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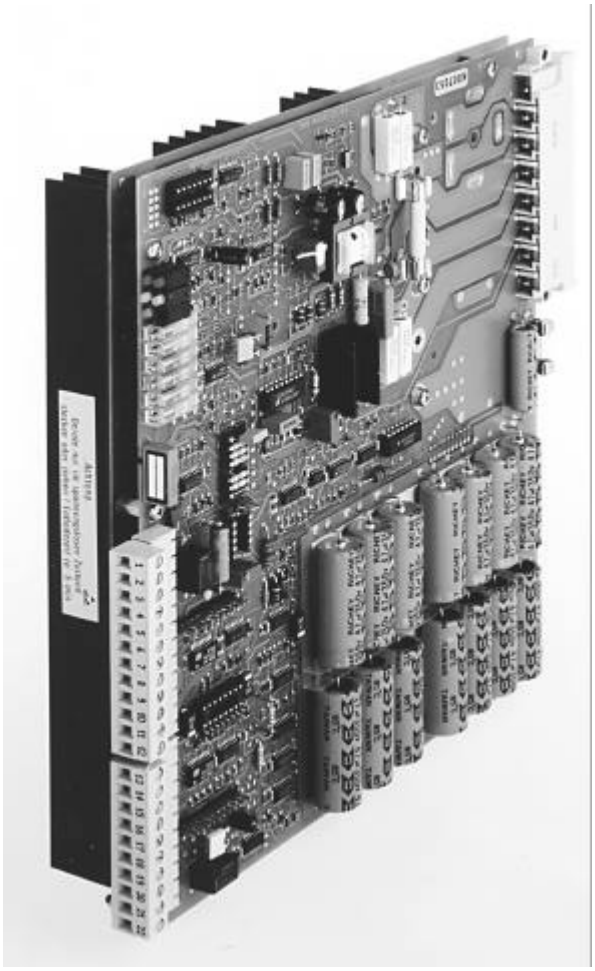


SERVO CONTROLLER

SMV... SERIES

Operating Manual

Edition February 2001

RECEIVING AND HANDLING

Upon delivery of the equipment, inspect the shipping containers and contents for indications of damages in curried in transit. If any of the items specified in the bill of lading are damaged, or the quantity is incorrect, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt.

Claims for loss or damage in shipment must not be deducted from your invoice, nor should payment be withheld pending adjustment on any such claims.

Store the equipment in a clean, dry area. It is advisable to leave the equipment in its shipping container until ready for use. Each amplifier is checked carefully before shipment. However, upon receipt, the user should make sure that the amplifier corresponds to or is properly rated in terms of rated voltage and current for the type of motor which is to be driven. The descriptive label affixed to the amplifier specifies electrical ratings.

Safety and Application Information

According to the enclosure the amplifiers, motors and power supplies may have live, uninsulated or rotating parts or hot surfaces during operation.

The inadmissible removing of the required cover, inproper application, wrong installation or operation may lead to personal or material damages. For further information please refer to the manual. Only qualified personal are permitted to install or operate the equipment.

IEC 364, CENELEC HD 384, DIN VDE 0100, 0105, 0110 and national regulations must be considered.

According to these general safety information a qualified person is someone who is familiar with installation, assembly, commissioning and operation of the equipment. These person must have the appropriate qualifications.

General

The SMV series is a multi-axis speed control system for use with DC permanent magnet motors rated up to 10 kW. The regulators employ the well known Pulse Width Modulated (PWM) system for accurate control of motor speed and torque and operate with an efficiency better than 98 %.

The system is designed to be modular so that several different motor sizes can be controlled from one rack. The use of a separate modular power supply unit (PSU) common to all of the drivers within the rack ensures high overall efficiency by allowing the transfer of energy between driving and regenerating motors.

The energy dumping circuit is designed to clamp the DC bus rails to a maximum value in the event of all of the motors regenerating together. The excess energy is dissipated within a resistor which may be internal or external to the rack. The energy dumping circuit itself forms part of the power supply module.

For limit values, please look the specifications. Inadmissible working conditions or wrong application of the amplifiers should be avoided.

Never plug in or unplug any connectors on the amplifier when power is applied. A time of discharge of 3 minutes must be considered.

1 Specifications SMVE

Power Stage

Input voltage	see 1.1 basis models SMVE/E/N
Over voltage control	see 1.3 basis models power supplies
Output chopper frequency and formfactor	approx. 8 kHz , f = 1.01 (with rated current)
Protection	short-circuit, ϑ_{max} , - $\hat{I}_{max}$;- U_{max}

Speed Controller

Input voltage 1	Differential ± 10 V	Ri = 20 KΩ
Input voltage 2	Differential ± 10 V	Ri = 20 KΩ
Tacho input	± 12 V ... ± 30 V	Ri = 37 KΩ
Compensation network	PI (D)	
P-gain correction with	potentiometer	
I-gain correction with	components	
Speed control range	1:20000 (stat.)	
stat. control default	30...3000 U/min ± 0,1 %	
	1...30 U/min ± 2 %	
	< 1 U/min ± 5 %	

Current controller

Bandwidth	1 kHz
Compensation network	PI
Current limit 1	rms current I_{Aeff}
Current limit 2	max. armature current I_{Amax}
Enable	terminal X8/20 against 0 V

Signals

Drive signal	terminalX8/21 connected with X8/22
Signal relay (dry relay contact)	max. contact charge 160 VDC, 20 mA
Drive signal	signal LED green
Over current	signal LED red
Over voltage	signal LED red
I^2t rms current limit	signal LED yellow
Limit - PLS	signal LED yellow

General Specifications

Operating temperature ϑ_u	0...45 °C, derating 2 %/ K from 45 °C on
Storage temperature	-10...+60°C
Cooling	convection cooling or forced cooling (see table)
Humidity	65 % relative humidity max.
Protection and isolation group	IP 00 / C according to VDE 0110
Mounting width and measurements	see point 10.5, further specifications!
Min. input voltage	U_{CC} > 60 V
Max. operating voltage	U_{CCN} + 10 V

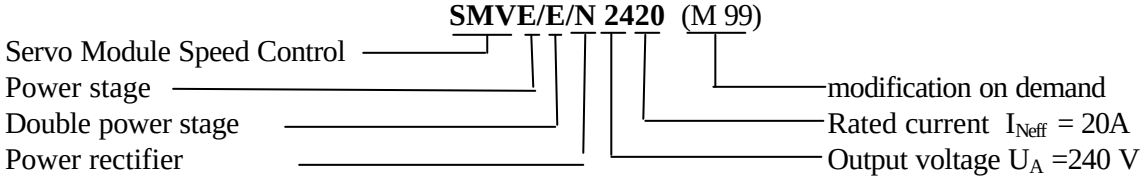
1.1 Axis Modules

Basis mode	U_A	I_{max}	I_{Neff}	U_{CCN}	U_N	t	Fan	Feeding
	(in V)	(in A)	(in A)	(in V DC)	(in V AC)	(in s)		
SMVE 1010	100	20	10	125	-	5	I_N >8A	DC
SMVE 1510	150	20	10	160	-	5	I_N>15A	DC
SMVE 1520	150	40	20	160	-	5	I_N>15A	DC
SMVE 1530	150	60	30	160	-	5	I_N>15A	DC
SMVE 2410	240	20	10	250	-	5	I_N>15A	DC
SMVE 2420	240	40	20	250	-	5	I_N>15A	DC
SMVE 2430	240	60	30	250	-	5	I_N>15A	DC
SMVEN 1510	150	20	10	(160)	113	5	I_N>15A	AC
SMVEN 1520	150	40	20	(160)	113	5	I_N>15A	AC
SMVEN 2410	240	20	10	(250)	177	5	I_N>15A	AC
SMVEN 2420	240	40	20	(250)	177	5	I_N>15A	AC
						5		
SMVEE 1540	150	80	40	160	-	5	yes	DC
SMVEE 1560	150	120	60	160	-	5	yes	DC
SMVEE 2440	240	80	40	250	-	5	yes	DC
SMVEE 2460	240	120	60	250	-	5	yes	DC

U_A: output voltage on U_{CCN}; $\hat{I}_{max}$: maximum output current ; I_{Neff} : permanent output current
τ : time constant of rms current imitation, for operation of SMVEE amplifiers fan is necessary
Other voltages or currents on demand.

1.2 Order Example

A) Standard without option



B) With Option Limit Switch: OS1

SMVE/E/N 2410 002

The article number (type label) builds the correct type name and can be asked from the producer.

1.3 Power Supplies SMN/W

Power supply	U_N (VAC)	U_{CC} (VDC)	I_N [1)] (A)	P_{rated} (w)	U_{on}	U_{off}	SMVE/E	$U_Ü$ [2)]
SMN 13	90	125	90	2 x 375	137	130	10xx	140
SMN 19	113	160	90	2 x 375	202	191	15xx	218
SMN 29	177	250	90	2 x 375	304	292	24xx	320
SMN 13 S	90	125	25	2 x 375	137	130	10xx	140
SMN 19 S	113	160	25	2 x 375	202	191	15xx	218
SMN 29 S	177	250	25	2 x 375	304	292	24xx	320
SMNW 13	90	125	25	1 x 200	137	130	10xx	140
SMNW 19	113	160	90	1 x 200	202	191	15xx	218
SMNW 29	177	250	90	1 x 200	304	292	24xx	320
SMNW 13 S	90	125	25	1 x 100	137	130	10xx	140
SMNW 19 S	113	160	25	1 x 100	202	191	15xx	218
SMNW 29 S	177	250	25	1 x 100	304	292	24xx	320
SMN 1690	113	160	90	-	-	-	15xx	-
SMN 2590	177	250	90	-	-	-	24xx	-

[1)] with fan [2)] approximate value

The SMN power supplies have two braking units in order to connect two external braking resistors. It works with one or two resistors. The SMNW power supplies are fitted with a internal braking resistor. For further information look the manual of our SMN/W range.

Note

The braking power rated should be calculated before the operation. If the permanent power is higher than indicated in the table, an additional module can be used. The working of the braking module is shown by short light up of the LED H1 (yellow) on the power module. If H1 is lighting up permanently - switch off the power supply immediately! Supply voltage is too high or braking time is too long. In this case contact the service!

2 Principles of Operation

The servo modules are designed for rack systems in 6 sizes (HE). Their application range can be extended by using different options.

In order to grant the high reliability of the system and the security of the personal, the following regulations have to be considered: VDE 0100, VDE 0160, part 1 and 2 in relation with VDE 0660, part 5 as well as VDE 0113.
For limit values, please look the specifications. Inadmissible working conditions or wrong application of the amplifiers should be avoided.

Mounting position:	front connector vertical
Cooling:	free convection or forced cooling necessary (Ch. 1.1) It is important that there is a free air circulation and no other sources of heat are near to the amplifier. The surrounding temperature must not exceed 45°C. .
Connections:	Do not connect or interrupt connections within the motor power circuit during operation. **Never plug or unplug any connectors on the amplifier when power is applied. Consider the minimum time of 3 minutes of discharge of the capacitors.**
Electronic supply:	± 15 V are produced internally from the power voltage, maximum charge: 20 mA external
Mains AC supply:	via transformer with galvanically separated primary and secondary winding

3 Functions and Options

The amplifiers of the SMVE/E/N range have all functions of a modern speed control system:

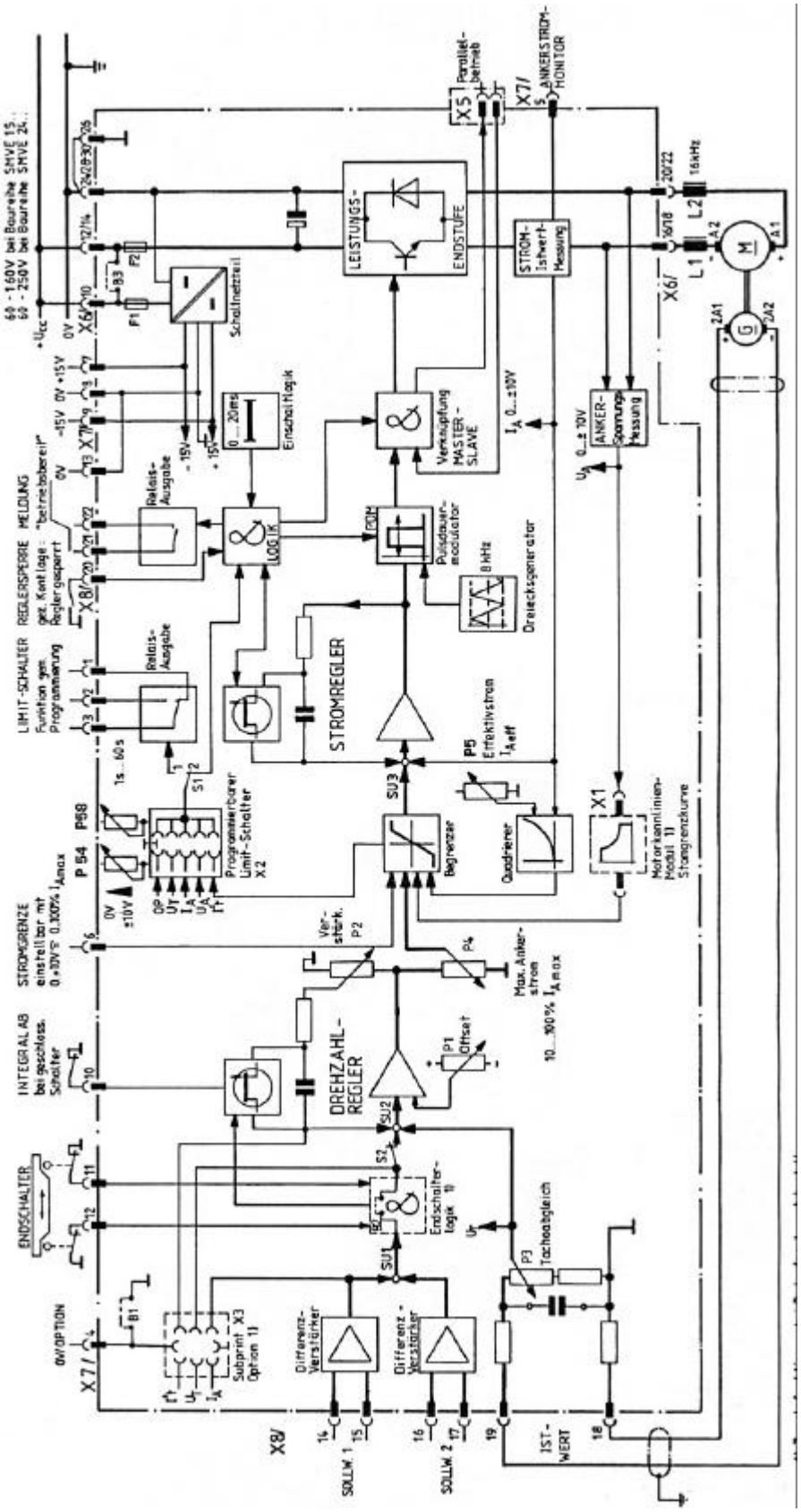
- 4-Q-speed controller with internal current control
- internal ± 15 V electronic voltage
- control functions ($\hat{I}_{max}$, U_{CCmax}, ϑ_{max})
- dry relay contact for drive healthy signal
- control signal for rms current: yellow LED
- default signal: one red LED for over current and one for overvoltage
- drive okay signal: green LED
- dry relay contact for PLS

SMVE XX XX	DC power supply
SMVEE XX XX	"double power stage" for increasing power - DC power supply
SMVEN XX XX	AC current supply, 1- or 3-phase supply

The main features of the SMVE range are high dynamics, stability and a large range of supply voltage (60 - 240 V). In addition special battery working amplifiers (24/48 V), amplifiers for increased supply voltage (310 V) and several options are available.

Wherever high dynamics and precision are demanded, the SMVE range is first choice.

3.1 Block Diagram



3.2 Functional Description

Speed controller
fast PI controller, for exact control of motor speed by means of comparison of Speed demand and tacho voltage, produces current demand max. ± 10 V

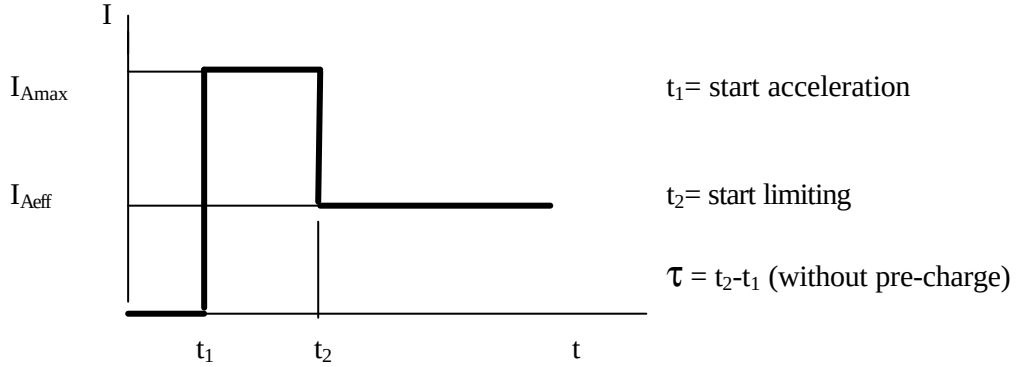
Current controller
fast PI controller for exact control of armature current enclosing the whole range of output voltage, produces control voltage for PWM

Pulse Width Modulator (PWM)
produces logic control signals for the power stage by special modulation technics

Power stage
MOS-FET, IGBT or bipolar power stage in bridge circuit for low-loss power control

Armature current measuring
fast measurement of the current value - standardisation I_{max} = 10 V

rms current limit
calculation, the rms value of the armature current and limitation on the adjusted value (I_{Aeff} = 0,1- 0,5 I_{max}) time constant τ ca.5s



LED H3 (yellow): signal for current limit, can be analysed by PLS (look Ch. 3.4 PLS function).

Production of electronic voltage
produces the internally necessary ± 15 V from the power voltage - DC/DC-converter

Fault indication
The internal fault indication, the processing of the enable input and the signal of drive healthy are collected in the logic block.

3.3 Further Standard Functions

The number of functions of the SMVE range exceeds the "conventionally" available standard functions and can be extended by additional "option boards".

3.3.1 External Current Limit

The external current limit allows the fast limitation of the output current by applying a positive control voltage on X7 / PIN 6 (front). A voltage of 0...10 V corresponds to approx. 2...100% I_{max}. If the input is open the maximum current adjusted with P3 is correct. The external current limit is in addition to P3.

3.3.2 Integral Off Function

By applying 0 V on X7 / PIN 10 the speed controller will be switched over from PI to P-mode. Thus a higher stability and a lower drift can be reached under certain conditions.

3.3.3 Second Input (Speed Command)

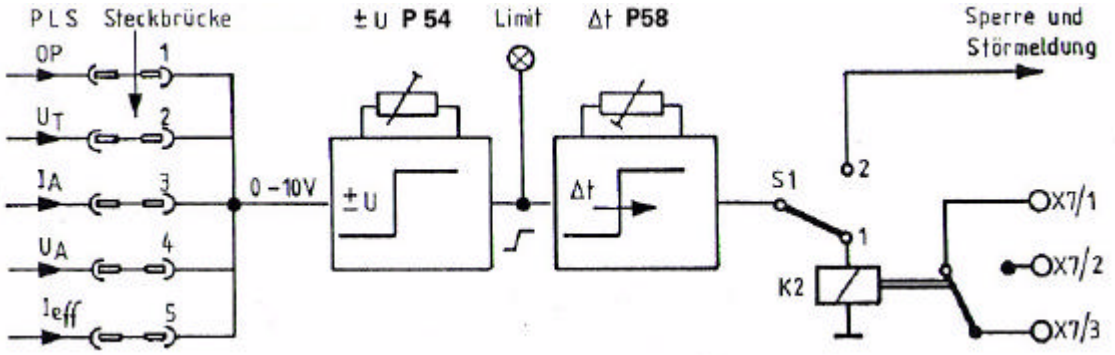
Two equivalent speed demand inputs are available on the amplifier. The weighting can be influenced by changing R111 input 1 and R112 input 2. This can be usefull for normal operation mode and adjustment mode, for example:
Input 1 10 V = 3000 rpm ⇒ fast motion
Input 2 10 V = 300 rpm ⇒ operation motion.

3.3.4 Armature Current Monitor $I_{A\text{-}Monitor}$

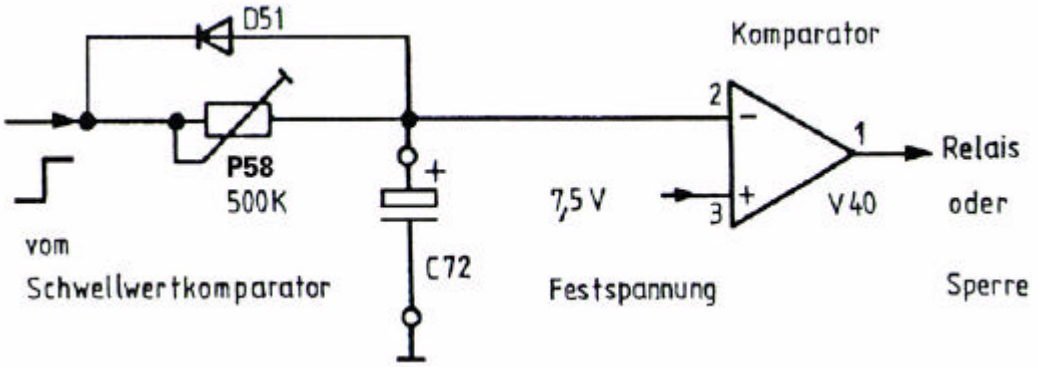
A voltage proportional to the armature current is available (0...± 10 V ≈ 0...± I_{max}).

3.4 PLS-Function

The amplifiers of the SMVE range are fitted with an electronic comparator circuit (PLS - programmable limit switch). This receives signals from a jumper and may be triggered by any voltage within a 10 V range. The comparator triggers a variable delay timer (1 - 60 secs) adjustable by P58. The variable timer will either inhibit the output or switch a warning relay or both after the adjusted delay time. The required action is selected by jumper S1. The required input signal is selected by the jumper as shown in the figure.



PLS-system - delay time



C72 is on soldering terminals and can be removed or modified if necessary.

Standard mounting: C72 = 100 µF, S1 on 1 relay active.

If required, the amplifier can be stopped, therefore S1 has to be switched on position 2.

Jumper Position	Name	Consequence
1	OP	Speed controller output / current demand
2	U_T	Tacho voltage
3	I_A	Armature current
4	U_A	Output voltage
5	I_{eff}	Rms current limit
	State of delivery:	PLS jumper on pos. 5 - I_{eff}

3.5 Options

Further option boards are available (contact your local sales office).

3.5.1 Limit Switch OS 1

The limit switches become inactive when connecting 0 V. If the input remains open, the negative and/or positive speed demand will be blocked. The logic level is fixed by factory and cannot be changed, standard: negative logic. On operation of the limit switch the motor stops in the given direction with a maximum adjusted I_{Amax}. Caution: do not connect voltage on the limit switch inputs!

3.5.2 Limit of Commutation Current OS 2

With certain motor types it becomes necessary to limit the armature current by high speed. By means of the armature voltage measuring and a plug module (X1) corresponding to the motor type the armature current will be influenced in a way that the required characteristic curve will be respected. We shall assure an exact dimension on every special application. For several different motor types corresponding modules are already available.

3.5.3 Speed Demand Integrator (Ramp) OS 3

The speed demand integrator is dedicated for "smooth" acceleration and deceleration of the motor, without having losses in exact control or control stiffness. The bandwidth of speed controllers becomes inferior for the speed demand. Every speed demand voltage, no matter if positive or negative, will be converted into a ramp. The time constant can be modified with P58 during operation, too.

3.5.4 Armature Voltage Control OS 4

With this option motors without tacho-generator can be controlled by measuring the armature voltage. At the same time there is the possibility to compensate the voltage drop (depends on current) in the armature circuit (IxR-compensation). Speed can be adjusted with P5.

Both options are on a common board. The different functions can be chosen by switches. The option board OS 3 / 4 is plugged on the option connector X3. For SMVE and SMVEN there are different option boards available [please indicate on order].

3.5.5 2. PLS OS 5

If the monitoring exceeds one signal, it is possible to plug another PLS-module on the X3 option connector, this allows the monitoring of two signal at the same time.

3.5.6 Reset Switch OS 10

With the front switch it is possible to reset a fault without switching off the supply voltage.

Further options on demand.

4 Power Supply - Mains Transformer

The power supply of the SMVE/N control modules is always assured by a 1- or 3-phase transformer with separated primary and secondary winding. The star point of the transformer will not be connected. The transformers delivered by us correspond to VDE 0550 regulations and are equipped with IP00 protection. They can be applicated in switch cabinets with the same power with surrounding temperatures up to ϑ_u = + 40°C. Standard winding of the transformers is according to vector group Y_Y0 (the star point cannot be connected).

4.1 SMVE/E Racks

In racks (SMVE/E) the power supply is assured via a common power module, type SMN/W XX. Therefore also a braking unit is available.

4.2 Power Supply of SMVEN Drives

The SMVEN amplifiers are equipped with an internal power rectifier, by this means a direct supply with AC voltage from a corresponding transformer (separated winding) is possible. The big capacitor battery absorbs the braking energy. If necessary an additional capacitor or a braking module can be connected on X6 / PIN 14/24. The amplifiers should be mounted in an upright position (see table 1.1). The earthing of the amplifier should be effected via X6 / PIN 28-32. You have to earth X6 / PIN 26, too. A direct connection to the power connector PIN 26 with X6 / PIN 28 is recommended.

4.3 External Supply of the Auxiliary Voltage, Variant 088

The auxiliary voltage is normally produced by the power voltage. In some applications separated supply can be helpful. By this the complete electronics (± 15 V) are supplied from aux. voltage. The power supply can be feeded separately if necessary. In this case you can order variant 088 and connect voltage to X6 / PIN 10. The range of voltages is the same as for the corresponding power supply. This function can be useful in case of service, when the power stage is running with reduced voltage.

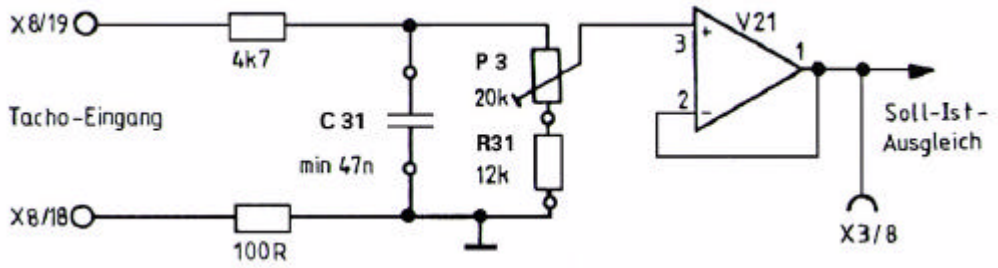
5 Adjustment and Personalisation, variable Components

The controller modules of the SMV range offer a lot of different modes of adjustment, personalisation and options. In order to achieve the best configuration for your application, please note the following indications.

5.1 Potentiometer

Tacho signal adjustment: P3

Standard adjustments:
left end position 30 V Tacho voltage correspond 10 V speed demand (R111 = 22 KΩ)
right end position 12 V Tacho voltage correspond 10 V speed demand (R111 = 22 KΩ)



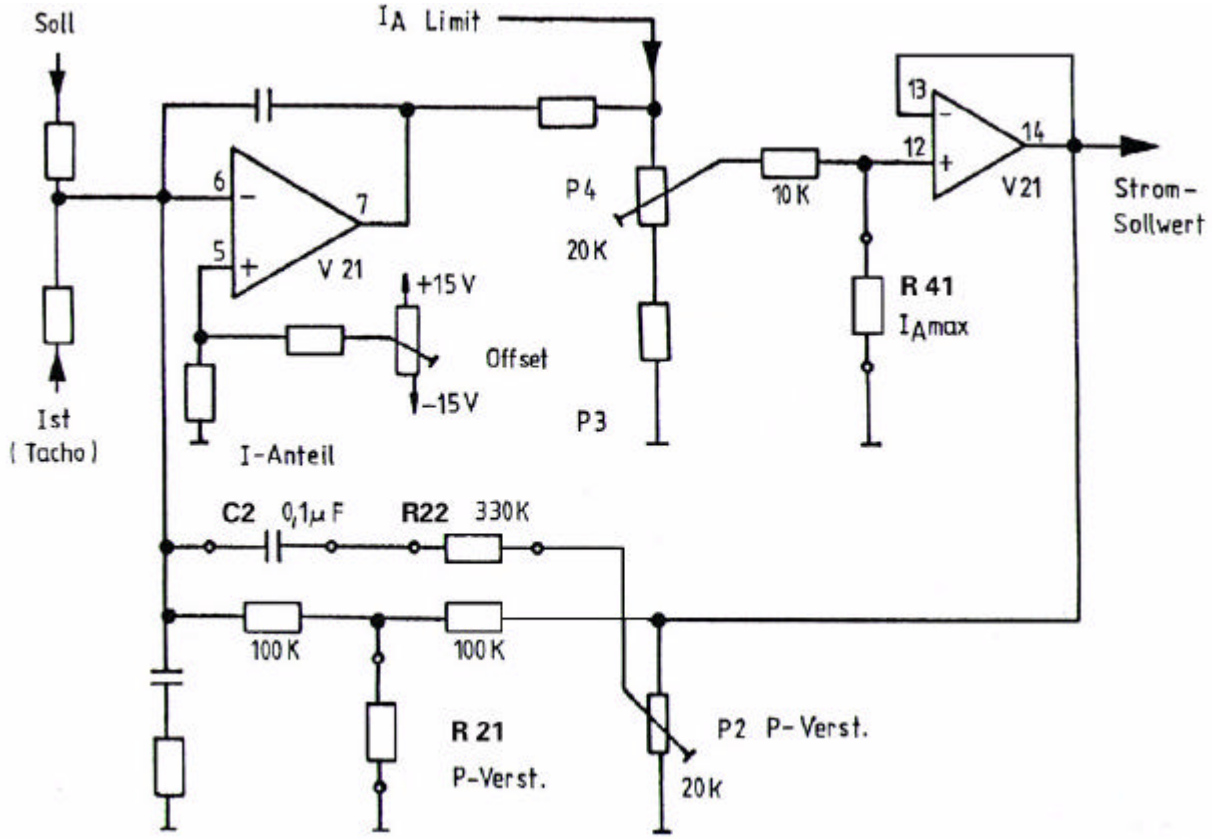
The range of input voltage can be extended by reduction of R31.

$$R31 = \frac{247}{U_{Tmax}^{-10}}$$

U_{Tmax} = max. Tacho voltage

Offset: P1
With a speed demand of 0 V the turning of the motor shaft can be stopped by P1. If the offset is not adjustable, you have to check the wiring and eventually the external charge of the ± 15 V. If necessary, the adjustment can be repeated after having achieved the operation temperature.

Proportional Gain: **P2**
Standard adjustment: right end position: 2000
left end position: 20



Max. Armature current I_{Amax} : **P4**
Standard adjustment: right end position: $I_{Amax} = 1 \times I_{max}$ = type-max. current
left end position: $I_{Amax} = 0{,}03 \times I_{max}$ (No.1.1)

The maximum armature current can be limited by the correct choice of the fixed resistor R24 (see table, No. 5.2). With that you can avoid a wrong adjustment on the P4 potentiometer.

Current Balance: **P7**
Adjustment of the internal armature current measuring! Fixed adjustment by the factory, it is not allowed to change!

Motor Effective Current I_{Aeff} : **P5**
Standard adjustment right end position: $I_{Aeff} = 1 \times I_{Neff}$ = type permanent current
left end position: $I_{Aeff} = 0{,}1 \times I_{Neff}$ (No. 1.1)

The maximum rms. value of the armature current ($I_{Aeffmax}$) can be limited by the correct choice of the fixed resistor R165 (see table No. 5.2). With that you can avoid a wrong adjustment on the P5 potentiometer.

5.2 Fixed Resistors - Capacitors

Speed demand value 1	R111	state of delivery:	22 KΩ
Speed demand value 2	R112	state of delivery:	22 KΩ
Tacho value	R31	state of delivery:	12 KΩ
IxR compensation	R12	state of delivery:	not mounted
Integral part speed controller	C2	state of delivery:	0,1 µF
P-gain	R21	state of delivery:	330 Ω
Current controller P-gain	R4	state of delivery:	110/220KΩ
Current controller I-gain	C4	state of delivery:	15/6,8 nF
Time constant PLS	C72	state of delivery:	100 µF
Limit of modulation rate	R53	state of delivery:	not mounted
Max. armature current I_{Amax}	R41	state of delivery:	not mounted
Max. effective current $I_{Aeffmax}$	R51	state of delivery:	18 KΩ
PI-gain	R22	state of delivery:	330 KΩ

Reduction of a type value on:	R41 maximum armature current I_{Amax}	R51 effective armature current $I_{Aeffmax}$	R53 modulation rate
100 %	-	18 KOhm	-
90 %	91 KOhm	13 KOhm	-
80 %	39 KOhm	10 KOhm	-
70 %	24 KOhm	7,5 KOhm	27 KOhm
60 %	15 KOhm	5,1 KOhm	18 KOhm
50 %	10 KOhm	3,6 KOhm	12 KOhm
40 %	6,8 KOhm	2,2 KOhm	8,2 KOhm

5.2.1 Personalisation Plug X10

On the personalisation plug X10 the most important variable components are integrated.

16 poles Dil-Header

PIN	Component	Remark
1 - 16	C2	I-part speed controller
2 - 15	R22	PI-gain
3 - 14	R21	P-gain
4 - 13	R53	modulation rate
5 - 12	R41	I_{Amax}
6 - 11	R31	tacho evaluation
7 - 10	R111	speed demand value 1
8 - 9	BR9	no enable if open

5.3 Integral Gain of Speed Controller

C2 defines the characteristics of the control circuit. Increasing the value leads to smooth, not critical control, the reduction is responsible for hard, fast control, but also for increasing tendency to oscillations. Normally the behaviour can be adjusted with the P-gain. An increase of C2 is recommended in case of high inertia.

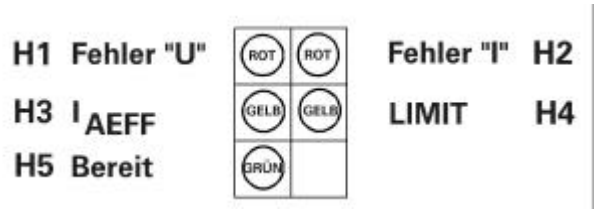
Proportional Gain Speed Controller P2 / R 21 / R22

The proportional gain of the speed controller can be modified by P2 and R21 without any influence on the time constant T_N. By alteration of R22 time constant and amplification can be influenced.

5.4 Current Controller

The current control circuit of the controller modules has been adjusted by the factory and should not be changed. If a changement becomes necessary because of a special application, it can be altered by R4/C4 PI-component of the current controller. Afterwards it is necessary to check correct function of the current control circuit.

5.5 Security Functions and Visual Fault Indications



Reactions in case of default:
a) stop of power stage
b) "ready"-Relay-contact opens
c) warning through LED indication (H1+H2 red), green LED (H5) is no more lighting

The fault is registered until switching off the power voltage or reset by reset switch OS 10.

Overcurrent and Short Circuit Sensor and Earthing Monitoring:
Electronical, extremely fast security circuit (delay time approx. 6µs). The power stage is protected even in case of a complete short circuit. Also control defaults on the power stage or defaults in the driving electronics are indicated.

Reaction: look above (a,b,c) Indication: fault "I"

Over Voltage Control:
In case of over voltages of the dc voltage power supply U_{CC}, the fault will be indicated (for the limit see technical data).

Reaction: see above (a,b,c) Indication: fault "U"

± 15 V-Control
In case of sudden decrease of voltage of the electronical supply voltage below ± 12 V, the fault will be indicated.

Reaction: see above (a,b) fault will not be registered Indication: fault "I" and "U"

Temperature Control of the Power Stage:
A temperature sensor controls the temperature of the power stage heat sink. If the temperature of the heat sink is higher than 90°C, the power stage will be stopped.

Reaction: look above (a,b,c) Indication: fault "I" and "U"

Reset: after fault correction or after cooling of the power stage
switch off and switch on the power voltage or use the reset (OS10)

Under Voltage Control
The drives are running from 50 VDC supply voltage on. In case of values lower than 50 V the power stage will be blocked and signals light up. Indication: 2 x LED red, "fault U" and "fault I", Reset: when the voltage is higher than 50 VDC.

6 Wiring

1. It is important that the amplifier is properly earthed.
2. When connecting the motor cables you have to consider that voltages with very high differences occur. It is recommended to connect the motor cables far away from the control cables. Every motor needs a separate cable, which should be shielded in order to reduce electrical noise.
3. The control equipment and the amplifier must operate at the same potential.
4. The speed demand inputs are differential inputs. The polarity can be adjusted according to application. **Important:** The speed demand voltage must be connected galvanically with the GND PIN. If necessary you have to arrange one pole in a bridge circuit with 0 V.
5. Shields must not be used for potential equalisation and have to be connected to earth on both sides.
6. It is recommended, especially in case of multi-axis racks, to install a separated earth rail near to the drives.
7. All control and signal cables must be drilled and shielded in pairs.
8. Speed demand and tacho cables must be connected shielded in pairs.
9. If cables with two outside shields are used, the outside shield must be earthed on both sides (look point 5), the inside shield has to be earthed with the amplifier. The GND contacts (X 1) of the controller modules are not suited for being connected with the shield cable.
10. The main supply connection has to be made in a way, that no peak voltages can be produced when the amplifiers are switched on or off, otherwise you have to arrange for a over voltage protection.

6.1 Rack System

The mechanical construction is arranged in a way that wall mounting or swivel frame mounting is possible. Fixing is possible on the front (SMRS) or on the back (SMRA).
The rack mounting begins on the left side with the power supply module or controller module, further controller modules follow in order of rated current. For the width of the modules and sizes of the racks please read chapter 10.6 and 10.7.

7 Setting up the Amplifier

Before setting up the amplifier modules, please check the following:
- earthing according to Chapter 6.1-9 and connection example
- transformer voltage
- wiring
- special adjustments
- rated current and rated voltage of the amplifier
- are all variable components mounted in accordance with the application
- are all switches in the right position
- are all brides closed according to the required function

Pre-Adjustment of the Potentiometers before Switching on
(only necessary if not adjusted by the factory)
- P-gain P2 on left limit
- I_{Amax} P4 on left limit + 5 turns, if not adjusted by the factory.
- I_{Aeff} P5 on left limit + 10 turns, if not adjusted by the factory.

7.1 Offset Adjustment

Disconnection of the speed demand or 0V indication. Switch on the amplifier and enable. Possible reactions:
a) Fast drift of the motor on high speed, depends on position of P4 (I_{Amax}-adjustment).
Reason: Confusion of the control circuit poles
Remedy: Correction of the poles of the tacho **or** motor connections

b) The motor does not turn or drifts very slowly, also in case of right stop of P4 I_{Amax}. If positive or negative speed demand is indicated, the motor reacts with running right-handed or left-handed. You have to check the "speed demand polarity" in relation to "direction of turns" and if necessary to change the speed demand inputs. Repeat the offset adjustment 5-10 minutes later (amplifier should have operation temperature!).

7.2 Armature Current Adjustment I_{Amax}, I_{Aeff}

Maximum Current Adjustment I_{Amax}

Simple Method:
The position of the I_{Amax} potentiometer P4 is linear. If the position is "right turn limit", the maximum output current is on maximum of this type of controller. There is a range of 20 turns of the shaft trimmer. The number of turns from the "left turn limit" enables a direct relation to the output current.
Example: required: $I_{Amax} = 0{,}75 \times I_{max}$ type
Result: turns from the left turn limit: 20 x 0,75 = 15 turns.

Oscillografical Method:
Measuring of the current by DC current probe or current monitor. Speed demand has to be controlled positive and negative in a cyclical way with square-wave voltage. Maximum current will be measured and can be adjusted during the acceleration or braking phase. Please note that repetition frequency is not so high that effective current will be reached, this would activate the I_{Aeff} limit.

Effective Current Adjustment I_{Aeff}
If the value has not be adjusted by the factory, you can do as follows:
- adjustment data: I_{Aeff} = motor rated current
- if there are chokes in the circuit (note: L_{min}), short circuit of motor connection or replace motor by chokes (note minimum inductivity Ch. 10.6).
- feed in speed demand of approx. + 1 V and enable the amplifier, current measuring (see I_{Amax} adjustment).

Reaction: Short-term I_{Amax}, is flowing, then follows permanent reduction on I_{Aeff}.
With P5 the required value can be adjusted.

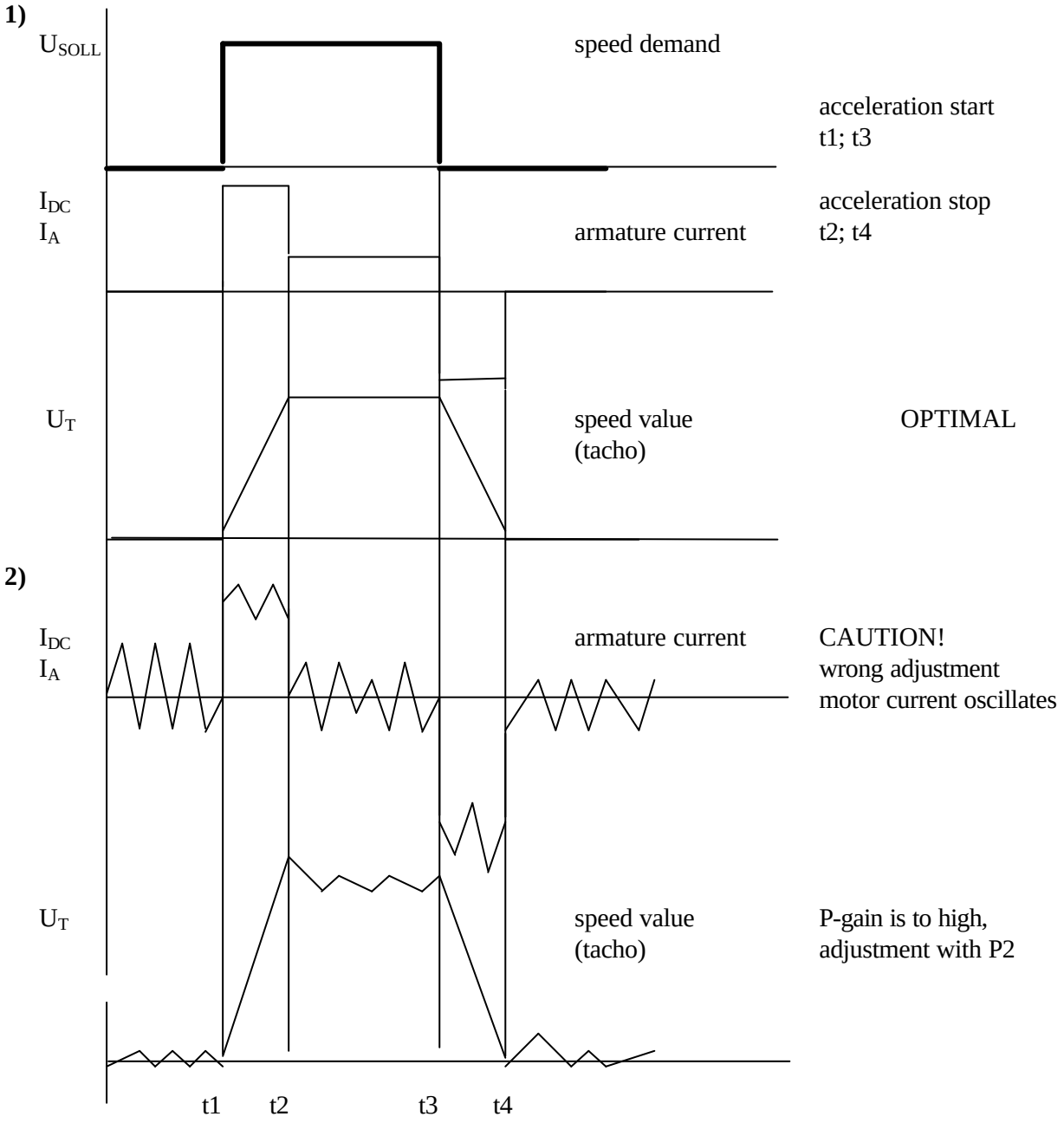
7.3 Speed Adjustment

If the speed demand (polarity) corresponds with the direction of rotation (see Ch. 7.1), you can adjust the speed for a certain speed demand with P3. If the speed cannot be measured directly on the motor shaft, the tacho voltage can be evaluated. If the required values cannot be adjusted, please check the following points:
- Is the supply voltage (U_{CC}) sufficient for the required speed?
- Is the tacho voltage higher than 30 V? (see Ch. 5.1 tacho adjustment)
- Is the speed demand adjustment correct? (see Ch. 5.2, R111 and R112)

7.4 Speed Loop Adjustment (P-gain)

The controller modules are delivered with a standard adjustment and can be adapted with P2 for special applications. If the adjustment is not possible, the PI-compensation network of the speed controller must be modified (C2, R22). When smaller amplifiers are applicated and the oscillation of the system does not mean an unallowed use, you can go on as follows:
- increase of P-gain by P2 until the control circuit oscillates
- reduction of P-gain until the system remains stable on stop, after charge (torque jump) or after a new switch-on

Caution! Notice the charge of the connected mechanical equipment!
If an oscillograph is available, the best adjustment can be assured. With a signal generator or control a speed demand pulse (+ 2 V) can be applied. The over-oscillation of the current value should not exceed 15 - 25 % of the limit value, the over-oscillation of the tacho voltage should not exceed 5 %.

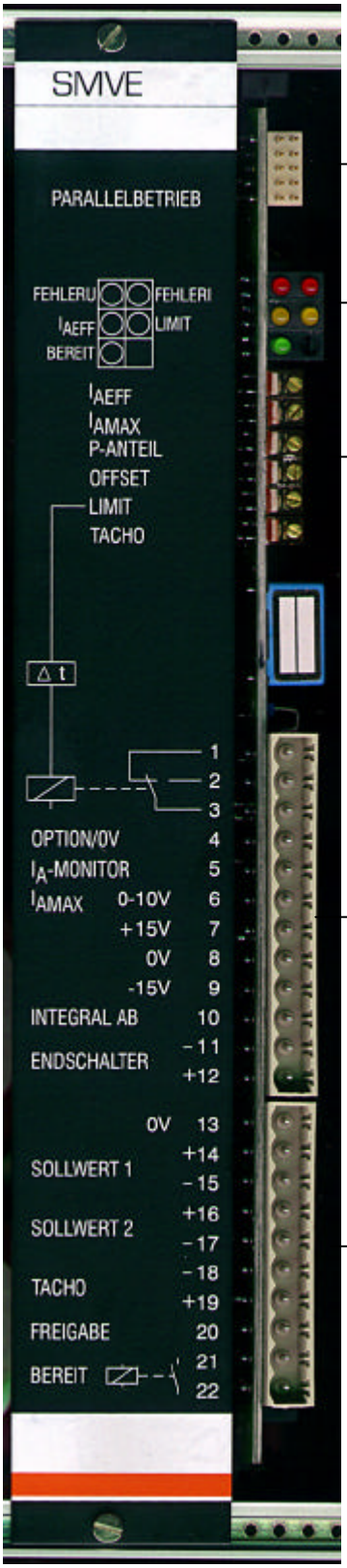


optimal adjustment of the speed controller - start-stop-operation

8 Fault Finding and Remedy

Fault	Cause and Remedy
motor does not run, no flow of current	no supply voltage U_{CC}; green LED (power supply and controller) must light; check ± 15 V and U_{CC} and fuses; controller stop or wrong logic level; no speed demand; interrupted motor wiring; wrong wiring of limit switch (option) or wrong logic level;
motor does not run although current is flowing	motor is blocked mechanically; evtl. release integrated brake, check mechanical equipment; short circuit of motor wiring;
motor runs unevenly	P-gain is to high, left turn of P2; I-part is to inferior, increase C2; resonance of torsion because of resilient tacho drive; use of stiffer drive; noisy speed demand voltage, check earthing and shields
motor drifts without speed demand	offset adjustment, check speed demand; speed demand is not connected to earth, look connection example;
motor turns up uncontrolled directly after switch-on	wrong poling of tacho or motor connection, change poles of motor **or** tacho connection; interrupted tacho connection or defect tacho; measuring of the connection, if necessary change of tacho;
motor drift to one side in case of charge	defective grounding in the speed demand input, speed demand must be wired differentially;
controller shows tracking error	wrong poling of tacho or motor connection; mechanical equipment is to slowly - check the mechanical equipment; adjustment of I_{Amax} or I_{Aeff} to low; adjustment of speed to low; controller circuit oscillates - to optimise the P-gain;
maximum speed is not reached or controller shows tracking error on acceleration in the high speed range	DC voltage is to low - input voltage to check, if necessary feed 3-phases or use an additional capacitor (ask service for information); motor is not suited for high speed, see motor data;
red LED when braking	over voltage caused by to high braking energy, use the second braking resistor or an additional capacitor;
red LED after enable	short circuit in the motor circuit or fault of the power stage; check motor circuit, change the controller module;
red LEDs after long operation	overtemperature of the power stage, check the cooling; pause of operation of the controller module;
sporadic faults	check wiring, check supply voltage with regard to peak overvoltages, if necessary use mains supply input filter and overvoltage limitation; check controller circuit with regard to stability, adjust P-gain; check motor brushes.

9 Front View


SMVE
PARALLELBETRIEB
FEHLERU
FEHLERI
IAEFF
LIMIT
BEREIT
IAEFF
IAMAX
P-ANTEIL
OFFSET
LIMIT
TACHO
Δ t
1
2
3
OPTION/0V 4
IA-MONITOR 5
IAMAX 0-10V 6
+15V 7
0V 8
-15V 9
INTEGRAL AB 10
ENDSCHALTER -11
+12
0V 13
SOLLWERT 1 +14
-15
SOLLWERT 2 +16
-17
TACHO -18
+19
FREIGABE 20
BEREIT 21
22
X5 (option)
LED-indication
potentiometer
X7
X8

10 Terminal Description and other Technical Data

10.1 Front Connectors X7 and X8

12- and 10-poles connectors type Weidmüller

PIN	Signal Direction	Type	Remark
		X7	
1	OUTPUT	PLS open	dry relay contact, PLS - system, possible charge of contact: 150 VDC / 125 VAC, 35 W - 60 VA
2	OUTPUT	PLS closed	
3	INPUT	PLS middle	
4	INPUT/OUTPUT	0 V GND	selection of function via BR 1, see table 10.3
5	OUTPUT	$I_{A\text{-}Monitor}$	$\pm$ 10 V $\approx \pm I_{max}$ (R_i = 1kΩ)
6	INPUT	$I_{ext.}$	open or 0...+10 V
7	OUTPUT	+ 15 V ± 3 %	auxiliary voltage, possible charge: max. 20 mA
8	GND	0V	electronic ground (GND)
9	OUTPUT	- 15 V ± 3 %	auxiliary voltage, possible charge: max. 20 mA
10	INPUT	Integral down	open or 0 V
11	INPUT	(+) limit switch input	only effective with option OS 1 "limit switch" • 0 V: turning direction active • open: turning direction stopped • Caution: never switch voltage on!
12	INPUT	(-) limit switch input	
		X8	
13	GND	0 V	GND-connection for speed demand
14	INPUT	(-) speed demand 1:	differential, R_i = 20 kΩ, max. difference of the input voltage ± 10 V, max. voltage against ground ± 20 V
15	INPUT	(+) Speed demand 1:	
16	INPUT	(-) Speed demand 2:	differential, data like PINs 14, 15 The addition of the values of speed demand 1 and speed demand 2 results in the effective speed demand.
17	INPUT	(-) Speed demand 2:	
18	INPUT	(-)tacho input	R_i = 37 kΩ with standard wiring
19	INPUT	(+)tacho input	
20	INPUT	enable	puts the power stage into operation, following options are possible (Ch. 10.3 solder strap): • Standard: active "low" (0 V) • option 1: active "high" (+15 V) • option 2: galvanic separation (opto coupler)
21	K	"drive healthy"-indication	dry relay contact, the relay contact is closed when the amplifier is ready to start and without faults, in case of fault or when there is no voltage the contact will open immediately.
22	K	"dirve healthy"-indication	maximum charge of contact: 150 VDC / 175 VAC, 35 W - 60 VA
	K = relay contact		
Caution! No external voltages on outputs and ± 15 V connections!			

10.2 Power Connectors X6 Back of the Amplifier

14-poles connectors type H15 DIN 416612

PIN	Signal Direction	Type	Remark
4	INPUT	L1'	AC-Feeding via transformer only for SMVEN drives
6	INPUT	L2'	
8	INPUT	L3'	
10	INPUT	+ U_{ST}	auxiliary voltage, Caution! No power connection (see Ch.4.3)
12	INPUT	+ U_{CC}	power supply from $I_N \geq 10$ A on use two PINs
14	INPUT	+ U_{CC}	
16	OUTPUT	A2	motor connection front $I_N \geq 10$ A on use two PINs
18	OUTPUT	A2	
20	OUTPUT	A1	
22	OUTPUT	A1	
24	0V power	GND	power ground, use 2 contacts at least
26	0V electronics	GND	electronic ground
28	0 V power	GND	power ground from $I_N \geq 10$ A min. on use three PINs
30	0 V power	GND	
32	0 V power	GND	

10.3 Solder Straps

Strap	Meaning (closed)	Meaning (open)	State of Delivery
BR 1	0 V / option X7 - PIN 4 is on 0 V potential	• any function of the option board can be chosen • external reset-function (BR 10) • enable with floating input (BR 6)	closed
BR 2	limit switch option choice no limit switch option (OS1) available	limit switch option (OS 1) active	closed
BR 3	internal supply look Ch. 4.3	auxiliary supply	closed
BR 4	current demand for Master/Slave operation standard or Master drive	current value for Slave drive	closed
BR 5	current demand for Master/Slave operation Master and Slave drive	standard drive	open
BR 6	enable option with floating input (only if U1 is mounted)	no floating input	open
BR 7	enable logic level active "high" (+15 V to + 24 V)	enable logic level active "low" (0 V)	open
BR 8	enable logic level standard: active "low" (0 V)	enable logic level active "high" (+ 15 V to + 24V)	closed
BR 9	no enable if there is no personalisation connector amplifier without Personalisation connector	amplifier with personalisation connector	closed
BR 10	external reset option external reset option active	no external reset option available	open

10.4 Test Points

Test Point	Remark
	the following test points can be used:
TP 1:	speed demand
TP 2:	tacho voltage
TP 3:	current demand
TP 4:	DC/DC supply control signal
TP 5:	armature current value
TP 6:	PWM sqare wave
TP 7:	PWM triangle wave
TP 8:	PWM signal before delay
TP 9:	PWM signal before delay
TP 10:	PWM control signal - power stage
TP 11:	PWM control signal - power stage
TP 12:	PWM control signal - power stage
TP 13:	PWM control signal - power stage
Caution! All test points are related to ground 0 V_E/GND, no floating power stage!	

10.5 Further Technical Data

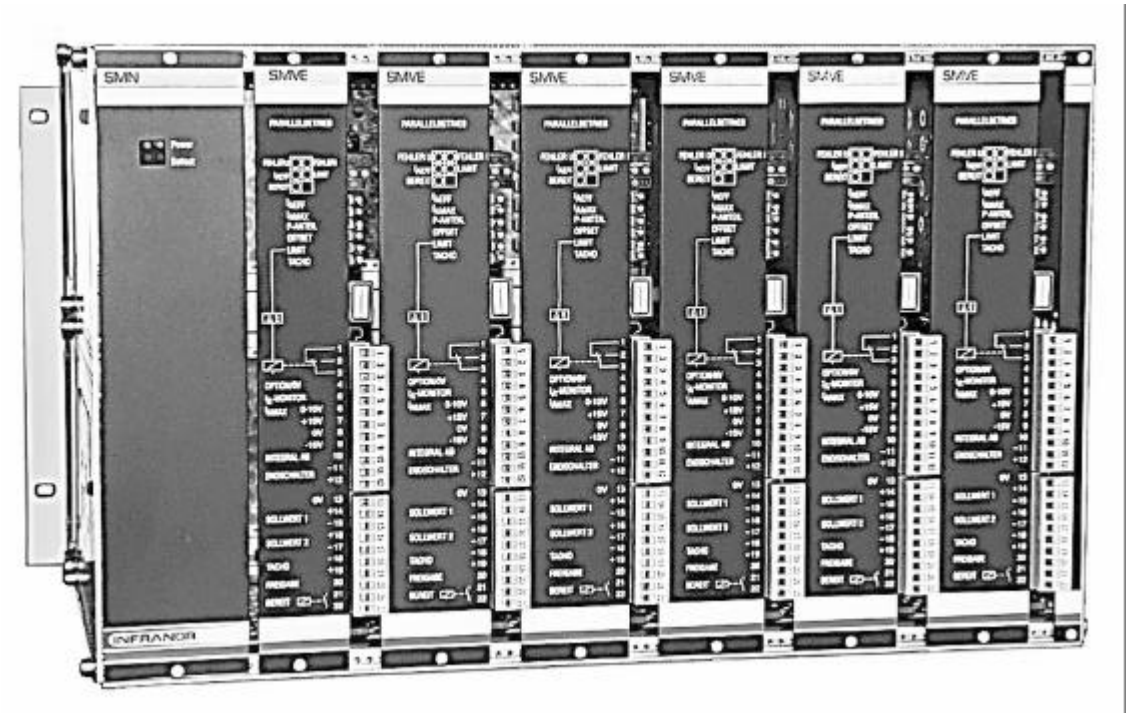
Type	Choke Type	L_{min} (mH)	Width in TE (units)	Form	Weight (Kg)	
SMVE/N 1010	D1010	2 x 0,17	12	1/4	1,2	
SMVE/N 1510	D1510	2 x 0,25	12	1/4	1,2	
SMVE/N 1520	D1520	2 x 0,15	12	1/4	1,2	
SMVE/N 1530	D1530	2 x 0,10	12	2	1,7	
SMVE/N 2410	D2410	2 x 0,40	12	1	1,2	
SMVE/N 2420	D2420	2 x 0,20	12	1	1,2 / 2,0	
SMVE 2430	D2430	2 x 0,15	12	2	1,7	
SMVEE 1540	D1540	2 x 0,25	20	3	3,0	
SMVEE 1560	D1560	2 x 0,15	20	3	3,0	
SMVEE 2440	D2440	2 x 0,30	20	3	3,0	
SMVEE 2460	D2460	2 x 0,25	20	3	3,0	
L_{min} : minimum inductivity in the armature circuit, 1 TE (unit) ≈ 0,2 "						

10.6 Fuses

Type	Fuse F1 (A)	Fuse F2 (A)	Size F1	Size F2	Voltage
Control Module	Output Power Supply	Power			
SMVE/E/N XX 10	1 A F	10 A MT	5 x 20 mm	6,3 x 32 mm	250V
SMVE/E/N XX 20	1 A F	20 A MT	5 x 20 mm	6,3 x 32 mm	250V
SMVE/E/N XX 30	1 A F	30 A MT	5 x 20 mm	6,3 x 32 mm	250V
Power Module	**Ballast 1**	**Ballast 2**			
SMN/W 13	10 A MT	10 A MT	6,3 x 32 mm	6,3 x 32 mm	250 V
SMN/W 19	10 A MT	10 A MT	6,3 x 32 mm	6,3 x 32 mm	250 V
SMN/W 29	10 A MT	10 A MT	6,3 x 32 mm	6,3 x 32 mm	250 V
SMN/W 13 S	10 A MT	10 A MT	6,3 x 32 mm	6,3 x 32 mm	250 V

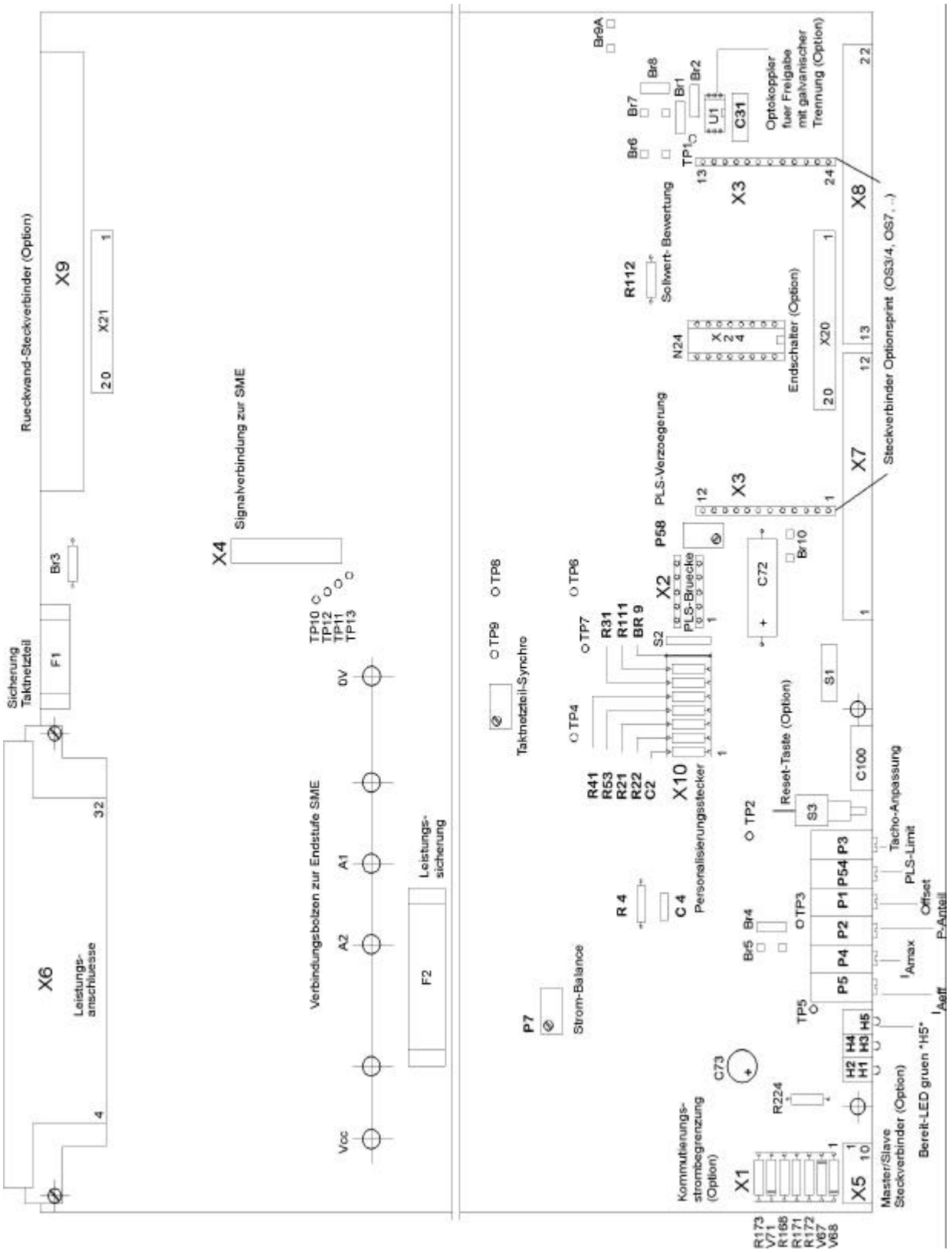
10.7 Rack Sizes

Rack Type	Size a (mm)	Size b (mm)	Units (TE)	Rack height
SMRA/S 24	160	127	25	6 HE
SMRA/S 36	221	188	37	6 HE
SMRA/S 48	282	249	49	6 HE
SMRA/S 60	343	310	61	6 HE
SMRA/S 72	404	371	73	6 HE
SMRA/S 84	465	432	85	6 HE
Rack according to DIN 41 494, Part 1; 1 TE = 5,08 mm or 0,2´´; 1 HE = height module ≈ 44,45 mm The Rack SMRS 84 is arranged for 19´´ standard swivel frame mounting.				

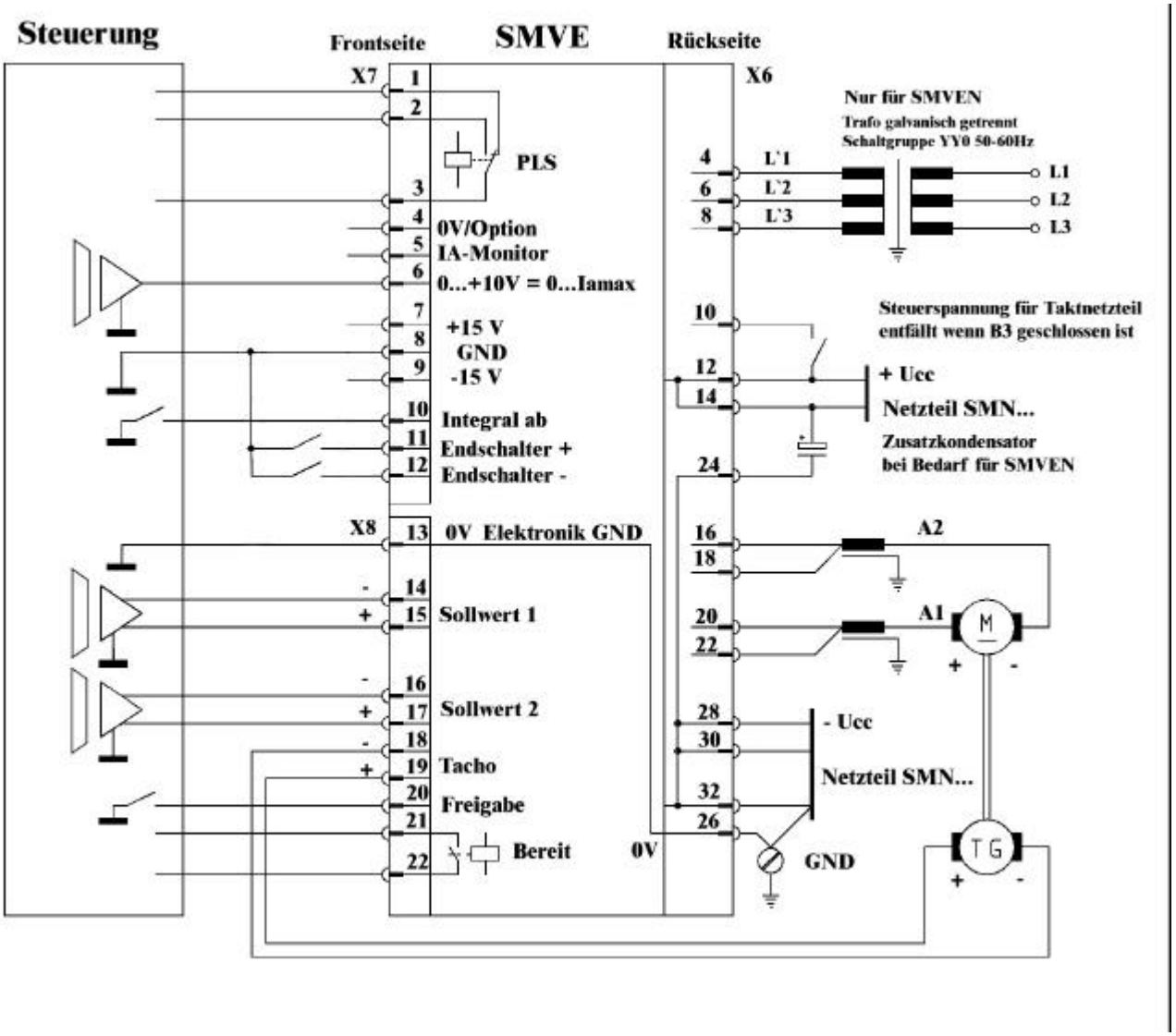


11 Examples of Connections and Drawings

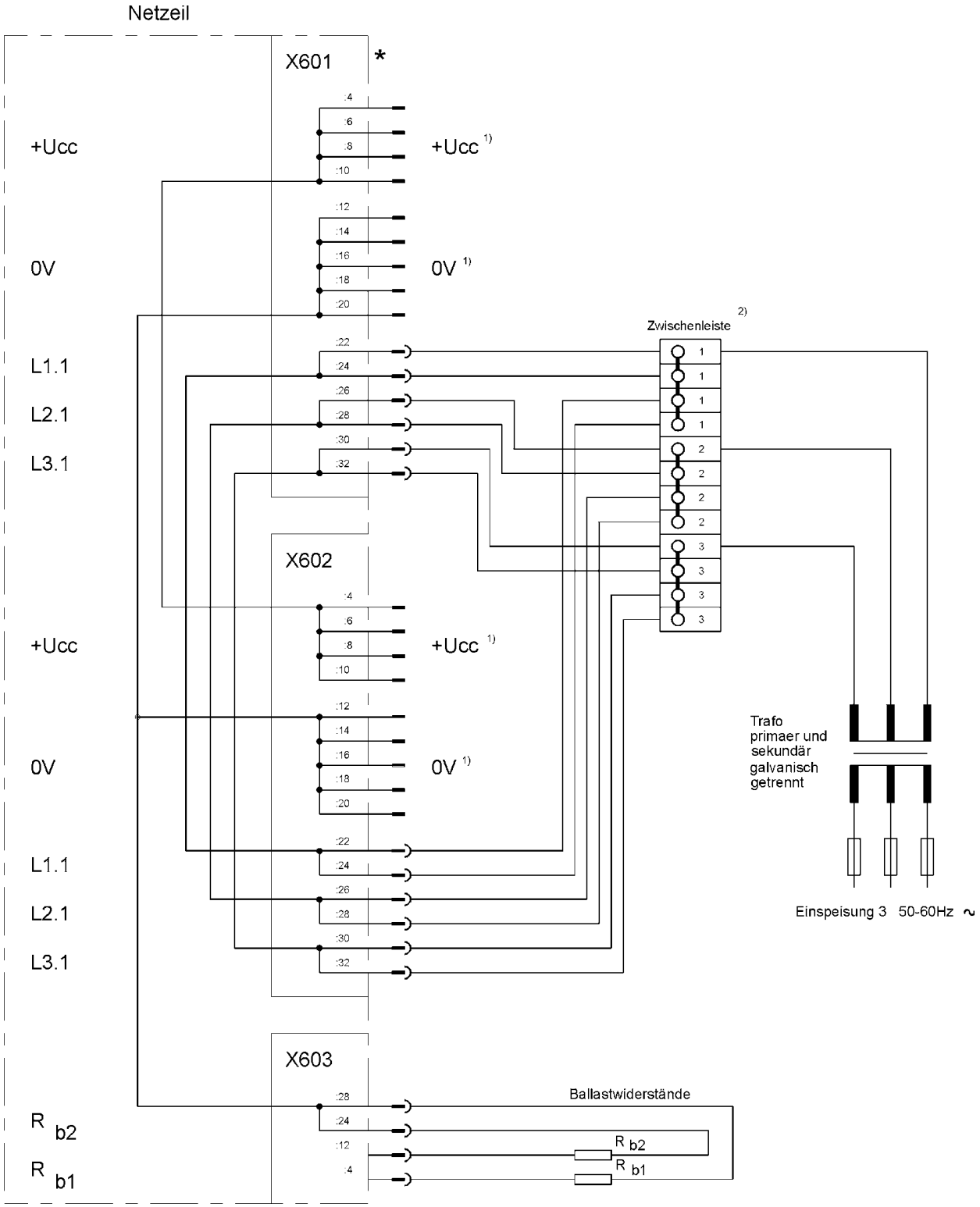
11.1 Mounting Scheme



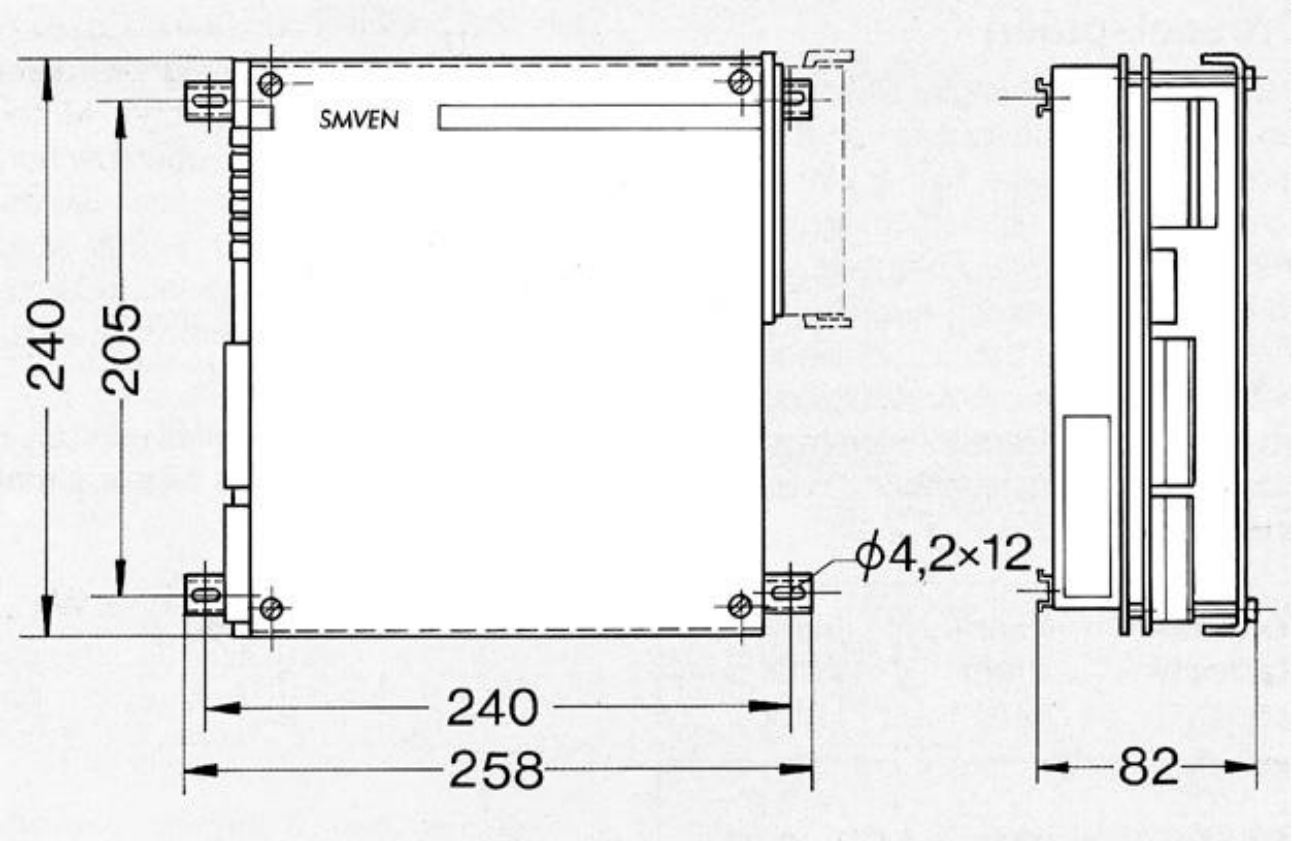
11.2 Connection SMVE/E/N Control



11.3 Rack Connection



11.4 Sizes SMVEN



11.5 Forms

Form 1	SMVE	with MOS-power stage	width: 50 mm
Form 2	SMVE	with IGBT or bipolar power stage	width: 50 mm
Form 3	SMVEE	"double power stage" - bipolar	width: 96 mm
Form 4	SMVEN		width: 82 mm

12 CAUTION!

Summary of all IMPORTANT INSTRUCTIONS and WARNINGS

Cover inside - Safety Information
Chapter 6 Wiring
Chapter 7 Setting up the Amplifier

Page 3
You find the limit values in the technical data. Never plug in or unplug any connectors on the amplifier when power is applied. A time of discharge of 3 minutes must be considered.
The net connection is effected via a transformer with galvanically separated primary and secondary winding.
The braking power should be calculated before operation or by try. If permanent power higher than indicated in the table are necessary, an additional module can be used.
A short light of H1 on the power module indicates whether the braking module is working. If H1 lights permanently the supply voltage is to high or the braking is to much: switch off the amplifier immediately. A permanent exceed of the limit values leads to the destruction of the controller or power module.

Page 19
Caution: All test points are related to 0VE/GND - no galvanic separation to the power stage!
No external voltages on the outputs and ± 15V connections.

Page 21
Caution: Maximum charge of ±15V are 20 mA per controller module!

Abbreviations and Formula Signs

Notion	**Abbreviation**	**Explanation**
maximum current of the drive	I_{max}	depends from the type, look Ch. 1.1
limit current	$\hat{I}_{max}$	$\hat{I}_{max}$ is relevant for the control function of over current
rated current	I_{rms}	depends on the type, look Ch. 1.1
output current - maximum value	I_{Amax}	adjusted peak current, max. I_{max}
output current rms value	I_{Aeff}	adjusted permanent current, max I_{nenn}
current demand	IDC	
output voltage	U_A	output voltage if $U_E = U_N$
input voltage	U_E	DC or AC power voltage
circuit voltage	U_{CC}	DC power voltage
over voltage	$U_Ü$	if U_{CC} reaches the indicated value, the amplifier is blocked - fault signal
ballast on	U_{Bon}	switch-on-limit of the braking module
ballast off	U_{Boff}	switch-off-limit of the braking module
limit switch positive direction	END +	stops the positive direction
limit switch negative direction	END -	stops the negative direction
electronical ground	0V/GND	reference point for signals
reset		returns the fault memory
external current limit	Iext	limitation of the maximum output current
drive healthy signal	drive healthy	operation contact (normally open contact)
enable	Enable	signal for enable or stop of the controller module
speed demand (speed)	U_{SOLL}	speed demand voltage
tacho voltage	U_T	speed proportional voltage
switch-on limit	in	index/identification
switch-off limit	off	index/identification

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