

MANUAL

Thyristor motor controller

Classic P1

1 Quadrant

Part 1 **Thyristor motor controller P1**

Part 2 **Analogue Control Electronics REG-xx**



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1 Basic - Informationen

1.1 Safety advice

Electronic equipment is not fault proof.

Attention – High voltage
AC250/440V~ - DC 180/300V=
Shock hazard / Danger of life!!



Before installation or commissioning begins, this manual must be thoroughly read and understood by the technical staff involved.

The devices are electrical equipment (EB) to the power electronics for the control of power flow in electrical power systems.

Protection rating IP00.

**Control and power connections can
voltage lead, works without the drive!**

Measured before disassembly voltage!



1.2 Standards and guidelines:

The device and its associated components can only be installed and switched on where the local regulations and technical standards have been strictly adhered to:

EU Guidelines:	2004/108/EG, 2006/95/EG, 2006/42/EG EN 60204-1, EN292, EN50178, EN60439-1, EN61800-3, ECE-R100 ISO 6469, ISO 26262, ISO 16750, ISO 20653, ISO12100
IEC/UL:	IEC 61508, IEC364, IEC664, UL508C, UL840
VDE Regulations:	VDE100, VDE110, VDE160
Trade body guidelines:	VGB4

The user must ensure that in the event of:

- device failure
- incorrect operation
- loss of regulation or control

the axis will be safely de-activated.



It must be ensured that the machines, equipment or vehicles are fitted with device independent monitoring and safety feature.

Non-earthed systems (e.g. vehicles) need to be secured isolation monitors.



There must be no danger to persons and property arising!

Assembly

- should only be carried out when all voltages have been removed and the units are secured
- should only be carried out by suitably trained personnel

Installation

- should only be carried out when all voltages have been removed and the units are secured
- should only be carried out by suitably trained personnel for electricians
- should only be carried in accordance with health and safety guidelines

Adjustments and programming

- should only be carried out by suitable trained personnel with knowledge in electronic drives and their software
- should only be carried out in accordance with the programming advice
- should only be carried in accordance with health and safety guidelines

CE

When mounting the units into machines and installations the proper operating of the units may not be started until it is ensured that the machine, the installation, or the vehicle comply with the regulations of the EC machinery directive 2006/42/EG and the EMC guideline 2004/108/EG.

On the installation and test conditions described in the chapter CE-advice it is adhered to the EC guideline 2004/108/EG including the EMC standards EN61000-2 and EN61000-4.

A manufacturer's declaration can be requested.

The manufacturer of the machine or installation is responsible for observing the threshold values demanded by the EMC laws.

QS

The devices are archived with serial number and the test data from the manufacturer for 5 years.

The inspection reports may be requested.

1.3 General and features

This manual describes the basic unit and is only in connection with the manual of the control electronics (e.g. REGxx) valid.



Manual use in connection with:

- an analogue control **REGxx**
- options

Build

- switch cabinet mounting a
- according to the VDE, DIN and EU regulations
- standard control electronics REG
- intrinsically safe power section with current control loop
- optional units

Galvanic isolation between

- the power section and the housing
- the power section and the control electronics

The distance of air gaps and leakage paths adhere to the VDE standards (>8mm).

Components

- fully insulated thyristor modules, comfortably over-dimensioned
- only components customary in trade and industrially standardized are used
- LED displays
- DIP-switches for the PI-adjustment of the current control loop
- precision potentiometers for fine adjustments
- plug-in jumpers for the system set-up

Characteristics

- Series Classic P1
- Thyristor drive for dc motors
- Power range 2,7kW to 12 kW
- Drive in the first quadrant
- Fast analogue current control
- 26-pin interface
- Features of the control electronics
- See manual REGxx or third-party product documentation
- Optional units

1.4 Technical Data

P1 230/180-x

Power connection:	200 ... 250V~
Auxiliary voltage connection:	200 ... 250V~
Output voltage:	max. +180V=
Cooling:	self

P1 230/180-x			15	25	40
Input current		A~	16,5	27,5	44
Output current	- peak 5s	A=	30	50	80
	- continuous	A=	15	25	40
El. power		kW	2,7	4,5	7,2
Input fuses	input	ff	20	30	50
Main choke		Typ	K78-16	K84-25	K84-50
		mH	1,2	0,7	0,5
Armature chokes		Typ	EI135A-16	EI135B-24	EI150B-35
		mH	33	16	8
Dimension W x H x D		mm	200x160x112	200x160x120	200x160x120
Weight		kg	2,10	3,10	3,50

P1 400/300-x

Power connection:	360 ... 440V~
Auxiliary voltage connection:	360 ... 440V~
Output voltage:	max. +300V=
Cooling:	self

P1 400/300-x			15	25	40
Input current		A~	16,5	27,5	44
Output current	- peak 5s	A=	30	50	80
	- continuous	A=	15	25	40
El. power		kW	4,5	7,5	12
Input fuse	input	ff	20	30	50
Main choke		Type	K78-16	K84-25	K84-50
		mH	1,2	0,7	0,5
Armature chokes		Type	EI135A-16	EI135B-24	EI150B-35
		mH	33	16	8
Dimension W x H x D		mm	200x160x112	200x160x120	200x160x120
Weight		kg			3,50

1.5 Specification

Specification

Mains frequency	50 or 60Hz $\pm 5\%$
Protection rating	IP 00
Format	VDE 0100 groupe C, VDE 0160
Humidity rating	class F acc. to DIN 40040
Site of installation	< 1000m above sea level
Operating temperature range	0 ... 45°C
Extended operating temp. range	up to 60°C reduced 2%/°C
Storage temperature range	-30°C to + 80°C

Current control loop circuit

Amplification	
- input signal	0... + 10V=
- output signal	0... + 200% type current
Enable	+10V
Control precision	$\pm 2\%$
Control range	>1:50
Speed control loop circuit (with REG)	
Control precision (without actual value error)	$\pm 0.1\%$
Control range	> 1:200

1.6 Interface

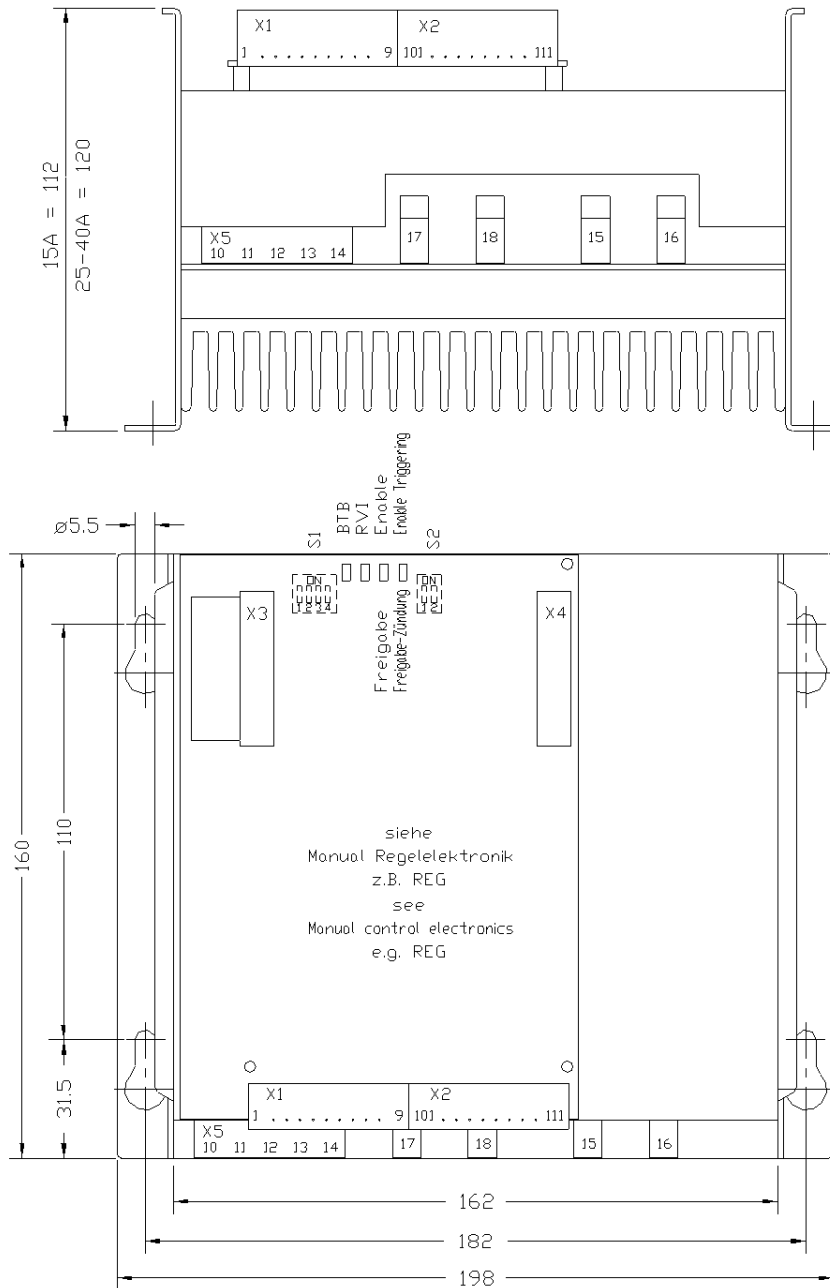
Interface control electronics X3

Function		Connector no
+ 24V	$\pm 10\%$	X3: 1 and 2
+ 15V	$\pm 2\%$	X3: 3 and 4
- 24V	$\pm 10\%$	X3: 5 and 6
- 15V	$\pm 2\%$	X3: 7 and 8
Device GND	0	X3: 9, 10, 11, 12, 13, 14
I command value (GND)	0	X3: 15
I command value (Signal)	+10V=	X3: 16
Current controller enable	+10V=	X3: 17
Drive disable 1	+10V=	X3: 18
Drive disable 2	+10V=	X3: 19
n (speed) actual	+5V=	X3: 20
I- (current) actual	+5V=	X3: 21
Over current power section	n.B. (not occupied)	X3: 22
Trigger angle 1	+10V=	X3: 23
Trigger angle 2	+10V=	X3: 24
Drive ready BTB	+10V=	X3: 25
not assigned	n.a.	X3: 26

Mechanical installation

2 Mechanical installation

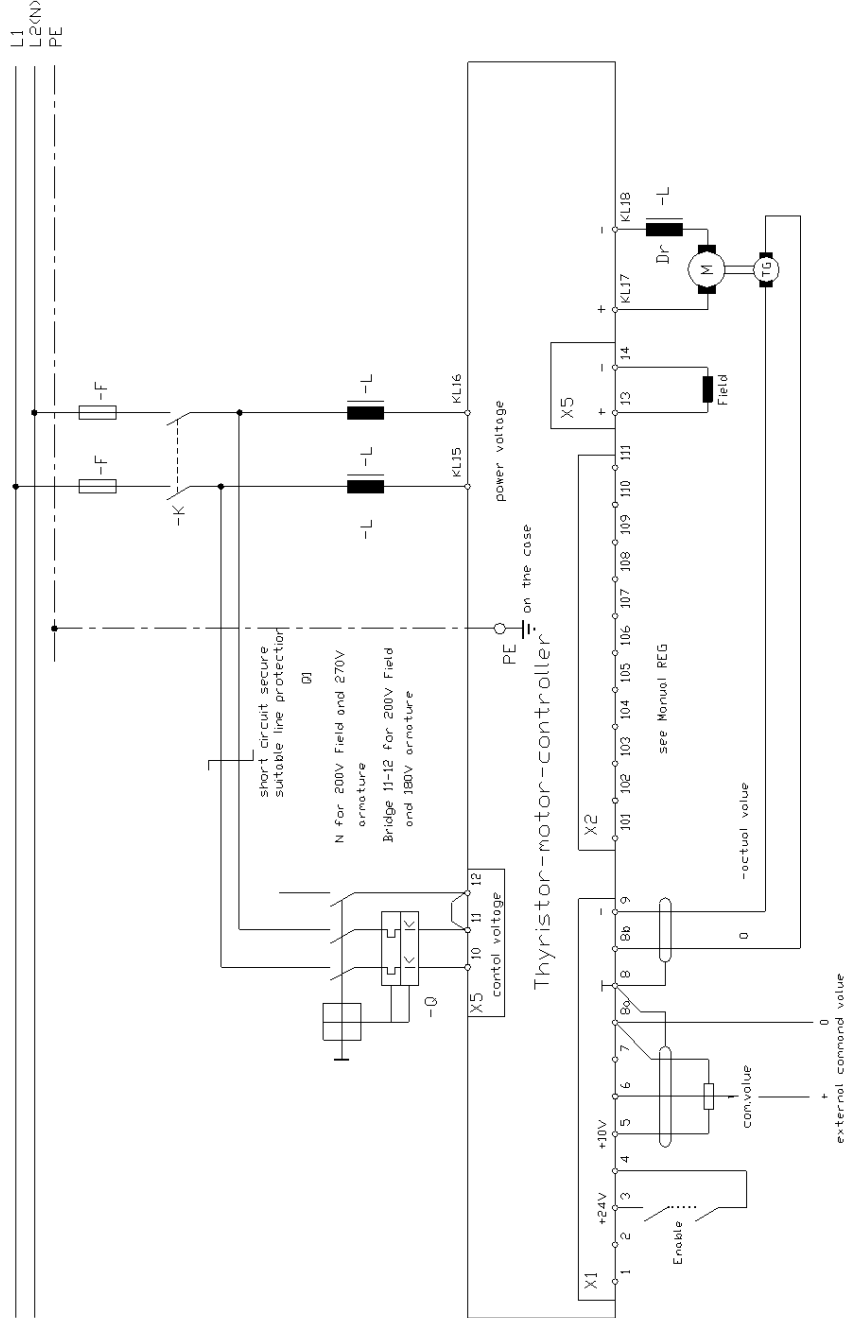
2.1 Mounting / Dimensions



P1-Mass-1

3 Electrical installation

3.1 Connections/ Connection diagram



P1-A020

3.2 CE – Advice

The devices adhere to the EU guidelines 89/336/EWG and the technical standards EN61000-2 and 61000-4 provided that the following conditions are observed:

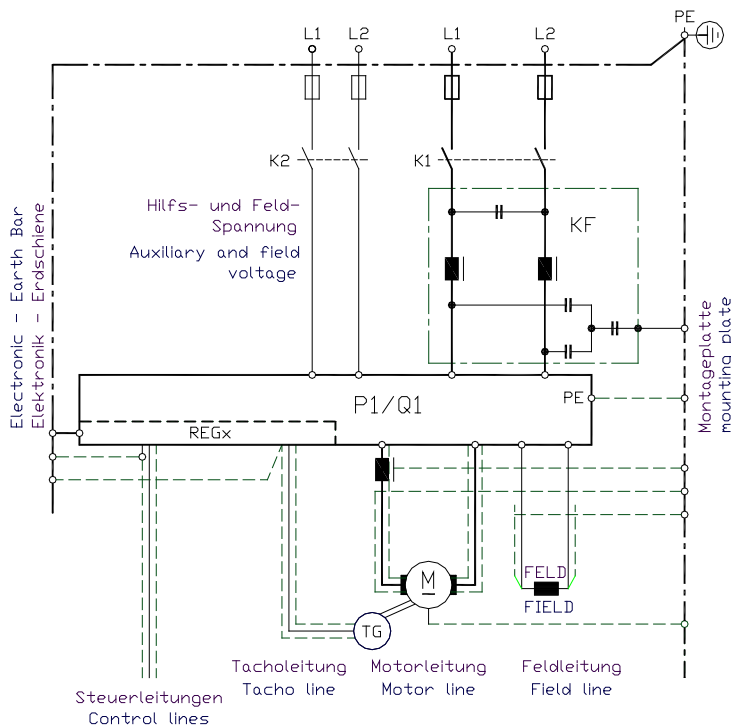
- the device, the power choke and the filter capacitors are mounted on a 500x500x2 mm mounting plate.
- The mounting plate must be connected to ground using a 10mm² wire.
- The motor housing must be connected to ground using a 10mm² wire.
- The device ground X1:8 must be connected to the mounting plate using a 2,5mm² wire.
- Device PE screw be connected to the mounting plate using a 4mm² wire , l = 50mm

Connection:

Power choke type: see technical data
 Filter capacitors: 0.5µF/600V~ 2 x 1µF (x) + 1 x 0,5µF (y)
 Conductor length between the device and the power choke <250mm

Motor connection:

Motor conductors l = 1.5m, shielded
 Tacho and all control lines l = 1.5m, shielded
 Shielding connected to PE



KF = Kommutierungsdrössel mit Filterkondensatoren
 KF = Commutation choke with filter capacitor

P1-Q1-Aufbau-EMV-1266

The connection instructions are for general information and are not binding.

Attention:

The order of the connections to the connector numbers or screw terminals is obligatory.
All further advice is non-obligatory.

The input and output conductors may be altered or supplemented in accordance with the electrical standards.

Note:

- Connection and operating instructions
- Local regulations
- EG-guideline 89/392/EWG, 84/528/EWG, 86/663/EWEG
- VDE, TÜV regulations and Trade body guidelines
- CE advice, EMC



Connection				
Conductor minimal cross - section				
Type current	A	15	25	40
ac power supply Cross sectional minimal	mm²	1,0	2,5	4
Motor line Cross sectional minimal	mm²	1,0	2,5	4
Auxiliary voltage Cross sectional minimal	mm²	0,5	0,5	0,5

Electrical installation

3.3 Power supply

Switch on: the auxiliary voltage and the supply voltage simultaneously.

Switch off: the supply voltage after the auxiliary voltage.

Input filter: see CE-advice (Capital Electrical Installation)
Short conductor length to be used between the input filter and the device
Operation with 60Hz: switch S3 / contact 1 in position ON

Auxiliary voltage connection:

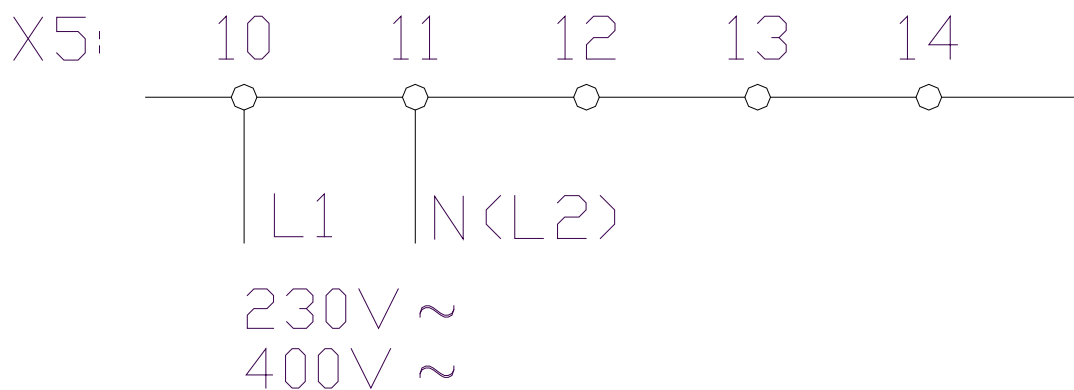
Connection: terminal X5:10, X5:11

Power supply: 230V~ or 400V~

Input current: 0,1 A

Phase position: regardless

Internal fuses: 2,5 Af



P1-Hilfssp-1

Att
ent
ion
:
note
typelab
el/
control
voltage



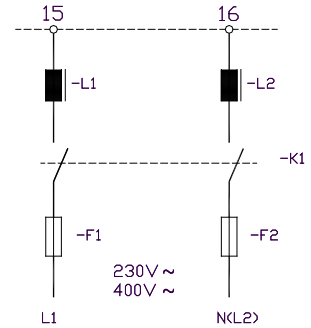
XXX

3.4 Direct power connection/ with transformer

Direct power connection:

Connection:

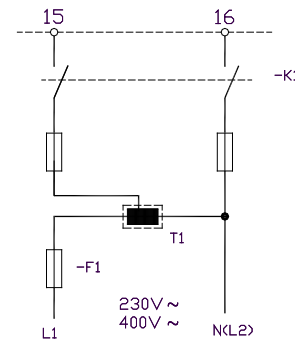
Phase L1	terminal X10:15
Phase L2 (N)	terminal X10:16
Input fuse	super fast acting fuse
Power choke	inductance >200μH



P1-Netz-1

Power connection with a transformer:

Transformer performance:	1,1 x continuous motor power
Secondary voltage:	1,35 x motor power
Trafosicherung:	slow acting
Eingangssicherung:	super fast acting fuse



P1-Netz-2

Attention:

- If the secondary voltage produced by the transformer are inferior to 60% of the rated device voltage, the voltage watchdog has to be adapted.
- these modifications may only be effected in the factory
- the transformer secondary voltage has to be indicated on order.

Internal watchdog for fuse failures.



Electrical installation

3.5 Motor connection

Connection

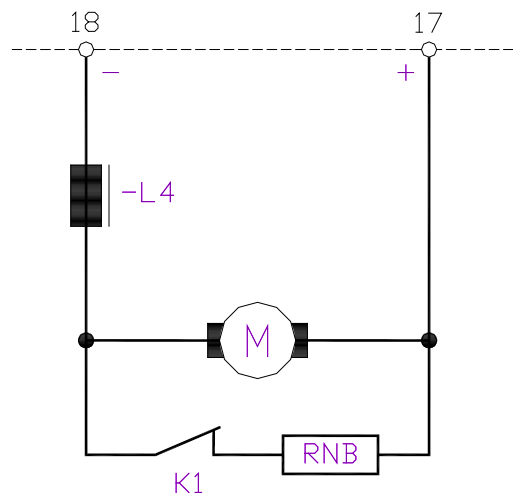
Motor- terminal X10:18
 Motor+ terminal X10:17

Armature choke

Inductance $L4 \text{ (mH)} = \frac{-UA}{IA} \times 2,4$

An armature choke should always be used with a P1 devices

Turn in the armature circuit:
 circuit energized
 Release locked



- DC
 -

P1-Motor-1

Warning:

Faulty switching will create arcing across the switch contacts.



Power supply failure – brake resistor

- Break contact of the mains contactor K1
- in parallel to the motor armature
- without separation from the device

Attention:

Power lines have to be shielded and routed separately from control lines!

For electro-magnetic interferences please refer to the CE advice.



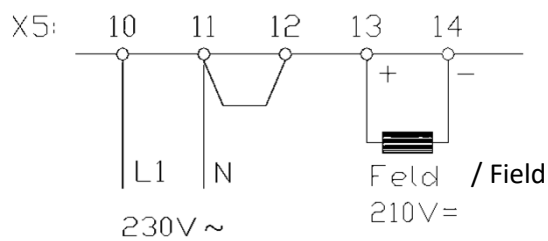
Electrical installation

3.6 Field connection

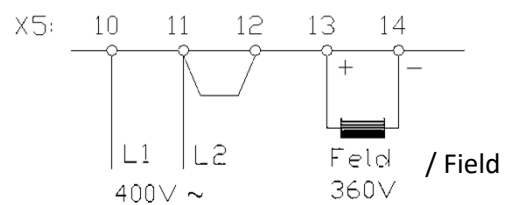
Connection

Input		Terminal
		X5:10, X5:12
Field	negative	X5:14
Field	positive	X5:13

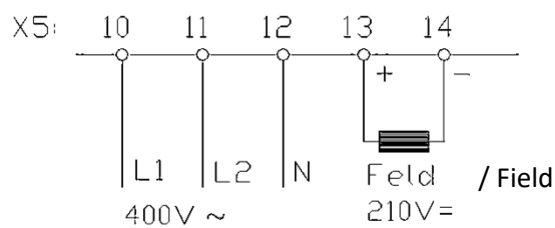
Field voltage



P1-Feld-1



P1-Feld-2



P1-Feld-3

Power voltage

230V~
400V~
400V~ with N

Field current
Fusing
Control

Field voltage

210V=
360V=
210V=

max. 1,5A
2,5 Af
deleted

3.7 Actual value connection

Tacho

Suitable actual value encoders:

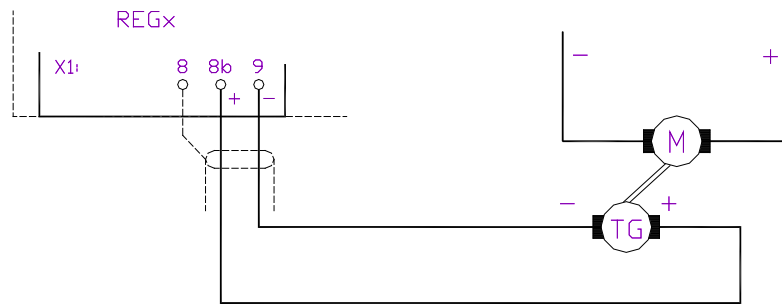
- DC tacho generator
- Brushless tacho generator with evaluation electronics
- Incremental encoders with evaluation electronics
- SC or three-phase tacho with rectification

Connection

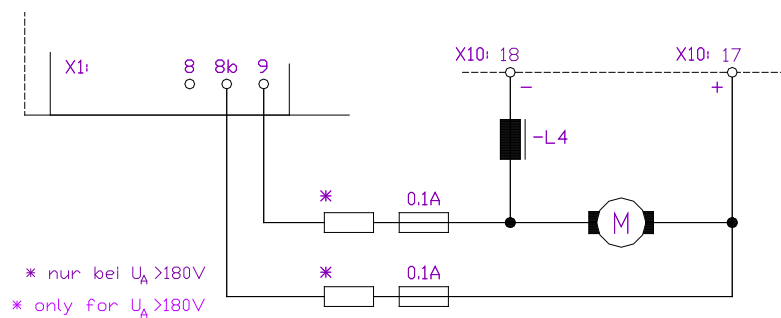
Control electronics (see MANUAL REGxx)

- in case of a positive command value
- Tacho positive X1:8b
- Tacho negative X1:9
- Shield X1:8

P1-Tacho-1



Armature voltage



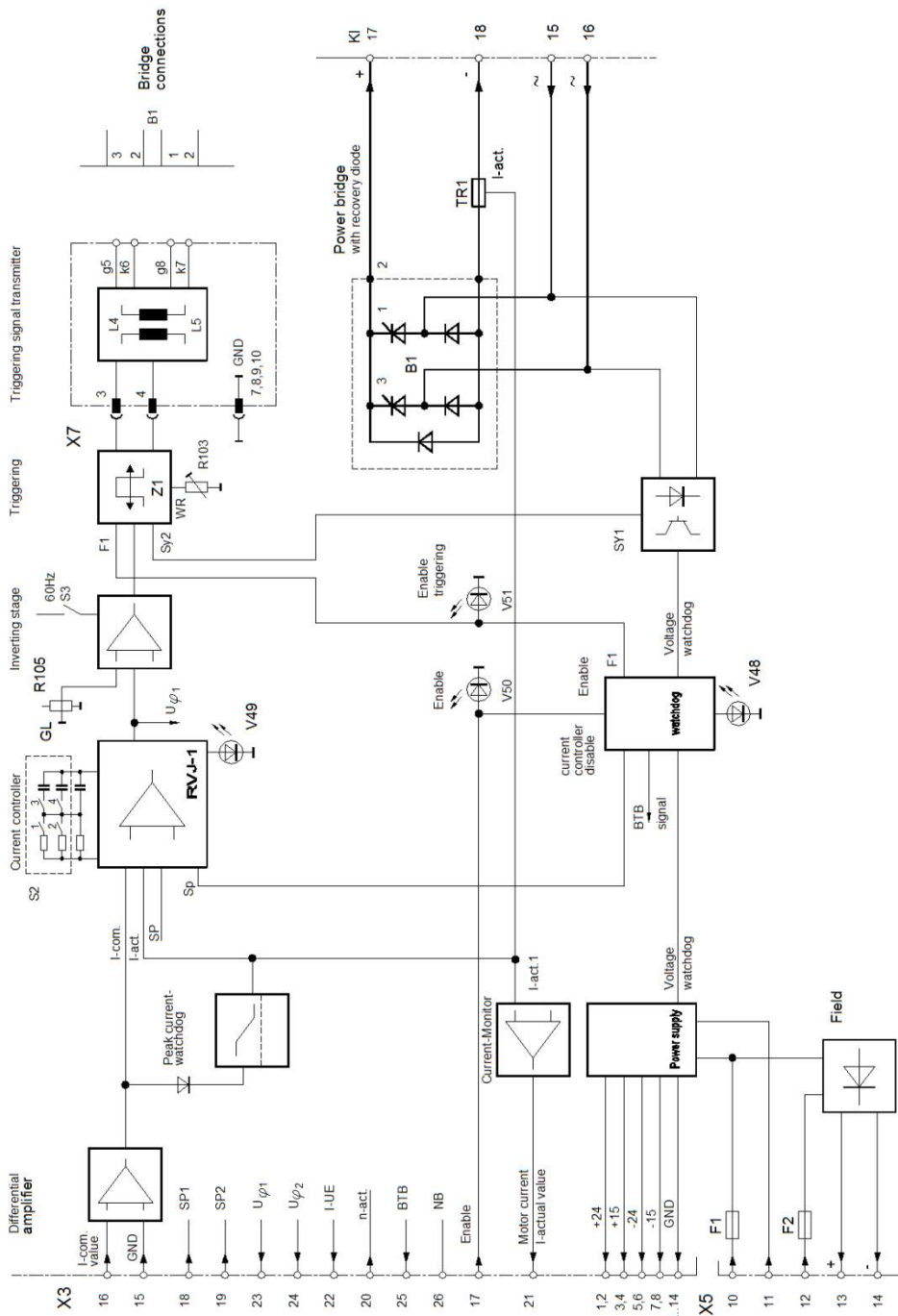
P1-Ankersp-1

Ground referenced actual value

- fuses 2 x 0,1A/500V directly in the armature circuit
- for armature voltage >180V additional resistors are required
- Use unit EXZU-UA1 (Manufacturer)

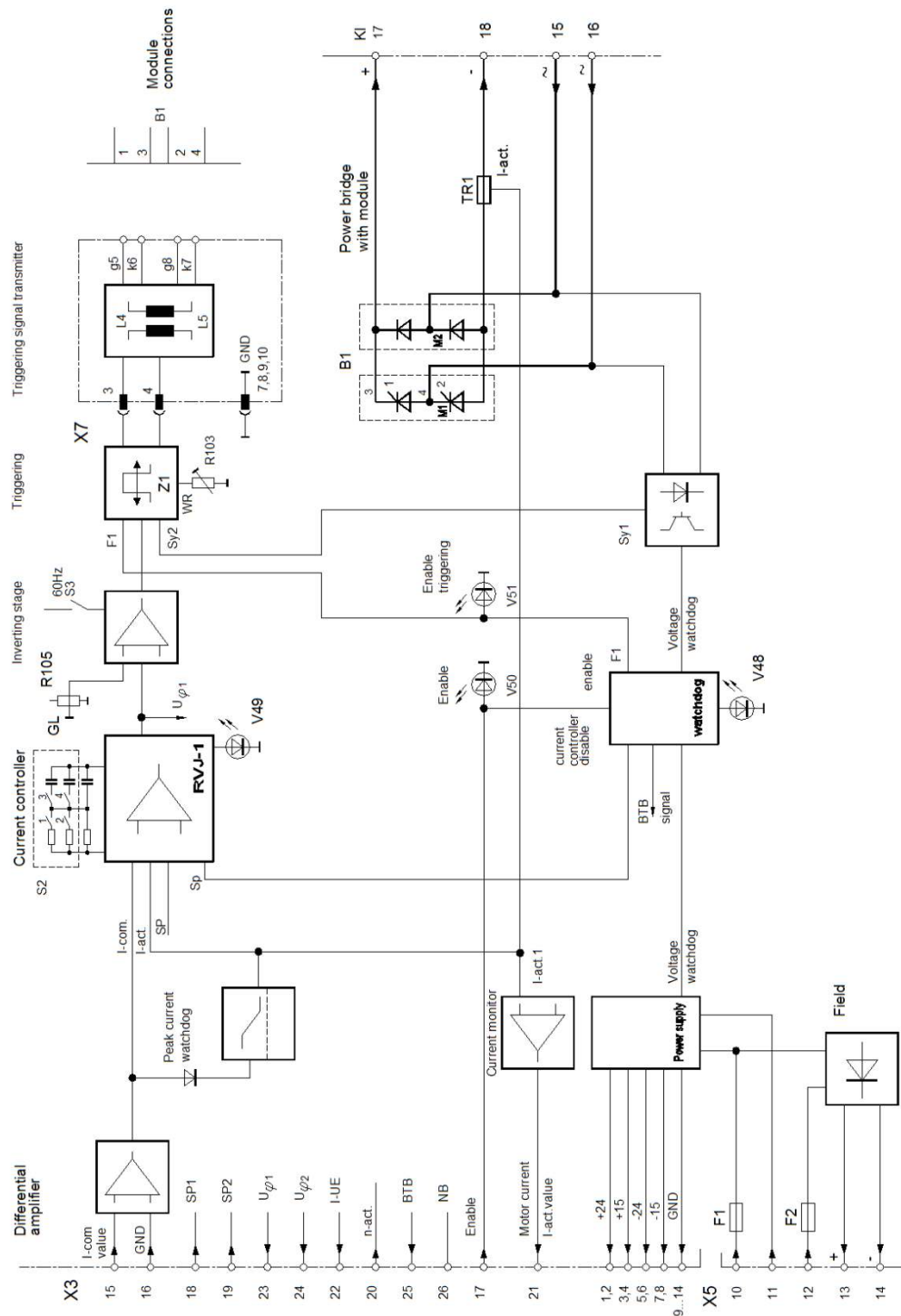
4 Adjustment

4.1 Circuit diagrams



E-P1-S072

Circuit diagramm



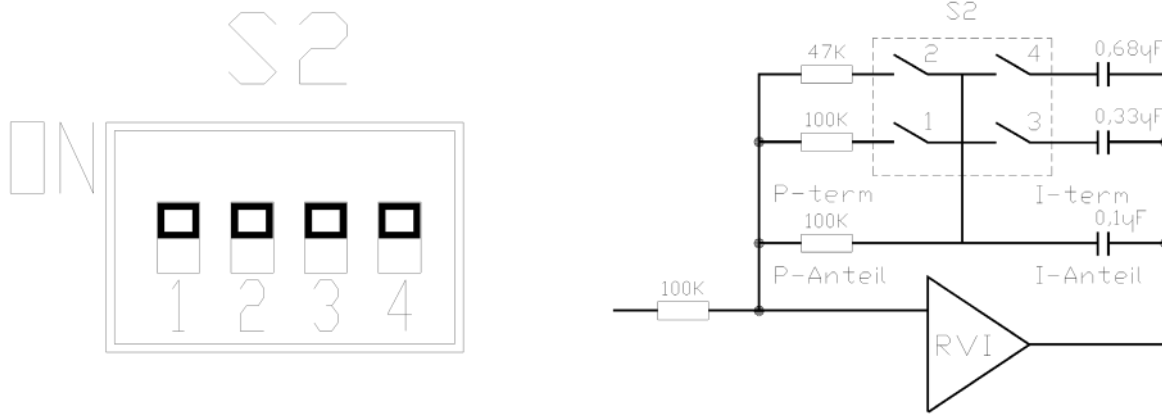
E-P1-S082

Adjustment

4.2 Current controller

PI loop circuit

Adjustments with the DIOP switch S2



P1-S2

P1-Strompara-1

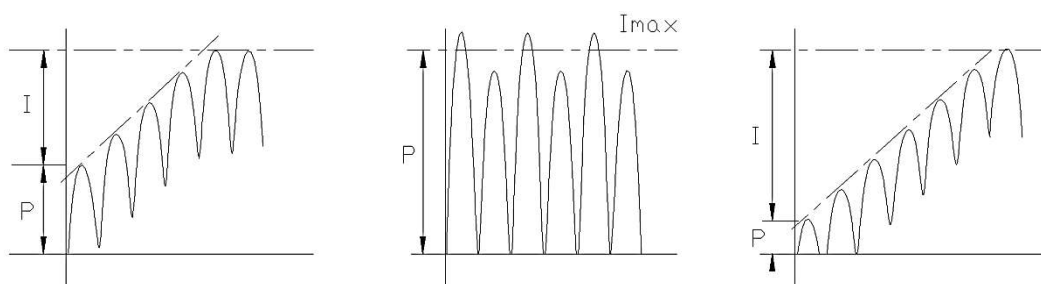
Optimization of the current controller

- Connect an oscilloscope across the current actual value
- Current command value step-change 1V
- Increase the current command value by 1V steps to 10V
- Alter the P-amplification by means of the DIP switches S2:1 and S2:2
- Optimal adjustment (see fig. 1)
- Not permissible adjustment (see fig. 2)
- Alter in integral part by means of the DIP switches S2:3 and S2:4

X3:21

X3:16

Oscilloscope – Current adjustment



Zchn.
 Classic
 /Classi
 c-
 Strom-
 PI-1
 G G G
 r r r
 a a a
 f f f
 i i i
 c c c

 1 2 3
 : : :
 s a P
 e r -
 t p a
 t l r

4.3 Displays

Some important functions are indicated by LEDs:

Display	LED
Drive ready	BTB
Current controller enable	enable
Triggering enabled	enable triggering
Current command value direction	RVI-1
The green LEDs indicate the active states!	

BTB-signal – Drive ready

BTB-signal X3:25 >+10V
 Error X3:25 <+2V

Error

Auxiliary voltage supply +24V, +15V, -15V
 Power supply:
 Fuse failure
 Under-voltage

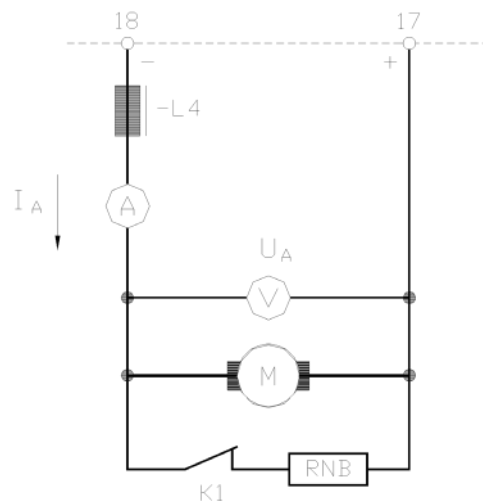
In case of errors or failure the power section is internally disabled without delay.

Measurements:

Measure instruments: multi meter for current
 and voltage

ammeter Shunt or clamp-on

Measure faults: mean value >> actual
 value
 acc. to the form factor
 approx. 1 bis 5 %



P1-arm

Measured values

with a positive command value

Voltage X10:18 negative / X10:17 positive
 max. 0,75 x power supply

Current Ammeter in the motor circuit

Measured values across REG

Speed X2:109 -5V (10V) for ±100% speed
 Current X2:111 +5V (10V)f for ±200% current
 GND X2:104

5 Commissioning

5.1 Commissioning

Connection advice

Connect the drive in accordance with the P1 manual and the control electronics manual (e.g. REG).

Attention:

Check the power supply voltage with that specified on the type plate.

Insert correct fuses according to the technical data.

Check the field voltage connection and the motor and tacho connections.

For 60 Hz applications set the DIP switch S3, contact 1 to ON

Commissioning

Basic connections – Mains supply, field, tacho or armature feedback, drive enable, command value.

For armature voltage control the tacho watchdog must be switched off.

Drive enable switch open or drive enable voltage 0V:

Command value	0 V
Switch S9	adjust to tacho voltage
For armature voltage control	adjust to 0
Switch S4	position 2
Switch S5	position 6
Imax1- Potentiometer	left full scale
Imax2- Potentiometer	adjust to approx. 10 % of full scale
Potentiometer Xp	adjust to 50 %
Potentiometer Id.	= 100 %
Potentiometer IxR	= left full scale
Potentiometer nmax.	= left full scale
Potentiometer INT	= left full scale

Apply the voltage:

LED L3 (BTB) and LED L7 (stationary) **must** light.

All other LEDs are off.

Close the switch drive enable or apply a drive enable voltage of 10V:

LED L1 and L2 must also light.

The drive must be at a standstill or turn slowly (offset, nmin).

If the drive accelerates in the correct direction, the polarity of the tacho voltage and the armature voltage feedback must be changed.

If the drive accelerates in the wrong direction, the polarity of the armature of the field must be changed.

Increase the command value voltage to approx. 10%:

The drive must accelerate to approx. 10% of the speed. If the rotation direction is wrong, change the polarity of the **tacho and the field** or the polarity of the **tacho and the armature**.

Current controller amplification:

(Switch S2 on the power section)

The current amplification is adjustment to a low armature circuit inductance (all switch „on“).

High inductance values can lead to motor oscillation which cannot be influenced by means of the speed controller. In this case, first set switch S2-2 to “off”.

If the drive still does not run smoothly, set the switch S2-1 to “off”.

The current response can be measured by means of an oscilloscope across the test point X4:20.

Speed controller amplification:

Adjust on the REG board.

Adjust the P-term to the lowest possible setting from 1 to 5 (switch S4).

Adjust the I-term to match the axis momentum (switch S5).

large axis momentum - high adjustment value

small axis momentum - low adjustment value

With the command value set to 10% speed, increase the amplification by turning the potentiometer Xp clockwise. When the drive begins to oscillate, reduce the amplification by turning the potentiometer anti-clockwise by approximately 10%.

For the fine adjustment of the amplification the control response should be measured by means of an oscilloscope across the test point X4:15.

Further adjustment:

Such as speed, peak current, continuous current, etc. (rf. to the manual REG).

Switch OFF:

If the switch „drive enable“ is opened, or the drive enable voltage is switched to 0V, LED L1 and L2 will extinguish and the drive will be disabled.


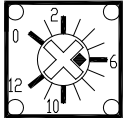
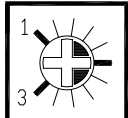
DS1:K4 in position OFF.

After approx. 2s the thyristor triggering circuit is disabled.

Commissioning adjustment:

The adjustment should be documented in the protocol and the adjustment potentiometer should be sealed with a suitable lacquer.

5.2 Protocol (commissioning)

Customer				Machine No.1	
Device				Series No.	
Control voltage	[V~]				
Power voltage	[V~]				
Field voltage	[V=]				
Input REGxx					
Enable	Contact ?	Voltage [V=]			
Nominal value	Type	Voltage [V=]			
Auxiliary nom. value	Type	Voltage [V=]			
Current nom. value	I _{max1} extern	Voltage [V=]	no function		
Current nom. value	I _{max2} extern	Voltage [V=]			
Speed controll settings REGxx					
Switches					
Tacho-adjustment		S9	Position		 <p>REG5 - Schotax 1</p>
P-term		S4	Position		
I-term		S5	Position		
D-term		S8	Position		
Poti-Stellungen					
Speed	n _{max}	P4	Position		 <p>REG5 - Poti 1</p>
Peak current	I _{max1}	P5	Position	no function	
Peak current	I _{max2}	P6	Position		
Continuous current	I _D	P7	Position		
Integrator	INT	P1	Position		 <p>REG5 - Poti 2</p>
Amplification	X _p	P3	Position		
I _x R Compensation	I _x R	P2	Position		
DIP Switches					
ON	No.				
OFF	No.				

Commissioning P1xx with REGxx

Setting-Current controller			
Switch setting			
Switch S2	open	(off)	
	closed	(on)	
Switch S3 / Contact 1	60Hz	ON	
	50Hz	OFF	
Measuring value			
Armature voltage	max.	[V=]	
Armature current	peak	[A=]	
Armature current	steady	[A=]	
Tachometer voltage	max.	[V=]	
Acceleration	X4:16	[V/ms]	
Integrator	X4:14	[V/ms]	
Motor data			
Identification / name plate specifications			
Producer:			
Type		Serien-Nr.	
Motor voltage [V=]		Motor current [A=]	
Field voltage [V=]		Field current [A=]	
Tacho voltage [V/min ⁻¹]		Tachometer type	
Brake [V]		Fan [V]	
Nominal speed [U/min]			

6 Faults

6.1 Error diagnosis

Error diagnosis	
Malfunction	Causes
Motor does not run	<ul style="list-style-type: none"> -Wrong power supply and motor connections -Activated fuses -Missing enable or command value -Current limit too low -Missing BTB
Motor speeds up	<ul style="list-style-type: none"> -Wrong polarity of the actual value (Tacho armature voltage) -Values of the tacho switch S9 too low -Command value too high <p>For armature voltage control</p> <ul style="list-style-type: none"> -Field current too low -Fuses, armature voltage feedback activated
Motor runs unsteadily	<ul style="list-style-type: none"> -Mechanical defect of the tacho -Tacho malfunction -Amplification on the speed controller too low or too high -Wrong PID parameter -Command value errors -Amplification of the current controller too low or too high
No motor torque	<ul style="list-style-type: none"> -Current limits too low -Field current too low -Mechanical overload of the axis