

Manual

Classic Q3 1000-2000A

4 Quadrant

Thyristor Drive

Teil 1	Thyristor Drive	Q3 x/x- 1000 to 2000A
Teil 2	Analoque Control Electronic	REG4



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1 Basic information

Electronic equipment is not fault proof. This fact should be borne in mind for all possible operating conditions.

ATTENTION - High voltage AC 500V~, DC 650V=
500V ~ac, 650V=dc



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

If any uncertainty arises, the manufacturer or dealer should be contacted.

Q3 devices are power electric parts used for regulating energy flow.

Protection rating IP00.

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	89/392/EWG, 84/528/EWG, 86/663/EWG, 72/23/EWG
EN61800-3	EN60204, EN50178, EN60439-1, EN60146,
IEC/UL	IEC364, IEC 664, UL508C, UL840
VDE Regulations	VDE100, VDE110, VDE160
TÜV Regulations	
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 also be ensured that the machine or equipment are fitted with device in dependent monitoring and safety features.

Setting adjustments

- should only be carried out by suitably trained personnel
- should only be carried out in accordance with health and safety guidelines

Assembly

- should only be carried out when all voltages have been removed.

QS

Test results are archived with the device serial number by the manufacturer.

CE The device adheres to the following: Guideline EU 89/336/EWG. EMC stan

Attention:

This manual Q3 only describes the basic control unit.

Manual Q3

This device description must be read in conjunction with the manual for

- an analogue control REG xx
- an external field control F2 xx
- options Multi xx

**General information**

Series Classic Q3

1 Basic information

Build

- switch cabinet mounting
- according to the VDE, DIN and EU regulations
- standard control electronics REG
- intrinsically safe power section with current control loop
- controlled or uncontrolled field supply unit
- 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

- only components customary in trade and industrially standardised are used
- high-quality bases for the IC with external connections
- LED displays
- precision potentiometers for fine adjustments
- plug-in jumpers for the system set-up

Characteristics

- * Series Classic Q3
- * Thyristor drive for dc motors
- * Power range 6.75kW to 1.1MW
- * Drive and brake in all 4 quadrants'
- * Energy recovery
- * Intrinsically safe power section
- * Fast analogue current control
- * Temperature watchdog - power section
- * Circular current-free dual bridge circuit
- * Controlled or uncontrolled field rectifier
- * 26-pin interface
- * Features of the control electronics:
see Manual REGxx or third-party product documentation
- * Optional units

Classic Q3 1000-2000A

Q3 400/450-1000-2000

Power connection 360 ... 440V~
 Auxiliary voltage connection 360 ... 440V~, 200 ... 250V~ oder Option
 Output voltage max. $\pm 450V=$
 Cooling ventilation fan
 Field supply - external Field current controller F2.1 400/340-20

Q3 400/450-		1000	1500	2000
Input current	A~	800	1200	1600
Output current	- peak 5s	A=	2000	3000
	- continuous	A=	1000	1500
El. power	kW	450	675	900
Fuses	ff	installed	installed	installed
	AFF	6x1000	12x1000	12x1000
Power chokes	Type	3x KU240-1000	3x KU240-1500	3x KU240-2000
	mH	0,05	0,03	0,02
Armature chokes	Armature chokes are necessary only for special applications			
Dimensions w x h x d	mm	550x800x520	550x800x520	550x800x520

Q3 500/550-1000 bis 2000

Power connection 450 ... 550V~
 Auxiliary voltage connection 360 ... 440V~, 200 ... 250V~ oder Option
 Output voltage max. $\pm 550V=$
 Cooling ventilation fan
 Field supply - external Field current controller F2.1 400/340-20

Q3 500/550-		1000	1500	2000
Input current	A~	800	1200	1600
Output current	- peak 5s	A=	2000	3000
	- continuous	A=	1000	1500
El. power	kW	550	825	1100
Fuses	ff	Installed	Installed	Installed
	AFF	6x1000	12x1000	12x1000
Power chokes	Type	3x KU240-1000	3x KU240-150 0	3x KU240-2000
	mH	0,05	0,03	0,02
Armature choke	Armature chokes are necessary only for special applications			
Dimensions w x h x d	mm	550x800x520 0	550x800x520 0	550x800x520 0

1 Basic information

Specification

Mains frequency	50 or 60Hz $\pm 5\%$
Protection rating	IP 00
Format	VDE 0100 group 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 by 2%/°C
Storage temperature range	-30°C to + 80°C

Current control loop circuit

Amplification

- input signal	0 to $\pm 10V=$
- output	0 to $\pm 200\%$ type current
Over-current limiting	10s 200% type current
Control precision	$\pm 2\%$
Control range	1:50
Enable	$> +10V$

Speed control loop circuit (with manual REG)

Control precision (without actual value error)	$< \pm 0.1\%$
Control range	$> 1:1000$

Interface control electronics X3

Function

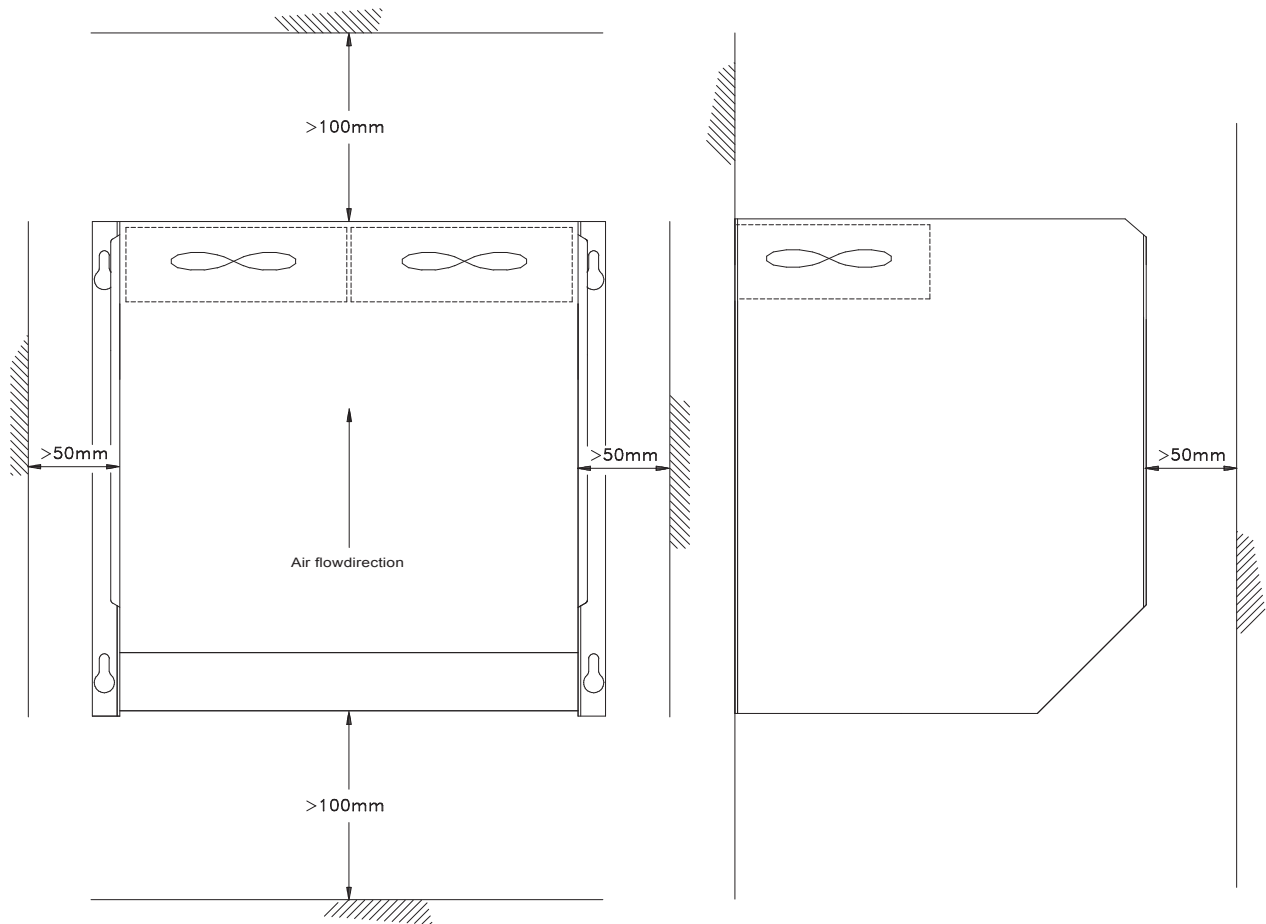
+ 24V	$\pm 10\%$	
+ 15V	$\pm 2\%$	
- 24V	$\pm 10\%$	
- 15V	$\pm 2\%$	
Device	GND	0
I command value (GND)		0
I command value (signal)		+10V=
Current controller enable		+10V=
Drive disable1		+10V=
Drive disable 2		+10V=
N (speed) actual		+10V=
I (current) actual		+5V=
Over-current power section		+10V=
Option U _A		$\pm 10V=$
Option U _A		0-10V=
Drive ready BTB		+10V
		+5V

Connector no.

X3: 1 and 2
X3: 3 and 4
X3: 5 and 6
X3: 7 and 8
X3: 9, 10, 11, 12, 13, 14
X3: 15
X3: 16
X3: 17
X3: 18
X3: 19
X3: 20
X3: 21
X3: 22
X3: 23
X3: 24
X3: 25
X3: 26

Classic Q3 1000-2000A

Mounting



Ambient temperature 0 to <45°C (reduced, up to 60°C)
 max. cooling unit temperature 80°C (internal watchdog)

Air-mass throughput 1000-2000A 2500m³h

Dissipation loss with max. power		
Unit Q3-x/x	Unit W	Mains choke W
1000	3700	1000
1500	5400	1300
2000	7200	1600

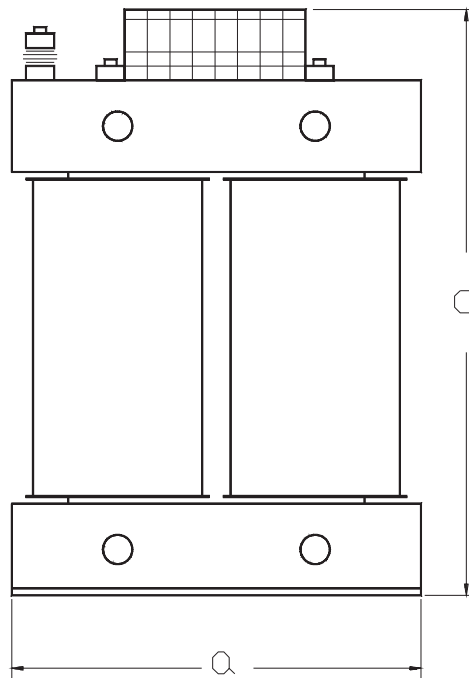
2 Mechanical installation

1-phase mains choke

Features	
UN	400V~50/60Hz
UK	4%
Protection rating	IP00
Isolation class	T40/E
Vertical angle bracket	

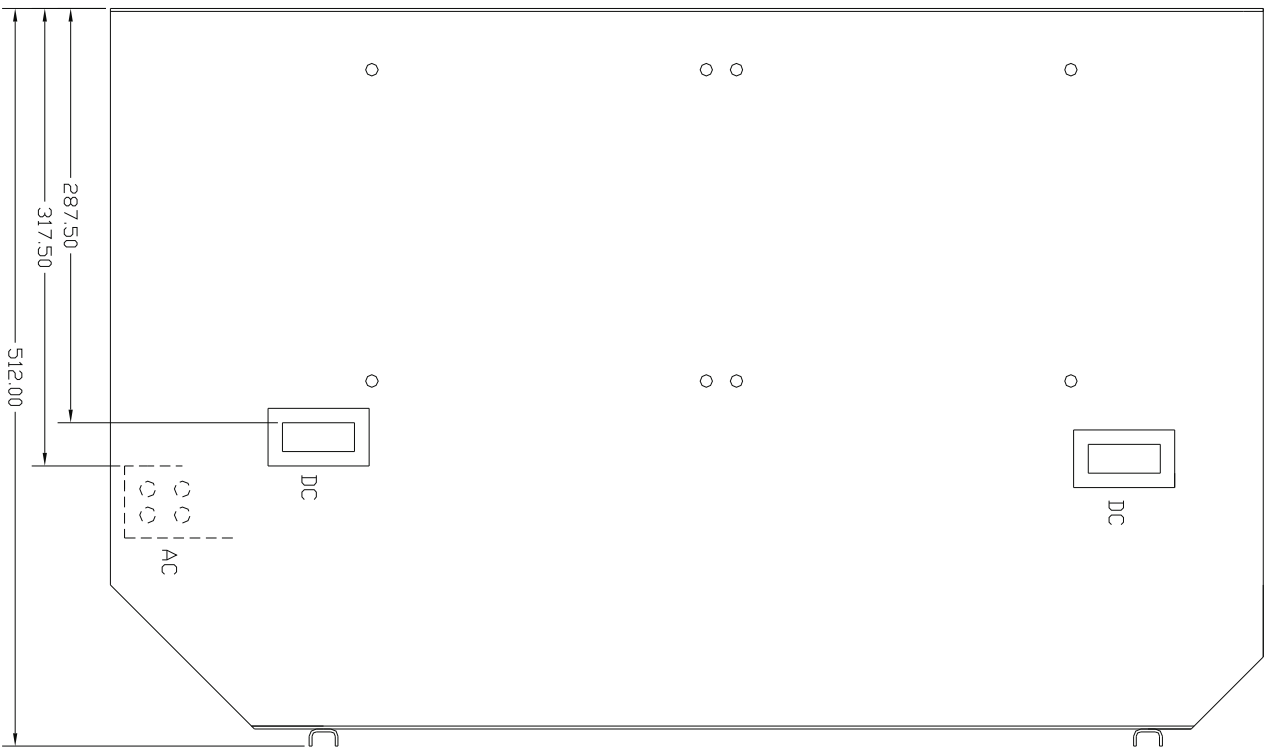
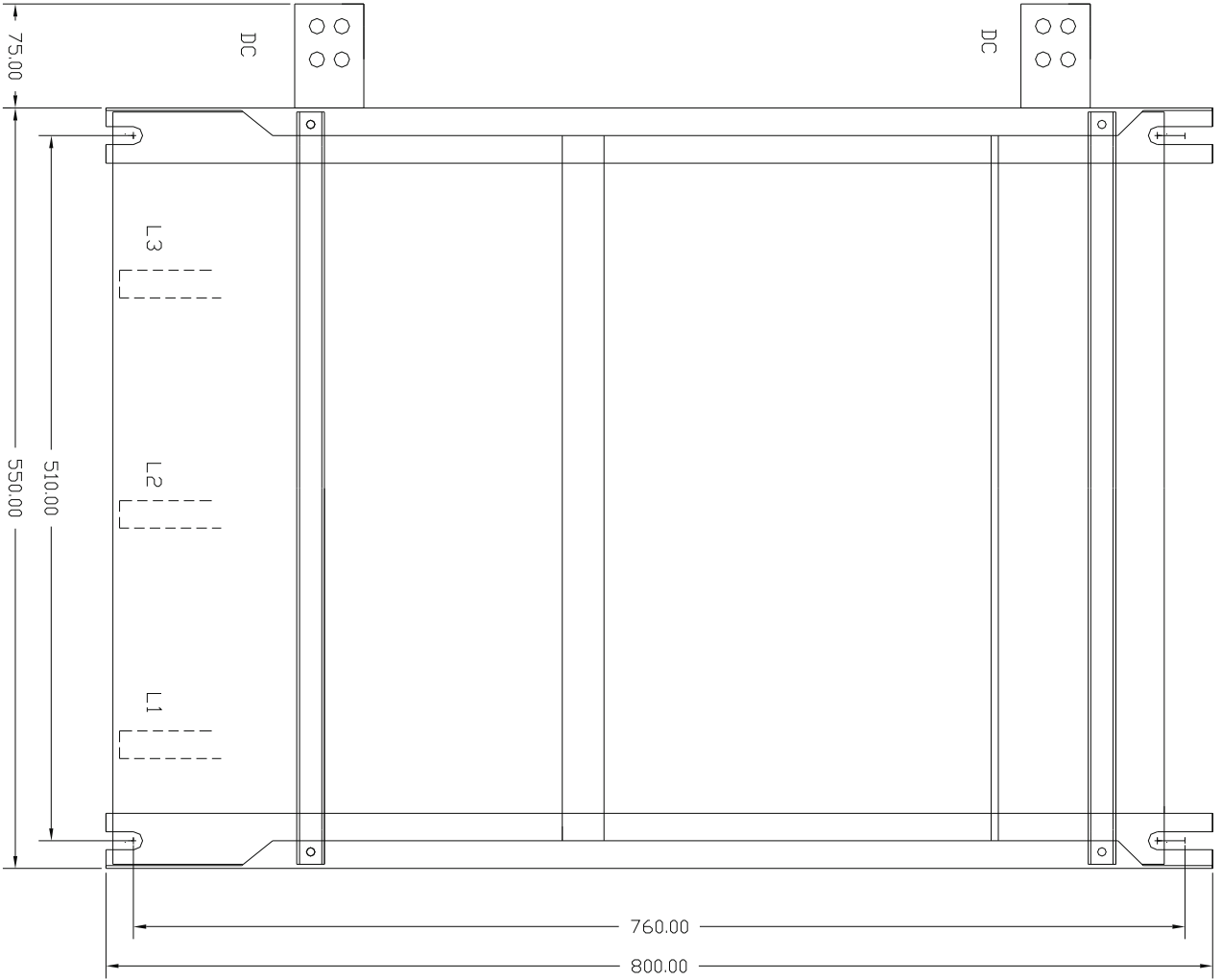
Units Q3-x/x	Choke type	L mH	PV W	Dimensions					Weight kg	Screw M
				a	b	c	d	e		
1000	KU240-10 00	0,05	1000	320	270	470	250	190	98	10
1500	KU240-15 00	0,03	1300	320	270	470	250	190	98	10
2000	KU240-20 00	0,02	1500	320	270	470	250	190	98	10

with filter: KDFxx

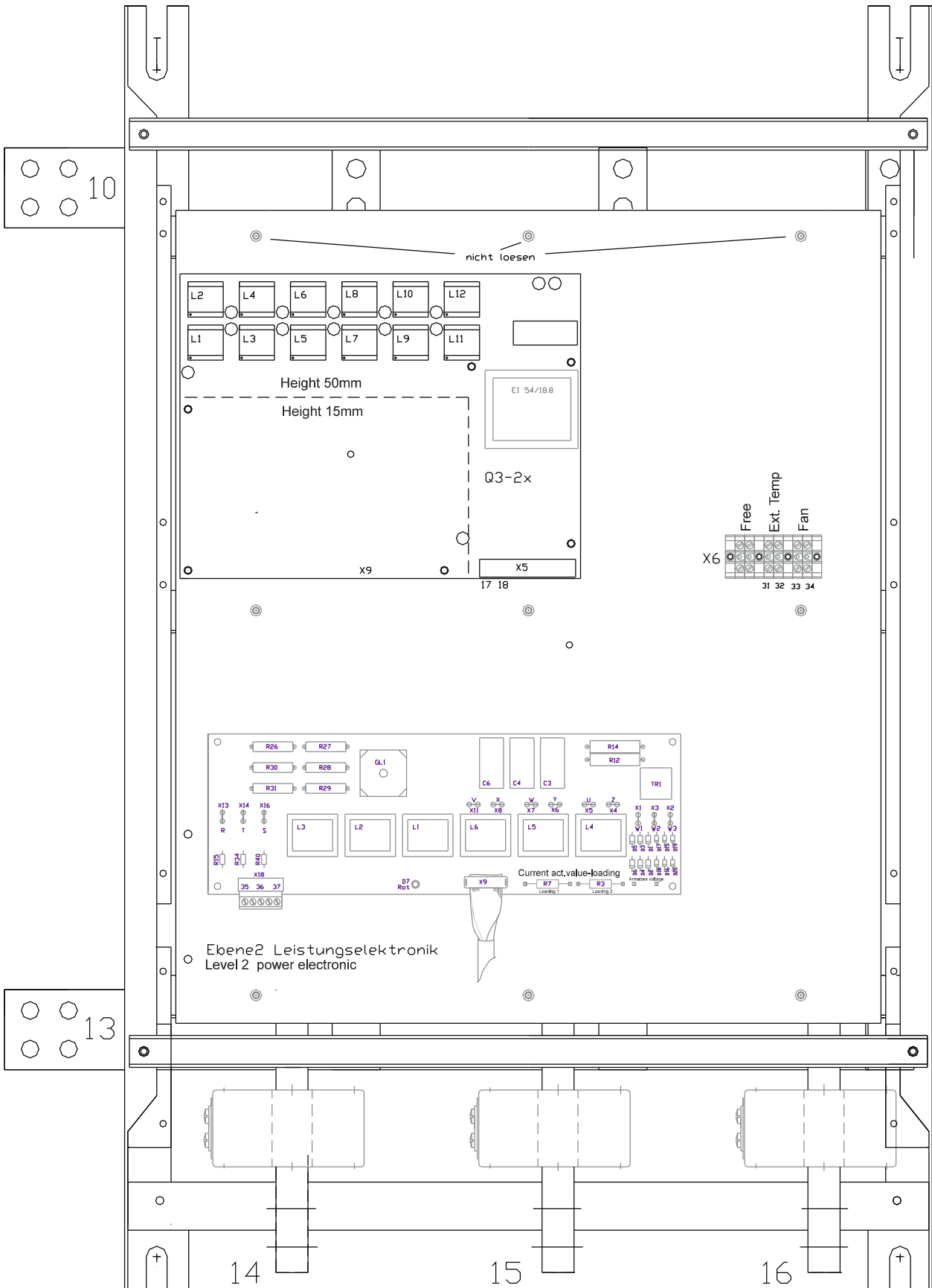


Classic Q3 1000-2000A

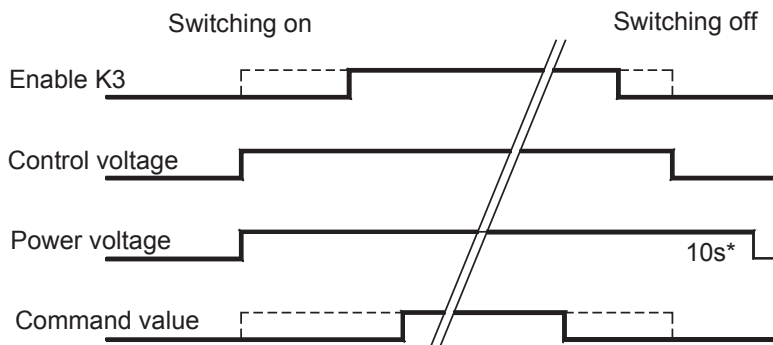
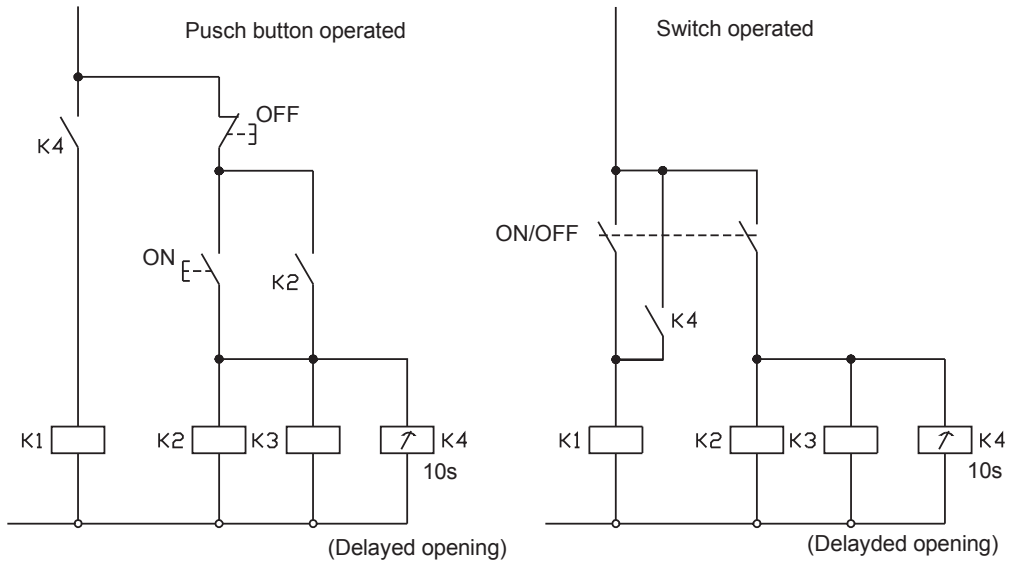
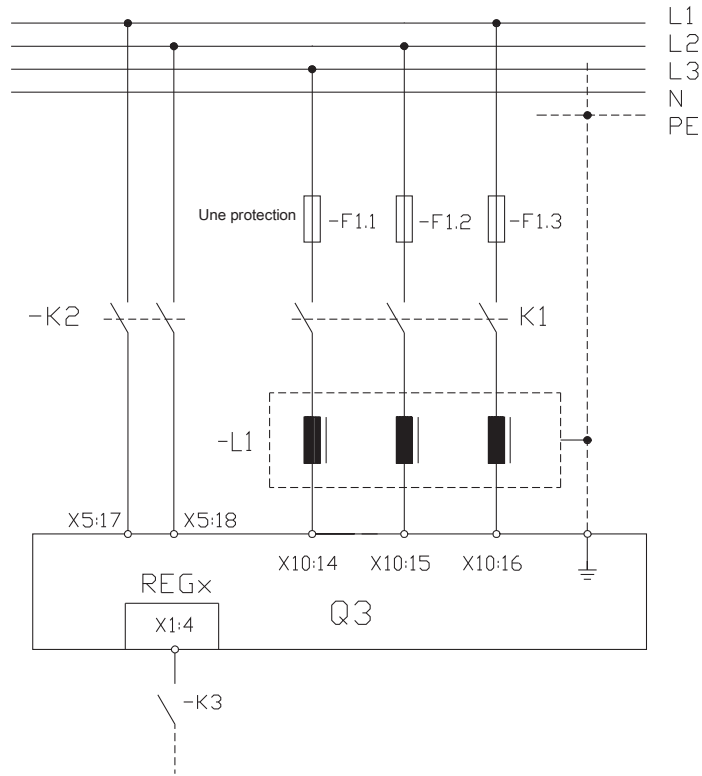
Dimensions



3 Electrical installation

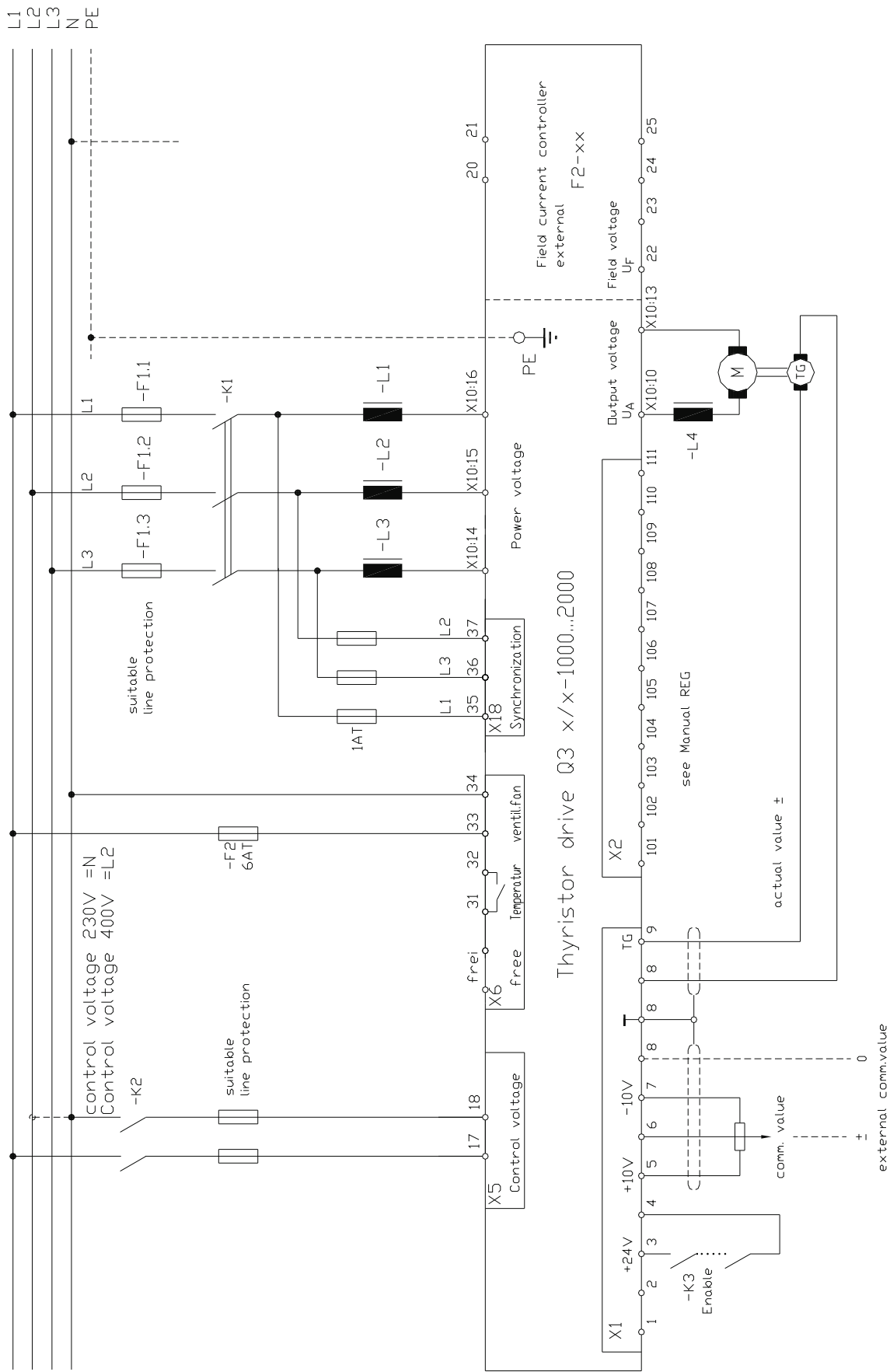


Q3-2AU2



* switching-off delay stand-still 0.3s

3 Electrical installation



EMC-Advice
 All control lines have to be shielded
 Motor- and Field lines have to be shielded

CE Advice

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

- The device, the transformer, and 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 must be connected to the mounting plate using a 4mm² wire, l = 50mm.

Three-phase connection:

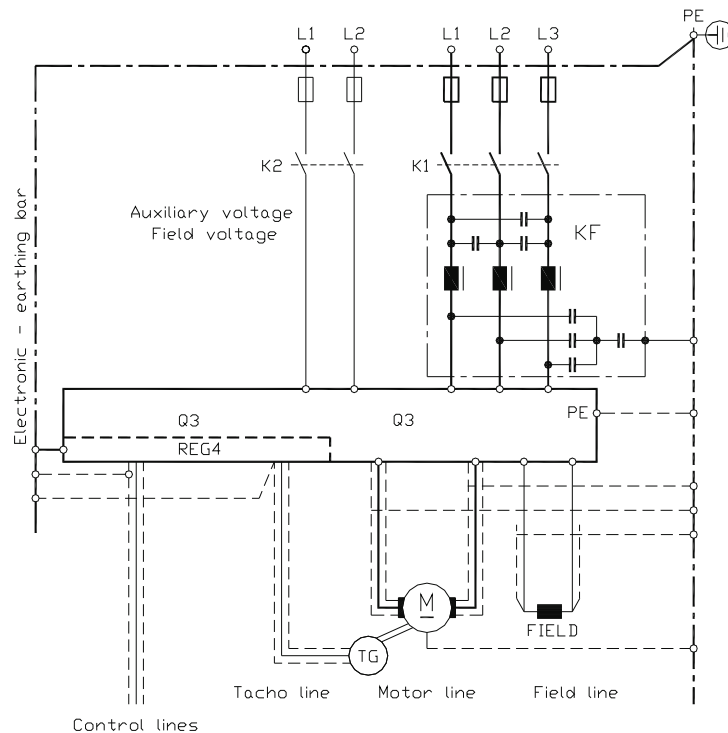
Power choke type: see technical details
 Filter capacitors: 0.5mF/600V~ 3 x 1mF (x) + 1 x 1mF (y)

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

Connections diagram



KF = Commutation choke with filter capacitor

3 Electrical installation

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**
- **EU guideline 89/392/EWG**
- **VDE and TÜV regulations and Trade body guidelines**

Switch on the auxiliary voltage and the supply voltage simultaneously.

Switch off the supply voltage after the auxiliary voltage

Input filter

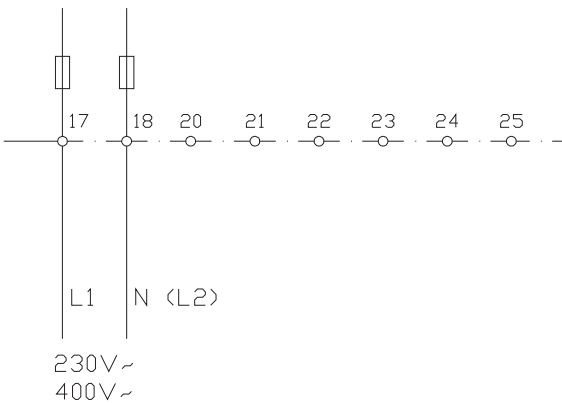
see CE advice, page 14

Short conductor length to be used between the input filter and the device

Auxiliary voltage connection

Connection	terminal X5:17, X5:18
Power supply	400V~ ±15%
Special voltages	24V~, 110V~, 230V~, 500V~
Input current	max. 300mA
Phase position	regardless
Internal fuses	FE1, FE2 0.8AT

- Min. line cross-section 0.5mm²
- External fuse
- Min. line protection 6A



Note:

**Observe the respective type plate.
Control voltage XXX**



Direct power connection

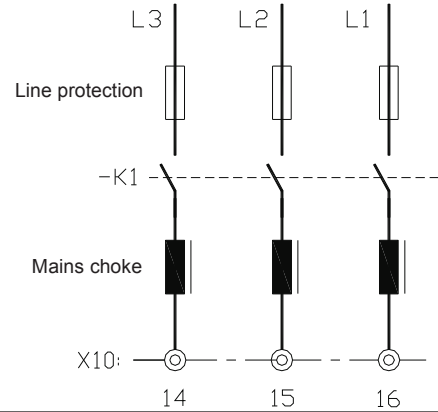
Phase L1 Bolt X10:16
 Phase L2 Bolt X10:15
 Phase L3 Bolt X10:14

Note:

L1,L2,L3 - clockwise rotating field

Protecting earth - PE connection

To work without PE connection is forbidden !!!



Q3 x/x-current type	Power choke KD- three phasecurrent K - phase choke	Fuses A Super fast acting installed
1000	KU240 -1000	6 x 1000 A FF
1500	KU240 -1500	12 x 1000 A FF
2000	KU240 - 2000	12 x 1000 A FF

Power connection with an auto-transformer

Transformer performance

1.1 x continuous motor power

Secondary voltage

0.9 x motor power

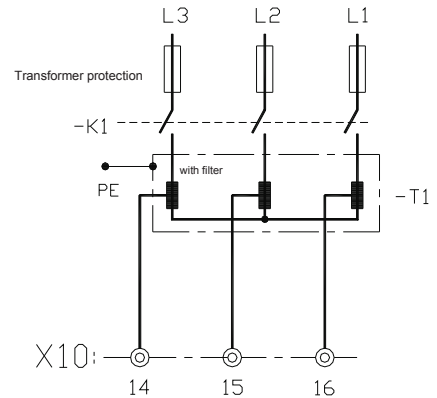
Transformer fuses

Slow acting

Observe the switch-on current!!!

Input fuses F1, F2, F3

rf. to the table above



Attention:

If the secondary voltages produced by the transformer are inferior to 60% the voltage watchdog has to be adapted. These modifications may only be effected in the factory and thus, the voltages have to be indicated on order.

Watchdog power connection

BTB inactive

dark LED

>>> missing phase

>>> wrong rotating field

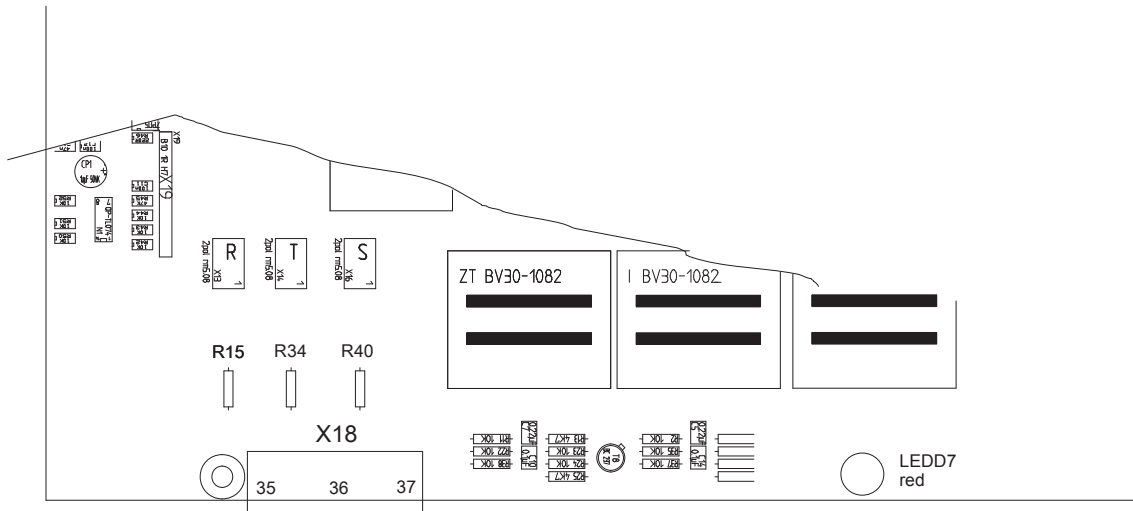
3 Electrical installation

Option - External synchronization

For special applications it might be necessary to tap the synchronization before the power commutating choke, e.g

- when operating via field triggering circuit
- in case of an instable power supply

When changing to external synchronization, the 3 resistors 0 Ω (R15, R34, and R40) on the board 'Q3 - Ein3' have to be removed.



Connection across the terminals X18:35, 36, 37

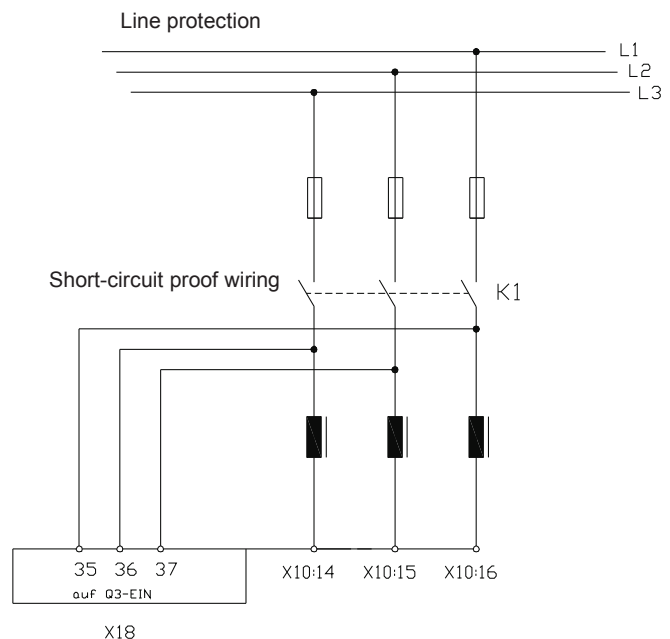
Observe the phase position!

- L3 across X10:14 (via power choke) and directly across terminal X18:36
- L2 across X10:15 (via power choke) and directly across terminal X18:37
- L1 across X10:16 (via power choke) and directly across terminal X18:35

The wiring has to be short-circuit proof or protected by means of a line protection on.

The phase position function has a watchdog and in case of wrong connections the LED D7 on the board Q3-on3 will light and the BTB signal on the controller extinguishes when the controller is enabled.

LED D7 also lights if there is a breakage of the installed fuses.



Free



3 Electrical installation

Connection

positive command value

Motor- bolt X10:13

Motor+ bolt X10:10

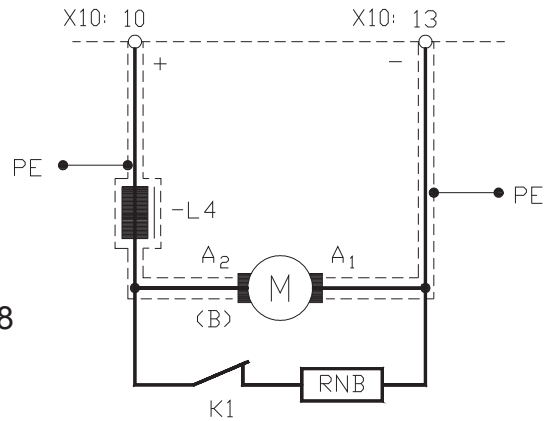
Note:

Armature choke only for a few applications

Inductance: $L \text{ [mH]} = U / I \cdot x 0.8$

Standard version without a choke

Motor lines have to be shielded.



Unit Q3 x/x-	Power choke*	Min. conductor cross-section (mm ²)
Type current	Direct current	
1000	auf Anfrage	2x 240
1500	auf Anfrage	2x 240
2000	auf Anfrage	2x 240

* Chokes are necessary only for special applications

Switching in the armature circuit

- dc circuit current-free
- disable inactive



Warning:

Faulty switching will create arcing across the switch contacts.

Power supply failure - brake resistor

Break contact of the mains contactor K1

Rating: Resistor RNB = max. armature voltage/2 x type current

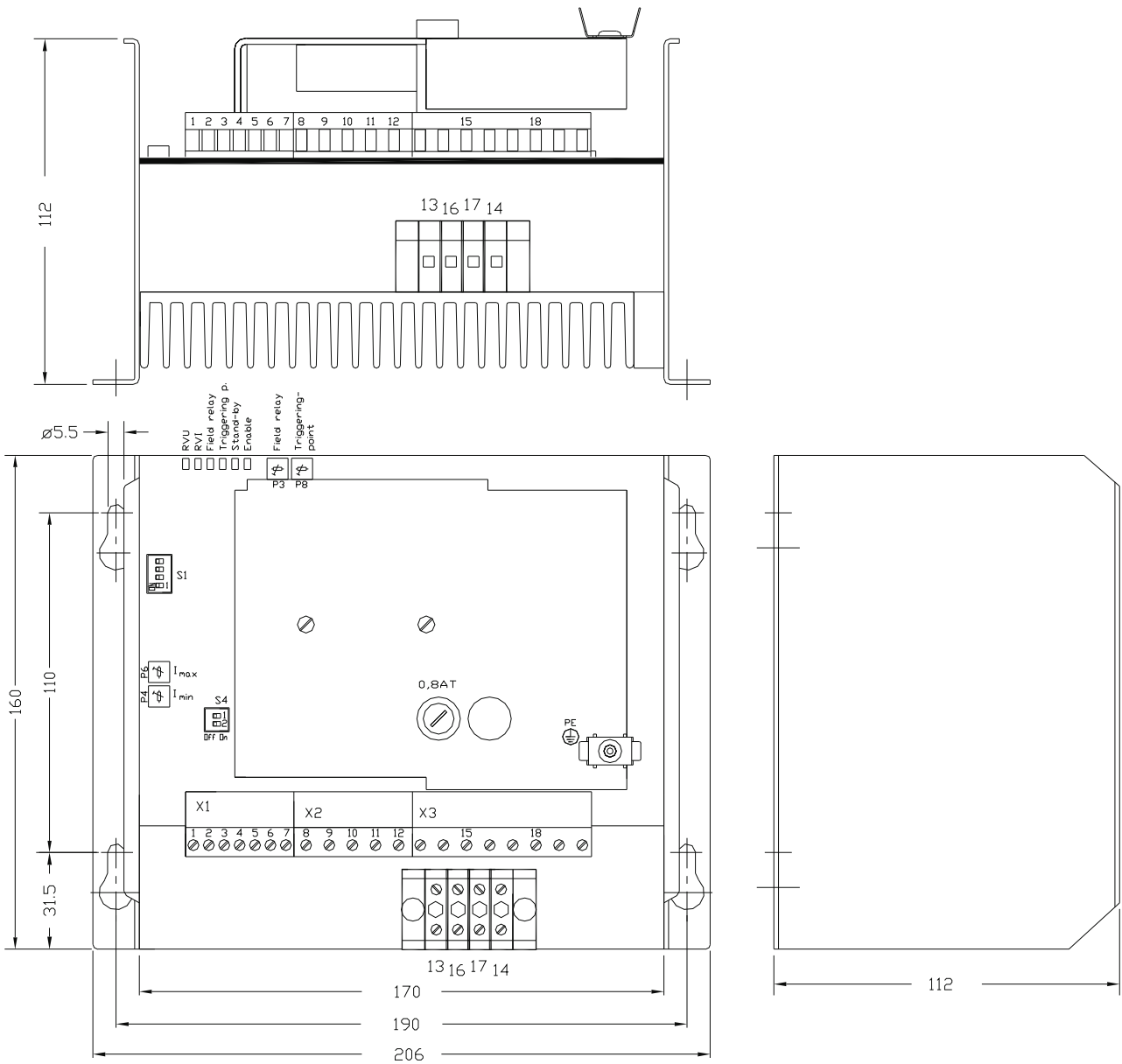
Attention:

Power lines have to be shielded and routed separately from control lines!
For electro-magnetic interferences please refer to the CE advice.



Field regulator is not installed.

External field current regulator F2.1 xx



5 Adjustments

Actual value connection

Tacho

Suitable actual value encoders:

- DC tacho generator
- Brushless tacho generator with evaluation electronics
- Incremental encoders with evaluation electronics

Note: AC or three-phase tachos with rectification are not suitable

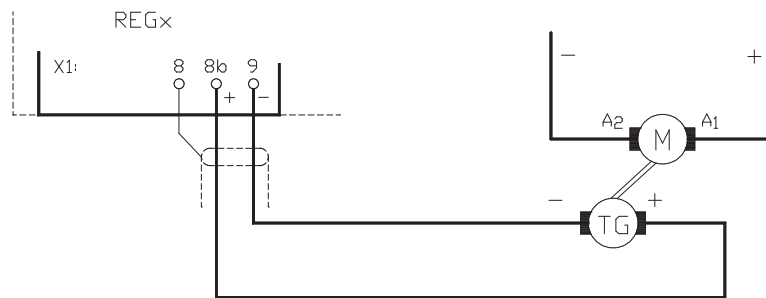


Connection

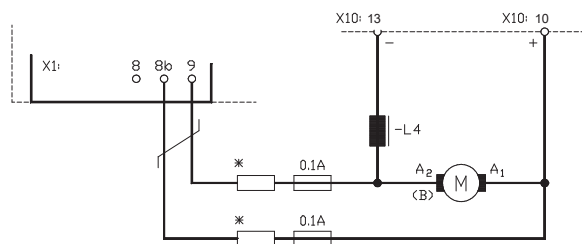
Control electronics (see Manual REG)

In case of a positive command value

Tacho positive	X 1:8b
Tacho negative	X 1:9
Shield	X 1:8



Armature voltage



*Only by U > 180V

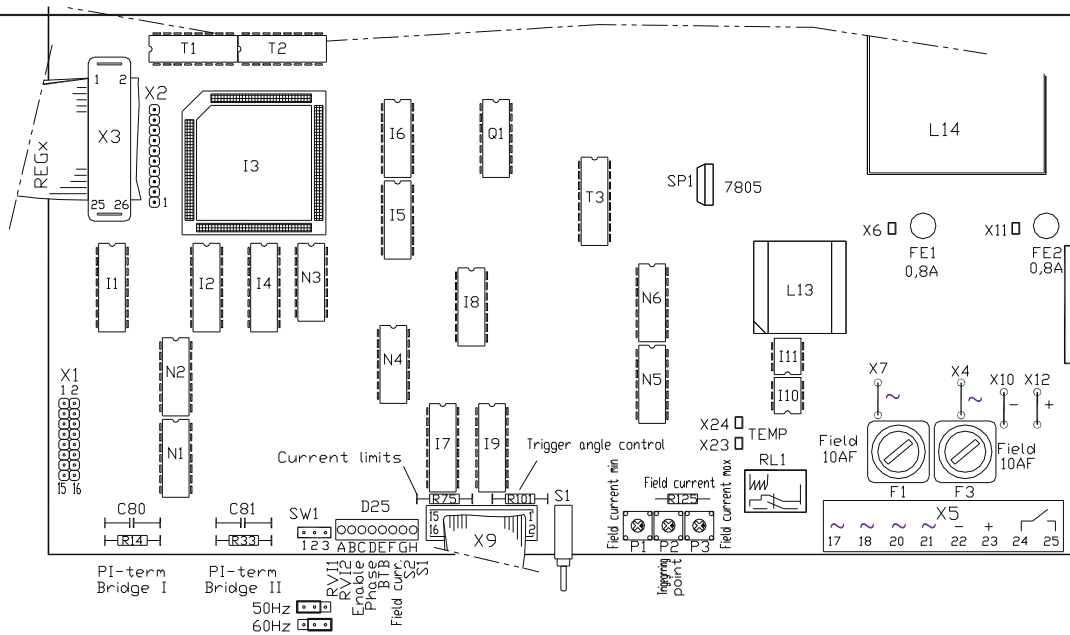
Ground referenced actual value

- Fuses 2x 0.1A >>> directly in the armature circuit
- For armature voltage >180V =>>> additional resistors are required
- Use unit EXZU-UA1
- (two resistors and two fuses in insul. case)

Note: Observe Manual REG

Option: In case of internal potential-free armature voltage control please indicate on order.



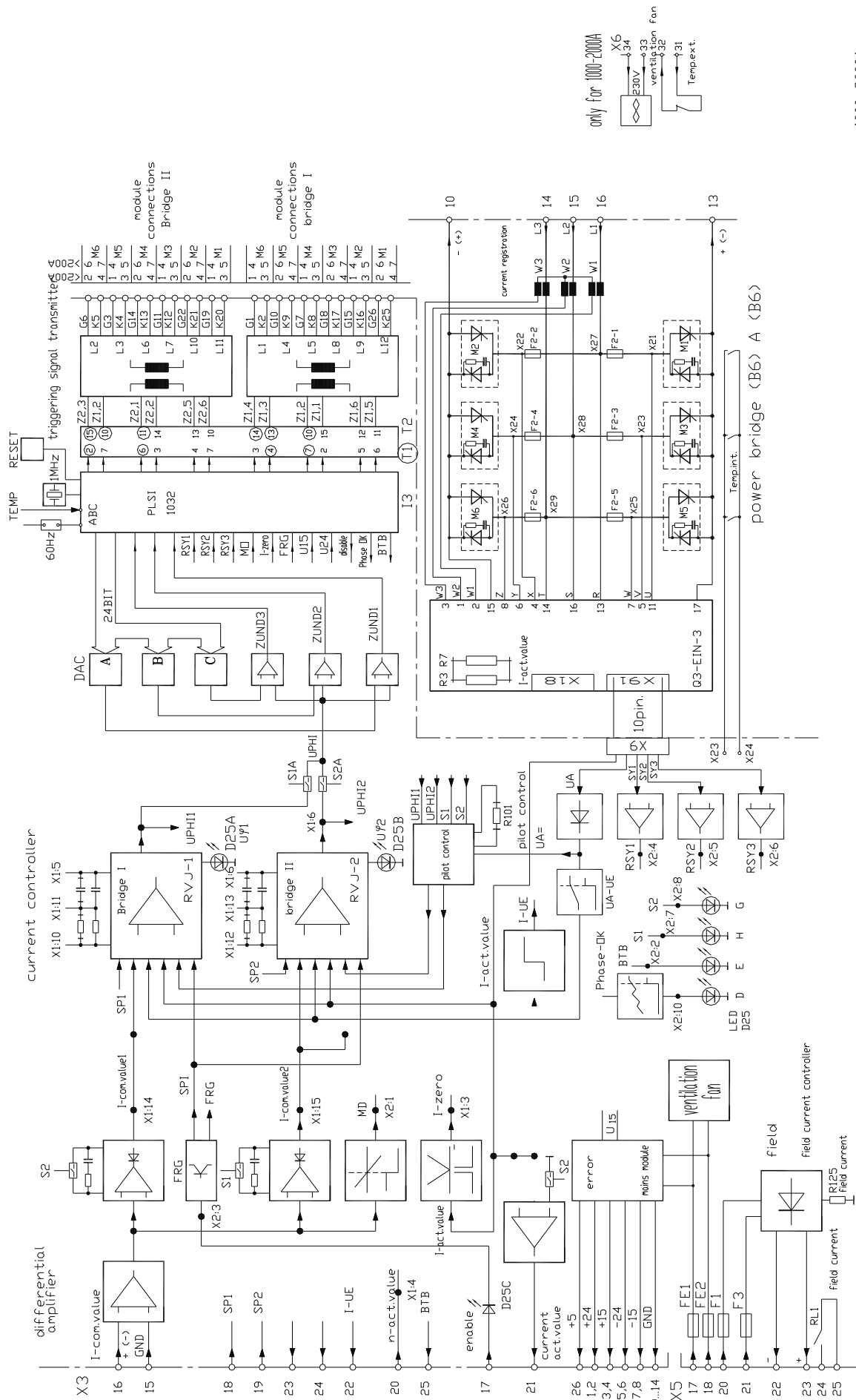


Adjustments

Variable elements

Variable elements	Function	Range
R14	P-amplification current controller 1	18kΩ to 470kΩ
R33	P-amplification current controller 2	18kΩ to 470kΩ
R75	Exact adjustment current limit	100kΩ to 470kΩ
R101	Trigger angle control	240kΩ to 560kΩ
R125	Field current	
C80	Integral term - current controller 1	0.1μF to 2.2μF
C81	Integral term - current controller 2	0.1μF to 2.2μF
Potentiometer		
P1	min. field current	0 to 15%
P2	Triggering point for armature/field control	200 to 450V
P3	max. field current	0 to 100%
Jumper		
SW1 Pos.1-2	50Hz adjustment	
SW1 Pos.2-3	60Hz adjustment	
Switch		
S1	Reset	
LED displays		
D25A	Current control loop RVI-1	control active
D25B	Current control loop RVI-2	control active
D25C	Enable current controller/triggering	enabled
D25D	Phase error	error
D25E	BTB ready	operational
D25F	Field current	uminous intensity =field current
D25G	Current flow direction S2	(only for a controlled field) active
D25H	Current flow direction S1	active

5 Adjustments



1000-2000A

Current controller - PI loop circuit

for a positive command value

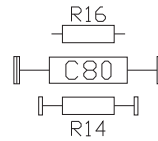
Bridge 1

negative R14, C80

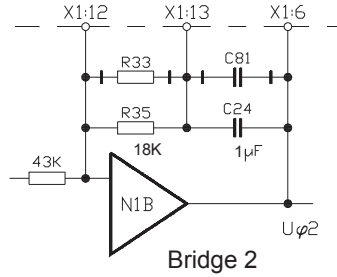
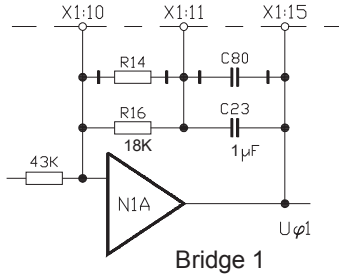
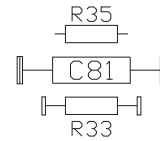
Bridge 2

positive R33, C81

Bridge 1



Bridge 2



Basic set-up

Amplification ~0.4

Integration time ~18m

Changing the amplification

Bridge 1

$$X_p = \frac{18k\Omega \times R14}{18k\Omega + R14} \times \frac{1}{43k\Omega}$$

Bridge 2

$$X_p = \frac{18k\Omega \times R33}{18k\Omega + R33} \times \frac{1}{43k\Omega}$$

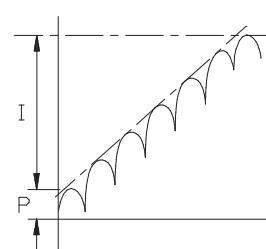
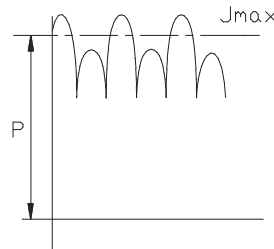
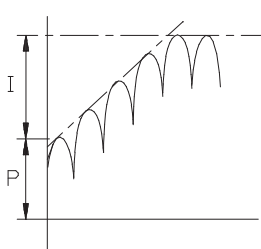
Changing the integration time

$$\tau [ms] = \frac{18k\Omega \times R14}{18k\Omega + R14} \times (1\mu F + C80)$$

$$\tau [ms] = \frac{18k\Omega \times R33}{18k\Omega + R33} \times (1\mu F + C80)$$

Bridge 1

Bridge 2



Optimization of the current controller

- Connect an oscilloscope across the current actual value
- Current command value step-change ±1V

X3:21
X3:16

5 Adjustments

BTB signal - Drive ready

BTB signal	X3:25	>+5V
Error	X3:25	<+5V

Error

Voltage error	24V, 15V, 5V	saved
Phase error, rotating field		saved
Defective input fuse		saved
Over-temperature		saved

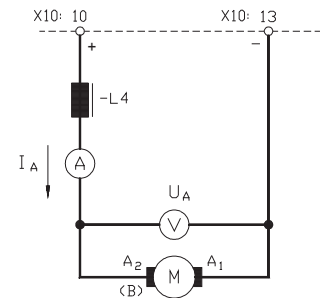
In case of errors or failure the power section is immediately internally disabled without delay.

To clear the saved error re-enable the drive (switch off/on or reset key)

Measurements

Measurement advice

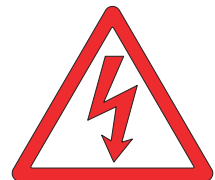
Measuring instruments:	multimeters for current and voltage shunt or clamp-on ammeter
Measuring faults:	mean value > actual value acc. to the form factor approx. 1 to 5%



Measured values

with a positive command value

Voltage:	X10:10 positive	X10:13 negative
	max 1.15 x power supply	
	For 400V ~	>> 460V=



Current: ammeter in the motor circuit
5s 200%, continuously 110% type current

Measured values across REG4 (selectable, see Manual REG4)

Speed	X2:109	±5V or ±10V	for ±100% speed
Current	X2:111	±5V or ±10V	for ±200% current
GND	X2:104		

Commissioning Q3 x/x-x with REG4

Check the following connections before commissioning
Observe the type plate!

**Basic connection - power connections Q3**

Power supply	power	bolts X10:14, X10:15, X10:16
Power supply	auxiliary voltage	terminals X5:17, X5:18
Motor connection	A1/A2	bolts X10:10, X10:13
Protecting earth	PE	earthing screws PE on the housing

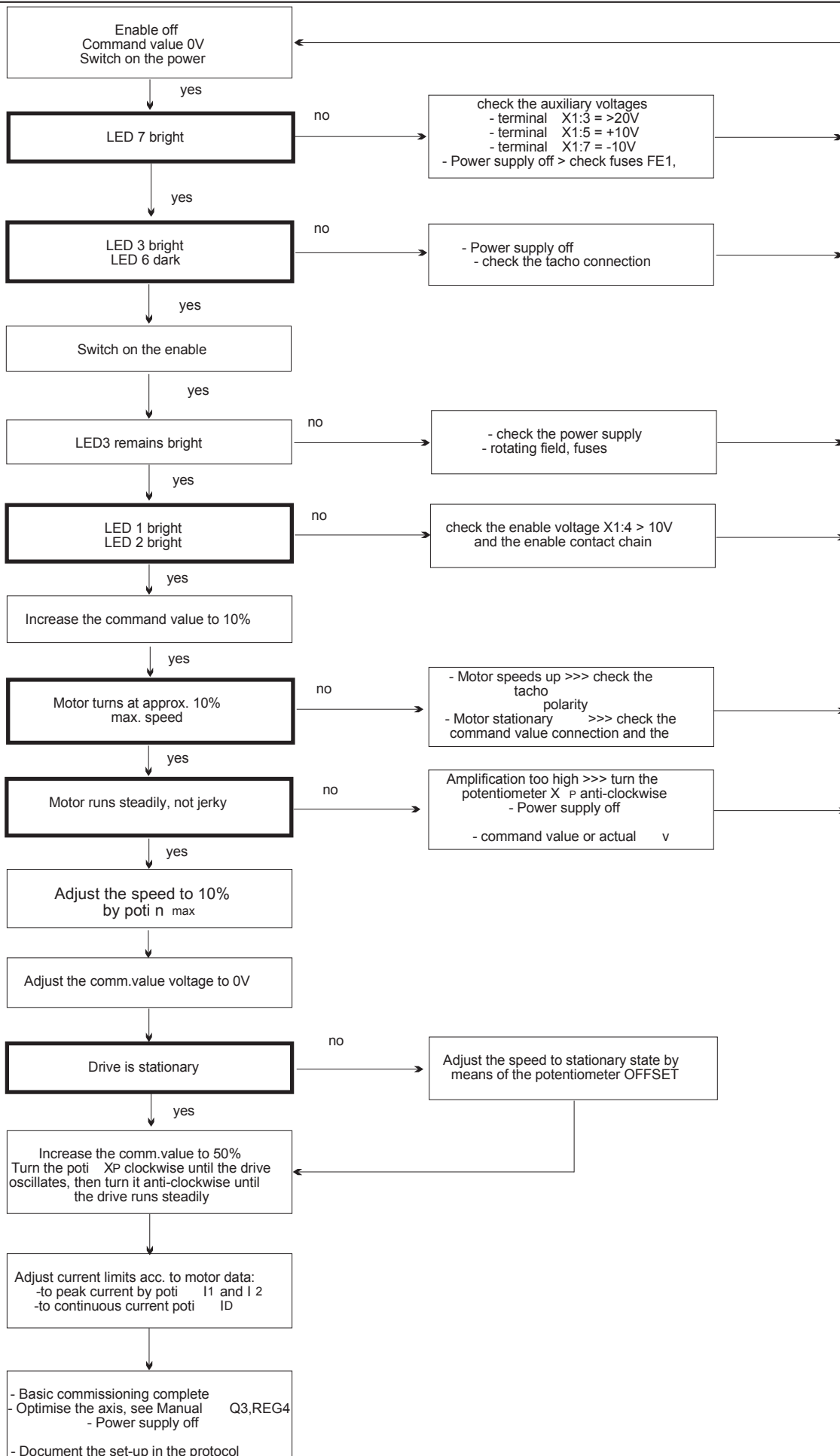
Control connections

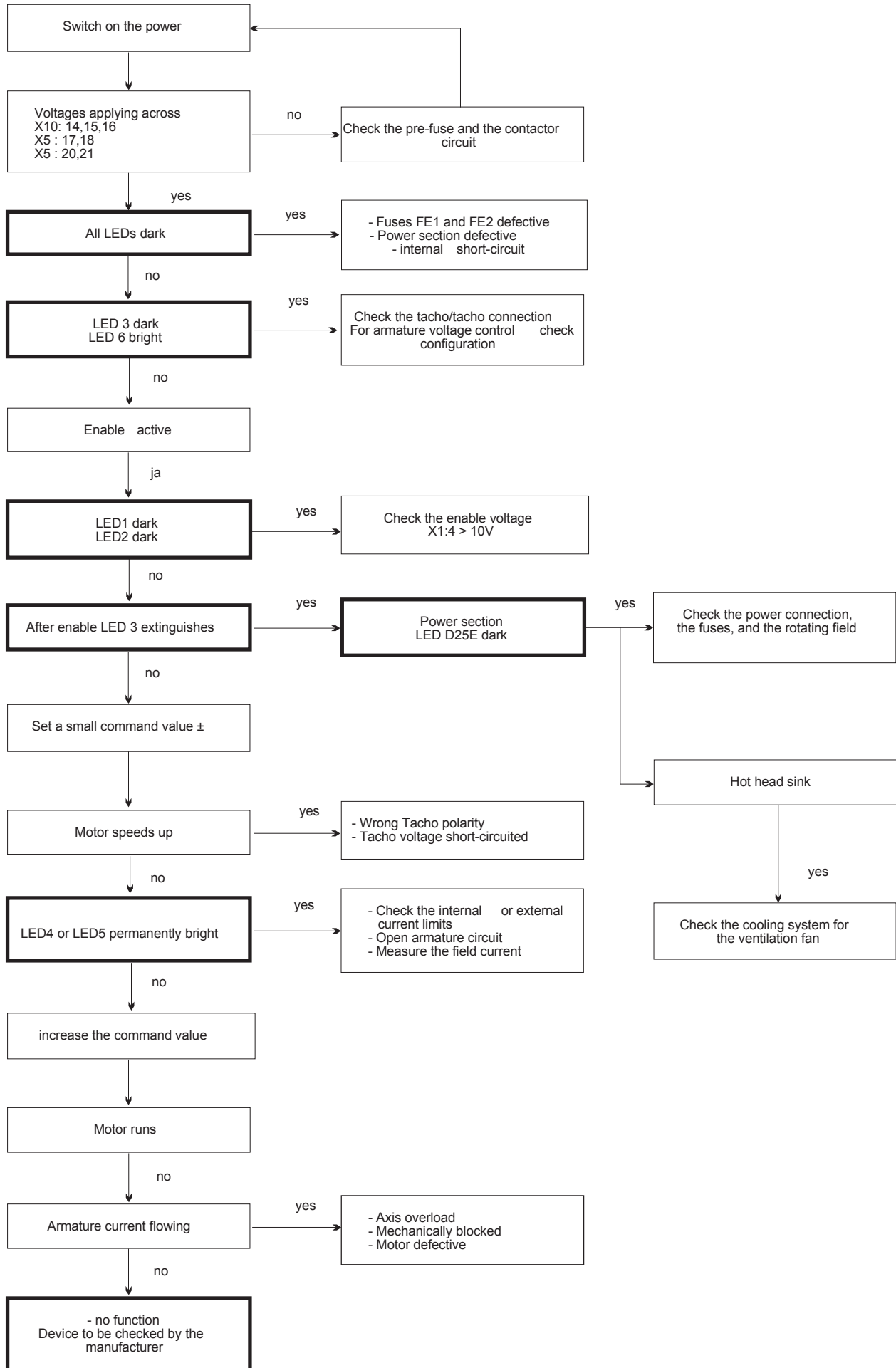
Enable	contact between X1:3 and X1:4
Command value	signal X1:6, GND X1:8a
Actual value	signal X1:9, GND X1:8b
Shields	X1:8

Control electronics REG4

Switch	S4	PI amplification	position 4
Switch	S5	I-term	position 4
Switch	S8	D amplification	position 8
Switch	S9	actual value	position 8
Potentiometer	I1	peak current	10%
Potentiometer	I2	peak current	10%
Potentiometer	ID	continuous current	100%
Potentiometer	XP	amplification	50%
Potentiometer	INT	integrato	left full scale
Potentiometer	n _{max}	speed	left full scale
Potentiometer	offset	offset	50%

6 Commissioning





7 Faults

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 For armature voltage control - 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 of 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

Guarantee

We guarantee that the device is free from material and production defects. Test results are recorded and archived with the serial number.

The guarantee time begins from the time the device is shipped, and lasts one year. WE undertakes no guarantee for devices which have been modified for special applications.

During the warranty period, we will, at its option, either repair or replace products that prove to be defective, this includes guaranteed functional attributes. We specifically disclaim the implied warranties or merchantability and fitness for a particular purpose. For warranty service or repair, this product must be returned to a service facility designated by us.

For products returned to us for warranty service, the Buyer shall prepay shipping charges to us and we shall pay shipping charges to return the product to the Buyer.

However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to us from another country.

The foregoing warranty shall not apply to defects resulting from:

- * improper or inadequate repairs effected by the Buyer or a third party,
- * non-observance of the manual which is included in all consignments,
- * non-observance of the electrical standards and regulations
- * improper maintenance
- * acts of nature

All further claims on transformation, diminution, and replacement of any kind of damage, especially damage, which does not affect our device, cannot be considered. Follow-on damage within the machine or system, which may arise due to malfunction or defect in the device cannot be claimed.

This limitation does not affect the product liability laws as applied in the place of manufacture (i. e. Germany).

We reserve the right to change any information included in this MANUAL.

All connection circuitry described is meant for general information purposes and is not mandatory.

The local legal regulations, and those of the Standards Authorities have to be adhered to. We do not assume any liability, expressively or inherently, for the information contained in this MANUAL, for the functioning of the device or its suitability for any specific application.

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Copying, modifying and translations lie outside our liability and thus are not prohibited. Our products are not authorised for use as critical components in the life support devices or systems without express written approval.

The onus is on the reader to verify that the information here is current.

Protocol

Q3 x/x-x with REG4

Customer Machine No.

Device Q3- Serial No

Control voltage [V~]

Power supply voltage [V~)

Field voltage [V=]

Inputs REG4

Enable contact ?		voltage [V=]	.....
Command value	type	voltage [V=]	.....
Command value, additional	type	voltage [V=]	.....
Current command value I _{max1}	external	voltage [V=]	.....
Current command value I _{max2}	external	voltage [V=]	.....

Speed controller settings REG4

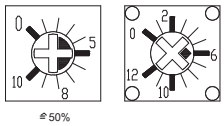
Switches

Tacho adjustment	S9	Position	.....
P-term	S4	Position	.....
I-term	S5	Position	.....
D-term	S8	Position	.....



Potentiometers

Speed	n _{max}	P4	Position	.....
Peak current	I _{max1}	P5	Position	.....
Peak current	I _{max2}	P6	Position	.....
Continuous current	I _D	P7	Position	.....
Integrator	INT	P1	Position	.....
Amplification	XP	P3	Position	.....
IxR compensation		P2	Position	.....



DIP switch

ON	no.	.....
OFF	no.	.....

Protocol

Q3 x/x-x with REG4

Current controller settings Q3

P-amplification	R14 =	...	R13 =	...
I-term	C80 =	...	C81 =	...

50/60Hz

Jumper SW1	Pos. 1-2 (50Hz)	Pos. 2-3 (60Hz)
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Measured data Q3 - REG4

Armature voltage	max.	[V=]
Armature current	peak	[A=]
Armature current	continuous	[A=]
Tacho voltage	max.	[V= ]	.....
Acceleration	X4:	[V/ms]	.....
Integrator	X4:	[V/ms]	.....

Motor data

Type plate data

Manufacturer	.....
Type	.....
Serial number	.....
Motor voltage [V=]	.....
Motor current [A=]	.....
Tacho voltage [V/min-1]	.....
Tacho type	.....
Brake [V]	.....
Fan [V]	.....