

Manual

Classic Q1-k

4 Quadrant Circular Current

Q1-k



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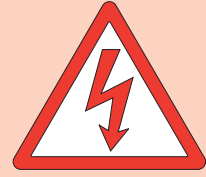
Thyristor controller Q1-k

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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



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.

Q1 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
 EN60204, EN50178, EN60439-1, EN60146, EN61800-3

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 independent 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 standards EN61000-2 and EN61000-4.

Thyristor controller Q1-k

Attention

This device description must be read in conjunction with a control manual (e.g. REG).

The following control units for 4 quadrant control are available:
analogue control REGx

General information

In conjunction with a control board (e.g. REG) the Classic Q1 range of thyristor drives act as current controllers (moment of inertia controllers). A 26-pin connector, common to all boards, is used to connect the power section and the control electronics. Using this interface it is possible for any external control arrangement including third party equipment to drive the power section.

Q2 drives are used to control the speed, voltage or moment of inertia of dc motors in current circulating 4 quadrant mode. Moment of inertia is applied continuously to the motor without interruption.

Characteristics

- The thyristor current controllers are designed for switch cabinet mounting acc. to the VDE regulations
- Galvanic isolation between the control electronics and the power section
- The distances of air gaps and leakage paths are superior to 8mm
- Comfortably over-dimensioned power semi-conductors
- Only components customary in trade and industrially standardised are used
- LED display for the main operating states
- The PI-adjustment of the current controllers is effected through the use of two 4-position switches- Protection cover against contact with the unit
- Front mounting of the control electronics
- As far as possible plug-in terminals are used for the connection
- High power connections have to be connected across power terminals or threaded bolts
- The output stage is an anti-parallel dual bridge circuit

1 Basic information

Q1 230/180-x-k

Power connection	200 ... 250V~
Auxiliary voltage connection	200 ... 250V~
Output voltage	max. $\pm 180V=$
Cooling	self cooling

Q1 230/180		15-k	25-k	40-k
Input current	A~	16.5	27.5	44
Output current	A=	30	50	80
- peak	A=	15	25	40
- continuous				
El. power	kW	2.7	4.5	7.2
Input fuses (fast acting)	A	20	30	50
- input	A	35	50	63
- output				
Mains chokes	Type	K78-16	K84-25	K84-50
	mH	1.2	0.7	0.5
Circular current chokes	Type	EI135A-16	EI135B-24	EI150B-35
	mH	33	16	8
Dimensions	wxhxd	200x240x100	200x240x100	200x240x127
	mm			

Q1 400/300-x-k

Power connection	360 ... 440V~
Auxiliary voltage connection	360 ... 440V~
Output voltage	max. $\pm 300V=$
Cooling	self cooling

Q1 400/300		15-k	25-k	40-k
Input current	A~	16.5	27.5	44
Output current	A=	30	50	80
- peak	A=	15	25	40
- continuous				
El. power	kW	4.5	7.4	12
Input fuses	A	20	30	50
(fast acting)- input	A	35	50	63
- output				
Mains chokes	Type	K78-16	K84-25	K84-50
	mH	1.2	0.7	0.5
Armature chokes	Type	EI135B-16	EI150B-24	UI120B-40
	mH	38	17	13
Dimensions	wxhxd	200x240x100	200x240x100	200x240x127
	mm			

Thyristor controller Q1-k

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
Input signal	0 to $\pm 10V=$
Output	0 to $\pm 200\%$ type current

Enable +10V

Current control loop circuit

- control precision $\pm 2\%$
- control range 1:50

Speed control loop circuit with REG

- control precision $\pm 0.1\%$
(without actual value error)
- control range 1:300

Function

+ 24V	$\pm 10\%$
+ 15V	$\pm 2\%$
- 24V	$\pm 10\%$

X3: 5 and 6

- 15V	$\pm 2\%$
-------	-----------

Connector no.

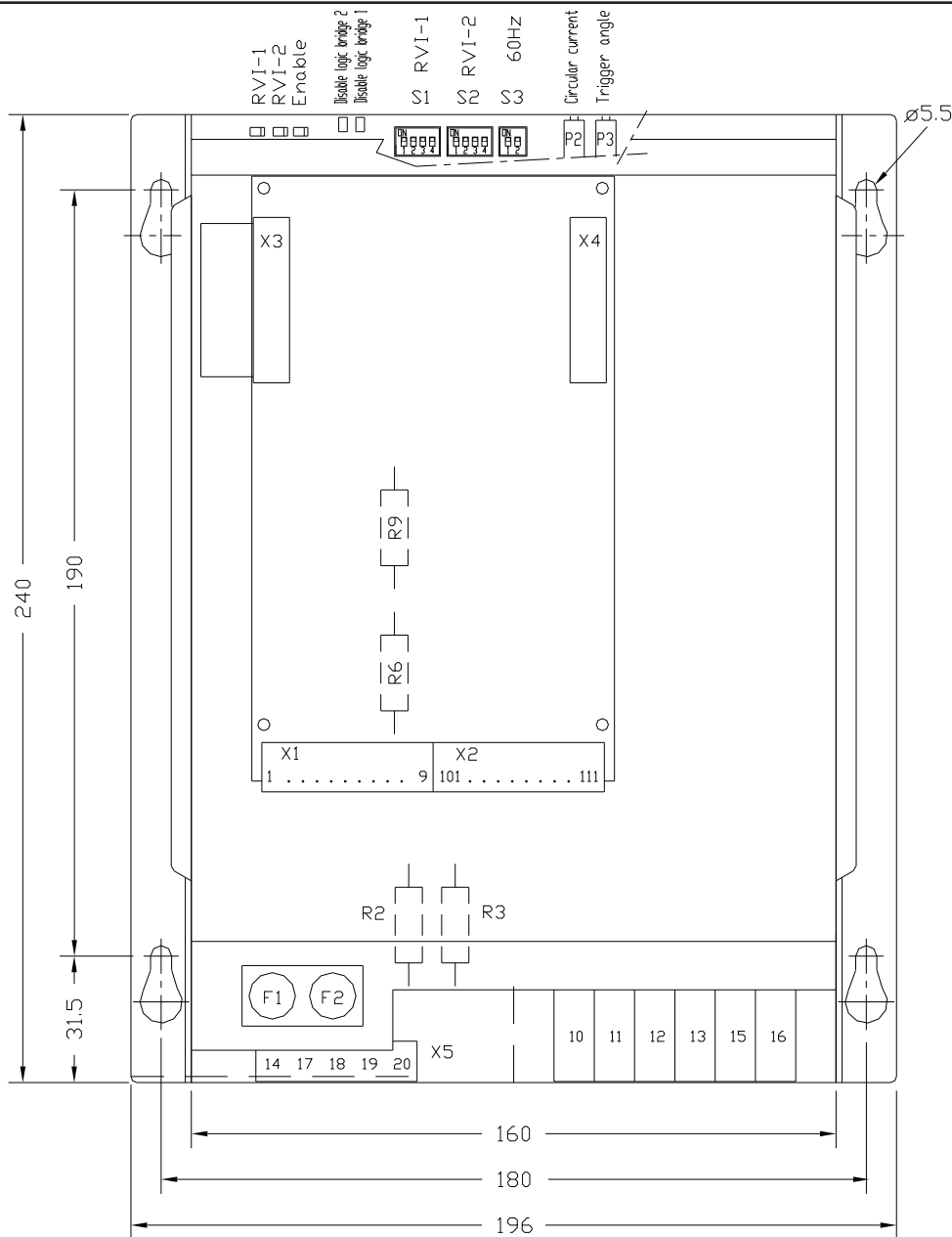
X3: 1 and 2

X3: 3 and 4

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)	$\pm 10V=$	X3: 16
Current controller enable	+10V=	X3: 17
Drive disable1	+10V=	X3: 18
Drive disable 2	+10V=	X3: 19
N (speed) actual	+10V=	X3: 20
I (current) actual	+10V=	X3: 21
Over-current power section	n/a	X3: 22
Trigger angle1	+10V=	X3: 23'
Trigger angle 2	+10V=	X3: 24
Drive ready BTB	+10V=	X3: 25
not assigned	n/a	X3: 26

2 Mechanical installation



Adjustments:

Switch S1	PI loop circuit	Current control loop RVI-1
Switch S2	PI loop circuit	Current control loop RVI-2
Switch S3	60Hz adjustment	Contact 1, 2 to ON
Potentiometer P2	Circular current	(higher when turning anti-clockwise)
Potentiometer P3	Trigger angle adjustment	adjusted in the factory and sealed with a lacquer

LED displays:

Enable	Enable	green	enabled
Current command value			
Current control loop	RVI-1	green	control active
Current control loop	RVI-2	green	control active
	(The luminous intensity depends on the trigger angle)		
Disable logic	Bridge 1	green	without function for Q1-k
Disable logic	Bridge 2	green	without function for Q1-k



5 Adjustments

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:

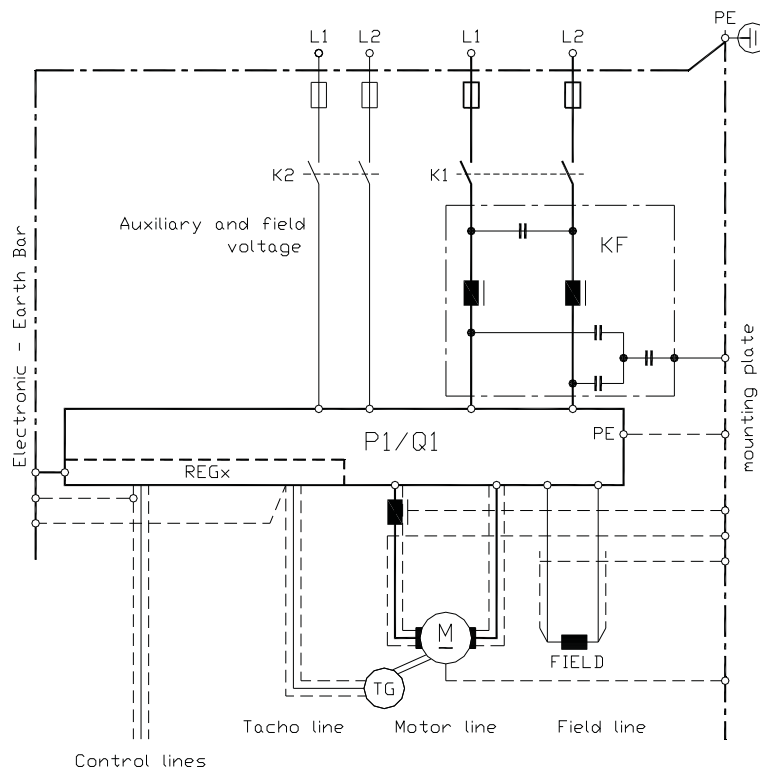
- The device, the transformer, and filter capacitors are mounted on a 500x500x2 mm mounting plate.
- The mounting plate must be connected to ground using a 10mm² wire.
- The motor housing must be connected to ground using a 10mm² wire.
- The device ground X1:8 must be connected to the mounting plate using a 2.5mm² wire.
- Device PE screw must be connected to the mounting plate using a 4mm² wire, l = 50mm.

Connection:

Power choke type: see technical details
 Filter capacitors: 0.5μF/600V~ 2 x 1μF (x) + 2 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 = Commutation choke with filter capacitor

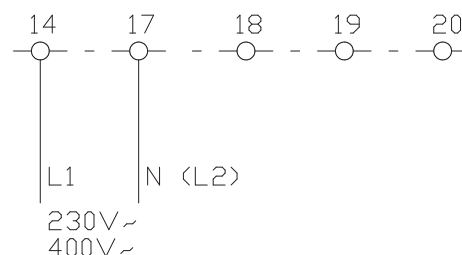
Thyristor controller Q1-k

Attention:

The order of the connections to the connector numbers or screw terminals is obligatory. The input and output conductors may be altered or supplemented in accordance with the electrical standards. All further advice is non-obligatory.

Auxiliary voltages

- Connection auxiliary voltage and field supply plug-in terminal X5
- Voltage 230V~ or 400V~ (rf. to the type plate)
- Input current 0.1A
- Fuses F1 and F2 2.5A f (rated for field current)

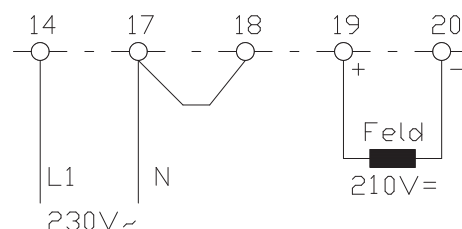


The phase position of the auxiliary voltage and the power supply voltage

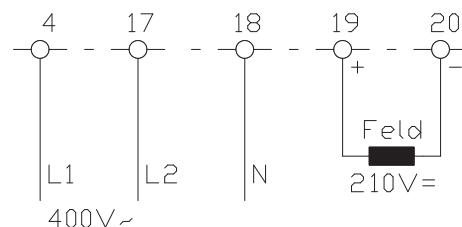
must correspond to each other. X5:14 corresponds to terminal 15 and X5:17 corresponds to terminal 16.

Field voltage

- | | |
|--------------------------|---------------------------|
| Connected voltage | Field voltage |
| 230V~ | 210V= |
| 400V~ | 210V= or 360V= |
| | (N across terminal X5:18) |

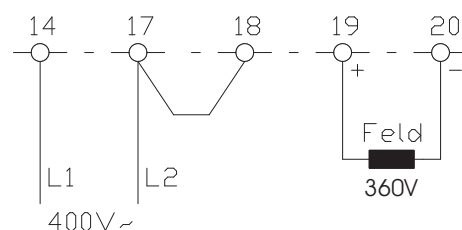


- Field current** max. 1.5A
- The field current has no watch-dog.



Fuse F1

If the field fuse drops out, the drive switches off.



5 Adjustments

The power connections must be protected by means of fast acting fuses.

The power choke inductance must be $>200\mu\text{H}$.

The phases of the power connection and the auxiliary voltage must be equal. There is an internal watchdog for the power connection. If the power supply or the fuses fail, the device switches off and the BTB contact opens.

Usually an auto-transformer is used.

Isolating transformers must be used for motors with a low over-voltage protection of slow acting fuses.

The transformer performance is determined by the permanent current and the secondary voltage.

Fast acting fuses must be installed between the transformer and the control unit. These fuses are monitored for drop-out by the power supply watchdog.

The phases of the secondary voltage of the transformer and the auxiliary voltage must be equal.

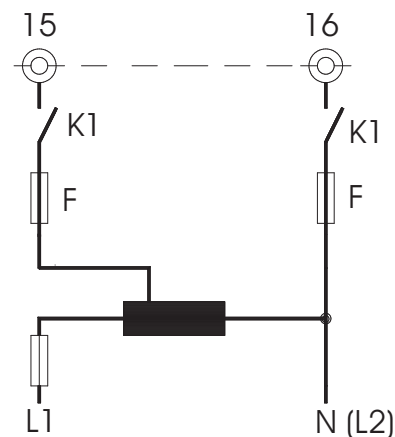
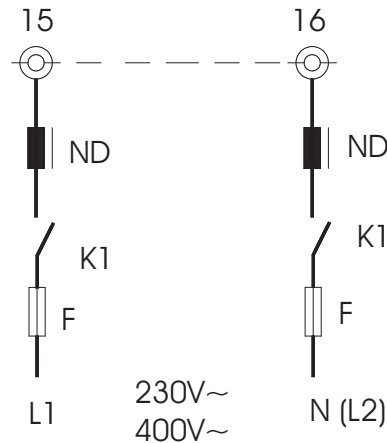
It has to be ensured that the contacts of the contactors on the input side of the transformer are sufficiently rated for the switch-on current of the transformer.

The transformer has to be protected by means
Attention:

For secondary voltages of the transformer inferior to $120\text{V}\sim$ the resistors R2 and R3 on the power section have to be reduced by connecting two resistors (each $22\text{k}\Omega$) in parallel.

60Hz mains supply:

In order to operate the thyristor drive via a 60Hz mains supply, the contacts 1 and 2 of the DIP switch S3 must be in position ON.



Thyristor controller Q1-k

The motor is connected to the terminals 10,11 and 12,13 via the circular current chokes and the motor fuses.

Min. circular current choke inductance:

$$L \text{ [mH]} = U_A/I_A \times 2.4$$

(Motor voltage divided by armature voltage times 2.4)

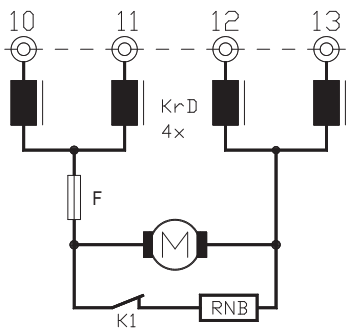
In case of dynamic over-current the rated choke current must be at least 0.7 times the adjusted peak current so that the chokes do not reach the saturation range.

The motor lines should only be switched during a current-free state.

Warning:
Switching off under current will create arcing across the switch contacts.
Switching on while the drive is enabled will cause the fuse to fail.

RNB resistors (brake resistors in case of power supply failure) are to be connected in parallel directly to the motor armature without isolating the motor from the control unit.

At the output of the armature choke the motor line is protected against short-circuits. A fuse F must be installed in the armature circuit. This fuse must be monitored and in case of failure of e4 the control unit must be disconnected from the power supply.



The conductor cross-sections must be rated for continuous motor current. The power lines and motor lines are to be routed separately from sensitive measuring and control

Conductor cross-section (minimal)				
Type current	A	15	25	40
ac power supply	mm ²	1.5	2.5	4
Motor line	mm ²	1.5	2.5	4

lines.

Compared to transistor chopper amplifiers the thyristor servo drives have little electro-magnetic and electro-static interferences which can easily be filtered.

5 Adjustments

The actual value is connected to the control electronics (e.g. REG) as tacho signal or armature voltage signal.

The quality of the actual value signal determines the control range and the control accuracy. Best results can be achieved through the use of dc tacho generators.

Three-phase tacho generators with rotor position evaluation or digital actual value encoders with direction-dependant signals can also be used.

Ac or three-phase tachos with rectification are not suitable for 4 quadrant operation.

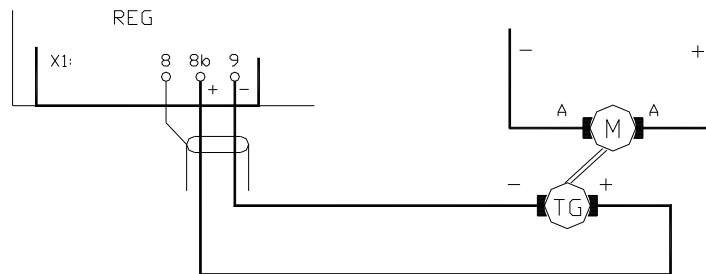
Tacho lines should be properly shielded and routed separately from power lines.

Shield to be connected to the device.

Please observe the tacho adjustment in the manual of the control electronics (e.g. REG):

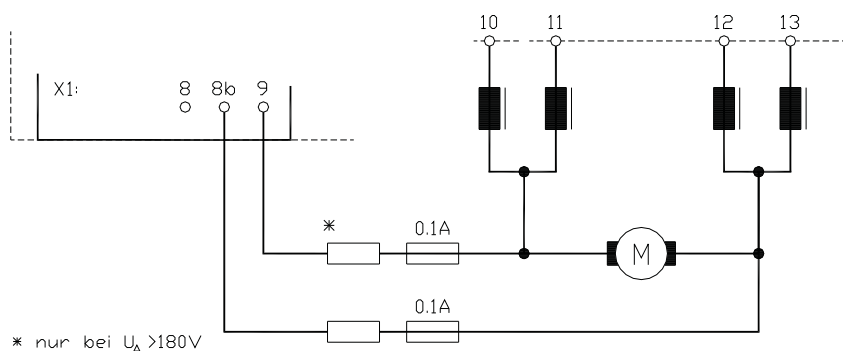
For 4 quadrant controls with small control ranges (up to 1:50) and little demands on accuracy and dynamic the armature voltage can be used as actual value signal.

The actual value lines must be protected by two fuses of 0.1A/500V installed directly in the armature voltage.



For armature voltages superior to 180V two additional drop resistors must be pre-connected.

The adjustment advice for armature voltage control with $I_x R$ compensation must be observed (rf. to the Manual REGx).



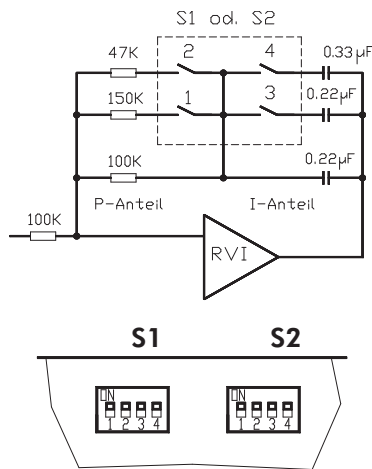
A floating input armature voltage control with an isolating amplifier (e.g. QTV1) is possible

Thyristor controller Q1-k

The current control characteristics of the power sections can adjusted.

The PI characteristics of the controller RVI-1 is adjusted by the 4-position DIP switch S2, the PI characteristics of RVI-2 by switch S1.

Switch position



All switches are closed on delivery of the devices.

This corresponds to the position for the lowest armature circuit inductance.

The proportional amplification can be changed via the contacts 1 and 2.

The integral time constant can be changed via the contacts 3 and 4.

Any changes of the current controller adjustment must be checked by means of an oscilloscope.

For circular current controlled devices the circular current can be adjusted by means of the potentiometer P1.

The circular current is increased by turning the potentiometer anti-clockwise.

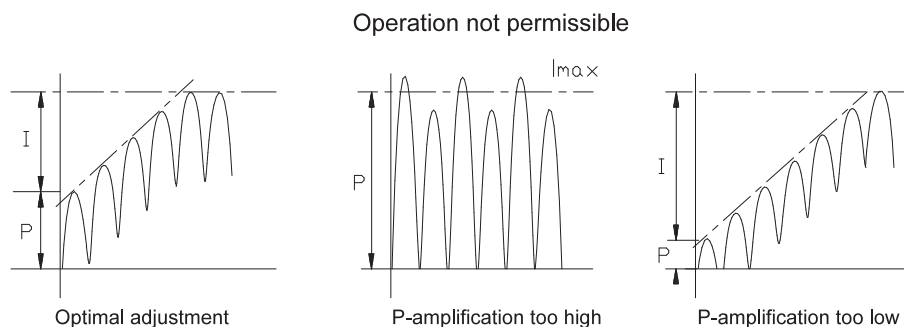
On delivery the devices are adjusted to low circular current.

The circular current can be measured across the choke circuit when the motor is at a standstill.

Please observe:

The device circular current corresponds to the circular current plus motor current. Thus, the motor current is reduced if the adjusted circular current value is too high. Optimal range: 3 to 10% circular current

Oscilloscope - Current adjustment (measured across REGx-X2:111)



For a 60Hz operation

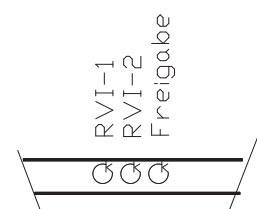
the jumpers S3 and S4 must be plugged-in.

Displays

Some important functions are indicated by LEDs:

- current controller enable (enable)
- current command value directions (RVI-1 or RVI-2)

The green LEDs indicate the active states.



5 Adjustments

BTB signal - Drive ready

The thyristor power sections have an internal watchdog.

No errors >>> BTB signal voltage > +10V

The BTB relay on the control electronics is triggered via the test output X3:25.

The BTB signal voltage is <2V if the following errors occur:

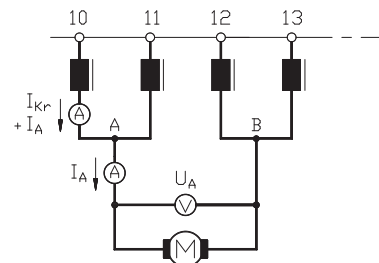
- auxiliary voltage supply: +24V, +15V, -15V
- power supply: fuse failure, under-voltage

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

Measurement advice

The current and voltage can be measured in the load circuit (motor circuit) by means of multimeters.

The dc current can be measured by means of measuring instruments which indicate mean values or by instruments which indicate actual values. When measuring the dc current with these different measuring instruments there will be measuring errors which are determined by the form factor. For rated device current and the correct motor chokes the actual value is 1 to 5% higher than the mean value.



The motor voltage is measured as dc voltage.

The max. dc voltage must not be superior to 0.75 x power supply.

If the speed command value (X1:6 (REG)) or the current command value (X3:16 or X4:15) are positive, the voltage across terminal 10 is positive against terminal 12.

The signals of the current and the speed can be measured across the terminals X2:109 and X2:111 of the control electronics REG.

Measured values

Speed	X2:109	±5V for ±100% speed
Current	X2:111	±5V for ±200% type current

Thyristor controller Q1-k

1. Connection advice

Connect the drive in accordance with the Q1 manual and the control electronics manual (e.g. REG).

Please observe in particular:

- The phase of the connections across the terminals 14-17 and 15-16 must be equal.
- Check the power supply voltage with that specified on the type plate.
- Insert the fuses according to the technical data.
- Check the field voltage connection and the motor and tacho connections!

2. 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 by means of jumper S16.

2.1 Drive enable switch open or drive enable voltage 0V

Command value		0V
Switch S9		adjust to tacho voltage
for armature voltage control		adjust to 0
Switch S4		position 2
Switch S5		position 6
Potentiometer	I_{max1}, I_{max2}	adjust to approx. 10% of full scale
Potentiometer	X_p	adjust to 50%
Potentiometer	I_D	= 100%
Potentiometer	I_{xR}	= left full scale
Potentiometer	n_{max}	= left full scale
Potentiometer	INT	= left full scale
Jumpers S6, S7, S12, S13, and S14		plugged-in

2.2 Apply the voltage

The LEDs 26- (BTB) and 9- (stationary) must light.

All other LEDs are off.

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

The LEDs D1 and D4 must also light.

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

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 or the field must be changed.

2.4 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.

6 Commissioning

2.5 Current controller amplification

(Switch S1, S2 on the power section)

The current amplification is adjusted to a low armature circuit inductance (all switches "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 S1-2 then switch S2-2 to "Off".

If the drive still does not run smoothly, set the switches S1-1 and S2-1 to "Off".

The current response can be measured by means of an oscilloscope across the test point REG X4:20 or REG X2:111 (see page 12).

Measured values: 2.5Vact. correspond to type current

5Vact. correspond to peak current

Attention:

If the current amplification is adjusted too high, this may cause the current controller to oscillate and current peaks which are not permissible. The motor may be damaged or the fuses activated.



2.6 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 adjusted value

small axis momentum - low adjusted 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

(see fig. in the manual REG).

2.7 Further adjustments

such as speed, peak current, continuous current, etc. (rf. to the manual REG and Q1-k).

2.8 Switching Off

If the switch 'drive enable' is opened, or the drive enable voltage is switched to 0V, first the LED D1 will extinguish and the drive will brake until standstill. After approx. 5s the LED D4 will extinguish and the drive is disabled. After approx. 5 more seconds, the thyristor triggering circuit is disabled.

2.9 Commissioning adjustment

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

Thyristor controller Q1-k

Protocol

Protocol

Customer Machine No.

Device Serial No

Control voltage [V~]

Power supply voltage [V~)

Field voltage [V=]

Inputs

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 Switches

Tacho adjustment S9 Position

P-term S4 Position

I-term S5 Position

Potentiometers

Speed n_{max} P4 Position

Peak current I_{max1} P5 Position

Peak current I_{max2} P6 Position

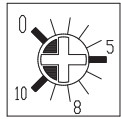
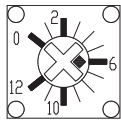
Continuous current I_D P7 Position

Integrator INT P1 Position

Amplification X_P P3 Position

IxR compensation P2 Position

Jumper (plug-in bridges)



Position 5

7 Protocol

Current controller settings

Switches

Switches S1, S2	open	(off)	.....
	closed	(on)	.....
Jumper S3, S4 60Hz	open	plugged	.....

Measured data

Armature voltage	max.	[V=]	.....
Armature current	peak	[A=]	.....
Armature current	continuous	[A=]	.....
DC tacho voltage	max.	[V=]	.....
Tacho voltage	max.	[V=]	.....
Acceleration	X4:16	[V/ms]	.....
Integrator	X4:14	[V/ms]	.....

Motor data

Type plate data

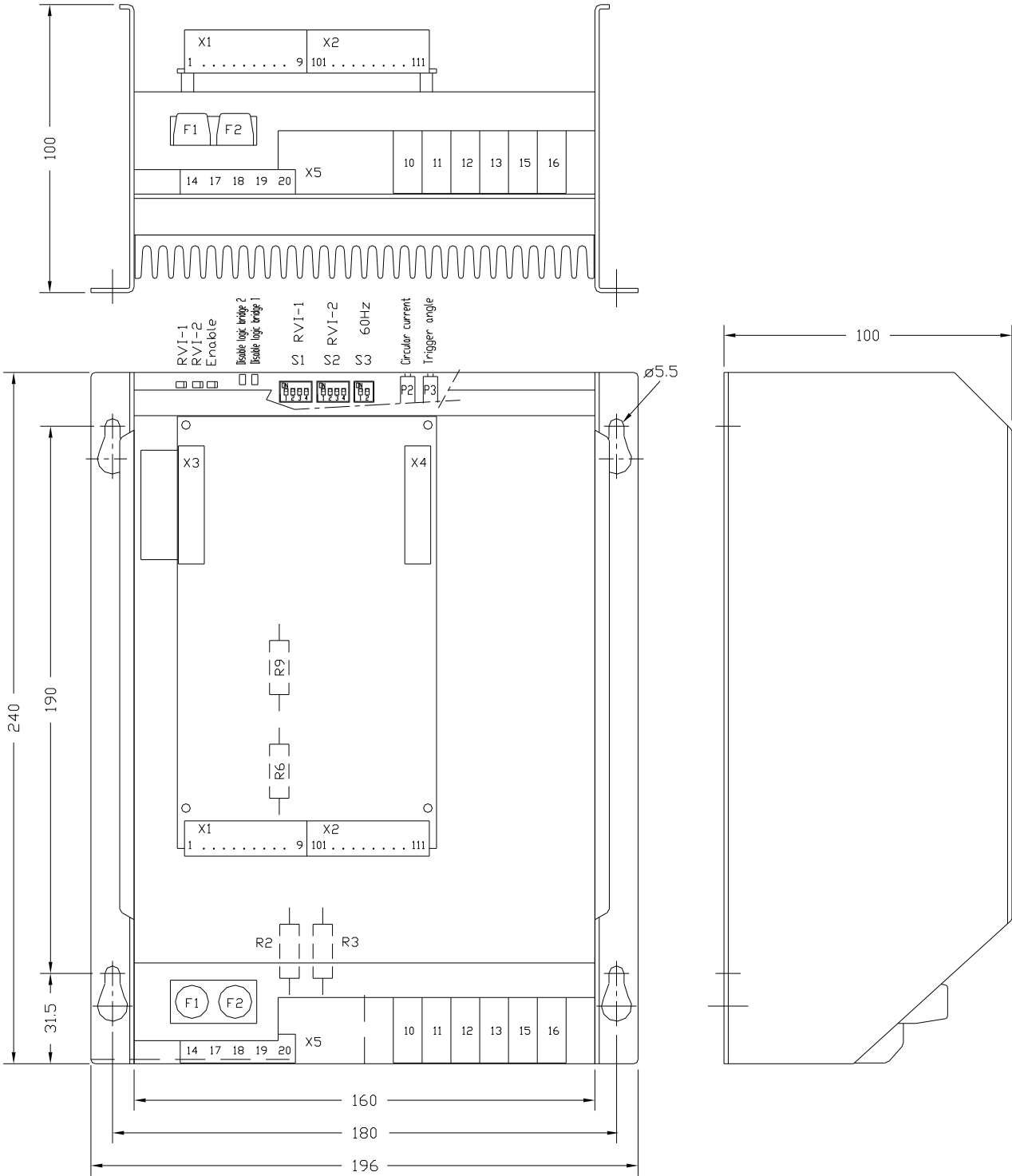
Manufacturer

Type Serial number

Motor voltage [V=] Motor current [A=]

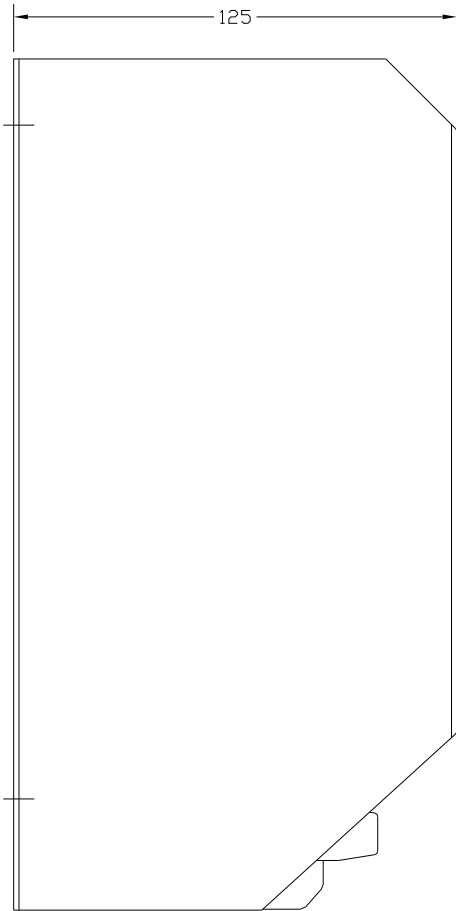
Brake [V] Fan [V]

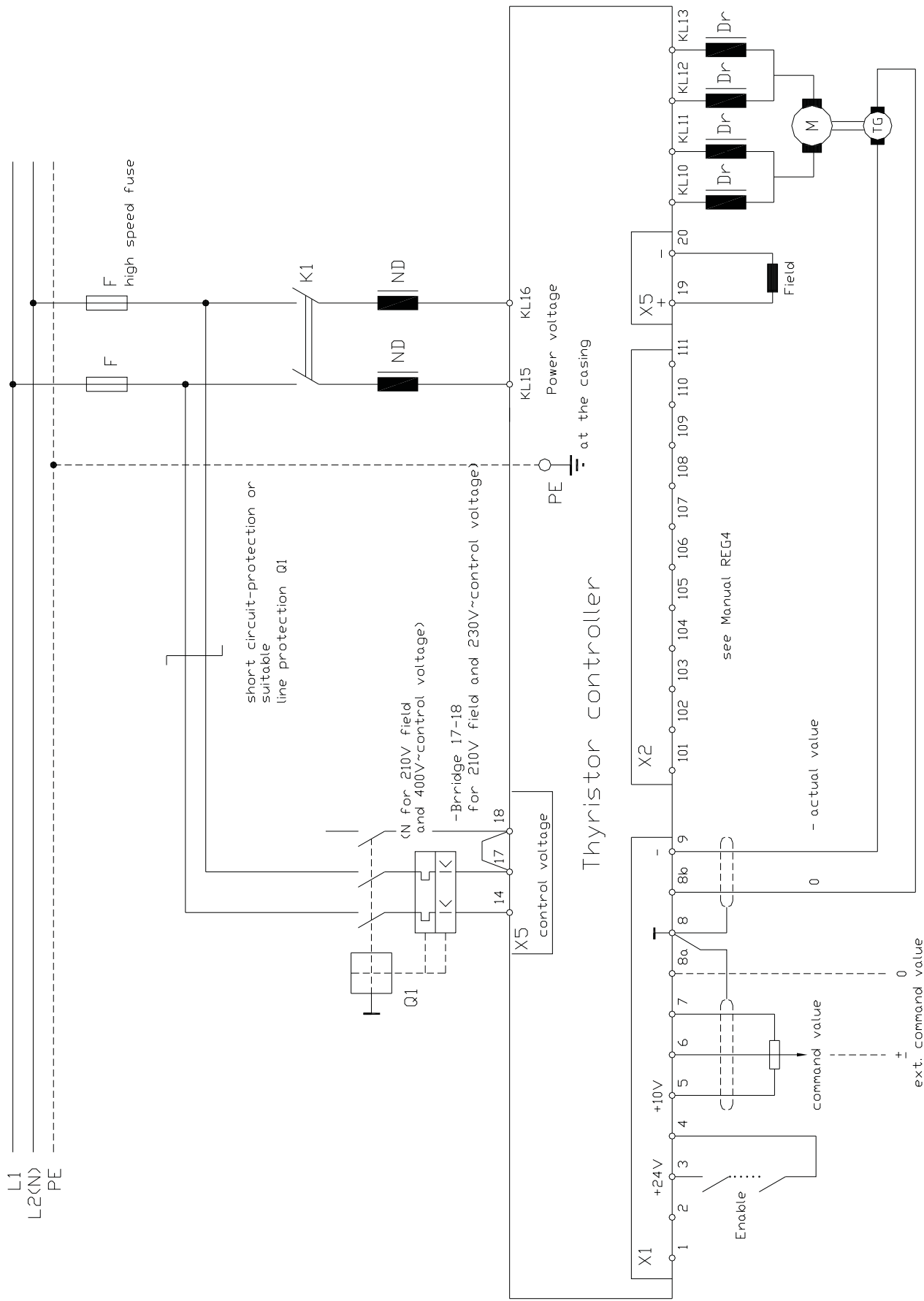
8 Drawings

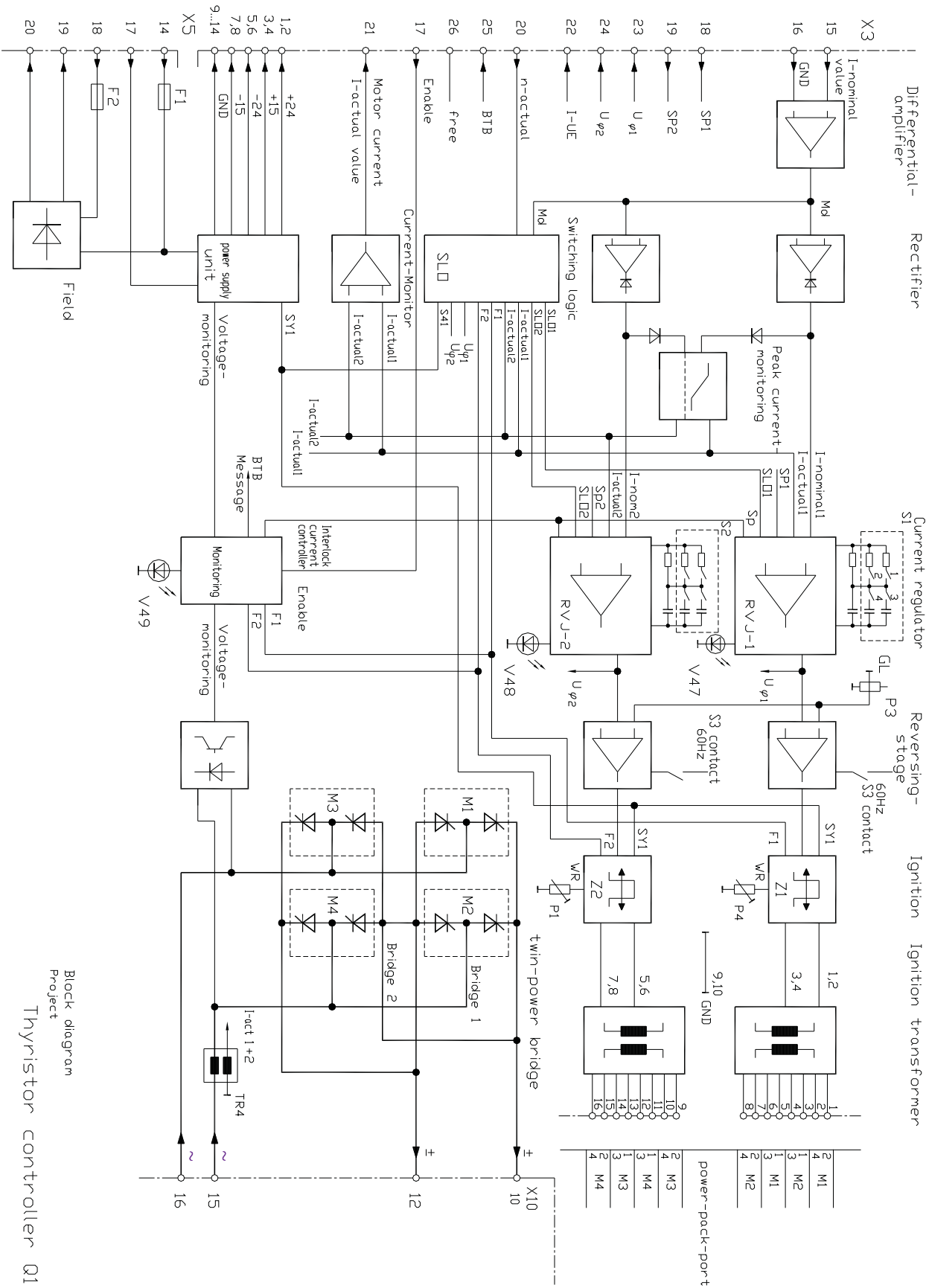


Dimensions Q1-k 15-25A

Dimensions Q1-K 40A







Block diagram
Project
Thyristor controller Q1