KOLLMORGEN
Seidel

Transistor Controller
Series 04S

CE

Assembly / Installation / Commissioning

Edition 12/99

Previous editions

Edition	Comment
09 / 91	First english edition
01 / 93	New layout, completely created with DTP
02 / 98	Seidel Servo Drives, CE, DIN A5
12 / 99	KMS, Layout

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

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Contents

Contents

Safety Instructions

Warning symbols : You must observe the important notes in the text, which are marked by the following symbols :


danger from electricity and its effects


general warning general notes

- **Only properly qualified persons are permitted to carry out activities such as transport, installation, commissioning and maintenance. Properly qualified persons are those who are familiar with the transport, installation, assembly, commissioning and operation of the products, and who have the appropriate qualifications for the task. The qualified personnel must know and observe the following standards and directives:**
  IEC 364 / 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 the installation and commissioning. Incorrect handling of the transistor controller can lead to injury to persons or to material damage. It is vital that you observe the technical data and the information on connection requirements (nameplate and documentation).**

- **The transistor controllers contain electrostatic-sensitive components, which can be damaged by incorrect handling. Discharge your body before touching the transistor controller. Avoid contact with highly insulating materials (artificial fibres, plastic films etc.). Place the transistor controller on a conductive surface.**

- **Keep all covers and cabinet doors closed during operation. Otherwise, there are severe hazards with the danger of death or severe injury or material damage.**

- **In operation, depending on the degree of enclosure protection, transistor controllers can have bare components which are live and have hot surfaces. Control and power connections can also carry a high voltage, even though the motor is not rotating.**

- **Never disconnect or connect the transistor controller when it is live. There is a risk of electric arcing with damage to contacts and personal injury.**

- **Wait at least two minutes after disconnecting the transistor controller from the mains supply voltage (at least five minutes if Option -24V- is fitted), before touching live sections of the equipment (e.g. contacts, screwed connections) or undoing any connections. Capacitors can still have a dangerous voltage after the supply has been switched off. To be safe, measure the voltage in the DC-link, and wait until it has fallen below 20V.**

Standards and Directives

Transistor controllers are components which are intended to be installed in electrical equipment and machinery.

When the transistor controllers are incorporated into equipment or machinery, then the start of prescribed usage is prohibited until it has been confirmed that the equipment/machine fulfils the requirements of the EC Directive on Machines 89/392/EEC, the EC EMC Directive (89/336/EEC) and the EC Low Voltage Directive 73/23/EEC.
EN 60204 and EN 292 must also be observed.

The Low Voltage Directive 73/23/EEC does not apply to the 04S amplifier, because of the low rated voltage.

The manufacturer of the equipment or machine is responsible for ensuring that it meets the limits which are laid down by EMC regulations. Advice on the correct installation for EMC – such as shielding, grounding, arrangement of filters – is included in this documentation.

CE -conformance

Conformance with the following Directive is mandatory for the supply of transistor controllers within the European Community:

since 01 January 1996 : EC EMC Directive 89/336/EEC

The 04S series of transistor controllers have been tested in an authorised testing laboratory, in a specified configuration with the system components as shown in Chapter II.

Any divergence from the configuration and installation which are described in the documentation means that you will yourself be responsible for carrying out new measurements to ensure that the regulatory requirements are fulfilled.

I General

I.1 Introduction

This manual explains the installation, commissioning, adjustment and adaptation of the 04S transistor controller.
The manual is divided into 6 chapters :

Chapter 1: General Information
Chapter 2: Notes on Installation and Commissioning
Chapter 3: Functions and Options
Chapter 4: Peripheral equipment
Chapter 5: Drawings
Chapter 6: Appendix and Ordering Information

Transport : only by personnel which know-how in the handling of electrostic-sensitive devices.
Installation : only by qualified persons, trained in electrical engineering.
Commissioning: only by qualified persons, with extensive knowledge of electrical engineering and drive technology.

We offer training and introductory courses on request.

I.2 Prescribed usage (“Use as directed”) of the transistor controller

We can only guarantee the correct functioning of the transistor controller when our isolating transformers and accessories are used.

The transistor controllers are intended exclusively for driving DC motors under speed and/or torque control. The transistor controllers are installed as components in electrical systems or machines, and it is only permissible to operate them as integral components of these systems or machines.
Series 04S transistor controllers are operated off the 3-phase industrial mains supply, with earthing, through an isolating transformer. This isolating transformer must meet the specification in Chapter IV.1.
The transistor controllers may only be operated in a closed cabinet, observing the ambient conditions defined in Chapter I.6.2.
The units must be mounted in a standard industrial 19"-rack housing, and contacts may only be made through one of our module back-panels or a type FH24+7 mating connector.
In accordance with the EC Machine Directive and accident prevention laws, you are obliged to carry out a hazard analysis of the machine before commissioning the transistor controller.

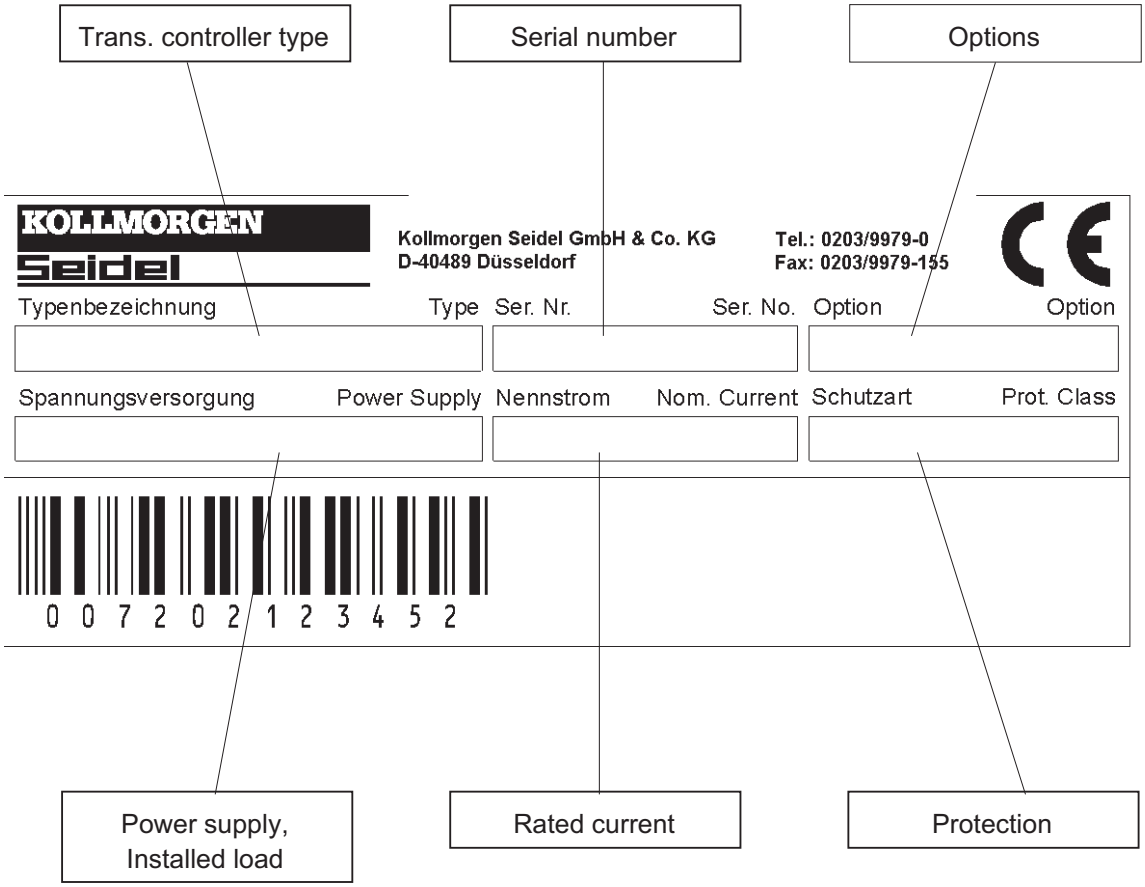
We can only guarantee the conformance of the transistor controller with the EC EMC Directive 89/336/EEC under the condition that only the components shown in Chapter II are used and that the rules for installation are followed.

I.3 Abbreviations used in this manual

Abbrev.	Meaning	Abbrev.	Meaning
AGND	analog ground	PELV	protected low voltage
BTB	system ready for operation	PSTOP	limit-switch input for clockwise rotation
CE	European Community	PWM	pulse-width modulation
DGND	digital ground	TA	tacho generator
DIN	Deutsches Institut für Normung (German Standards Institute)	$R_{Ballast}$	ballast resistor
EMC	electromagnetic compatibility	PLC	programmable logic controller
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 (Association of German Electrical Engineering Technicians)
NSTOP	limit-switch input for CCW rotation	VTA	analog speed monitor

I.4 Nameplate

The nameplate illustrated below is fixed to the transistor controller. The information shown below is printed in the individual sections.



I.5 04S equipment description

Design

The following transistor controllers must be operated with forced convection:
- ***all 04S transistor controllers with rated output currents > 8A***
- ***all 04S transistor controllers at ambient temperatures > 45°C***

Plug-in 19”-rack module, connection through module back-panels or mating connector FH24+7

Size

Unit	Format	Height units (HE)	Width units (TE)
04S	Eurocard, 220mm insertion depth	3HE (100mm)	12TE (approx. 61mm)

Options

-24V-	supply for the electronics from an external 24V power supply
-IxR-	speed control without a tachometer
---	front panel

Mains power supply

- 3-phase via isolating transformer
- 1-phase via isolating transformer
- DC-supply (battery)

Function

The 04S transistor controller is equipped for driving DC motors in 4-quadrant operation with tachometer feedback. The power section is implemented as a pulse-width modulated transistor stage with V-MOS transistors.

Variants

04S-M60-8-PB	:	rated output current 8A, with “soft” ballast characteristic
04S-M60-12-PB	:	rated output current 12A, with “soft” ballast characteristic

Accessories

Isolating transformers	:	series 3TxxK-60 (see Chapter IV.1)
-FH24+7-	:	mating connector DIN41612-M24+7 with solder contacts
F back-panels	:	instrument connections are accessible from the back, via plug terminals for the control signals and studs/flat pin connectors for the power connections
R back-panels	:	instrument connections are accessible from the front, plug terminals for the control signals and studs/flat pin connectors for the power connections
19”-rack modules	:	19” base units in various widths, with F or R back-panels

I.5.1 04S functional units

The following circuit sections are built onto a single Eurocard, 199x100x12TE with SMD-technology:

- 3-phase power supply with smoothing capacitors (-P-)
- single phase supply (any phase with the rated voltage, possibly with extra smoothing capacitance) is possible
- fuses for DC-link, ballast circuit and auxiliary power supply
- ballast circuit with **-w-** characteristic
- 4-quadrant output stage (**V-MOS transistors)**
- auxiliary supply, optionally (solder links) supply from the DC-link or an external 24 V DC source
- 2 differential setpoint inputs
- input for DC tacho
- Enable input
- limit-switch inputs positive / negative
- integral-off input for driving up to a fixed stop
- I^2t monitoring for actual current value
- PI current and speed controller
- trimmer potentiometer and fixed components for all important settings
- solder links for changing to IxR compensation for optional operation with tachometer or armature voltage control
- 24 V logic with electrically isolated optocouplers for the control signals, PLC-compatible
- system ready (BTB) relay with floating contact
- display LEDs for operational readiness / fault
- ±15 V auxiliary voltage outputs, ±20 mA

Protective and monitoring functions

- protected from short-circuit / earth short on the motor connection terminals
- monitoring of the operating voltages
- temperature monitoring of the output stage
- fuse-protection of: ballast circuit, DC-link, auxiliary supply
- I^2t monitoring of the amplifier and motor
- overvoltage protection

I.6 Technical data

I.6.1 04S technical data

Rated data	units	04S-M60/8-PB	04S-M60/12-PB
Rated supply voltage	V~	3x43	3x43
Rated installed load	kVA	0.5	0.75
Rate DC-link voltage	V=	60	60
Minimum DC-link voltage	V=	18	18
Rated output current	A	8	12
Peak output current	A	20	20
Switch-on threshold of ballast circuit	V	85	85
Switch-off threshold of ballast circuit	V	75	75
Pulse power of ballast circuit	W	1000	1000
Continuous power of ballast circuit	W	35	35
Overvoltage switch-off threshold	V	100	100
Form factor of the output current (under rated conditions with 0.5mH min. load inductance of the motor)	—	1.01	1.01
Bandwidth of the subordinate current controller	kHz	1	1
Output stage clock frequency	kHz	8.5	8.5
Residual voltage drop at rated current	V	4	4
Quiescent dissipation, output stage disabled	W	7	7
Dissipation at rated current (incl. power supply losses, without ballast dissipation)	W	40	80
Auxiliary voltage outputs	V	±15	±15
	mA	20	20
Inputs			
Setpoint 1, fixed setting	V	±10	±10
Setpoint 2, adjustable 0 — 100%	V	±10	±10
Max. common mode voltage (both setpoint inputs)	V	±10	±10
Input resistance (both setpoint inputs)	kΩ	20	20
Max. input drift (both setpoint inputs)	µV/K	±15	±15
Tacho input, adjustable	V	±8..75	±8..75
Logic inputs	V	24	24
	mA	8	8
Connections			
Controller: control signals and power signals		DIN 41612 - M24 + 7	
Backplane: control signals F03SMB		Combicon 5.08 16-pin	
R03SMB		Combicon 5.08 2x8-pin	
Power leads		Studs M6	
Mechanical			
Weight	kg	0.5	
Dimensions	mm	199 x 100 x 45 (single Eurocard,12 TE) compatible with 220mm insertion depth	

I.6.2 Permissible ambient conditions, ventilation, mounting position

Transport temperature/humidity	see Chapter VI.1
Storage temperature/ humidity/duration	see Chapter VI.1
Supply voltage tolerances **power stage** **aux. supply (Option -24V-)**	 3x43V AC ±10% min. 20V DC / max. 30V DC referred to -GND
Ambient temperature $T_{AMB.}$ in operation	0 ... +45°C under rated conditions +45 ... +55°C with derating 2.5%/°C **(forced convection)**
Humidity in operation	5 ... 85 % rel. humidity, no condensation
Site altitude	up to 1000m a.m.s.l. without restriction 1000 ... 2500m a.m.s.l. with derating 1.5%/100m
Pollution level	pollution level 2 according to EN60204/EN50178
Protection class	IP 00
Mounting location / position	in closed switchgear cabinet / normally vertical
Ventilation cont. current < 8A and $T_{AMB.}$ < 45°C	**self-ventilating** with natural convection (we always recommend forced convection at higher loads or in narrow spaces).
cont. current ≥ 8A or $T_{AMB.}$ > 45°C	**forced convection** ensure that the incoming air is dust-free and that there is an adequate supply of cooling air to the cabinet.

I.6.3 Cable cross-sections

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

Controller type Dimension	**04S-M60/8-PB [mm²]**	**04S-M60/12-PB [mm²]**
AC connection	4i x 1.5	4i x 2.5
DC-link	2 x 1.5	2 x 2.5
Motor leads	3i x 1.5	3i x 2.5
Tacho	2 x 0.25 (twisted, shielded)	
Setpoints	2 x 0.25 (twisted, shielded)	
Control signals, BTB	0.5	
+24 V / GND	1.0 (Option -24V-)	

I.6.4 Fusing

Rated data	**Type**	**04S-M60/8-PB**	**04S-M60/12-PB**
Fuse S1 (DC-link, 5x20mm)	AT	10	12.5
Fuse S2 (auxiliary supply, Microfuse)	AM	1	1
Fuse S3 (ballast, 5x20mm)	AT	2.5	2.5

I.7 Interference suppression

If interference occurs in the CNC, or the analog or digital path measurement systems, then there are some additional measures, listed below:

- additional ferrite rings on the motor leads
- wiring in armature chokes (please use the types supplied by us)
- HF filter on the CNC setpoint output (RC combination 1kΩ/10nF)

In each case you will have to try out which measures bring sufficient reduction in interference.

I.8 Ballast circuit

When the motor is braked, energy is fed back to the transistor controller. This energy is converted into heat in the ballast resistor. The ballast resistor is switched into circuit by the ballast circuit.

The ballast circuit starts to respond at a DC-link voltage of 85V.

Repetitive loading causes the switch-on threshold of the ballast circuit to rise to 90V, thanks to the built-in **-w-** characteristic, so that **power sharing** is achieved if several modules are **connected in parallel** on the same DC-link bus.

You should make a rough calculation of the ballast power dissipation which is to be expected, from the known drive data – especially for single axes.
The following method has proved itself for normal servo applications:

$$\textit{peak ballast power} > 0.33 \cdot \sum \textit{peak power of all amplifiers}$$

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

Our in-house application department can provide further assistance in calculating the required ballast power capacity for your system.

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II Installation and Commissioning

II.1 Important instructions

- Inspect the nameplate of the controller. Check that the rated voltage and rated current match the transformer and motor data.
- Do not switch on the operating voltage before you have read Chapter II of this manual (Commissioning).
- Make sure that the maximum permissible rated voltage of 43V~ on terminals 20 , 22 , 32 is not exceeded. An excessive voltage on these terminals will destroy the ballast circuit in the controller.
- Make sure that the controller has sufficient **ventilation** :
  up to 8A rated current : vertical mounting, natural convection
  above 8A rated current : vertical mounting, **additional fan**, forced convection
  An incorrect mounting position or a missing fan for rated currents above 8A will lead to destruction of the controller.
- Ensure that the cables have an adequate cross-section, to avoid excessive losses and overheating in the cables.
- Use twisted cables for setpoint, tacho and motor cables. Tacho and setpoint cables must also be shielded. Observe the notes in Chapter II.2.1 .
- Earth the DC-link (Pin 28 or stud —GND/PE). A DC-link circuit which is not earthed can endanger the operator of the equipment, in the event of an earth short in the motor or fault currents in the GND lead. Furthermore,the electronics can be destroyed if the earth is missing when there is a fault. An earth short in the motor will no longer be recognised if the earth connection is missing.
- All earth connections must be led out from a common star point, to avoid earth loops and potential drops in the earth lead. Connect all earth leads to a PE busbar, for instance in the switchgear cabinet.
- **Do not earth the tachometer cable**, since one side of the tacho connection in the controller has a low-impedance connection to Analog-GND.
- Take care that the shielding is connected correctly :
  Tacho shielding to the controller (Pin 28/stud —GND/PE)
  or to the shielding connection terminal
  Setpoint shielding to CNC-GND on the controls (single ended)
  Motor cable shielding to the PE busbar, using a shielding terminal
- Loop the BTB contact (Pins 8bd or terminals 8,9) into the safety circuit of the system. Only so can you be sure that the controller-ready function is monitored.
- The ±15V auxiliary voltages must not be led out of the cabinet. This avoids capacitively or inductively induced interference.

Warning
Never connect or disconnect the transistor controller while the system is live.
In unfavourable circumstances this could result in the destruction of the electronics.
Capacitors can still have a residual charge up to 120 sec. after switching off the mains supply. Measure the voltage in the DC-link, and wait until it has fallen below 20V.
Even when the motor is not rotating, control and power cables can still be live.

II.2 Installation

Only professional staff who are qualified in electrical engineering are allowed to install the transistor controller.

The installation procedure is described as an example. A different procedure may be sensible or necessary, depending on the application of the equipment.

We provide further know-how through training courses (on request).

Warning !

Protect the transistor controller from impermissible stress.
In particular, components must not be bent or insulation distances altered during transport and handling.
Avoid touching electronic components and contacts.

Caution !

Only install and wire up the equipment when it is not live, i.e. when neither the mains power supply nor the operating voltages of any other connected equipment is switched on. Take care that the switchgear cabinet is safely disconnected (with a lockout, warning signs etc.).
The individual voltages will be switched on for the first time during commissioning.

Ground and PE symbols

The ground symbol ⏚ , which you will find in all the wiring diagrams, indicates that you must take care to provide an electrically conductive connection with the largest possible area between the component indicated and the mounting plate in the switchgear cabinet. This connection is for the effective grounding of HF interference. It must not be confused with the PE symbol ⏚ (protective measure to EN 60204) .

Grounding system and protective earthing

The DC-link circuit is earthed on one side, and supplied from the mains via an isolating transformer which has a screen winding.
The reference potentials 0V/GND/PE (DC-link –) and AGND (control electronics) are connected inside the instrument, for functional reasons.
The central connection to PE is made on the back-panel.

The following notes should make it easier for you to carry out the installation in a sensible sequence, without overlooking anything.

Site

19" rack module in a closed switchgear cabinet.
Follow Chapter I.6.2 .
The site must be free from conductive or aggressive materials.

Ventilation

Check that the transistor controller is properly ventilated and keep to the permissible ambient temperature, **Chapter I.6.2**.

Assembly

Mount the 19" rack module and peripheral components close together, on an **earthed** mounting plate in the cabinet (see II.2.1).

Cable selection

Select cables according to EN 60204 and our specification in Chapter I.6.3.

Grounding Shielding

EMC-conform shielding and earthing: see Chapter II.2.1
Earth the mounting plate, motor housing, isolating transformer, DC-link, and the CNC-GND of the controls (see Chapter II.2.1).

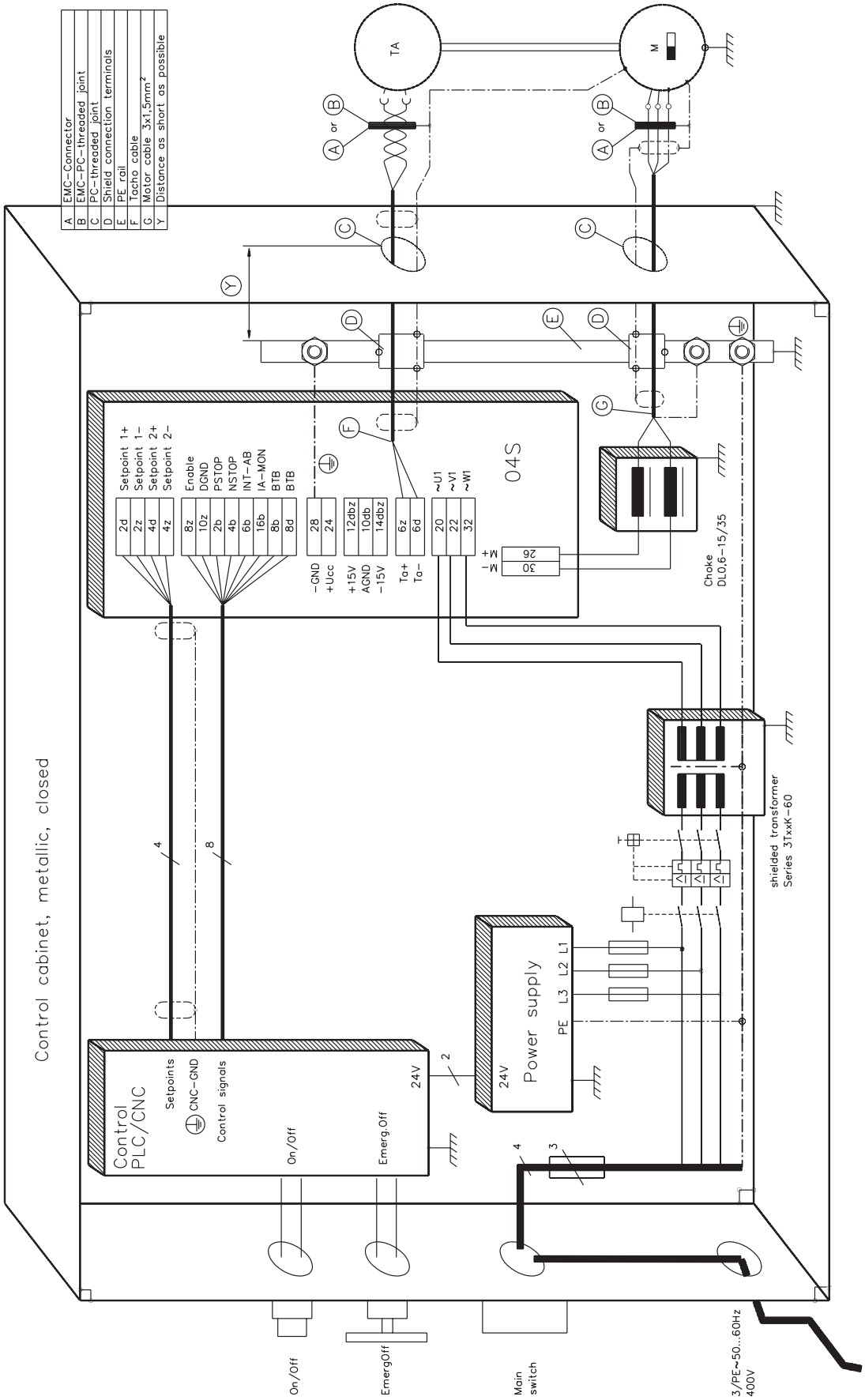
Wiring

— **Route power leads and control cables separately**
— **Loop the BTB contact into the safety circuit of the system**
— Connect up the logic/digital control inputs to the controller
— Connect up the analog setpoint input and AGND
— Connect the tacho, with all shielding connected to shielding terminals or EMC connectors
— Connect the motor leads, with the chokes close to the servo amplifier and shielding to shielding terminals or EMC connectors
— Connect the main power voltage (see Chapter I.6.2 for max. permissible values, use Seidel isolating transformer 3Txx)

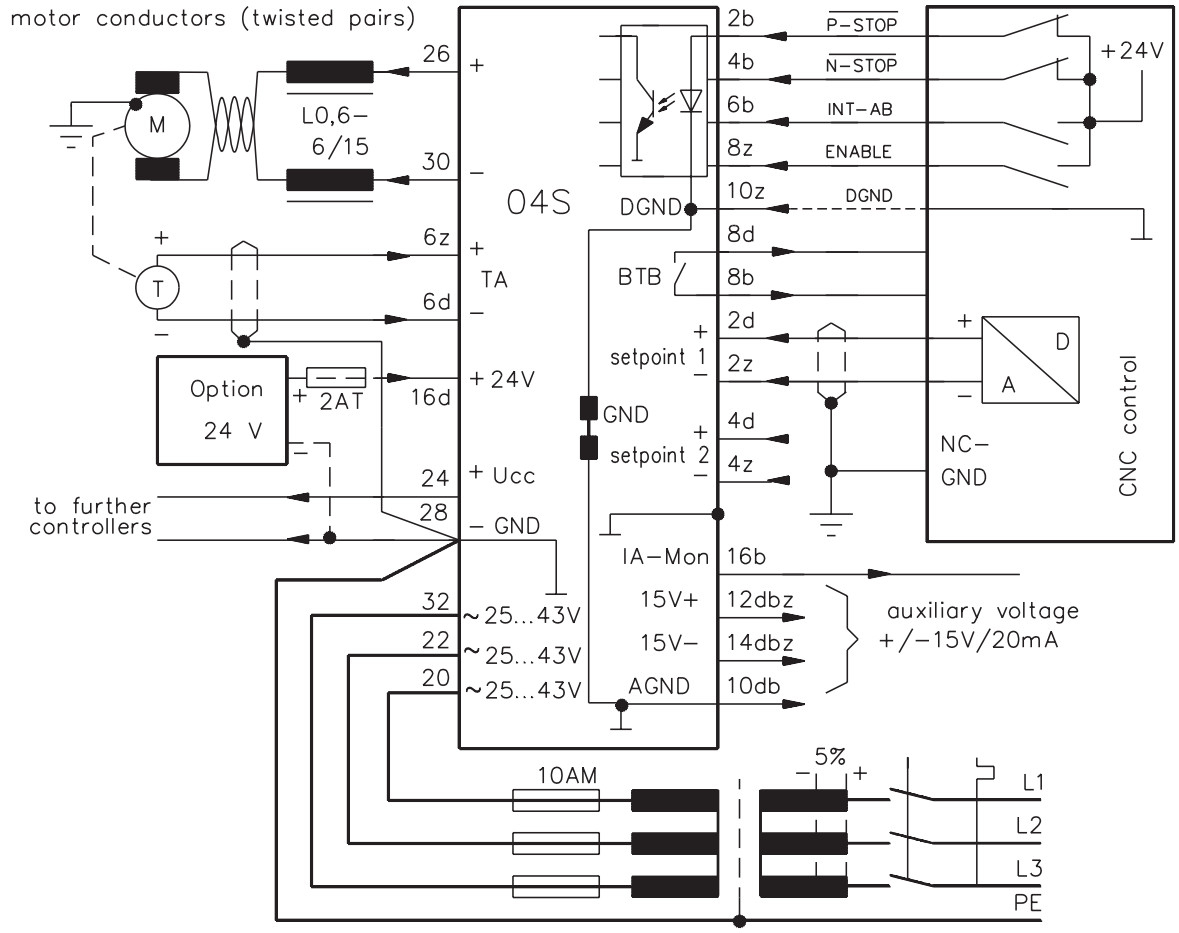
Final check

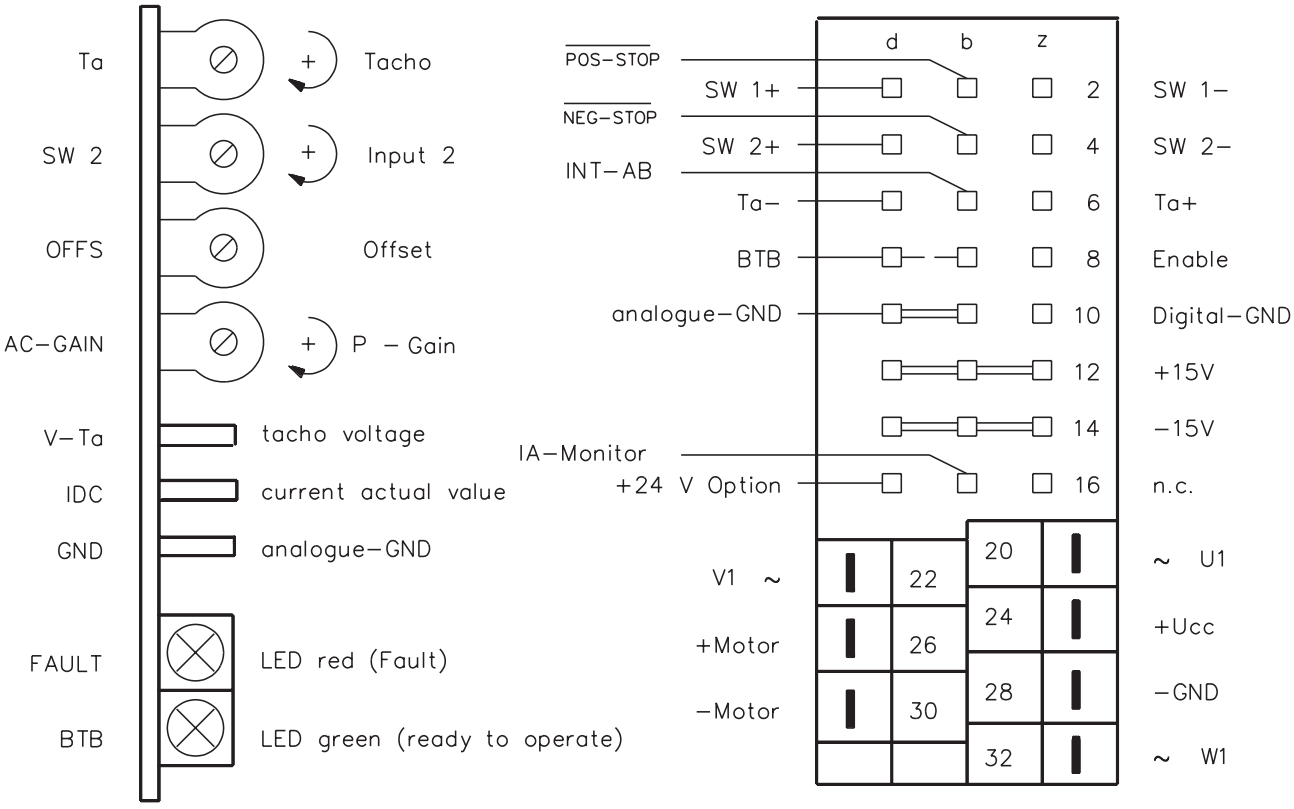
Final check of the implementation of the wiring according to the wiring diagrams which have been used.

II.2.1 CE - conform connections 04S, overview



II.2.2 Connection diagram 04S





II.2.3 Module back-panels F03SMB and R03SMB

Type: F03SMB for 04S controllers, connections at the back
R03SMB for 04S controllers, connections at the front

The module back-panels are attached from behind in the 19” module. The transistor controller is inserted into the module and plugged in to the back-panel. The electrical signals are made available on the back-panel through terminals, studs and flat-pin connectors.

You can find an illustration of the back-panels in Chapter V.3 .

The table below shows the assignments of the signals to the connector pins.

II.2.3.1 Pin assignments for 04S / F03S-MB

Edge conn. M7/24 (pin no.)	16-pin Combicon-conn. (terminal no.)	Signal designation	Short name (solder print)
2d	1	Setpoint 1+	SW 1 +
2b	10	Pos.Stop	PSTOP
2z	2	Setpoint 1-	SW 1 -
4d	3	Setpoint 2+	SW 2 +
4b	11	Neg.Stop	NSTOP
4z	4	Setpoint 2-	SW 2 -
6d	6	Tacho–	TA
6b	15	Integral Off	IAB
6z	5	Tacho+	TA
8d	8	System Ready-	BTB
8b	9	contact	BTB
8z	16	Enable	E
10db	12	Analog-GND (AGND)	GND
10z	---	Digital-GND (DGND)	---
12dbz	13	+ 15V	+ 15
14dbz	---	– 15V	---
---	14	---	-15/24
16d	---	24V-DC aux. voltage	---
16b	7	Armature current	R(IDC)
20	M6 stud	~25...43V	~ U1
22	M6 stud	~25...43V	~ V1
24	M6 stud	+ Ucc	+Ucc
26	Faston tab - 6.3	+ Motor	+M
28	M6 stud	– Ucc / Analog-GND	–GND/PE
30	Faston tab - 6.3	– Motor	–M
32	M6 stud	~25...43V	~ W1

II.2.3.2 Pin assignments for 04S / R03S-MB

Edge conn. M7/24 (pin no.)	20/2x10 pin Combicon conn. (terminal no.)	Signal designation	Short name (solder print)
2d	1	Setpoint 1+	SW 1 +
2b	10	Pos.Stop	PSTOP
2z	2	Setpoint 1-	SW 1 -
4d	3	Setpoint 2+	SW 2 +
4b	11	Neg.Stop	NSTOP
4z	4	Setpoint 2-	SW 2 -
6d	6	Tacho–	TA
6b	15	Integral Off	IAB
6z	5	Tacho+	TA
8d	8	System ready-	BTB
8b	9	contact	BTB
8z	16	Enable	E
10db	M6 stud/terminal	Analog-GND (AGND)	-GND/PE
10z	12	Digital-GND (DGND)	DGND
12dbz	13	+ 15V	+ 15V
14dbz	14	– 15V	– 15V
16d	24	24V-DC aux. voltage	+ 24V
16b	7	Armature current	IDC
20	terminal	~25...43V	W1
22	terminal	~25...43V	V1
24	M6 stud/terminal	+ Ucc	+Ucc
26	terminal	+ Motor	M+
28	M6 stud/terminal	– Ucc / Analog-GND	-GND/PE
30	terminal	– Motor	M–
32	terminal	~25...43V	U1

II.3 Commissioning

II.3.1 Important instructions

- Check that the instructions in Chapter II.1 have been followed.

- The correct step-by-step procedure for commissioning will help you to avoid causing any damage. If you require further information, please get in touch with our applications department.

- Controller setting, optimisation, and the configuration of circuit blocks by using the solder links is permitted.
  Any further manipulation will invalidate the guarantee.

- **Never connect or disconnect the modules when the system is live**
  This is vital to avoid burning out contacts, or even destroying entire circuit modules in the controller, and to avoid personal danger from fully charged capacitors.
  Residual charge in the capacitors can still have a dangerous level more than 120 sec. after switching off the mains supply.
  Connect or disconnect the controller only when the voltage is below the minimum threshold level. Watch the LEDs in the controller after the supply voltage has been switched off. After a short time the green LED will go out and the red LED will light up briefly. Now you can pull out or plug in the controller.

- Push the module carefully and completely into the rack housing, to ensure that the connectors make a good contact. Poor contact will lead to contact burnout.

II.3.2 Notes on commissioning

The procedure for commissioning is only described very briefly here. We can provide you with further know-how in one of our **training courses** (on request).

In multi-axis systems, commission each transistor controller individually.

Caution !

Check that all current-carrying connections are protected against accidental contact. The nominal DC-link voltage is 60V-DC.

Never disconnect any of the electrical connections to the transistor controller while it is live. Capacitors can still have a residual charge for more than 2 min. after switching off the mains supply.

The heat sink temperature on the transistor controller can reach 80°C in operation. Check (measure) the heat sink temperature. Wait until it has fallen below 40°C before you touch it.

Warning !

If the transistor controller has been stored for longer than 1 year, then first of all the
DC-link capacitors will have to be re-formed.
This is done by connecting the instruments to a voltage of not more than half the normal operating voltage (possibly via a limiter resistor).

Our applications department can give you detailed information on the re-forming procedure.

The following instructions should help you to carry out the commissioning in a sensible sequence, without causing any hazard to persons or machinery.

Check installation	Check that the wiring carried out matches the wiring diagram (transformer, motor, and earth connections, control signals).
	Check the instrument nameplates (rated voltage and current, special adjustment - if required).
	Test the emergency stop circuitry before the first switch-on.
Set up safe values	Reduce the gain (turn potentiometer AC-GAIN to left stop) for safety.
Commissioning the transformer	Pull out all the modules. Switch on the supply voltage, check the secondary AC voltage. Switch off the supply. Switch on the fan.
Make system safe	Plug in one transistor controller. Inhibit the Enable signal and check out the emergency stop function.
	***Caution !*** ***Make sure that any unintended movement of the drive cannot cause danger to machinery or personnel.***
Switch on supply	Switch on the supply.
Provide setpoint, Enable	Move the axis by switching on the Enable signal while a (small) setpoint is present.
Optimisation	Adjust the axis (AC-GAIN, OFFSET, TACHO – if these are not already set up).
Switch off supply	Switch off. Measure the DC-link voltage. Wait until the voltage has fallen below 20V.
Make system safe	Plug in, secure, and commission the other transistor controllers, one after another.

III Functions and Options

III.1 Important notes

- Alterations to the transistor controller can only be carried out by **professionally qualified personnel**.
  Setting and optimisation of the transistor controller, and the configuration of circuit blocks by using the solder links is permitted.
  Any further manipulation will invalidate the guarantee.
- The controller must be **recommissioned** after every alteration. See Chapter II.3 .

III.2 Description of the functions

III.2.1 Input functions

III.2.1.1 Setpoint inputs SW1, SW2

The transistor controller has two non-interacting differential inputs for the setpoints.
Input 1 has a fixed setting for differential input voltages of max. ± 10 V.
Input 2 is equipped with an adjustable attenuator (P 2),
range of adjustment 0 — 100%

— clockwise rotation increases the speed (increasing effect)
— a positive voltage on terminal 1 relative to terminal 2, or on terminal 3 relative to terminal 4 causes a clockwise rotation of the motor (looking at the shaft end) if it is correctly connected.

The common-mode voltage range (important to avoid earth loops) is an additional ±10V for both inputs, the input resistance is 20 kΩ.

III.2.1.2 Tachometer input Ta

P1 is provided for fine adjustment of the tachometer, the range of adjustment is 8 — 75V.
The fixed resistor **R106** determines the tachometer normalisation.
The standard components installed are dimensioned for tacho voltages of 8V or 75V at a setpoint voltage of 10V and with P1 on the right stop or left stop respectively.
Increasing R106 increases the tachometer voltage range.

III.2.1.3 Digital control inputs

All the inputs are **electrically isolated** by optocouplers. The ground reference is **Digital**-GND (DGND, pin 10z). The logic is designed for +24V/8mA (**PLC-compatible**) with a logic-high level of +12 — 30V.
Switching with +15V (terminal 13) is possible if required. In this case, Digital-GND (Pin 10z) and Analog-GND (pins 10db, terminal 12) must be joined.
As delivered, AGND and DGND are joined on the controller p.c.b. by a solder link.

If the back-panel p.c.b. F03S-MB is used, then Analog-GND (AGND) and Digital-GND (DGND) are accessible on the back-panel p.c.b., and can be linked there (pins 10db and 10z).

Enable input E

The controller output stage is activated by the Enable signal (input 24 V, **active high**, logic level 12 V — 30 V / 8mA referred to Digital-GND 10z, floating).
In the inhibited state, the motor which is connected is without torque, the integral portions of the speed and current controllers are also inhibited.

Limit-switch inputs $\overline{\text{PSTOP}}$, $\overline{\text{NSTOP}}$

Positive/negative limit-switches (terminals 10 / 11), **logic-high level in normal operation** (fail-safe against cable break). If an input signal is missing (limit-switch open) the corresponding direction of rotation is inhibited.

Integral-off input IAB (PIN 6b or terminal 15)

Logic-high level to change the speed controller over to **current control**.

III.2.2 Output functions

III.2.2.1 Armature current monitor output

The output (**IDC**, pin 16b or terminal 7) delivers ±10 V against AGND for ± **peak instrument current.** The measured value is nearly **proportional** to the **motor torque** which is delivered.
The output resistance is 2.2kΩ
This signal can also be used as a **current** setpoint signal for a second, 1:1 connected (slave) transistor controller in a tandem drive.
For operating the transistor controller as a 1:1 current controller, see Chapter III.3.1.

III.2.2.2 System ready contact BTB

The operational readiness (**BTB**, pins 8bd or terminals 8,9) is signalled via a **floating** relay contact **(100V / 0.1A DC).**

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

III.2.2.3 Measurement points

- **Armature current** monitor **(IDC**), normalisation ±10V for ± **peak instrument current**, output impedance 2.2 kΩ, reference point is Analog-GND.
- **Tacho monitor (VTA)** , the voltage corresponds to the tacho voltage.
  The reference point is Analog-GND.

III.2.3 Adjustment facilities

III.2.3.1 Tachometer potentiometer P1

The potentiometer P1 is used for the fine adjustment of the tachometer. The range of adjustment is 8 — 75 V.

The standard components installed are for tacho voltages of 8V or 75V at a setpoint voltage of 10V and with the potentiometer on the right stop or left stop respectively.

III.2.3.2 Setpoint potentiometer P2

Potentiometer 2 is used as an attenuator for the setpoint input 2.
Turning the pot. to the right increases the speed.
(range of adjustment 0 — 100%)

III.2.3.3 Offset potentiometer P3

The offset potentiometer P3 is used to compensate for error voltages which may be present in the operational amplifier or the setpoint voltage source (control) at a setpoint = 0V.
Make the adjustment with the transistor controller activated (enabled) and setpoint voltage = 0V so that the motor is at standstill.

III.2.3.4 AC-GAIN potentiometer P4

The proportional gain of the **PI** speed controller can be increased by turning P4 to the right (the control loop becomes stiffer). When the potentiometer is at the left stop, R24 fixes the basic gain at about 15.

The integral section is fixed by C4 at 150kΩ x 0.1μF = 15ms. Increasing C4 makes the control loop slower (softer) . Reducing C4 improves the response of the controller, but increases the tendency to oscillation. The standard components fitted will only need to be changed in very few cases.

The setting of P4 is made, while the amplifier is activated and the motor is at standstill (setpoint voltage = 0 V), by turning it to the right, up to the threshold of oscillation (this can be seen very clearly on an oscilloscope connected to the current monitors) and then turning it back until it is **clearly** below the threshold of oscillation.

R112 limits the gain for the I-section at very low frequencies to about 5000.

C33 limits the P-gain at medium frequencies (1ms time constant).

III.2.4 Other functions

III.2.4.1 Effective (r.m.s.) current I_{RMS}

The controller is capable of delivering the peak instrument current I_{PEAK} for a maximum of 5s, after which it is limited to the preset rated current I_{RMS} . To adjust for the permissible effective motor current, which is the determining factor for heating, I_{RMS} can be reduced according to the following table.

Amp. type	04S-M60/8	04S-M60/12
I-RMS	R I_{eff} [R145]	R I_{eff} [R145]
2A	82 Ω	82 Ω
3A	180 Ω	180 Ω
4A	390 Ω	390 Ω
5A	680 Ω	680 Ω
6A	1.2 kΩ	1.2 kΩ
7A	1.8 kΩ	1.8 kΩ
8A	2.7 kΩ	2.7 kΩ
9A	—	4.7 kΩ
10A	—	10 kΩ
12A	—	not fitted

The time t, during which the pulse current can be drawn, alters with I_{RMS} as below

$$t = \frac{25s}{\frac{I_{PEAK}^{\ 2}}{I_{RMS}^{\ 2}} - 1}$$

III.2.4.2 Peak current I_{PEAK}

As delivered, the basic adjustment for the transistor controller is set to 20A pulse current (I_{PEAK}). If the motor which is connected to the transistor controller or the control system requires lower values, then I_{PEAK} must be changed according to the following table.

04S-M60/8/12	
I_{PEAK}	R_{Imax} [R144]
4A	390 Ω
6A	680 Ω
8A	1 kΩ
10A	1.2 kΩ
12A	1.8 kΩ
15A	3.3 kΩ
20A	not fitted

III.2.4.3 Frequency response of the transistor controller

The basic setting is dimensioned for a bandwidth of 1kHz, so the delay time is insignificantly short. An alteration of the basic setting should only be considered in exceptional circumstances, and after consultation.

III.2.4.4 I^2t - monitoring

When the preset effective (r.m.s.) current limit is reached, the pulse current is limited until the effective loading falls.

This does **not** affect the BTB (system ready) signalling.

III.2.4.5 Indicators

Red and green LEDs for system-ready (BTB) and combined fault [FAULT]

The **green** LED lights up when the DC-link voltage is present and the auxiliary voltage supply (±15V) is functioning properly. The transistor controller is ready to operate when the green LED lights up **and** the red LED **does not** light up.
The BTB contact (floating n.o. (make) contact **100V / 0.1A** , pins 8bd or terminals 8,9) is closed when the transistor controller is ready to operate.
The **red** LED lights up on

- overcurrent (short-circuit / earth short)
- overvoltage (excessive peak ballast power)
- undervoltage of the aux. supply (< 18V)
- overheating of the heat sink (> 90°C)

In all cases, the BTB- signal is interrupted if a red LED lights up (fault signalling).
You can reset the signal, after the fault has been cleared, by switching the mains supply (or the 24V aux. supply) off and on again.
See Chapter V.2 for the layout of the LEDs.

III.3 Options

III.3.1 1:1 - control

You can change the speed controller over to **current control** by closing the solder link **LB 1:1.** The **proportional** section of the amplification is set to **1** in this case, the **integral** section is **bridged** and the **tacho signal** is **switched off** internally.

This affects both setpoint inputs

III.3.2 IxR - control

To convert to **armature voltage control** (without a tachometer) with IxR compensation, first of all **two solder links IxR/TA** must be soldered into the position **I x R** (standard setting: TA). **Only input 1** is available as a setpoint input. The unloaded speed can be set on P1 for a given setpoint voltage. A setpoint voltage of 10V produces an armature voltage of 40V with P1 on the right stop.

Afterwards, the I x R positive feedback can be adjusted at a setpoint = 0V by turning P2 (IN2) to the right up to the threshold of oscillation – with the motor **cold.**
The range of adjustment of P2 is from about 0 Ω up to about 5 Ω armature resistance.

III.3.3 Option -24V-, external 24V auxiliary voltage

As delivered, the auxiliary supply is fed from the DC-link circuit. If Option -24V- is activated in the transistor controller, then you can run the auxiliary supply from an external 24V DC source. The supply is then provided via pin 16d or terminal 14 against **-GND**

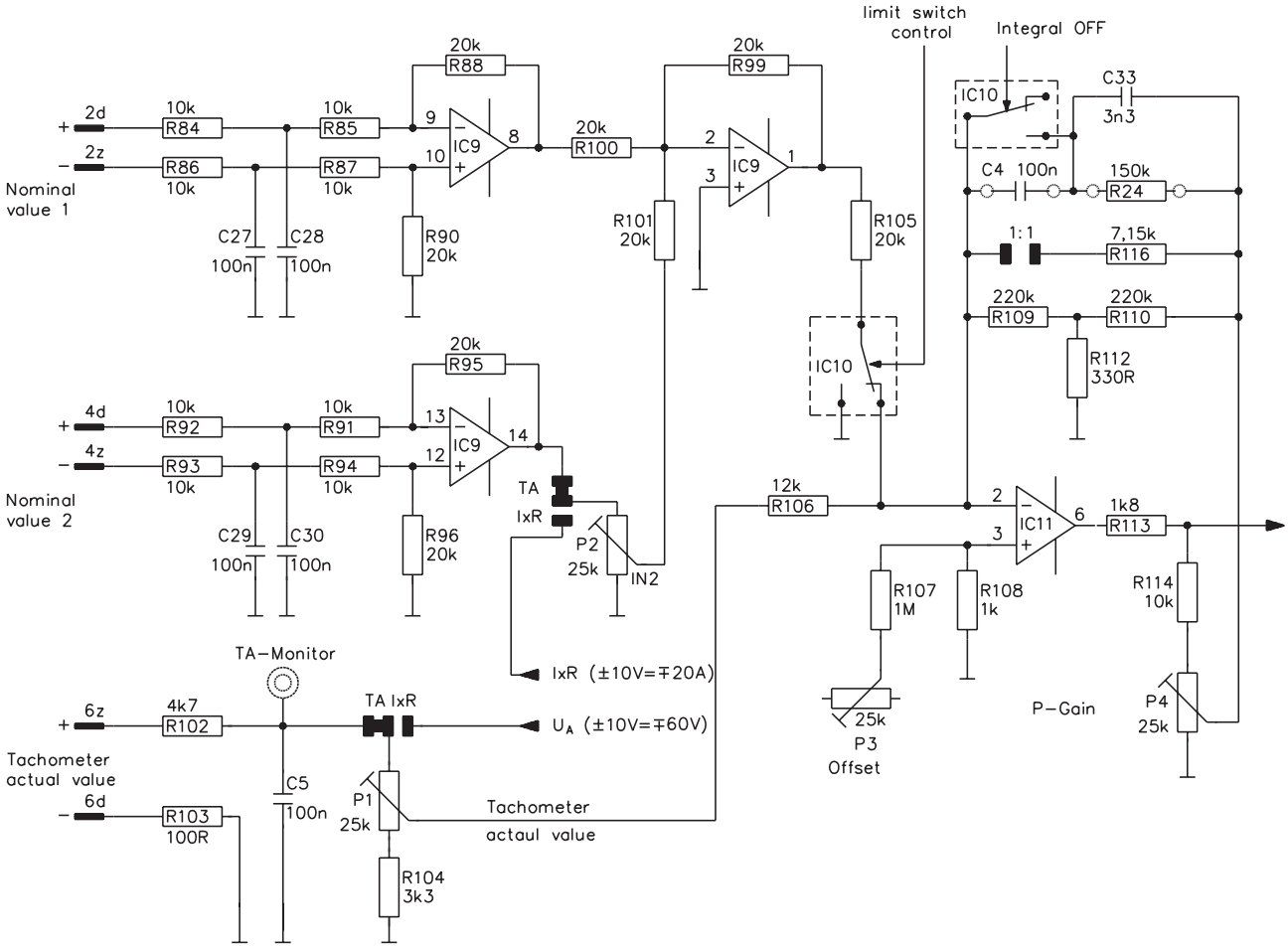
Advantages :
- BTB signal is available independently of the main power supply
- Fault signals remain stored in the transistor controller, even when the main supply is switched off.
- You can supply the DC-link from a very reduced voltage, allowing for the control loop stability. This can be useful, for example during setting up

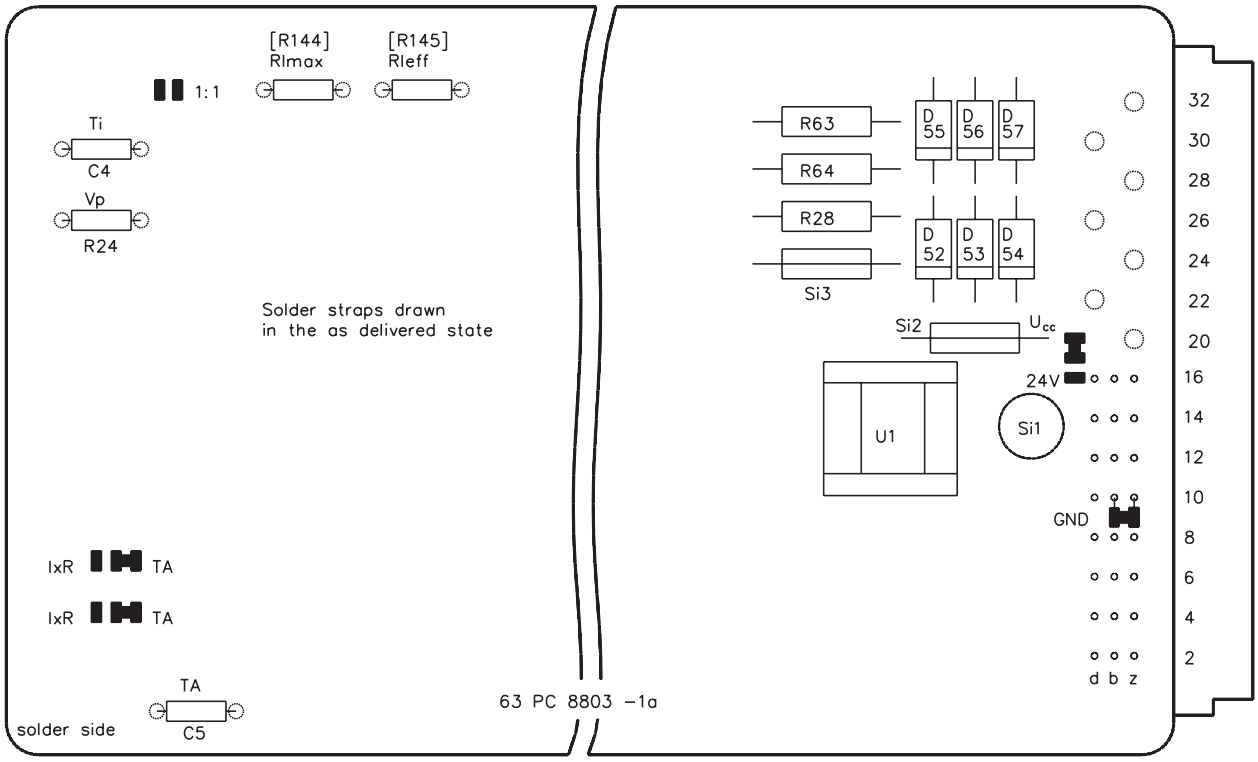
Disadvantage : Additional power supply needed

The switch-on threshold of the transistor controller is always 18V, so that 24V-**battery operation is also possible without the 24V option.**

In order to use this option, the solder links Ucc / 24V must be changed over to 24V (standard setting : Ucc).
When the back-panel p.c.b. F03SMB is used, the solder link -15V / 24V (see III.3.4) must be changed over to 24V.

III.3.4 Layout of the solder links





IV Peripheral components

IV.1 Isolating transformers

Isolating transformers are required to operate the equipment. In order to ensure that the installation functions properly and the guarantee conditions are fulfilled, the isolating transformers must meet the following specification:

Type: 3-phase isolating transformers, with a screen winding to VDE 0550, in Y/y or Y/Δ configuration.

Primary voltage: 400V with ±20V taps for adaptation to diverging mains supply conditions. We recommend using the 420V tap.

Secondary voltage: For 60V DC-link voltage: 43V~
The secondary star point must not be grounded.

Off-load voltage: (secondary) The permissible off-load voltage rise is approx. 4%

Short-circuit voltage: The relative short-circuit voltage U_K must be in the range 4% + 1%, in order to protect the rectifier diodes when switching on and in the event of overvoltage, in accordance with EN 50178.
A soft-start is necessary for transformers rated above 3kVA (for single axis systems) or 8kVA (for multi-axis systems).

Power factor: The loading of the transformer with a 3-phase bridge rectifier results in a power factor λ of 0.9.

Overload behaviour: The short-term overload which is typical for servo operation must not cause damage to the transformer or result in voltage drops which are larger than the U_K values.

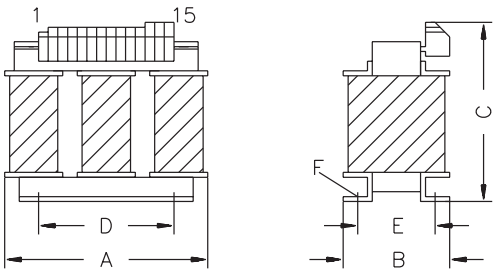
Warning !

Using a transformer which does not meet the above specification will affect the security of operation and could lead to damage to the transistor controller. We can only guarantee the functionality of the transistor controller if Seidel transformers are used (see below).

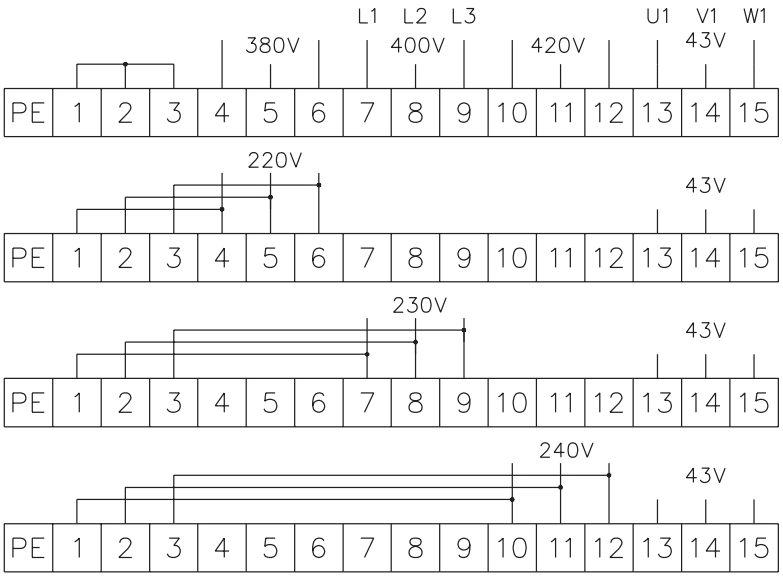
Seidel isolating transformers (3-phase, rated primary voltage 400V)

Type	Power / kW	Sec. voltage / V	Order- no.
3T0,7K-60	0.7	43	54164
3T1,5K-60	1.5	43	55028
3T3,0K-60	3.0	43	55618

IV.1.1 Transformer dimensions and connections



Type		Dimensions in mm						Weight
	Phase	A	B	C	D	E	F	kg
3T0,7K60	3	180	110	195	120	86	8x12	9,2
3T1,5K60	3	228	140	235	152	105	8x12	18,8
3T2,0K60	3	240	145	260	143	110	8x12	22,0
3T3,0K60	3	300	155	310	200	92	10x15	35,0

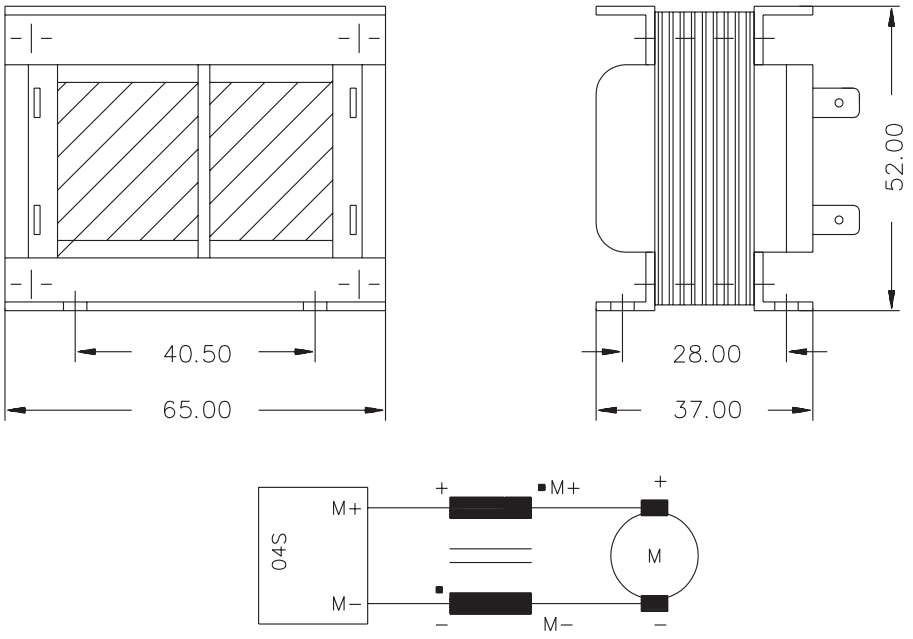


Other primary voltages available on request

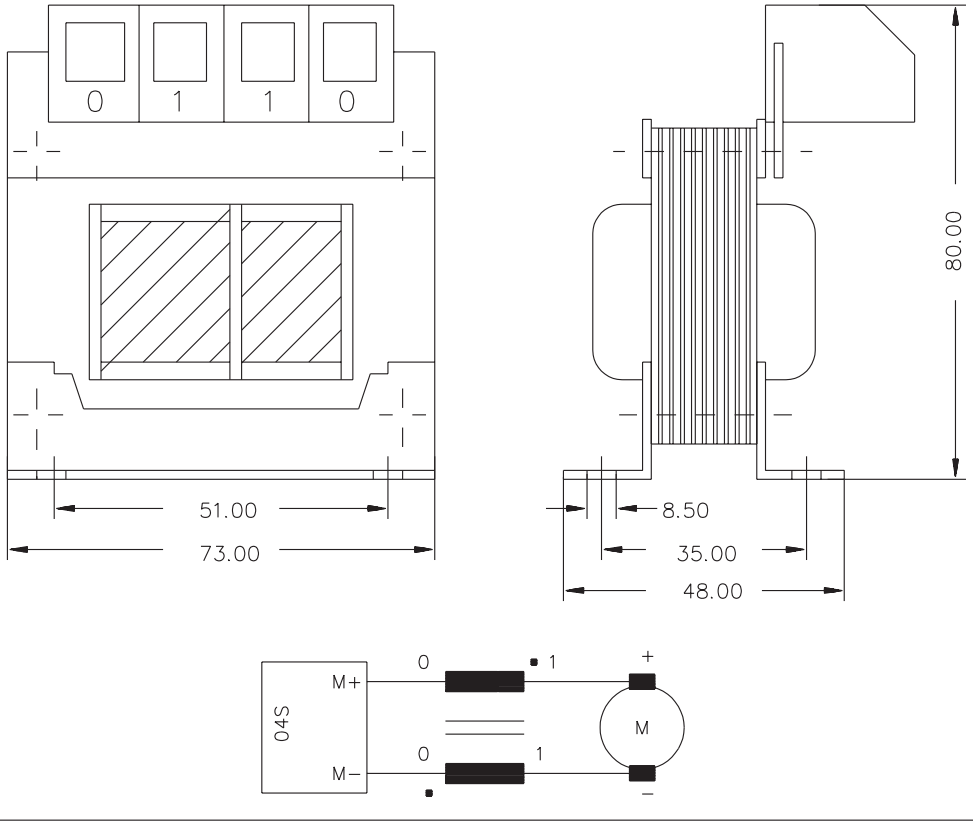
IV.2 Chokes

IV.2.1 Choke dimensions and connections

DL 0,6–6/15 , for 04S–M60/8



DL 0,6–15/35 , for 04S–M60/12



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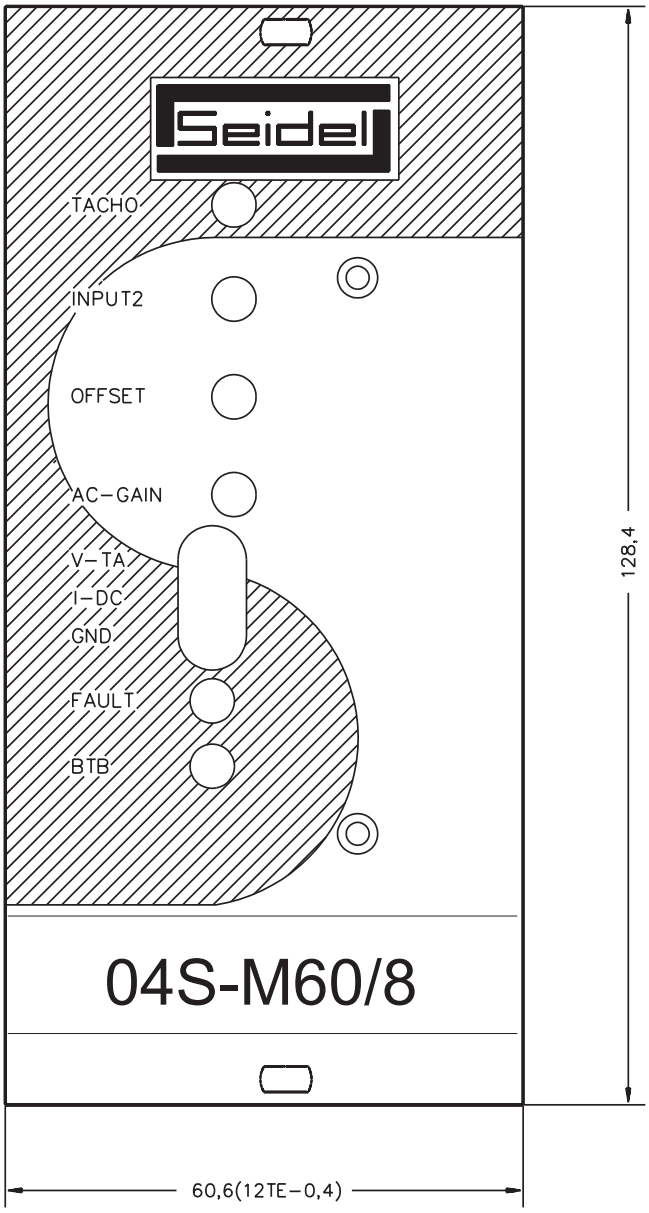
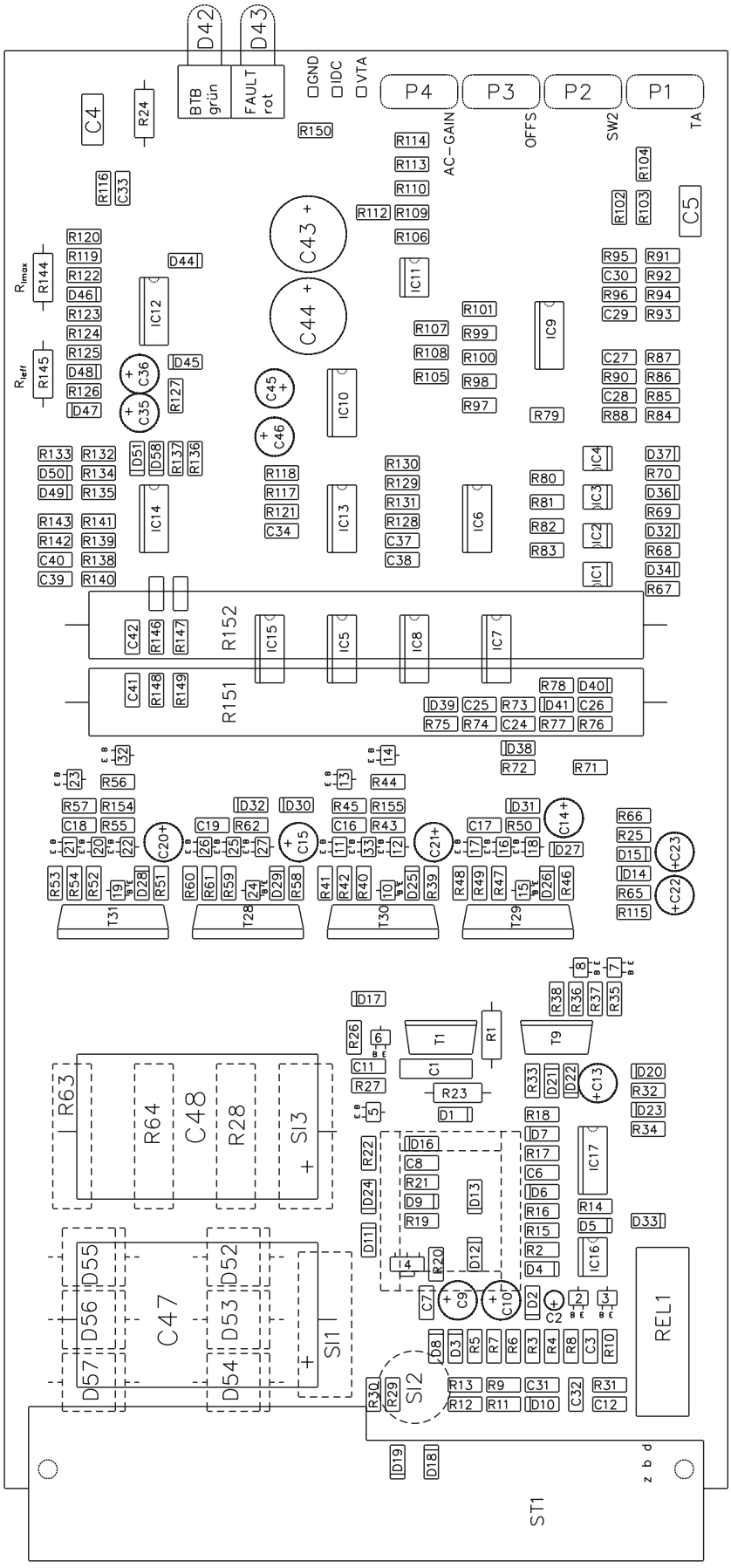
V Drawings

V.1 Front panel 04S (12TE), optional

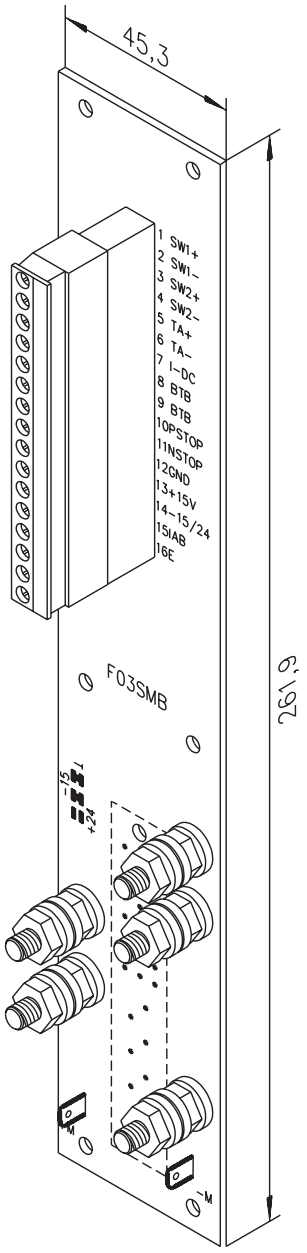
(TE = width units)



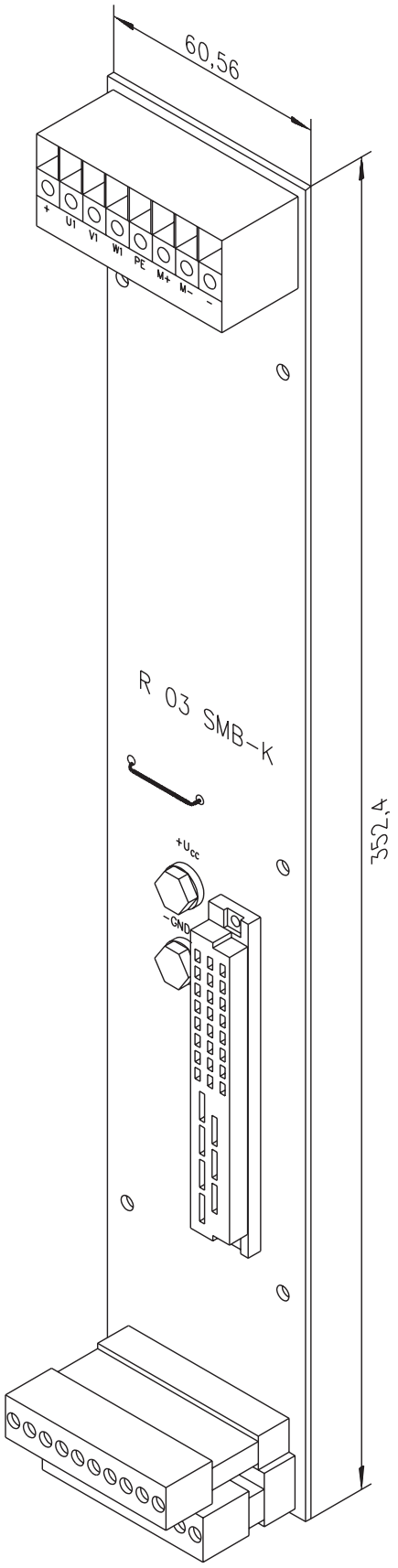
V.2 Component layout 04S



V.3 Back-panels F03SMB / R03SMB



F 03 SMB



R 03 SMB

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VI Appendix

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

Delivery package :
- 1 series 04S transistor controller
- installation/commissioning manual for 04S
- accessories as ordered (back-panels, 19" components)

Transport :
- only be qualified personnel
- only in the manufacturer's original recyclable packaging
- avoid shocks
- the transistor controllers contain electrostatic-sensitive components, which can be damaged by incorrect handling.
  Discharge yourself before touching the transistor controller.
  Avoid touching highly insulating materials (artificial fabrics, plastic films etc.). Place the transistor controller on a conductive surface.
- if the packaging is damaged, check the unit for visible damage.
- In this case, inform the shipper and the manufacturer.

Storage :
- only in the manufacturer's original recyclable packaging
- the transistor controllers contain electrostatic-sensitive components, which can be damaged by incorrect handling.
  Discharge yourself before touching the transistor controller.
  Avoid touching highly insulating materials (artificial fabrics, plastic films etc.). Place the transistor controller on a conductive surface.
- max. stacking height 15 cartons
- storage temperature –25 ... +85°C, max. 20°C/hr variation
- humidity relative humidity max. 95% , no condensation
- storage duration < 1 year without restriction
  > 1 year : the capacitors must be **re-formed** before commissioning the transistor controller. Contact our applications department for information on how to do this.

Maintenance :
- the instruments do not require any maintenance

Cleaning :
- if the front panel is dirty : clean with isopropanol or similar
  do not immerse or spray
- if there is dirt inside the unit : to be cleaned by the manufacturer

Disposal :
- the transistor controller can be reduced to its principal components by unscrewing it (aluminium heat sink and front panel, electronics boards)
- disposal should be carried out by a certified disposal company.
  We can give you suitable addresses.

VI.2 Fault-finding

The table below should be regarded as a “First-aid” box. There may be a wide variety of possible reasons for a fault, depending on the conditions in your system.

Multi-axis systems may conceal further causes of a fault.

Our applications department can give you further assistance with problems.

Fault	possible causes	ways to remove the cause of the fault
BTB-LED not lit	— break in supply voltage	— 04S : check U1,V1,W1 -24V-: check 24V supply
	— fuse S1 or S2 blown	— replace fuse
FAULT-LED lights up	— motor faulty	— replace motor
	— motor cable fault	— replace motor cable
	— output stage too hot	— ensure adequate ventilation, check/clean fan, reduce cabinet temperature
	— amplifier faulty	— return amplifier to manufacturer
motor does not rotate, no torque on the shaft	— Enable signal is missing	— check wiring
	— DGND missing	— check wiring, LB2
motor does not rotate, but shaft has torque	— break in setpoint cable	— check setpoint cable
	— limit switch is activated	— check PSTOP/NSTOP
	— brake not released	— check brake control
	— drive is mechanically blocked	— check mechanism
motor runs away	— motor connection faulty	— connect motor phases correctly
	— tacho cable faulty	— check cable
	— fault in motor tacho	— repair motor
motor oscillates	— AC-gain is too high	— turn AC-gain potentiometer anticlockwise
	— break in tacho cable shielding	— replace tacho cable
	— AGND not wired up	— connect AGND to CNC-GND

VI.3 Glossary

A	AC-gain, P-gain	proportion gain of a control loop
B	ballast circuit	converts superfluous energy, which is regenerated by the motor during braking, into heat in the ballast resistor.
C	common-mode voltage	amplitude of the common-mode disturbance which can be eliminated by a differential input
	continuous ballast power	the average power which can be dissipated by the ballast circuit
	current controller	regulates the difference between the current setpoint value t and the actual current to 0. Output : power output voltage
D	DC-link	rectified and smoothed supply voltage for the power stages
	disable	removal of the ENABLE- signal (0V or open)
E	earth fault	electrically conductive connection between a phase and PE
	Enable	enable signal for the transistor controller (+24V)
F	four-quadrant operation	the motor can drive and brake in both directions of rotation
	free convection	free movement of air for cooling
I	I²t threshold	monitoring of the actually required effective (r.m.s) current Irms
	input drift	temperature/age dependent drift of an analog input
	Ipeak, peak current	effective value of the peak current
	Irms, effective current	effective (root-mean-square) value of the current
L	limit switch	limit switch in the traverse path of the machine; function: break (n.c.)
M	machine	the complete assembly of all components or devices which are joined together, of which at least one is movable
	monitor output	output of an analog measurement value
	multi-axis system	a machine with several independent drive axes
O	opto-coupler	optical connection between two electrically independent systems
P	P controller	a control loop which functions purely proportionally
	PID- controller	a control loop with proportional, integral and differential elements
	potential isolation	electrically decoupled
	pulse power of the ballast circuit	maximum power which can be dissipated in the ballast circuit
R	ring core	ferrite rings for interference suppression
S	short-circuit	here: an electrically conductive connection between two phases
	speed controller	regulates the speed difference between the speed setpoint value SW and the actual speed to 0. Output : current setpoint
T	tacho time constant	filter time constant in the speed feedback of the control loop
	tacho voltage	a voltage proportional to the actual value of the speed
	thermostat contact	a temperature-sensitive switch built into the motor winding
	transistor controller	a control device for regulating the speed and torque of a servo motor

VI.4 Index

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