Q2

MANUAL

Classic Q2

4 Quadrant Circulating
Current Thyristor Drive

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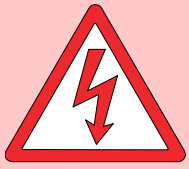
Contents

Contents:

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

ATENTION
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.
Q2 devices are power electric parts used for regulating energy flow for power plants.
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. EMV standards EN61000-2 and EN61000-4.

Attention
This device description MANUAL Q2 and must be read in conjunction with a control manual (e.g. REG).

The following control units for 4 quadrant control are available:
analog control REG

General information
In conjunction with a control board (e.g. REG) the Classic Q2 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
- The output stage is a 2-phase dual centre-tap circuit

Q2 220/160-x

Power connection Q2	2x100V ... 2x240V~
Control voltage connection	200 ... 250~ od. 360 ... 440V ~
Output voltage	max. ±160V=
Cooling	self cooling

Q2 220/160-		**10**	**20**	**30**
Input current (Phase)	A~	6	12	16
Output current Peak Continuous	 A= A=	 20 10	 40 20	 60 30
El. power	kW	1,6	3,2	4,8
Fuses (fast blow) Input	A	10	20	35
Mains transformer UI-	Type	120-A	150-B	180-B
Isolating transformer UI-	Type	150A	180B	210B
Chokes	Type mH	EI120A-12 49	EI135B-24 16	UI120B-40 7
Dimensions BxHxT	mm	200x240x100	200x240x100	200x240x127

General Specifications

Mains frequency	50 or 60 Hz ±5%
Protection	IP 00
Device layout	VDE 0100 Group C, DE 0160
Moisture rating	Class F to DIN 40040
Operating height	<1000m above sea level
Operating temperature	0 to 45°C
Extended operating temperature	up to 60°C, red. 2%/°C
Storage temperature	-30°C to +80°C
Amplification	
Input signal	0 to ±10V=
Output	0 to ± 200% continuous current
Enable	+10V
Current controller	
Control accuracy	±2%
Control range	1:50
Speed controller with REG	
Control accuracy	±0,1% (without command value error)
Control range	1:1000

Function			Connector no.
+ 24V		±10%	X3: 1 and 2
+ 15V		±2%	X3: 3 and 4
- 24V		±10%	X3: 5 and 6
- 15V		±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 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.b		X3: 22
Trigger angle1		+10V=	X3: 23
Trigger angle 2		+10V=	X3: 24
Drive ready BTB		+10V=	X3: 25
Free		n/a	X3: 26

EMC 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:

Transformer type: see technical details

Filter capacitors: 2x1µF(x) + 0.5x 1µF (y)

Conductor length between the device and the power choke <250mm

Motor connection:

Motor conductors

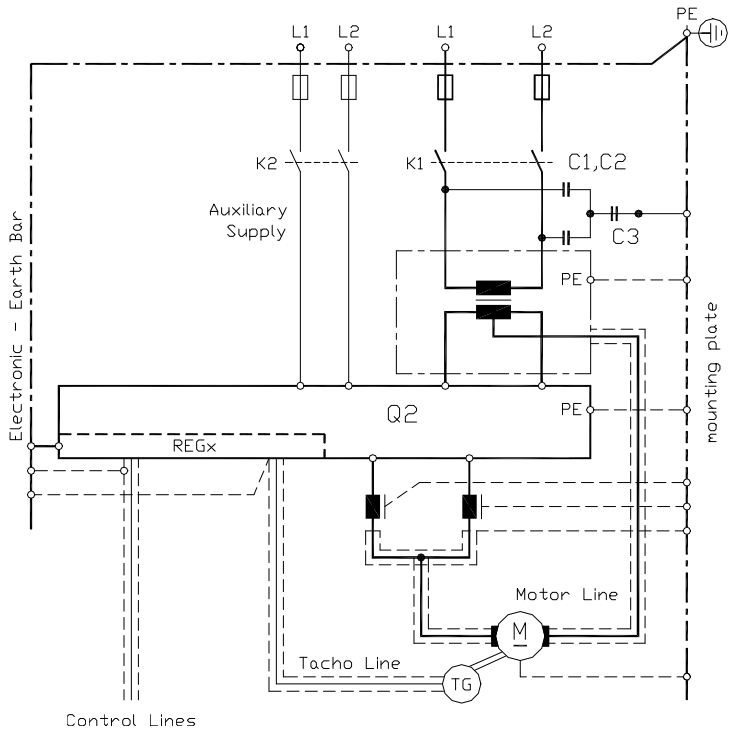
l = 1.5m, shielded

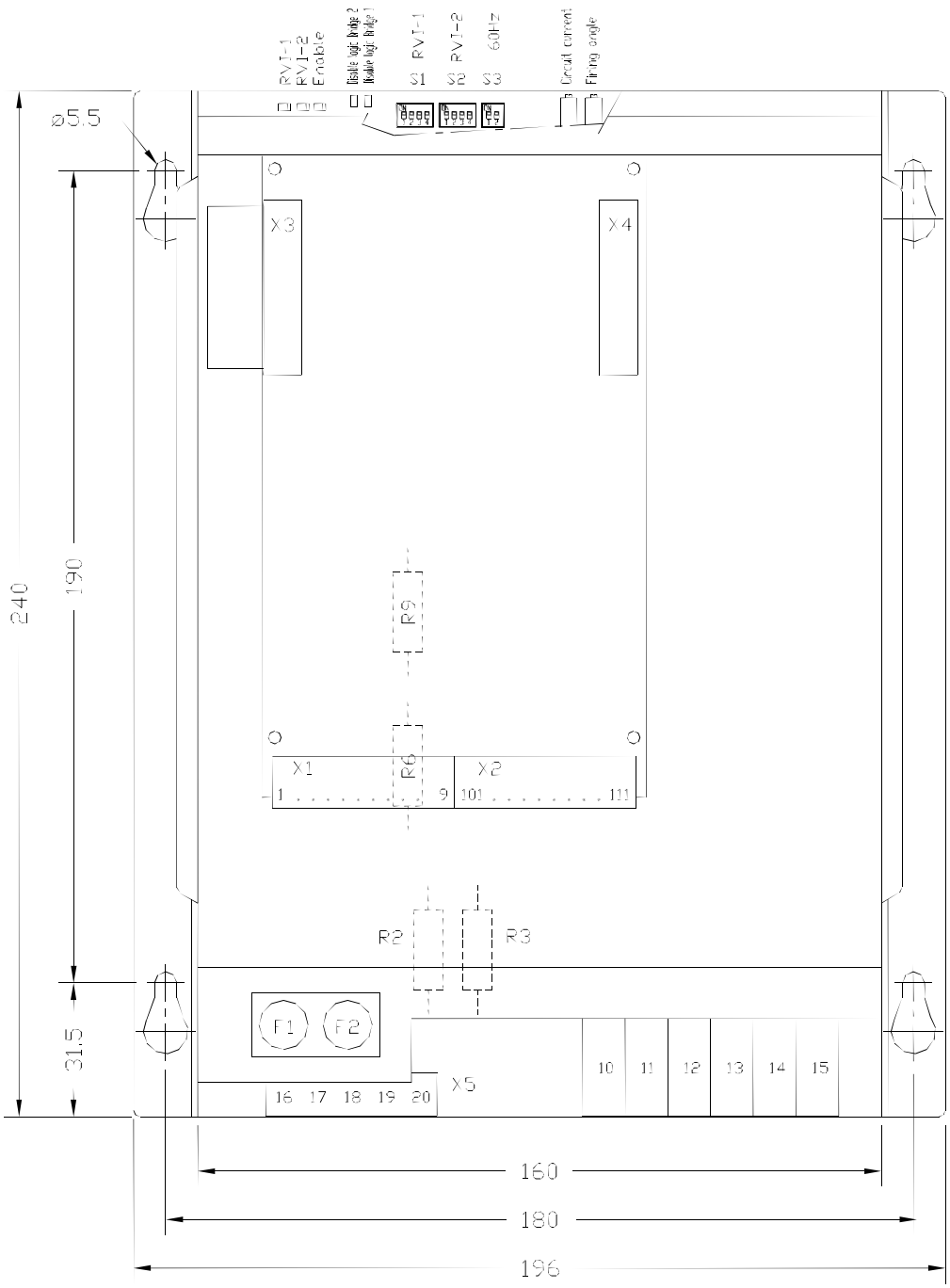
Tacho and all control lines

l = 1.5m, shielded

Shielding connected to PE

Connection diagram →





Adjustments:

Switch S1	PI- Switching	Current controller RVI-1
Switch S2	PI- Switching	Current controller RVI-2
Potentiometer P2	Circuit current	(anti-clockwise greater)

LED- Indication :

Enable	Enable	green	enabled

Command value current

Current controller	RVI-1	green	switched on
Current controller	RVI-2	green	switched on

(The luminous intensity depens on the ignation phase)

DIP Switch S3	contact 1 and 2	OFF = 50Hz
		ON = 60 Hz

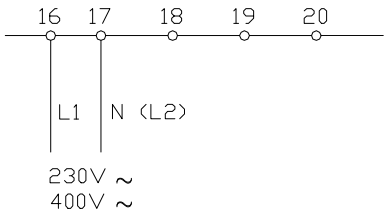
Attention:

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

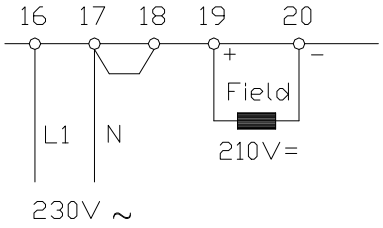
Voltage	230V~ or 400V~ (rf. to the type plate)
Input current	0.1A
Fuses F1 and F2	2.5A f (rated for field current)



The phase position of the auxiliary voltage and the power supply voltage must correspond to each other. X5:16 corresponds to terminal 13 and X5:17 corresponds to terminal 15.

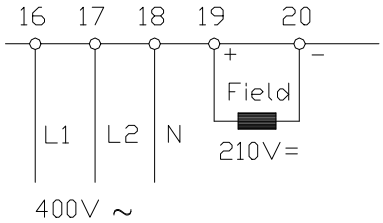
Field connection (optional)
Field voltage

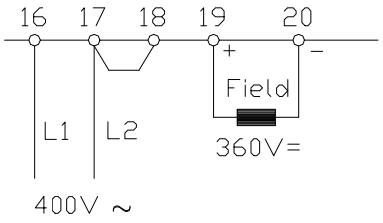
Connected voltage	**Field voltage**
230V~	210V=
400V~	210V= or 360V=



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

Fuse F1
If the fuse drops out, the drive switches off.





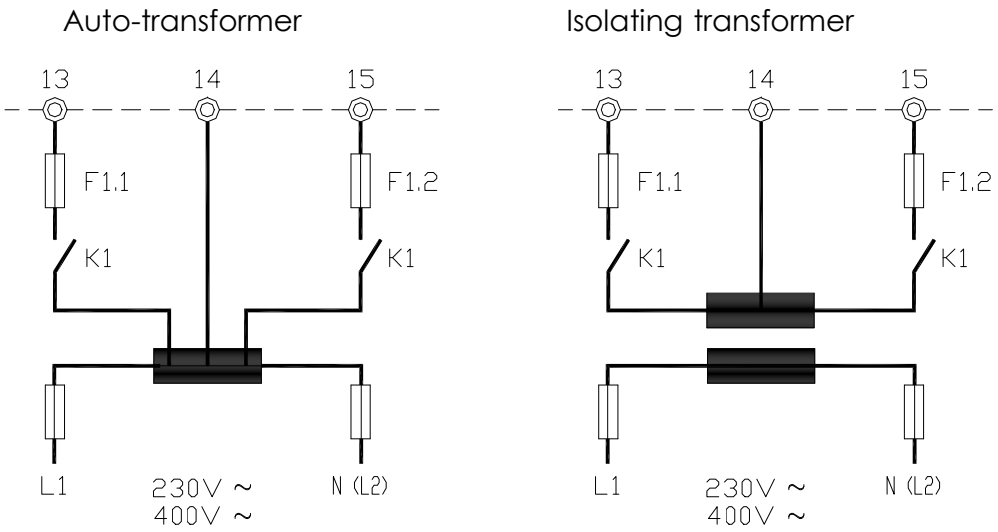
Power connections

Transformer power connection Usually an auto-transformer is used.
Isolating transformers must be used for motors with a low over-voltage protection.
Transformer rating
The transformer performance is determined by the permanent current and the secondary voltage.
To allow for the dc current loading, the transformer has to be over-dimensioned by a factor 1.5.

The transformer power is rated for a duty cycle of 100%.

PTr [VA] = secondary voltage x continuous current (I) x 1.5

The transformers recommended in the chapter 'technical data' are rated for a duty cycle of 60%.



F1.1 and F1.2 - Super fast acting

Quick fuses F1.1, F1.2 must be installed between the transformer and the control unit.
These fuses are monitored for drop-out by the power supply watchdog.
The connection across terminal 14 has no watchdog.

The phases of the secondary voltage of the transformer and the auxiliary voltage across X5 **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 of slow fuses.

Attention:
For secondary voltages of the transformer inferior to 120V~ the resistors R2 and R3 on the power section have to be reduced by connecting two resistors (each 22kOhm) in parallel.

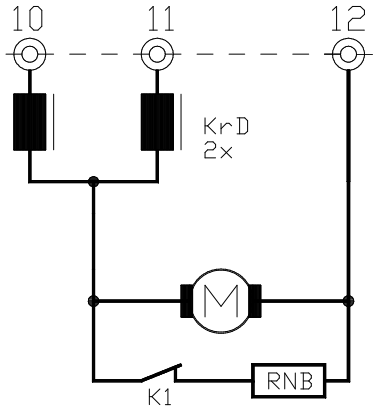
Motor connection

The motor is connected to the terminals 10, 11, and 12 via two circular current chokes (KrD). Min. armature choke inductance:

L [mH] = UA/IA x 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 choke does not reach the saturation range.

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



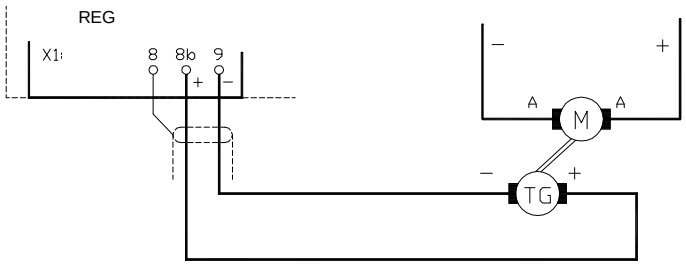
Warning:
Switching off under current will create arcing across the switch contacts.
Switching on while the drive is enabled will cause the fuse to fail.
RNB resistors (brake resistors in case of power supply failure) are to be connected in parallel directly to the motor armature without isolating the motor from the control unit. At the output of the circular current chokes the motor line is protected against short-circuits.

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 lines.

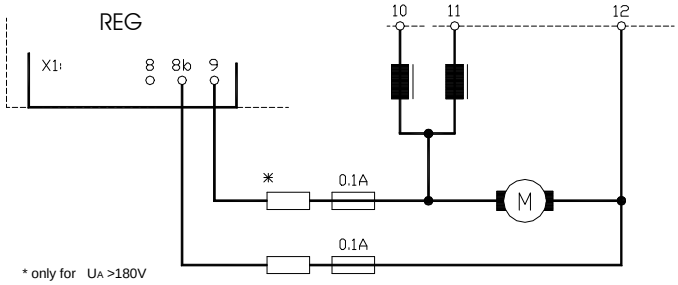
Conductor cross-section (min.)			
Type current	A	10	20 - 30
ac power supply	mm^2	1.5	1.5 - 2.5
Motor line	mm^2	1.5	1.5 - 2.5

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

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):

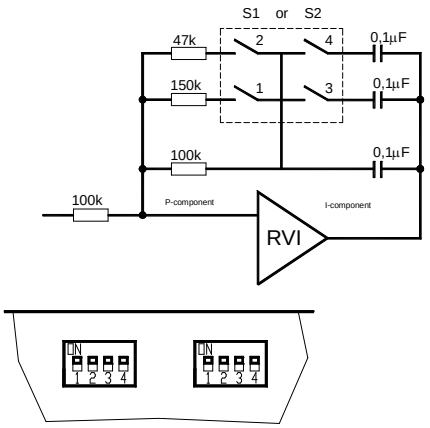


For 4 quadrant controls with small control ranges (up to 1:50) and little demands on accuracy and dynamic the armature voltage can be used as actual value signal.
The actual value lines must be protected by two fuses of 0.1A/500V installed directly in the armature voltage.
For armature voltages superior to 180V two additional drop resistors must be pre-connected.
The adjustment advice for armature voltage control with IxR compensation must be observed (rf. to the Manual REG).



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 S1, the PI characteristics of RVI-2 by switch 2.

Switch position



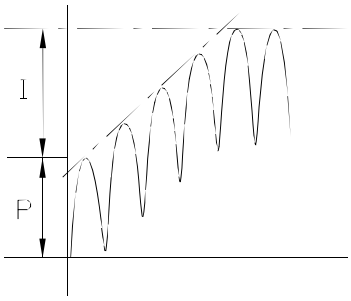
All switches are closed on delivery of the devices. This corresponds to the position for the lowest armature circuit inductance.
The proportional amplification can be changed via the contacts 1 and 2.
The integral time constant can be changed via the contacts 3 and 4.
Any changes of the current controller adjustment must be checked by means of an oscilloscope across the measuring point X2:11 against GND.
For circular current controlled devices the circular current can be adjusted by means of the potentiometer P2. 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

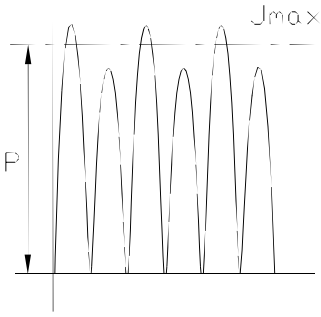
Oscilloscope - Current adjustment

Fig. 1



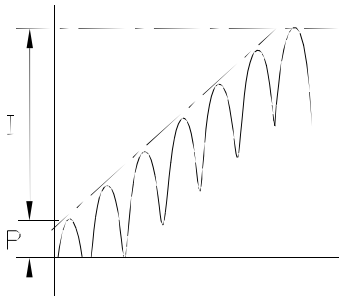
Optimal adjustment

Fig. 2



P-amplification too high

Fig. 3



P-amplification too low

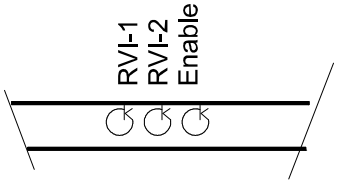
For 60Hz operation

the contacts 1 and 2 of the DIP switch S3 must be adjusted to ON.

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.



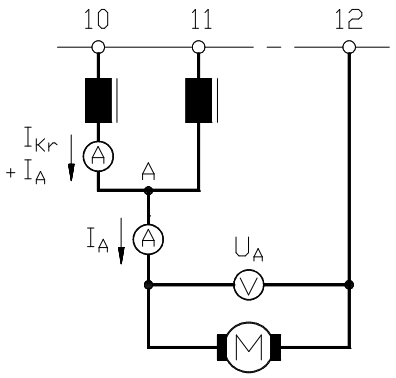
BTB signal - Drive ready

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.

The current and voltage can be measured in the load circuit (motor circuit)by means of multimeters.The circular current plus the motor current are measured in the choke circuit.
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 0.8 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 12 is positive against the choke centre point A.
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 (REG4)

Speed	X2:109	±5V or ±10V	for ±100% speed (to be chosen, rf. to the manual REG4)
Current	X2:111	±5V or ±10V	for ±200% type current (to be chosen, rf. to the manual REG4)

1. Connection advise

Connect the drive in accordance with the Q2 manual and the control electronics manual (e.g. REG).

Please observe in particular:

- The phases of the connection 16-17 and the connection 13-15 must be equal.

- Check the power supply voltage with that specified on the type plate.
- Insert the fuses according to the technical data (page 5).
- 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 please observe the advice in the manual REG4!

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
witch S4		position 2
Switch S5		position 6
Potentiometer Imax1, Imax2		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
Switch tacho control		**ON**: DS1 K:1, DS2 K:3 and 4 **OFF**: DS3 K:4, DS4 K:2 Bridges R13 and R14 soldered-in
Switch armature voltage control		**ON**: DS1 K:1, DS2 K:3 and 4, DS3 K:4, DS4 K:2 and 4; Bridges R13 and R14 open!

2.2 Apply the voltage

The LEDs 'BTB' and '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 'drive enable' and 'drive enable - power' 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.

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

Measured value: 2.5Vact. correspond to type current;
5Vact. correspond to peak current

Attention:

A current amplification which has been adjusted too high may cause current controller oscillations with current values which are not permissible. The motor may be damaged or fuses may drop out.

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.

2.7 Further adjustments

such as speed, peak current, continuous current, etc. (rf. to the manual REG4)

2.8 Switching Off - switch DS1 contact 4 'ON' (REG4)

If the switch 'drive enable' is opened, or the drive enable voltage is switched to 0V, the LED 'enable' will extinguish and the drive will brake until standstill. After approx. 2s the LED 'drive enable - power' will extinguish and the drive is disabled. After approx. 5 more seconds, the thyristor triggering circuit is disabled.

2.9 Commissioning adjustments

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

Protocol

Customer: . . . . . **Machine - No.** . . . . . .

Device: . . . . . **Serial- No..** . . . .

Control Voltage [V~] . . . . . .

Power (input) Voltage [V~] . . . . . .

Field Voltage [V=] . . . . . .

Inputs

Enable	Contact ?	Voltage [V=]
Command Value	type	Voltage [V=]
Command value additional	type	Voltage [V=]
Current (I) com. val.	Imax1 external	Voltage [V=]
Current (I) com. val.	Imax2 external	Voltage [V=]

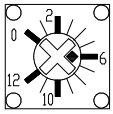
Speed Controller Settings

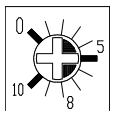
Switch Positions

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

Pot adjustment

Speed	nmax	P4	Position	. . .
Peak Current	Imax1	P5	Position	. . .
Peak Current	Imax2	P6	Position	. . .
Continuous Current ID	P7	Position	. . .	
Integrator	INT	P1	Position	. . .
Amplification	XP	P3	Position	. . .
Compensation	IxR	P2	Position	. . .





Switch DIP

ON Nr. . . . . .

OFF Nr. . . . . .

Settings current controller
Switch Positions

Switch S1, S2	open	(OFF) . . . . .
	closed	(ON) . . . . .
Switch S3 contact 1 and 2	50Hz	(OFF) . . . . .
	60Hz	(ON) . . . . .

Measured Values

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

Name Plate data

Manufacturer . . . . . .

Type . . . . . Serial Number . . . . . .

Motor Voltage [V=] . . . . . Motor Current [A=] . . . . .

Tacho Voltage [V/min-1]. . . . . Tacho Type . . . . . .

Brake [V] . . . . . Fan [V]

Guarantee

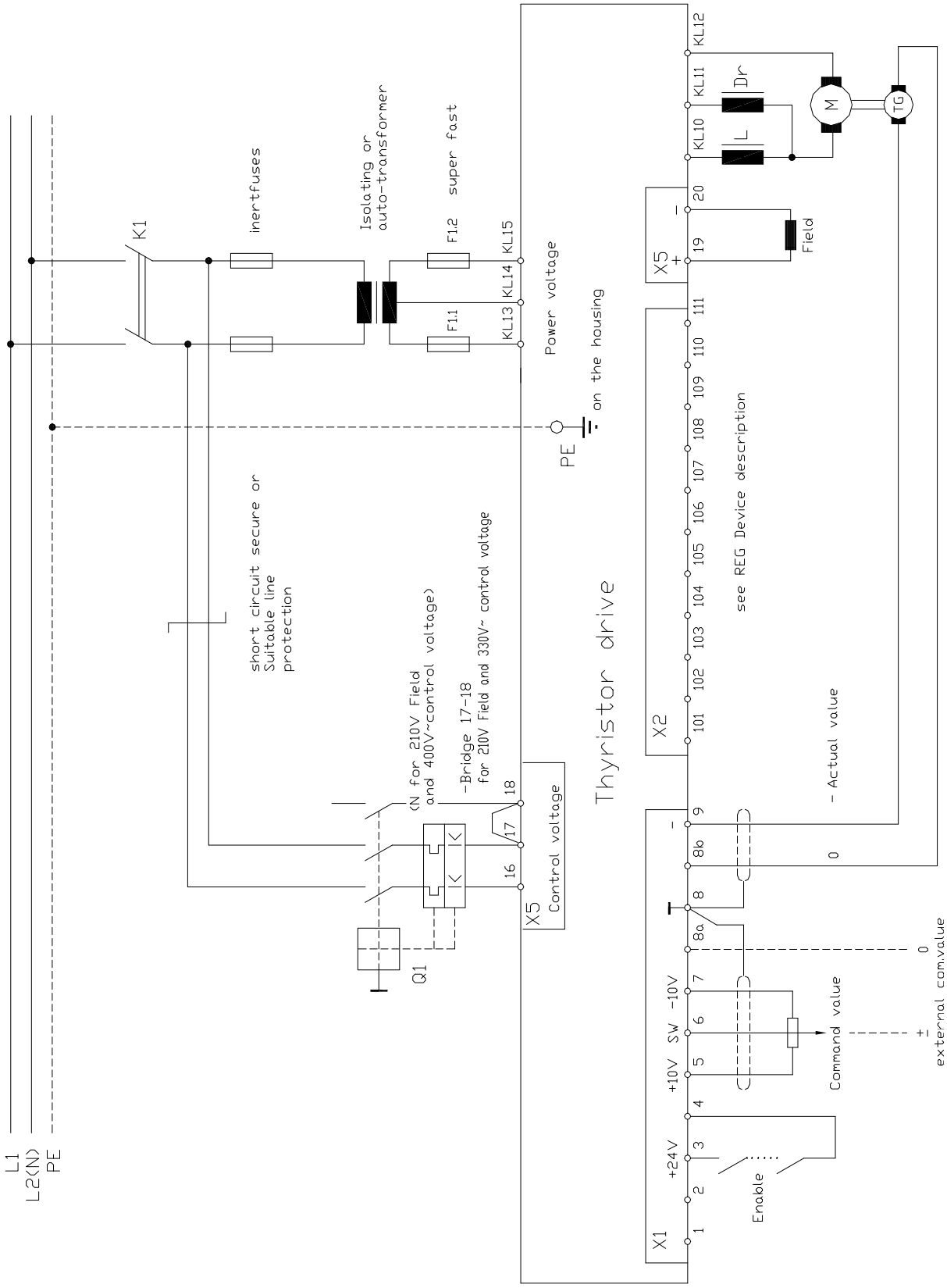
UNITEK guarantees that the device is free from material and production defects. Test results are recorded and archived with the serial number.
The guarantee time begins from the time the device is shipped, and lasts one year.
Unitek undertakes no guarantee for devices which have been modified for special applications.

During the warranty period, UNITEK will, at its option, either repair or replace products that prove to be defective, this includes guaranteed functional attributes. UNITEK specifically disclaims 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 UNITEK.
For products returned to UNITEK for warranty service, the Buyer shall prepay shipping charges to UNITEK and UNITEK 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 UNITEK from another country.
The foregoing warranty shall not apply to defects resulting from:

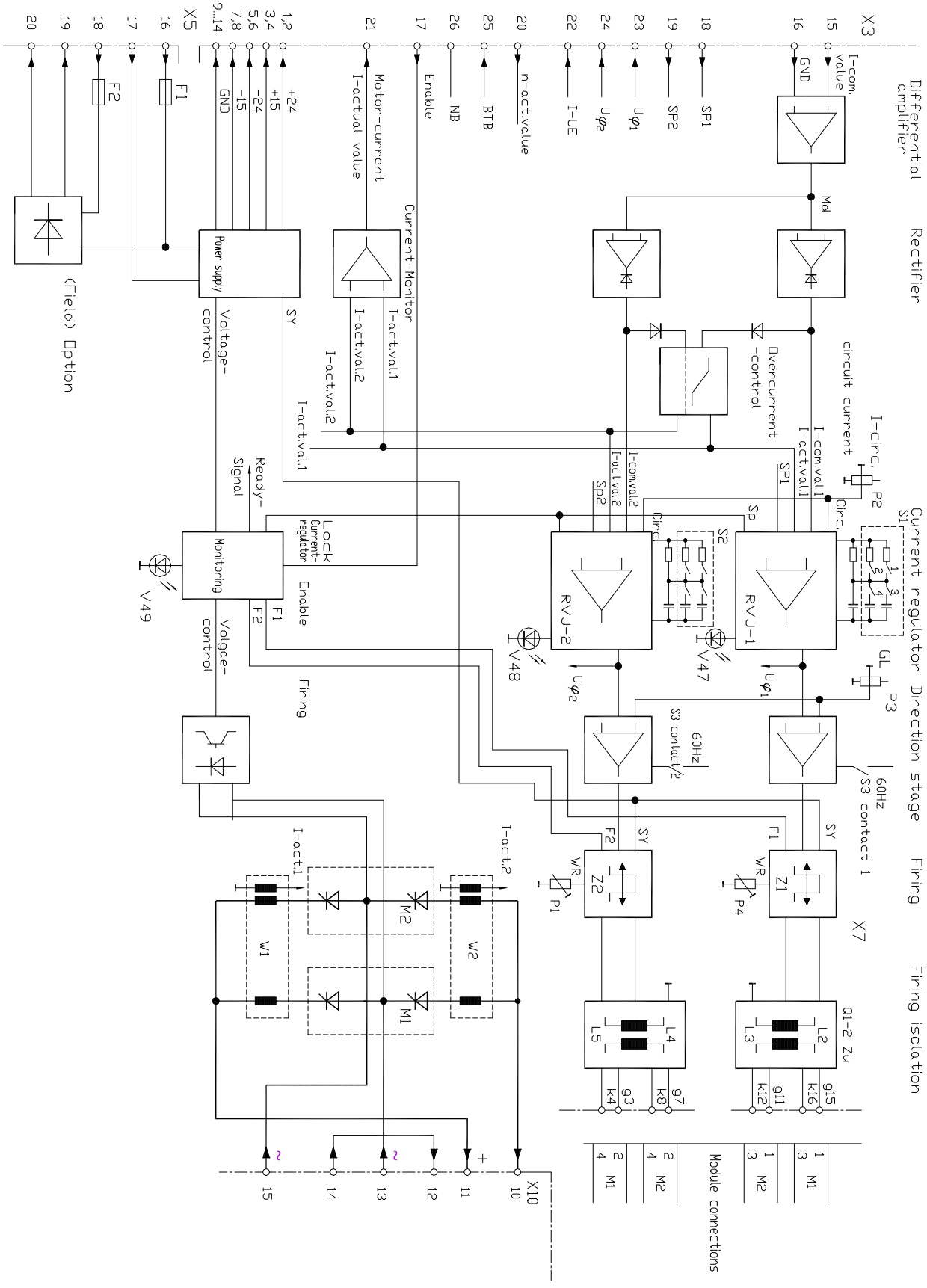
* improper or inadequate repairs effected by the Buyer or a third party,
* non-observance of the manual which is included in all consignments,
* non-observance of the electrical standards and regulations
* improper maintenance
* acts of nature

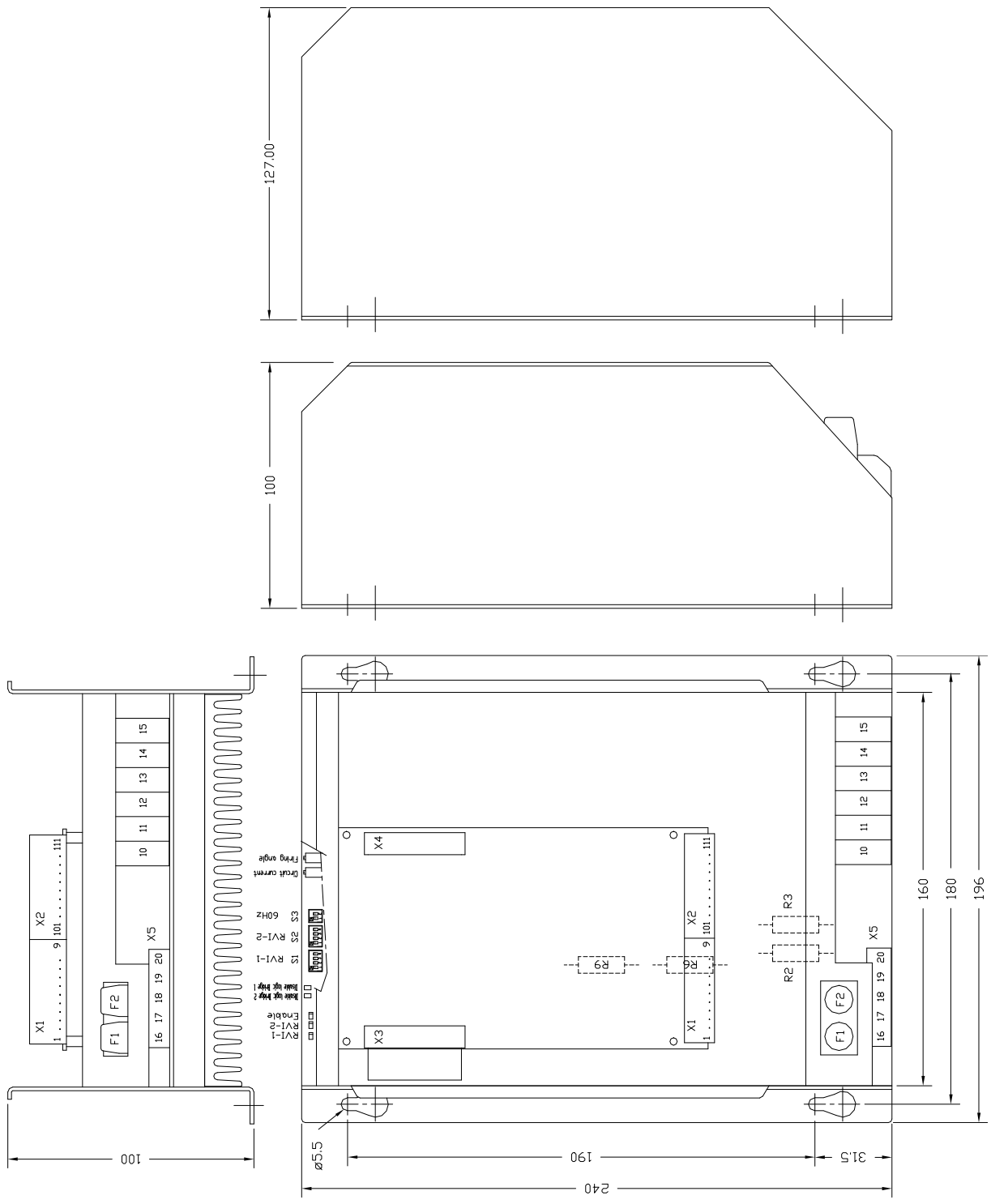
All further claims on transformation, diminution, and replacement of any kind of damage, especially damage, which does not affect the UNITEK device, cannot be considered. Follow-on damage within the machine or system, which may arise due to malfunction or defect in the device cannot be claimed.
This limitation does not affect the product liability laws as applied in the place of manufacture (i. e. Germany).
UNITEK reserves 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. UNITEK does 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.

Connections diagram



Circuit diagram




127.00
100
X4
X3
X2
X1
X5
F1
F2
R2
R3
R9
R6
S1
S2
S3
60Hz
RV1-1
RV1-2
Firing angle
Circuit current
Enable
100
190
240
31.5
ø5.5
160
180
196