wired up, even if you only use the ramp generator. As delivered, the Option board -01- is not inserted.

III.3.1.1 Ramp generator, RAMP

When Option board -01- is plugged in, potentiometer P301 can be used to set the desired rise time for a setpoint step.

Only effective for setpoint input 2

With C306, the maximum rise time when the potentiometer is at the **left stop** can be set at about 10msec per nF for a setpoint step of 10 V.
If it is optimally set (i.e. rise time **less** than the mechanical time constant of the control loop), this option can make a significant improvement to the the stability of the control loop, without noticeably reducing its speed.
The standard value for C306 is 10 nF, corresponding to 100 msec with P301 at the left stop.
The range of adjustment is 10...100 ms.

III.3.1.2 1:1 control

The speed controller can be switched over to **current control** by applying the 1:1 signal (input 24 V, active high, terminal 15). In this case, the **P**-gain is set to **1**, the **I**-component of the controller is **bridged** and the **tacho signal** is also internally **switched off.**

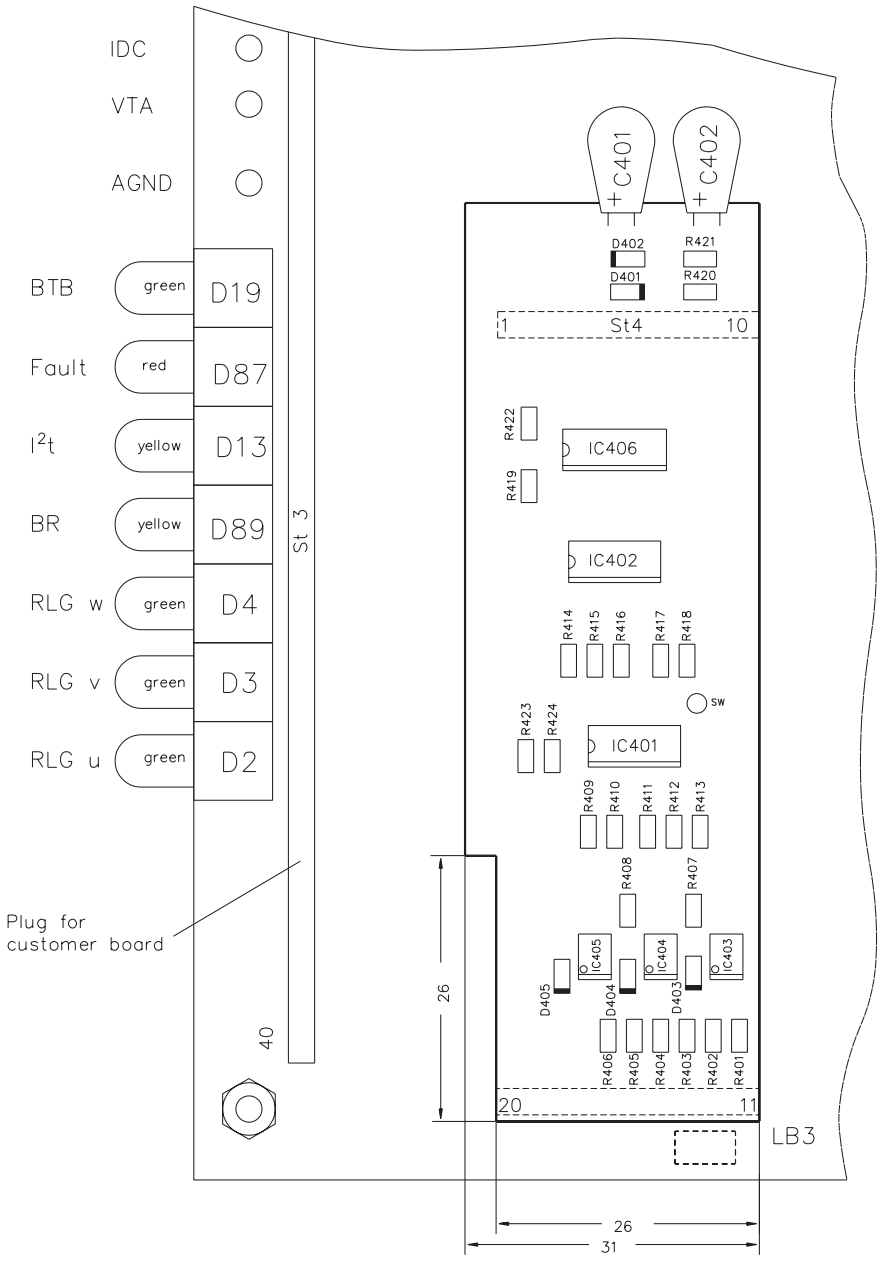
Effective for both setpoint inputs

III.3.1.3 Limit switch PSTOP, NSTOP

If a signal is missing (input 24 V, active high) the corresponding direction of rotation is **inhibited** and the drive is braked. In this case, the I-component of the controller is bridged, in order to limit the motor current if it drives onto a fixed stop.
PSTOP (terminal 10) inhibits counter-clockwise (left) rotation, NSTOP (terminal 11) inhibits clockwise (right) rotation.
If **both** signals are missing the drive brakes down to a standstill, regardless of the direction and speed (this can, for instance, be used for an emergency stop function).

Only effective for setpoint input 2

III.3.1.4 Option board -01- , mounting position and component layout



III.3.2 Option -24V-, external 24 V auxiliary voltage

As delivered, the auxiliary power supply is fed from the DC-link voltage.

If Option -24V- is built into the servo amplifier, then the auxiliary supply can be fed from an external 24 V DC source. The supply is fed from terminal 24 and **0V/GND** (not from terminals 12/17).

Advantages :
- BTB signal is available independently of the mains power supply
- Fault signals remain stored in the servo amplifier, even when the mains power supply is switched off.
- The supply for the DC-link can be made from a lower voltage (provided that the control loop stability is maintained), such as a 48 V battery. This can be advantageous, for example in setting-up operations.

Disadvantage : Additional power supply required.

If you want to **retrofit** an external 24 V DC supply to the servo amplifier, then several alterations

Warning !
Option -24V- must be built in if you want to run the servo amplifier with an external 24 V supply !
Servo amplifiers with Option -24V- must have forced ventilation, even when the DC-link voltage is switched off !

are necessary. Please contact us in this case.
If you order the servo amplifier with Option -24V- ex-works, then the necessary changes have already been implemented in the factory.

III.4 Solder links

III.4.1 Digital-GND, Analog-GND, LB2

As delivered, the solder link **LB2** on the motherboard is **closed**. This means that AGND is joined to DGND. To achieve potential separation of DGND (terminal 12) and AGND (teminal 17) you must open LB2.

III.4.2 Option board -01-, LB3

As delivered, the solder link **LB3** on the motherboard is **closed**.
If you want to use Option board -01- you must open LB3.

III.4.3 DC tacho [LB10, 11, 12, 13]

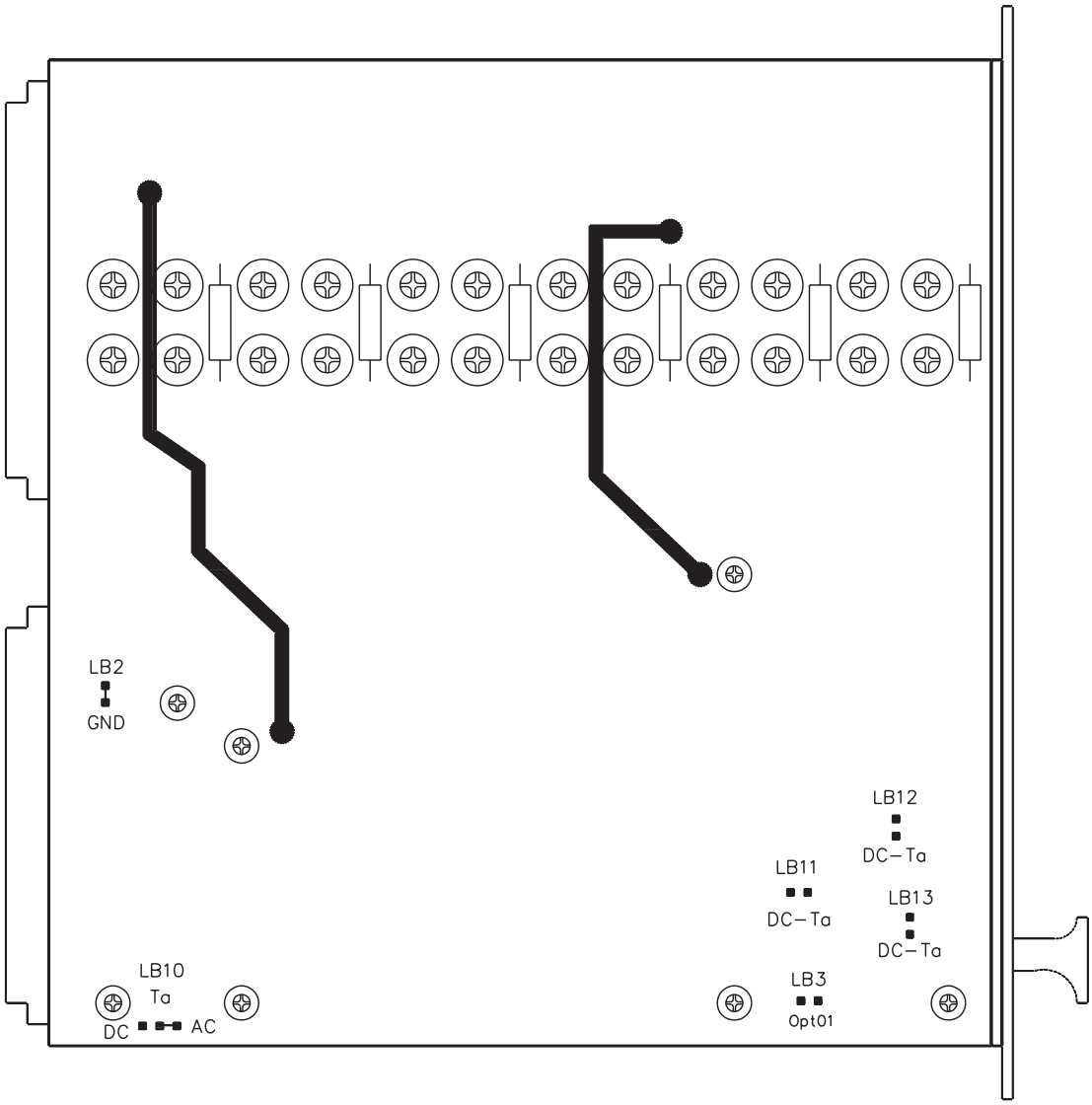
If you want to connect a motor with a DC tacho output to connector XST401 (SubD 9-pin), then you must change the following solder links :
- **open** LB10 and solder in position “DC”
- close (solder) LB11 and LB13

If required, closing LB12 provides stronger filtering of the tacho signal (time constant 1msec). In this case, please observe the recommended adjustments for the tachometer on the custom board (normalization by R310 on the custom board), as described in Chapter III.2.3.4

III.4.4 Other solder links

All other solder links can only be changed by the manufacturer.

III.4.5 Layout of the solder links, motherboard 60WKS



view : conductor side

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IV Peripheral equipment

IV.1 Isolation transformers

Isolation transformers are required to operate the equipment. The isolation transformers must meet the following specification, in order to ensure that the system operates correctly and that the guarantee conditions are fulfilled.

Design: 3-phase isolation transformer, with screen winding to VDE 0550, connected as Y/y or Y/d.

Mains supply voltage: 400 V with tappings ±20 V for matching to different mains supply conditions. We recommend connecting to the 420 V tapping.

Secondary voltage: for 240 V DC-link voltage : 172 V (phase-phase)
The secondary star point must not be earthed.

Off-load voltage: (secondary) The permissible of-load voltage rise is about 4 %
When off-load, the DC-link voltage of 240 V + 10 % (264 V) must not be exceeded.

Short-circuit voltage: The relative short-circuit voltage u_k must be about 4 %, to provide protection of the rectifier diodes on switch-on and in the event of overvoltages to EN 50178.
A soft-start circuit is required for transformes rated at more than 5kVA (for single-axis systems) or 8kVA (for multi-axis systems).

Power factor: The loading of the transformer by a 3-phase bridge rectifier results in a power factor λ of 0,8.

Overload behaviour: The typical short-term overload in servo operation must not cause a voltage drop which is larger than the u_k value, and must not damage the transformer.

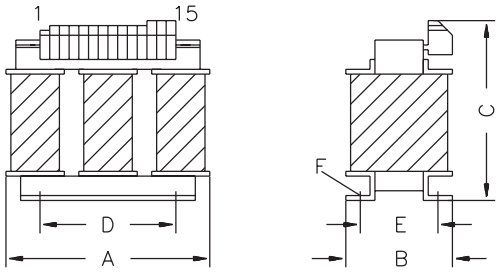
Warning !

The use of a transformer which does not meet the above specification affects the operational safety, and could lead to destruction of the servo amplifier.
We can only guarantee the functioning of the servo amplifier if Seidel transformers are used (see below).

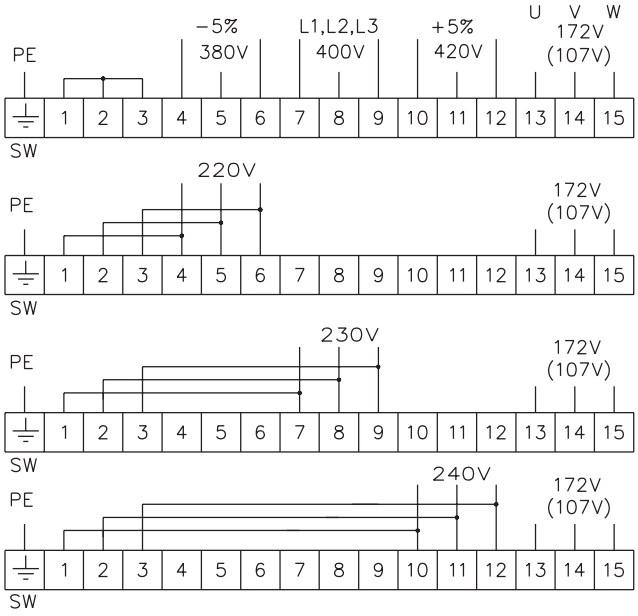
Seidel isolation transformers (3-phase, rated supply voltage 400 V)

Type	Power / kW	Sec.voltage / V	Order-No.
3T0,7K-240	0.7	172	63991
3T1,5K-240	1.5	172	60075
3T3,0K-240	3.0	172	56898
3T5,0K-240	5.0	172	55027
3T8,0K-240	8.0	172	57006

IV.1.1 Dimensions and connections of the isolation transformers



Type		Dimensions in mm						Weight
	Phase	A	B	C	D	E	F	kp
3T0,7K-240	3	180	110	195	120	86	8x12	9,2
3T1,5K-240	3	228	140	235	152	105	8x12	18,8
3T2,0K-240	3	240	145	260	143	110	8x12	22,0
3T3,0K-240	3	300	155	310	200	92	10x15	35,0
3T5,0K-240	3	360	175	385	240	135	10x15	62,0
3T8,0K-240	3	450	220	440	280	165	10x15	98,0
3T10K-240	3	450	220	440	280	165	10x15	109,0



Other primary voltages available on special order

Ordering informations 3T 3,0K-240

3-phase Isolated transformer with shielding Uk=4%

Power in kVA

DC-voltage in intermediate circuit 240 means 172V secondary voltage

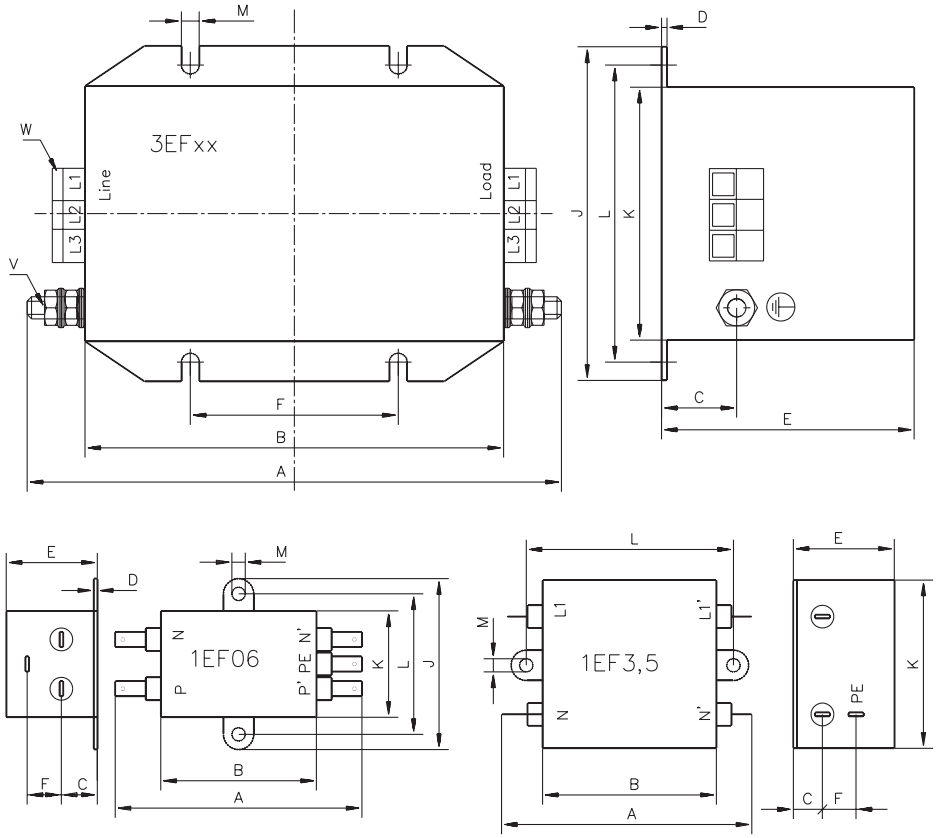
IV.2 Mains filter

Filter dimensioning to the empirical formula: $I_{Filter} \geq 2 \cdot \frac{P_{Trafo}}{400V \cdot \sqrt{3}} = 2 \cdot I_{Trafo}$

The table shows possible filter/transformer combinations:

Mains filter	Rated voltage V	Rated filter current A	Suitable for transformer	Calculated I_{Trafo} A
3EF-05	400	5	3T0,7-240 / 3T1,5-240	1 / 2
3EF-08	400	8	3T3,0-240	4
3EF-16	400	16	3T5,0-240	7
3EF-50	400	50	3T8,0-240 / 3T10-240	12 / 15
3EF-80	400	80		

IV.2.1 Dimensions and connections of the mains filter



	1EF06	1EF3,5	3EF05	3EF08	3EF16	3EF50*	3EF80*
Rated voltage	24V DC	230V AC	400V AC				
Rated current	6 A	3,5 A	5 A	8 A	16 A	50 A	80 A
A /mm	65,5	98	190	220	240	250	427
B /mm	41	75,9	150	180	200	200	350
C /mm	9,6	12	17	17	17	17	70
D /mm	0,5	–	0,75	0,75	0,75	0,75	1,13
E /mm	24,1	38,1	50	60	65	65	90
F /mm	9,1	15,5	85	115	115	115	375
J /mm	45	–	105	115	150	150	170
K /mm	28	55,6	75	85	119,5	120	
L /mm	37	87	90	100	135	135	130
M /mm	3,5	5,3	6,5	6,5	6,5	6,5	15
V			M6	M6	M6	M6	M10
W /mm^2	Faston	Faston	4	4	4	10	50
Weight /kg	0,065	0,3	1,1	1,8	1,8	3,1	9,5

IV.3 Power supply unit 56WK-P240/80-B

IV.3.1 PSU description 56WK-P

The powerful PSU type 56WK-P240/80-B, with an integral ballast circuit -B- and an external ballast resistor BAR375, is suitable for supplying several servo amplifiers of type 60WKS-M240/xx-P0 (0 = without ballast circuit).

	continuous rated current	pulse load capability
with convection cooling	30A	60A
with forced ventilation	90A	180A

Supply of multi-axis systems

The power supply unit type 56WK-P240/80-B is only for the supply of servo amplifiers without a ballast circuit (types with index -0 or -P0).

The power supply delivers up to 90 A to the DC-link circuit, while the motors are driven by the servo amplifiers, with a voltage which has an average value which is much lower. This means that one PSU is able to supply several amplifiers in a 19"-rack system. If the simultaneity factor of the axes is <1 , then it is possible to supply 6- to 8-axis systems with a single power supply unit of this type.

Monitoring / protection

If an overload or undervoltage occurs, then the floating BTB contact will open (terminals 1/2). Suppressor diodes are built into the instrument for protection against overvoltage.

Ballast circuit

Minimum resistance value : The permissible pulse current in the ballast circuit is 90 A / 240 V. The minimum permissible resistance value for the external ballast resistor is thus 3.3 Ohms.

Continuous load capability : The continuous load capability is basically determined by the ballast resistor, e.g 375 W for a BAR375. You can easily increase the ballast power, within the restric- tions of the minimum resistance, by connecting up more than one resistor. Please note, that the resistor R616 must be dimensioned according to the maximum permitted continuous power dissipation of the ballast resistor.

Fusing : In order to avoid overloading the ballast resistor by braking operations after the servo amplifier has been switched off by mains overvoltage or an equipment failure, the ballast resistor must be protected by a 10 A slow-blow fuse. For very high power requirements, the ballast circuits of two PSUs can be clocked in parallel, by joining the synchronization signals together (terminal 3).

Rough calculation of the ballast power (empirical formula) : You must make a rough calculation of the ballast power, to avoid overloading the ballast circuit.

$$\textit{peak ballast circuit power} > \frac{1}{3} \cdot \sum \textit{peak power of all the amplifiers}$$

$$\text{continuous ballast circuit power} > 0.03 \cdot \sum \text{continuous power of all motors}$$

IV.3.2 Technical Data 56WK-P

Rated data		Dim.	Power supply 56WK-P240/80-PB
Rated mains supply (installation) voltage		V~	3 x 90—172 / 50...60Hz +max. 10 %
Rated installed power		kVA	22
Rated DC-link voltage		V=	240
Rated output DC current, natural convection		A	30
Rated output DC current, forced ventilation		A	90
Peak output current (max. 5s), natural convection		A	60
Peak output current (max. 5s), forced ventilation		A	180
Fusing for bridge rectifier, external		AT	3 x 63
Fusing for ballast circuit, external		AT	10
Rated capacity of the smoothing electrolytics		µF	1800
Power diss. at rated current (without ballast circuit)		W	200
Undervoltage threshold (BTB)		V	90
Ballast circuit BAR375			
Threshold voltage (min.)		V	285
Rated voltage		V	300
Continuous power (natural convection)		W	3000#
Continuous power (forced ventilation)		W	5000#
Min. permissible ballast resistor (max. 90 A)		Ω	3.3
Pulse power for 1s		kW	27
Pulse power for 2s		kW	27
Pulse power for 5s		kW	20#
Ballast resistor, external			
Continuous power (natural convection)		W	375
Continuous power (forced ventilation)		W	500
Min. permissible ballast resistor (max. 90 A)		Ω	3.3
Monitoring and display			
Green LED for operational readiness			
Yellow LED for ballast circuit			
Monitoring of ballast power / undervoltage by floating contact 100 V / 0.1 A			
Connections			
Plug-in module		-	2 plug connectors DIN 41612, type E48
Backplane	undervoltage signal	-	plug terminals MSTB 2.5
	power signals	-	M6 studs / terminals
Ballast resistor	BAR375	-	6.3 mm fast-on spade
Mechanical			
Weight of plug-in module		kg	1.2
Dimensions (double Eurocard, 12 TE-units)		mm	220 x 233.4 x 60
Weight BAR375		kg	1
Dimensions BAR375		mm	310 x 75 x 35

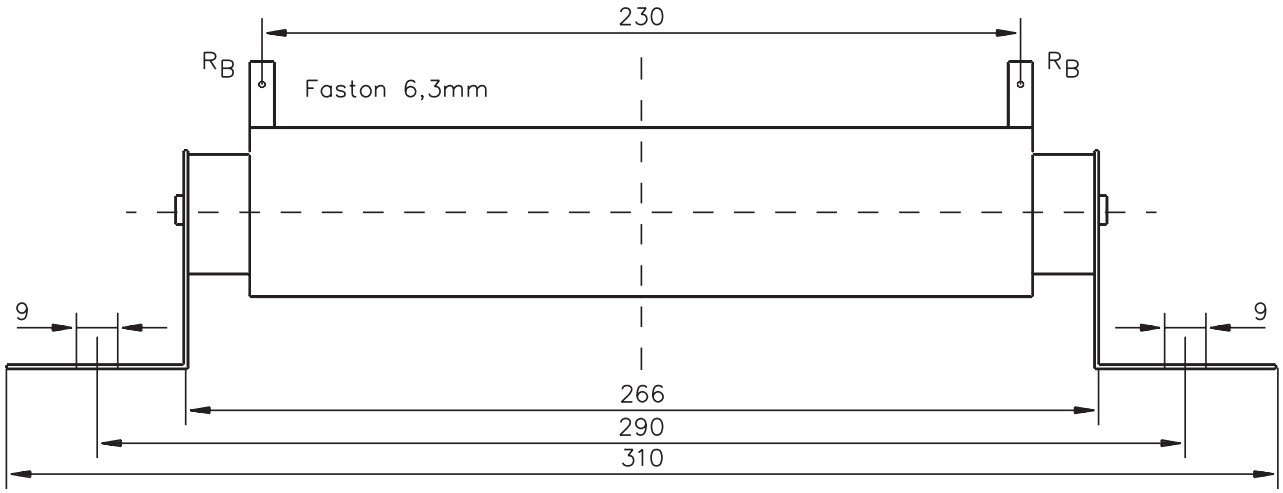
= limited in normal operation by the permissible power dissipation of the ballast resistors

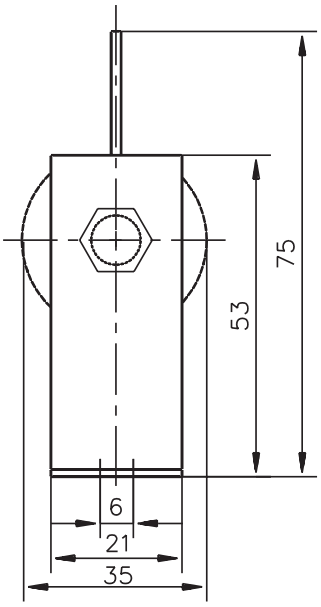
IV.3.3 Power supply backplane N56WKMB/RN56WKMB

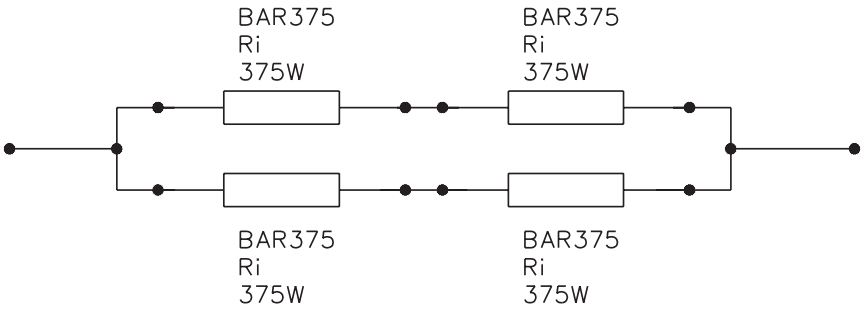
A drawing of the backplanes can be found in Chapter V.6 .

Socket 2 E48-top	Socket 1 E48-bottom	Signal designation	Connector MSTBW3
2-14ace	—	DC-link voltage +Ucc	—
16-26ace, 28ac	—	DC-link voltage -/GND	—
16-26ace, 28ac	—	Ballast resistor - (RB-)	—
30-32ac	—	Ballast resistor + (RB+)	—
30,32e	—	Undervoltage signal	1,2
28e	—	Synchronization signal	3
—	2-10ace,11e	Mains supply voltage U1 (L1)	—
—	12ac, 14-20ace, 22ce	Mains supply voltage V1 (L2)	—
—	24-32ace, 22a	Mains supply voltage W1 (L3)	—

IV.3.4 Ballast resistor BAR375



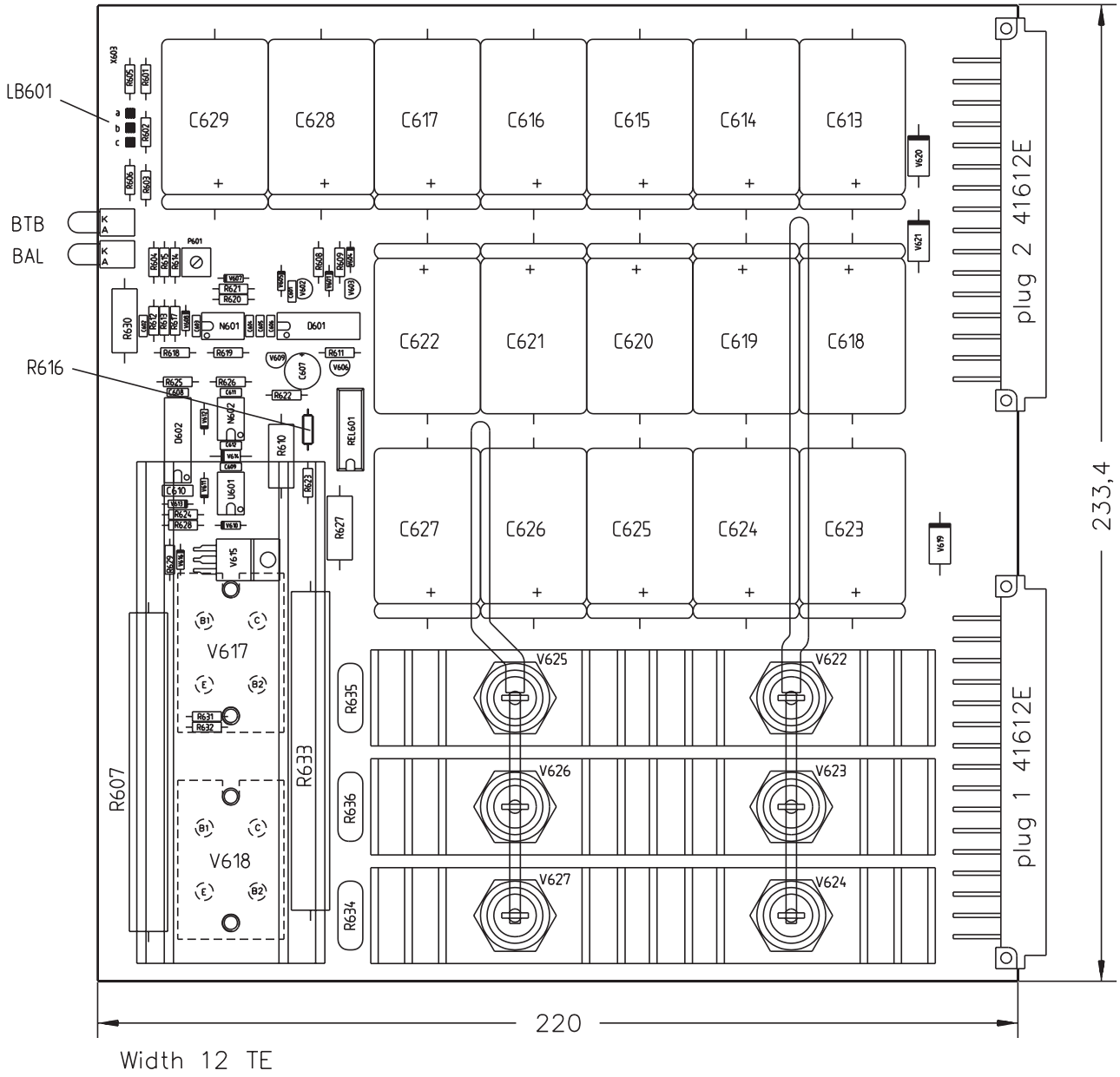




proposed wiring for quadruple power

Ri = Rges
Pi = 375W
Pges = 1500W

IV.3.5 Component layout diagram 56WK-P



LB601	Ucc	R_{Bmin}
a–b	240 V	3,3 Ω

P_{BAL}	BAR 375	R616
400 W	1 x R_{Bmin}	470 kΩ
1500 W	4 x R_{Bmin}	2,2 MΩ

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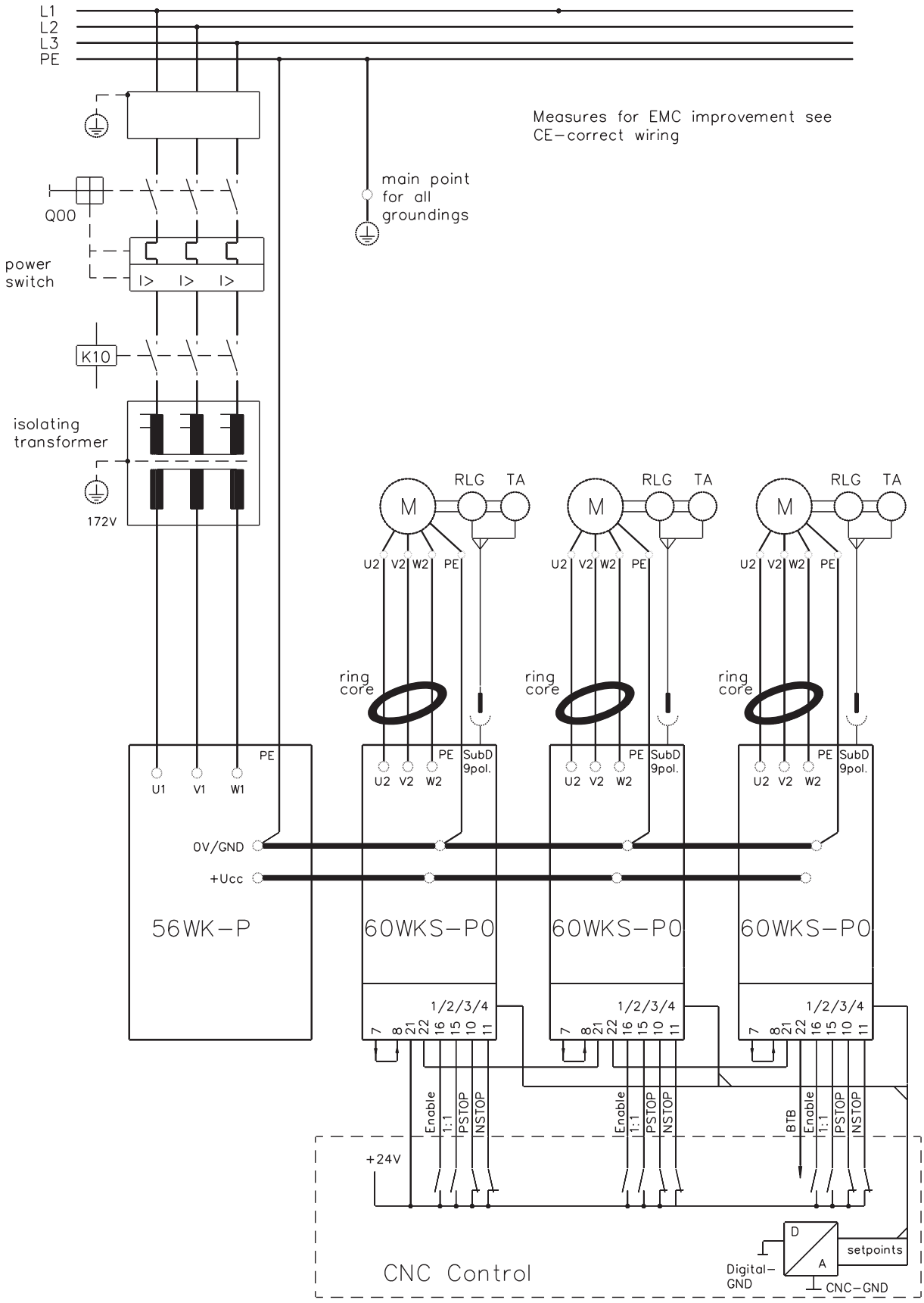
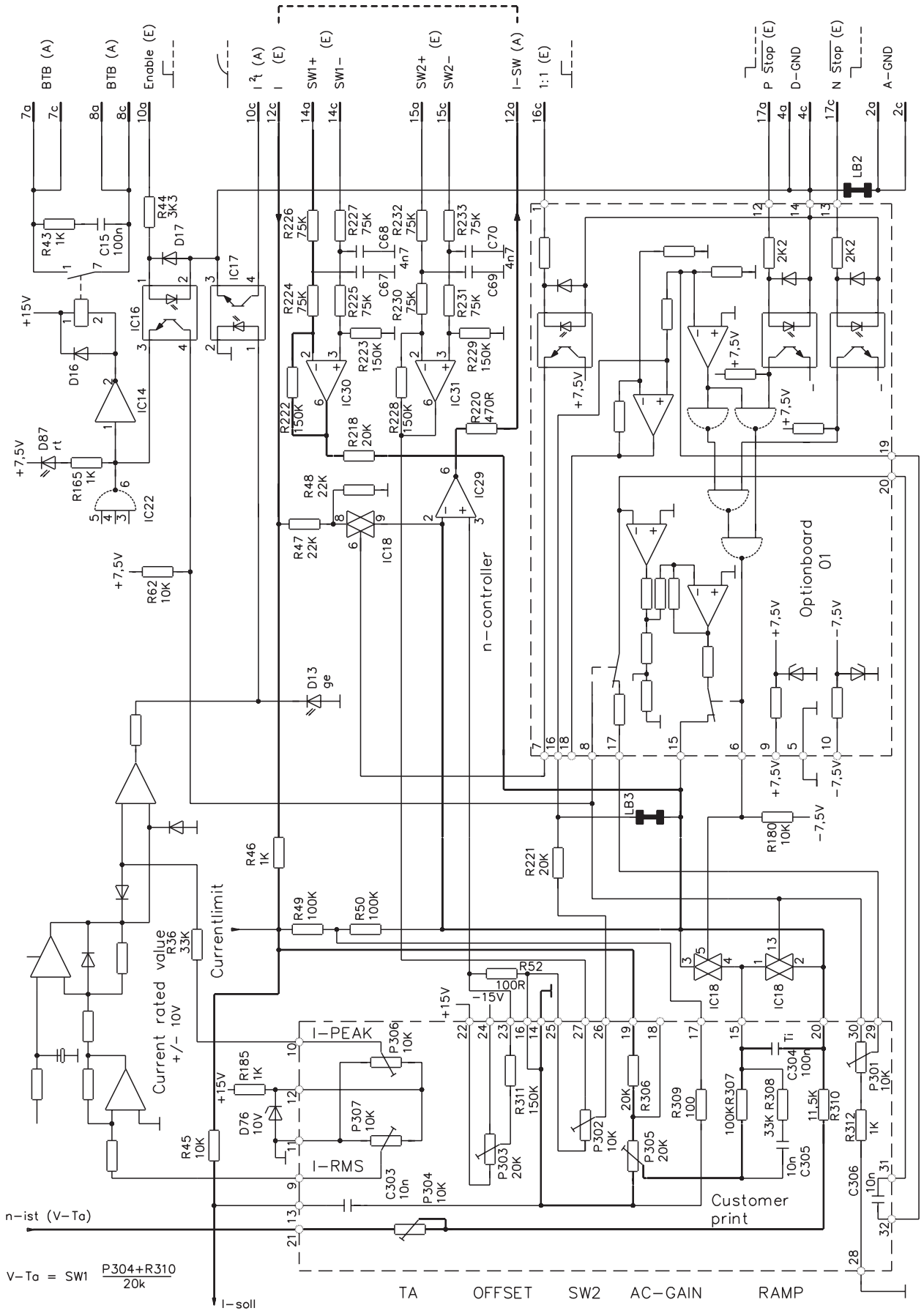
V Drawings

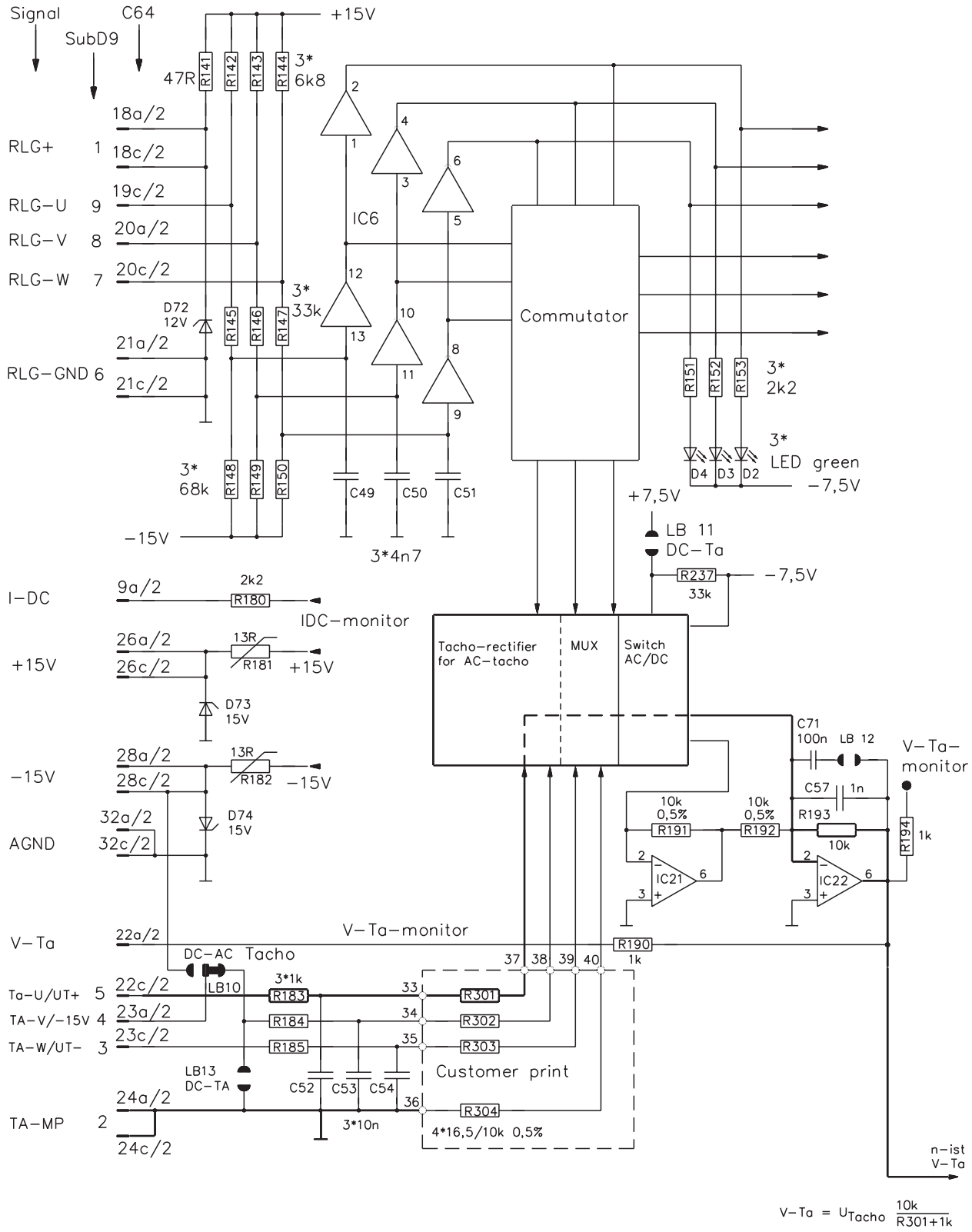
V.1 Wiring example: multi-axis system with power supply



V.2 Speed control loop 60WS

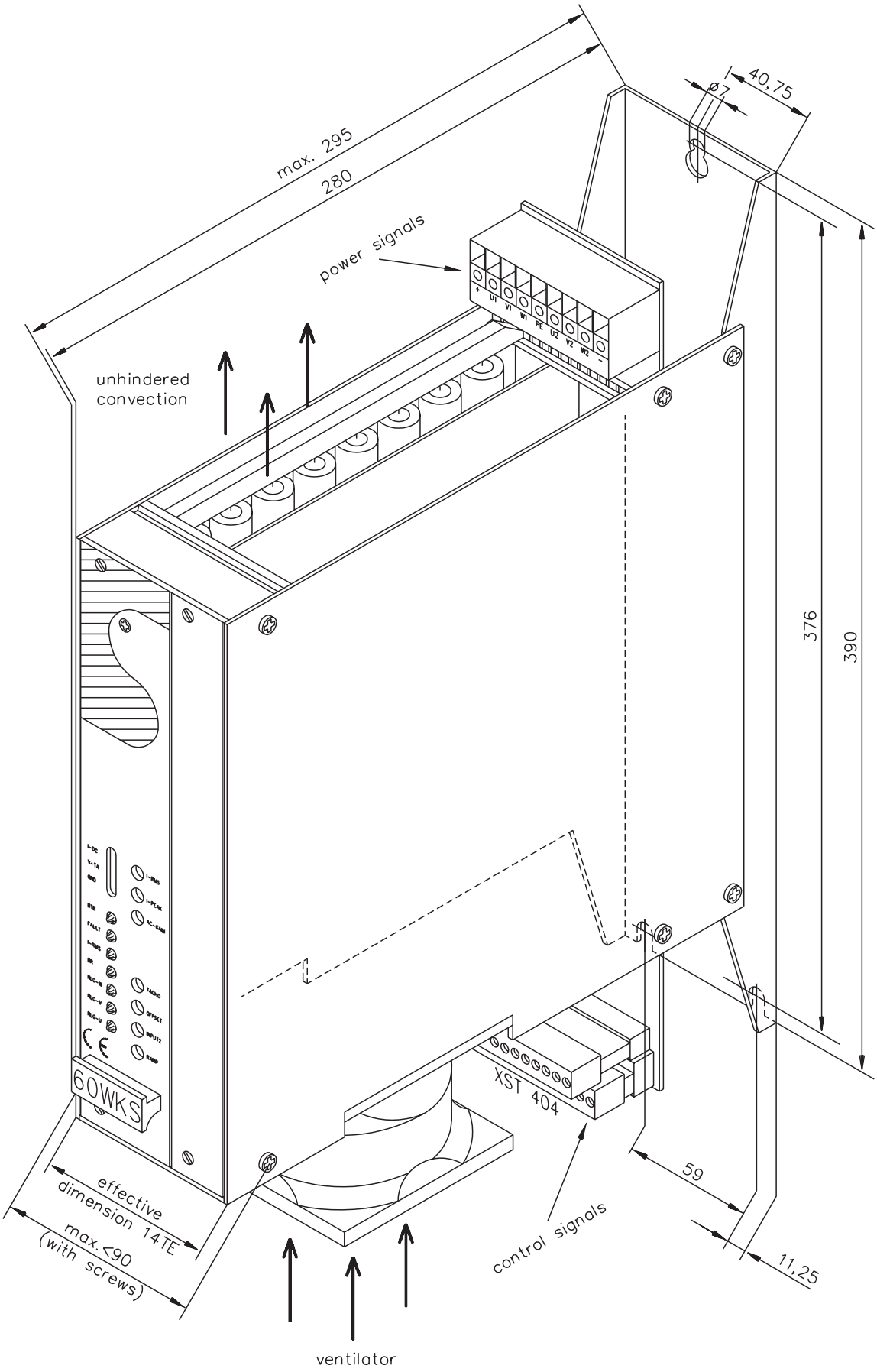


V.3 RLG-/TA input circuits for 60WKS

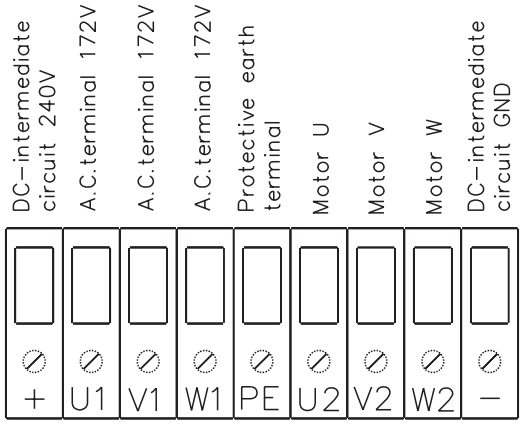


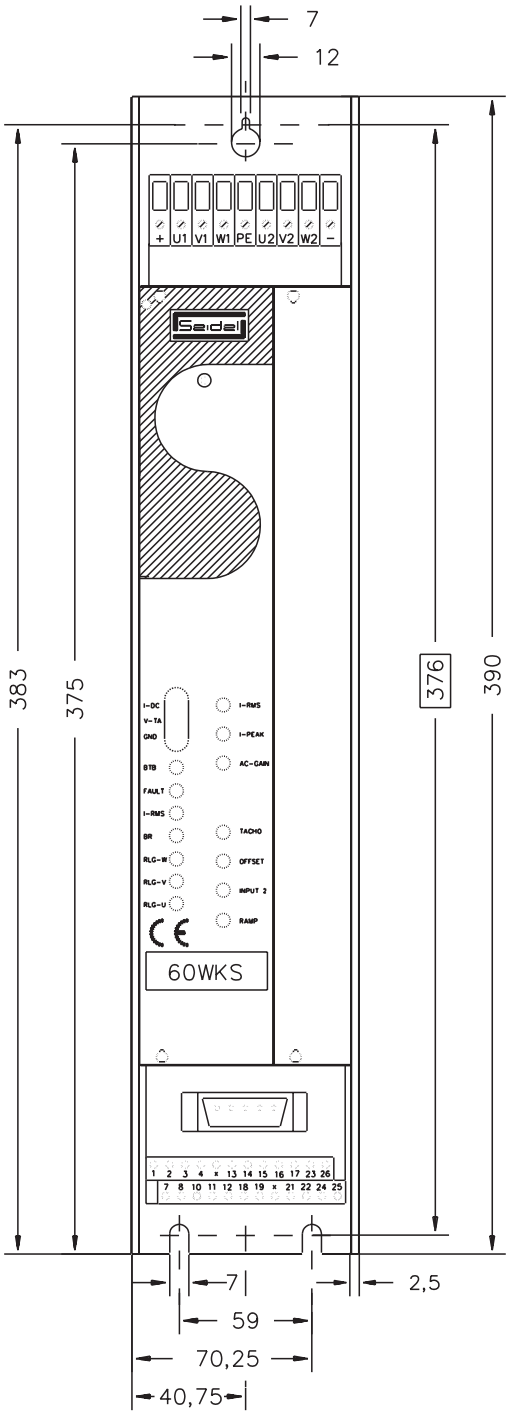
DC−Tacho : solder straps LB10, 11, 13 in position DC
Close LB12 if neccessary

V.4 Illustration of K1.1-L with 60WKS

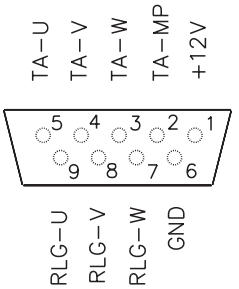


V.5 Frontal view and pin assignments for K1.1-L with 60WKS





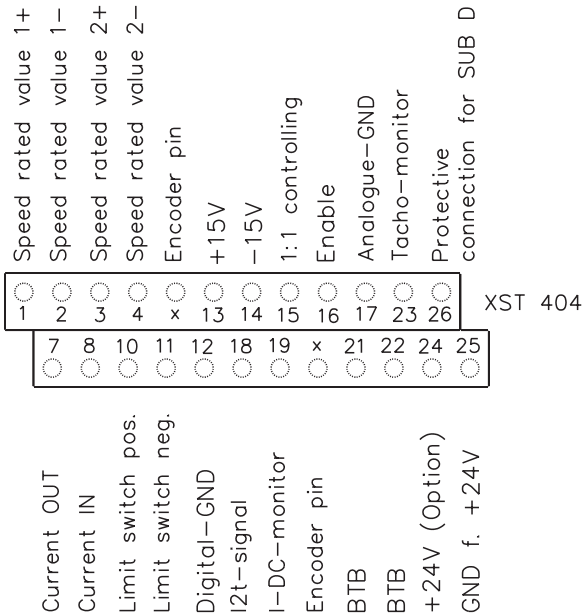
Back panel board
R60WKSMB



XST 401
Sub D 9 pole
female

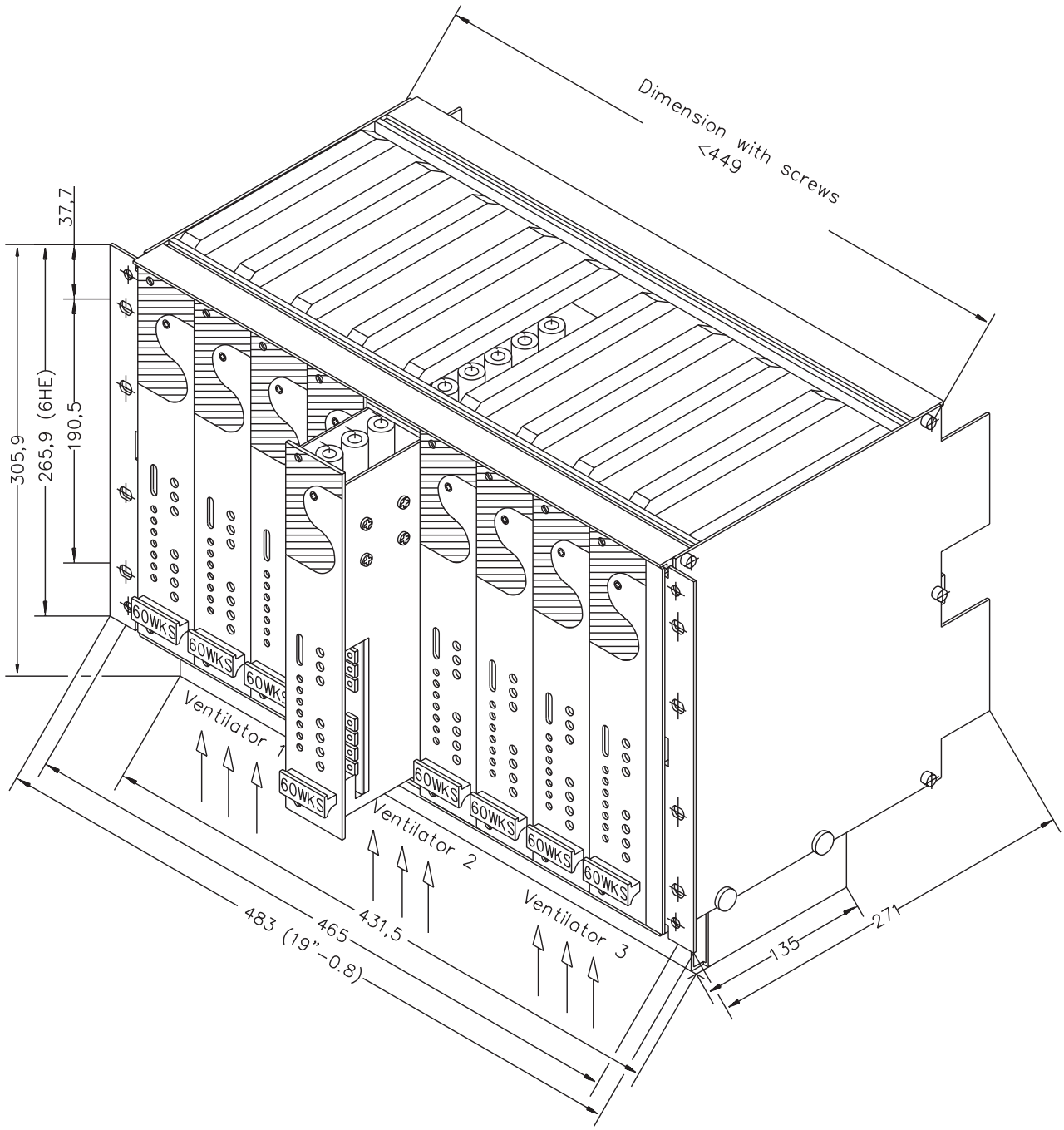
for
SM56...100

Top view of Combicon connector

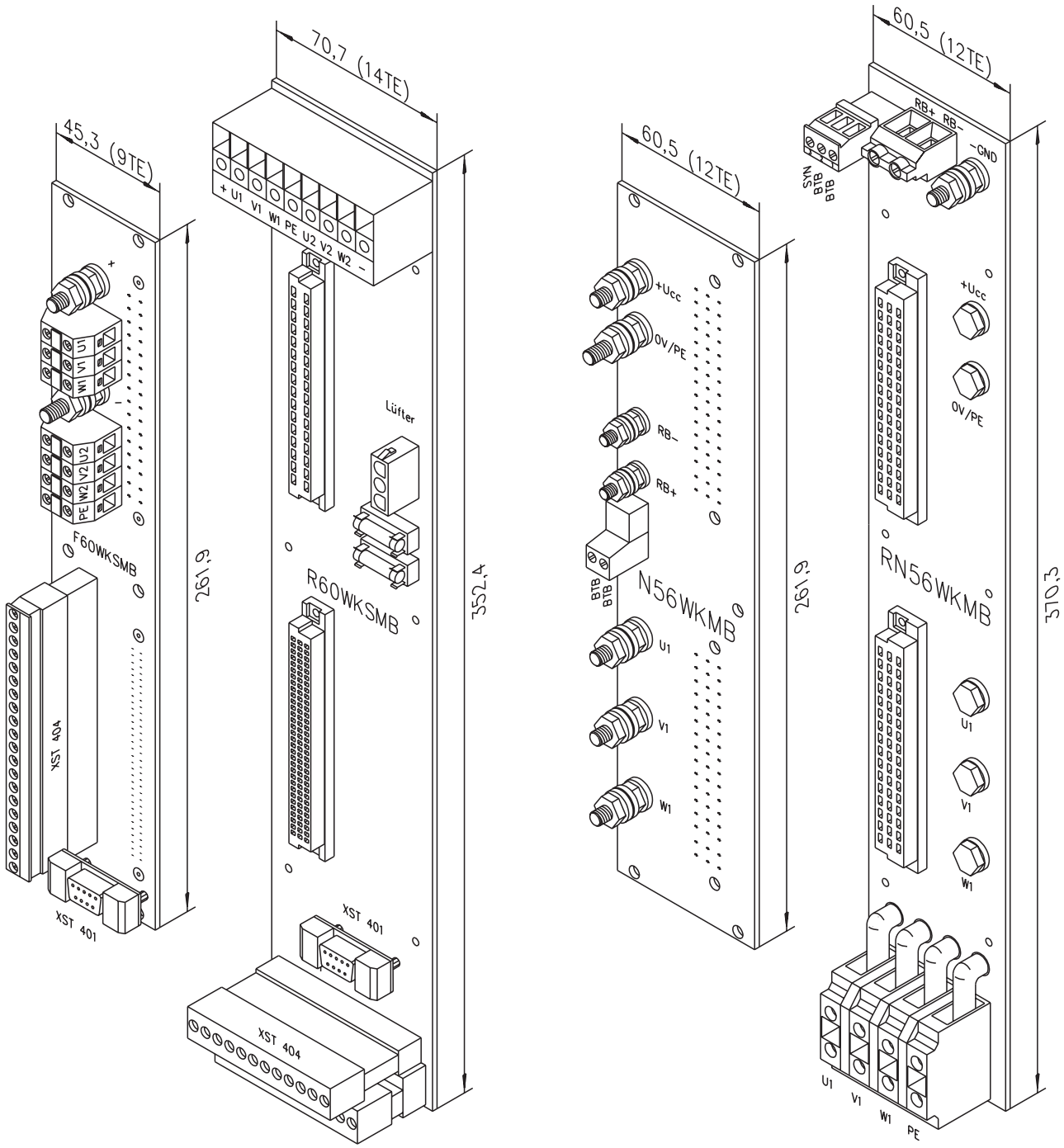


XST 404

V.6 19"-rack module 84TE with 9x60WKS



V.7 Backplanes F/R60WKSMB, N/RN56WKMB

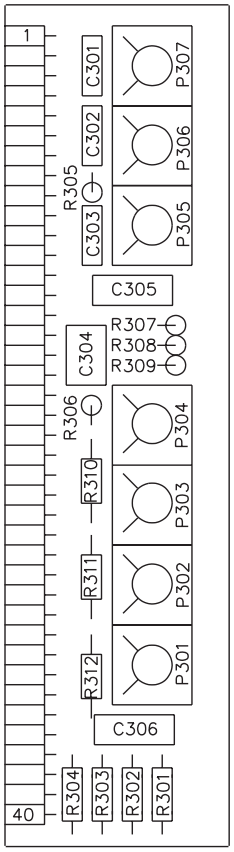


F60WKS R60WKSMB N56WKMB RN56WKMB

V.8 Custom p.c.b. 60WKS, form

Customer	Commission	Name	Material–No.

Position of Potentiometers



Adjustement

I RMS (0...In) = _____ A

I PEAK (0...In) = _____ A

AC – GAIN = _____ %

VP–(Gain) = _____ x

TI (R307xC304) = _____ ms

TACHO = _____ min^{-1}

OFFSET

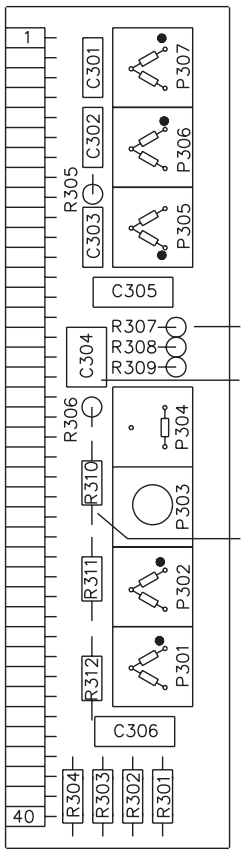
INPUT 2 = _____ V

RAMP (OPTION) = _____ ms

T RAMP

VTA (Tacho)

Fixed components



= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ nF
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ kΩ
= _____ nF
= _____ kΩ

● = ground

Standard components

Component / Motorser.	R301...R304(0,5%)	C304	R307	C306
SM	16,5k	0,1µ	100k	10n
SMF	39 k	0,1µ	100k	10n
SMC	10 k	0,1µ	47k	10n

Remarks:

Changes	Date	Components	Reason

Date:

VI Appendix

VI.1 Delivery package, transport, storage, maintenance, disposal

Delivery :
package
— servo amplifier from the 60WKS series
— 2 ring cores
— installation and commissioning manual for 60WKS
— accessories as ordered (backplanes, 19"-rack components)

Transport :
— only by qualified personnel
— only in the manufacturer's original recyclable packaging
— avoid shocks
— the servo amplifier contains electrostatically sensitive components, which can be damaged by incorrect handling.
Discharge yourself before touching the servo amplifier.
Avoid contact with highly insulating substances (artificial fabrics, plastic film etc.). Place the servo amplifier on a conductive surface.
— If the packaging is damaged, check the unit for visible damage.
Inform the shipping agent and the manufacturer.

Storage :
— only in the manufacturer's original recyclable packaging
— the servo amplifier contains electrostatically sensitive components, which can be damaged by incorrect handling.
Discharge yourself before touching the servo amplifier.
Avoid contact with highly insulating substances (artificial fabrics, plastic film etc.). Place the servo amplifier on a conductive surface.
— max. stacking height amplifier 60WKS : 15 cartons
— storage temperature –25...+85 °C, max. 20 °C/hr variation
— humidity relative humidity max. 95 %, no condensation
— storage time < 1 year without restriction
> 1 year : capacitors must be **re-formed** before commissioning the servo amplifier.
Information about this procedure can be obtained from out applications department.

Maintenance :
— the units do not require any maintenance

Cleaning :
— if the front panel is dirty : clean with isopropanol or similar
do not dip or spray
— if dirt is inside the unit : cleaning by the manufacturer

Disposal :
— the servo amplifier can be unscrewed and reduced to its principal components (aluminium heat sink and front panel, electronics boards)
— make sure that the disposal is carried out by a certified disposal firm.
Ask us for addresses.

VI.2 Fault-finding

The following table should be seen as a “First-Aid” box. There can be a large number of different reasons for the fault which has occurred, depending on the conditions in your system.

In multi-axis systems there can be further hidden causes of faults.

Our applications department can give you futher help with your problems.

Fault	Possible causes	Measures to remove the cause of the fault
BTB-LED not lit up	— supply voltage interrupted	— 60WKS : check U1,V1,W1 -24V- : check 24V supply
	— fuse F1, F3 or F4 blown	— replace fuse
FAULT-LED lit up	— motor fault	— replace motor
	— motor cable fault	— replace motor cable
	— output stage too hot	— ensure adequate ventilation, check/clean fan, reduce cabinet temperature
	— amplifier fault	— return amplifier to manufacturer
Motor does not rotate, no torque on the shaft	— Enable signal missing	— check wiring
	— DGND missing	— check wiring, LB2
	— P307 at left stop	— see table in Chapter III.2.3.6
	— link XST404/7-8 missing	— check wiring
Motor does not rotate, bur torque is present	— setpoint cable break	— check setpoint cable
	— motor phases in wrong sequence	— connect motor phases correctly
	— brake nor released	— check brake control
	— drive mechanically jammed	— check mechanism
Motor runs away	— motor cable fault	— check motor cable/phases
	— RLG-/ tacho cable faulty	— check cable
	— RLG/ tacho fault in motor	— repair the motor
Motor oscillates	— AC-gain too high	— turn AC-gain pot. to left
	— break in shielding of RLG-/ tacho shielding	— replace RLG-/ tacho cable
	— AGND not wired up	— jon AGND and CNC-GND

VI.3 Glossary

A	AC-gain, P-gain	Proportional gain of a control loop
B	Ballast circuit	Converts excess regenerative energy from the motor, during braking, into heat in the ballast resistor
C	Common-mode voltage	Amplitude of the disturbance which can be eliminated in an analog input
	Continuous power of the ballast circuit	The average power which can be dissipated in the ballast circuit
	Current controller	Regulates the difference between the current setpoint SW and the actual current value to 0. Output : power output voltage
D	DC-link	The rectified and smoothed DC supply voltage
	Disable	Removal of the ENABLE signal (0 V or open)
E	Earth fault/short	Electrically conductive connection between a phase and PE
	Enable	Enable signal for the servo amplifier (+24 V)
F	Final speed	Maximum value of normalized speed at ±10 V
H	Holding brake	A brake in the motor, which must only be activated at standstill
I	Input drift	Temperature and age-dependent drift of an analog input
	I²t threshold	Monitoring of the actually required effective current Irms
	Ipeak, peak current	Effective value of the pulse current
	Irms, effective current	Effective value of the continuous current
L	Limit switch	Limit switch for the traverse of the machine; function : break (n.c.)
M	Machine	The sum of all interconnected components or devices, of which as least one is movable
	Mains filter	External device to divert disturbances of the power supply leads to PE
	Multi-axis system	A machine with several independent drive axes
	Monitor output	Output of an analog measurement value
N	Natural convection	Free air movement for cooling
O	Optocoupler	Optical connection between two electrically independent systems
P	P-controller	Control loop with purely proportional characteristics
	Phase shift	Compensation for the phase lag between the electromagnetic and magnetic fields in the motor
	PID-controller	Control loop with proportional, integral and differential characteristics
	Potential isolation	Electrical decoupling
	Power contactor	System protection with phase-failure monitoring
	Pulse power of the ballast circuit	Peak power which can be dissipated in the ballast circuit
R	Reversing mode	Operation with a periodic change of direction
	Ring core	Ferrite ring for interference suppression
	Rotor position indicator	3-pole transmitter with Hall-effect sensors (3x120° mechanical/electrical)
S	Servo amplifier	Device for controlling the speed and torque of a servo motor
	Short circuit	Here: an electrically conductive connection between two phases
	Speed controller	Regulates the difference between the speed setpoint SW and the actual speed value to 0. Output : current setpoint
	SW ramps	Limitation of the rate of change of the speed setpoint SW
T	Tacho time constant	Filter time constant in the speed feedback of the control loop
	Tachometer voltage	Voltage which is proportional to the actual speed value
	Thermostat	Temperature-sensitive switch built into the motor winding

VI.4 Index

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