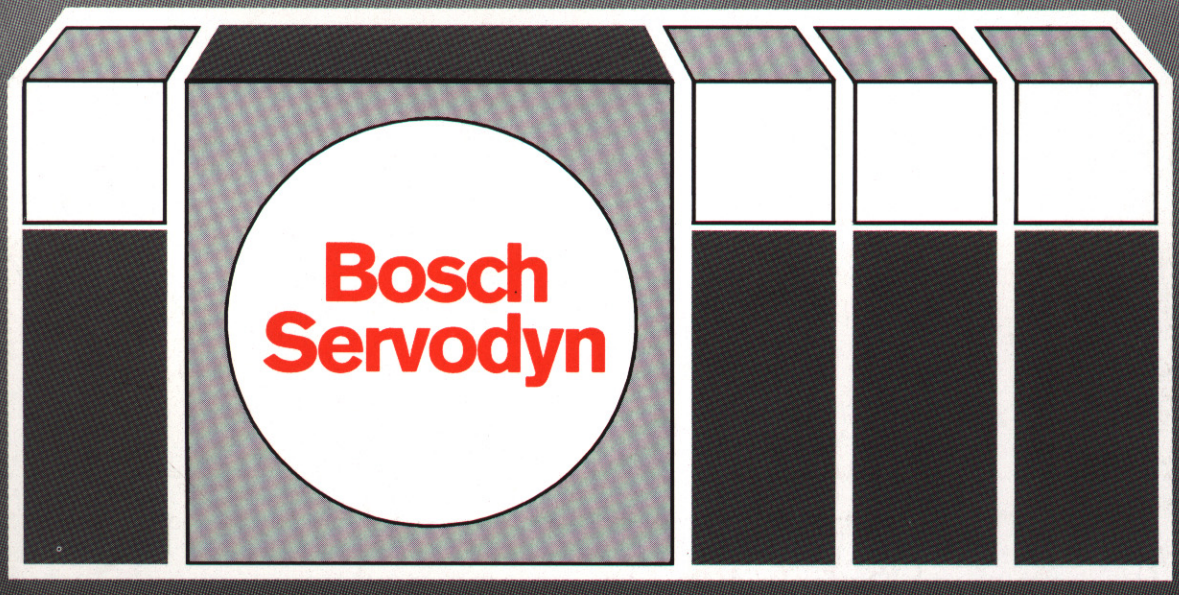
BOSCH

Flexible Automation

Bosch Servodyn

Servo Drives
Connections, Integration Instructions

P.-Nr. 3772/E1-09/84



Antriebstechnik
Drives

BOSCH

Schulungszentrum Flexible Automation

Kurse für:
- ○ Bediener, Einrichter
- ○ Projekteure, Programmierer
- ○ Inbetriebnehmer, Instandhalter

Kurs-themen:
- ○ Numerische Steuerungen (CNC) für Werkzeugmaschinen
- ○ Speicherprogrammierbare Steuerungen (SPS)
- ○ Elektrische Servoantriebe
- ○ Robotersteuerungen für Roboter und Handhabungstechnik
- ○ Widerstands-Schweißsteuerungen

Kurs-bezeichnung:

GL	= Grundlagen	C	= CPL/CPC
B	= Bedienen	I	= Inbetriebnahme Instandhalten
P	= Programmieren		

Ausbildungsvorschlag Servodyn-Antriebe

Für Einsteiger ohne Erfahrung (alle Bereiche) ▷ **GA-GL** Basiskurs

Für Konstrukteure, Projekteure, Ingenieurbereiche ▷ **SD - SY** Konzept, System

Für Inbetrieb-nehmer, Instandhalter ▷ **SD -A** für Servodyn-Achsantriebe Inbetriebnahme

SD -S für Servodyn-Spindelantriebe Inbetriebnahme

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Bosch Servodyn

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Bosch Servo Drives for the Whole of Machine Building

1. Construction of the Servodyn Range of Motors

Bosch servo motors are permanently excited machines with electronic commutation, suitable for applications in positional and velocity servo loops.

They have a 3-phase stator winding and a rotor excited by permanent magnets. They also incorporate a brushless tacho for velocity feedback . Rotor position feedback monitoring in the associated servo module controls the commutation of the currents from phase to phase (electronic commutation).

1.1 Main Features

- **maintenance-free operation**	through the use of motors and tachos of brushless constructi
- **long life**	bearing > 30,000 hrs winding > 70,000 hrs
- **constant torque**	throughout the range of the speed-torque characteristic
- **high resistance against demagnetisation**	admissible peak torque equal to 6 times the nominal torque
- **large overload capacity**	through advantageous heat dissipation; the complete dissipation loss is generated the stator winding, with low h resistance to the motor surfac
- **good synchronisation**	through special magnet configu ation and precise current regulation in all three phases
- **small cable diameters**	due to low motor currents
- **high protection standard**	due to completely sealed construction
- **operation directly from the mains**	without additional transformer or chokes

1.2 Construction Features

The motors conform to DIN standards as well as the VDE regulations.
The heat generation corresponds to VDE 0530 insulation material class F (155°C).

type of cooling

Self-cooling, i.e. the heat loss is eliminated through radiation and natural convection. The motors must be installed in such a way that adequate elimination of the heat loss is ensured.

protection standard

IP 54 to DIN 40050/40053 with coupled angled plug and prescribed cable diameter.

Note: Loosened screws must be resealed with Loctite 638.

construction

Basic construction B5, also suitable for use in V1 or V3 construction.
It must be ensured that no fluid remains in the flange bearing plate.

bearings

Fixed bearing on A-side (flange side) of motor, preventing heat expansion of the rotor from affecting the machine.
The dimensions of the bearings guarantee a life of at least 30,000 hrs.
For applications where the motor is mounted onto a gearbox the A-bearing can be sealed against oil with a special seal.

shaft end

In the standard version the motors are supplied with cylindrical shaft ends to DIN 748, with key and keyway to DIN 6885. Shaft without key and keyway is available as an option (see table of options).

vibration level

Three different vibration levels (N, R and S to DIN 45665) make optimum motor selection possible (see table of options).
The basic version corresponds to vibration level N (motors with key are balanced with the key).

disk brake

Due to the mechanical construction of the motor and the particular configuration of the winding it is possible to build a disk brake into the front section - without adding to the length of the motor. The braking torques are graduated and suited to the requirement for the different motor sizes.
It is of particular importance to the user that this system works without play.

electrical connection

The power connection as well as the control connections are made by plug connectors, reducing test and integration time to a minimum.

thermal motor overload protection

All motors incorporate a thermistor, which is integrated into the winding.
The evaluation of the monitor signal is done in the corresponding servo module.

tacho and commutation encoder

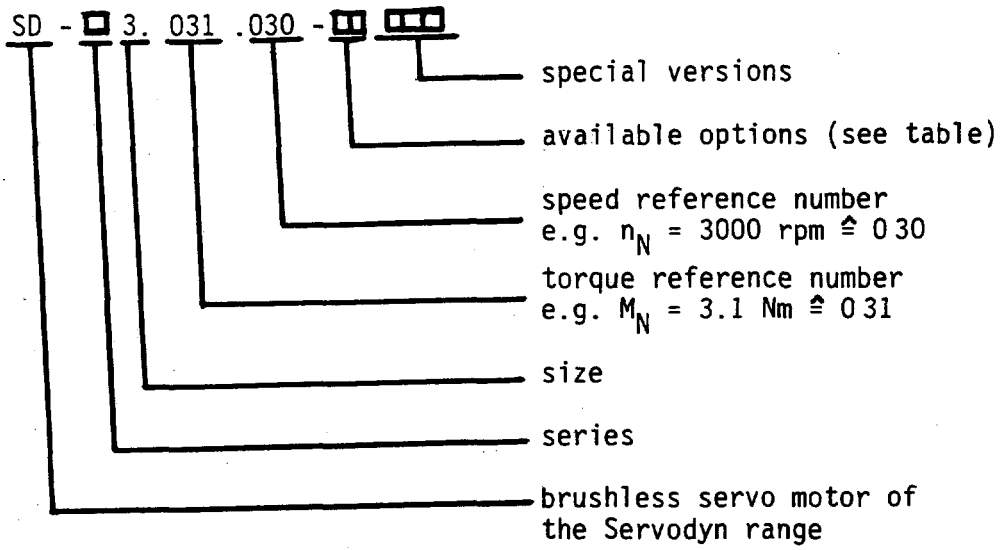
The two devices, both of brushless construction, are mounted at the non-driving end (B-side) of the motor. The tacho provides a DC voltage proportionate to the speed - 2.7 V/1000 rpm - with a max. ripple of 1.5%. The commutation encoder controls the switching of the phase currents in the associated inverter.

measuring system on the motor

Constructional modifications at the B-side of the tacho make it possible to fit a digital encoder (type ROD 426) or a resolver, size 11 (see section 1.3.1 Options and Special Versions).

1.3 Motor Description

Example



Series A: A3 to A5, with Canon connector system
A6, with Souriau connector system

Series B: B3 to B6, with Souriau connector system

1.3.1 Options and Special Versions

Option code table

code	matching plug	disk brake	shaft w/o keyway and key	vibration level R	2nd shaft end for handwheel*
X1	X				
X5	X	X			
1X			X		
2X				X	
3X			X	X	
4X					X
5X			X		X
6X				X	X
7X			X	X	X

* preparation for fitting of measuring system and 2nd shaft end for handwheel exclude one another.

X1 matching plug - part of the basic equipment

X5 Built-in Disk Brake
The motors can be supplied with a built-in disk brake to prevent movement of the feed axis at standstill and when the supply to the installation is switched off. The permanent magnet, single surface brake, which has been specially designed for this range of motors, works by the closed circuit current principle.
The permanent magnet generates a pull on the brake armature disk, i.e. the brake is closed when there is no current flowing, and the axis is held. The brake **is not** a working brake. However, approx. 2000 braking operations can be carried out for "Emergency Stop" or in the event of supply failures without the disk wearing excessively (provided machine inertia ≈ motor inertia, for all max. speeds).
Due to the operation by closed circuit current principle the brake functions as a safety brake, and the associated circuitry must be designed in such a way that it becomes electrically excited (brake mechanically open) when the motor rotates. When the nominal 24 V DC voltage is applied to the brake the current carrying coil builds up an opposing field which cancels the effect of the permanent magnet force and eases the brake or keeps it open. The dimensions of this brake make it possible to build it onto the bearing plate at the driving end without increasing the length of the motor housing. When the brake is open there is no residual torque, holding of the axis without play is guaranteed.

1X Shaft without Keyway and Key
Shaft end at the driving end without keyway and key for torque transmission by contact pressure (see dimension drawings of motors, section 2.5).

Note: Shaft-drive pinion connection
The shaft-to-hub connection is subject to multi-directional tension under load, resulting from torsion, radial and axial forces and the flexing torque. Shaft connections with key and keyway form a **single position location** and the fitting characteristics change under continuous usage (torque peaks during magnetic flux reversals), and asymmetrical wear in the shaft-to-hub fitting impairs smooth running. Increasing deformation can result in breakage.

In the case of a **force-locking** fitting the transmission of force must be produced entirely by contact pressure, ensuring reliable transmission of load.

2X Vibration Level R
The values produced by the motor remain below those specified for vibration level R in DIN 45665.

4X Second Shaft End
Hexagonal head for spanner or handwheel. For all motor sizes A3 - A6.
Max. admissible load: 50 Nm. Spanner size 13 (width over flats of hexagon).

Special Versions

004 Built-in ROD Encoder - Type ROD 426
Pulse count: 2500 pulses/rev.
(For technical data see section 2.4).
The encoder is connected via a socket built into the motor.

100 Oil-tight A-bearing (driving end)
If required, the motors can be supplied with a special shaft sealing ring (make Garlock) at the driving end. A reduction of the life (30,000 hrs) need not be assumed, if the fitting instructions are adhered to (half of the A-bearing must run in oil).
Observe the prescribed fitting position for the motors:
- The plug connector must point **downwards.**

200 Vibration Level S
The values produced by the motor remain below those specified in DIN 45665.

400 Special Shaft End Suitable for Hydraulic Release Coupling
Fitting dimension of shaft end K5; roughness tolerance error R_z = 1.6 µm.
(See dimension drawings of motors, section 2.5)

800 Resolver Measuring Gearbox (i = 1:5)
(other ratios on request)

Preparation for Fitting of Incremental Encoder
(not designated as a special version; simply Bosch part no.)

motor size SD-A3, Bosch part no. 104-912561
motor size SD-A4, Bosch part no. 104-912562
motor size SD-A5, Bosch part no. 104-912563
motor size SD-A6, Bosch part no. 104-913425

For digital positional servo loops an ROD 426 pulse encoder can be fitted.
The fitting kit contains the following: housing, intermediate flange, coupling, socket, plug-in coupline, various small parts (see dimension drawing 2.6).

Extension Kit for Fitting of Resolver Size 11
(not designated as a special version; simply Bosch part no. 104-912839).
Consists simply of an adapter connection flange for a resolver. In addition a complete fitting kit for incremental encoder is required (see previous item).

2. Technical Data

2.1 Motor Data

2.1.1 General Data of the Servodyn Range

max. ambient temperature	$T_{amb.\ max}$ = 40°C, at M_N
insulation class	F
protection standard	IP 54
construction	IEC flange; construction B5 (V1/V3)
noise level	max. 58 dB (A) at a distance of 1.5 m, middle of motor

2.1.2 Admissible Mechanical Load on Motor Shaft

Admissible axial and radial forces at the motor shaft:

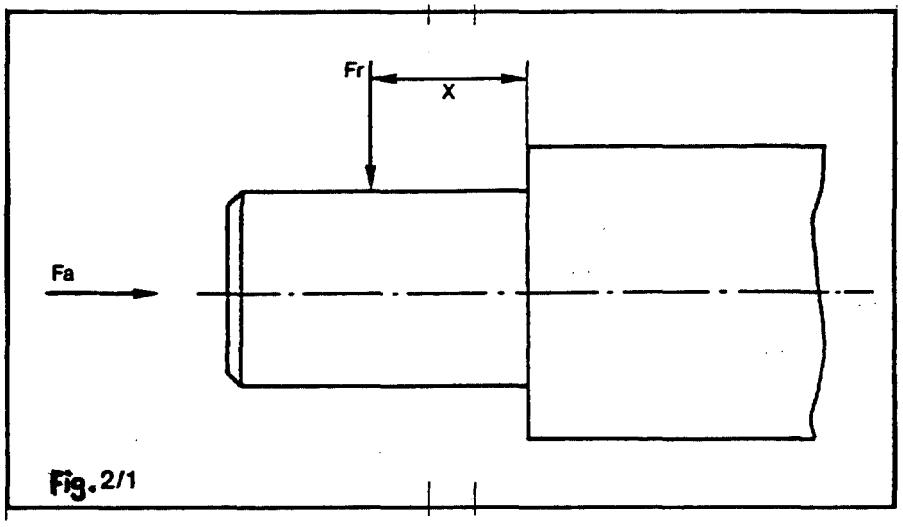
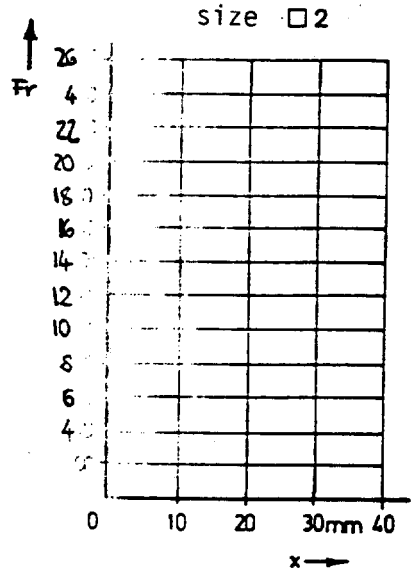


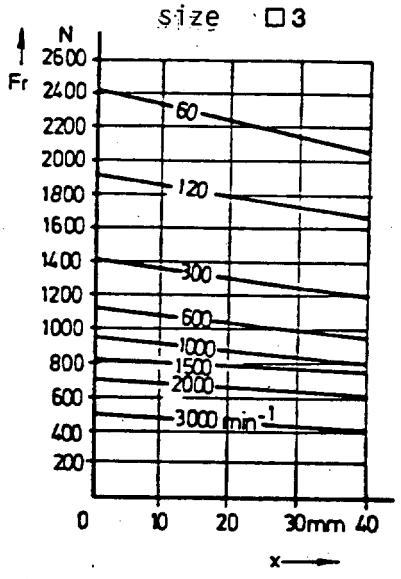
Fig. 2/1

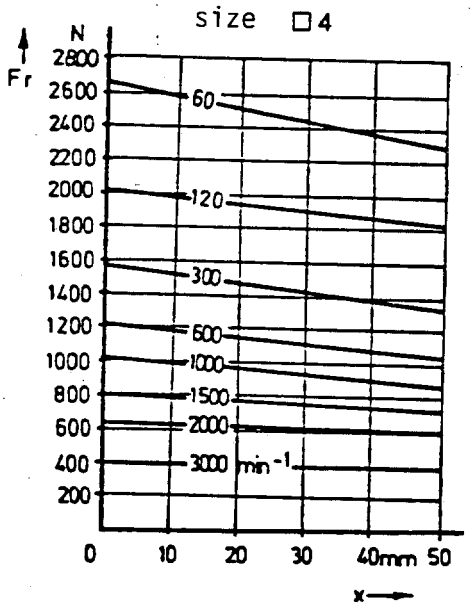
size	construction	admissible axial load Fa [N]
SD-□3	B5	200
	V3	110
	V1	240
SD-□4	B5	200
	V3	60
	V1	280
SD-□5	B5	400
	V3	120
	V1	600
SD-□6	B5	900
	V3	100
	V1	1400

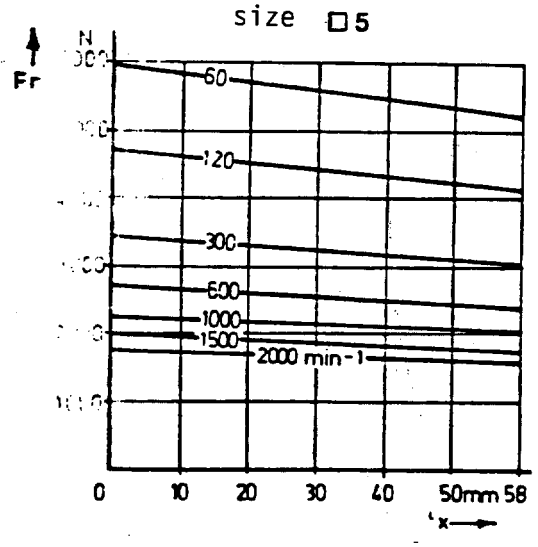
The fixed bearing at the driving end prevents temperature-related expansion at the driving side.

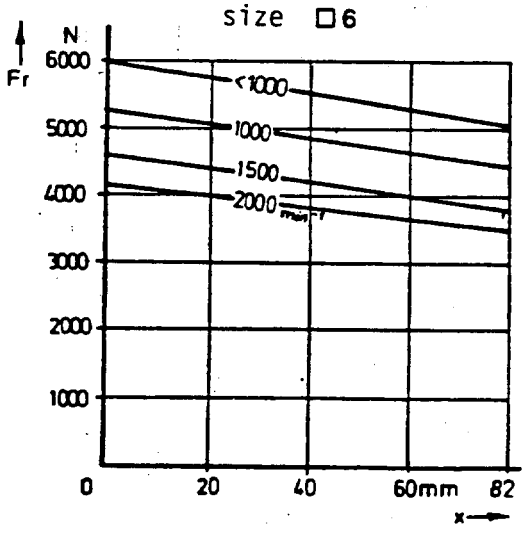
Admissible transverse forces at the motor shaft











2.1.3 Specific Motor Data

	Symbol	unit	SD-□3				SD-□4				SD-□5				SD-□6			
			031. 030-		050. 030-	068. 030-	070. 030-		140. 020-	140. 030-	250. 015-	250. 020-	380. 012-	380. 020-	480. 020-	720. 020-	960. 010-	960. 015-
continuous torque $t_w = 140°C$	M_0	Nm	3,1		5,0	6,8	7,0		14,0	14,0	25	25	38	38	48	72	96	96
nominal speed	n_N	min^{-1}	3000		3000	3000	3000		2000	3000	1500	2000	1200	2000	2000	2000	1000	1500
nominal current at M_0 $n \geq 0$; $\Delta t_w = 100$ K	I_0	A	3,25		5,3	7,5	7,5		9,8	13,5	12,9	17,2	15,4	22,8	29,7	44,9	30,8	46,3
peak current; at $t_a = 20°C$	I_{max}	A	24		47	57	50		66	92	64	84	93	112	180	262	192	288
torque constant $t_a = 40°C$; $\Delta t_w = 100$ K	k_m	Nm/A	0,955		0,94	0,91	0,933		1,429	1,037	1,94	1,46	2,46	1,70	1,62	1,60	3,12	2,07
voltage constant $t_a = 40°C$; $\Delta t_w = 100$ K	k_u	Vs/rad	0,960		0,97	1,07	1,004		1,462	1,04	2,08	1,57	2,60	1,75	1,68	1,68	3,2	2,16
winding resistance $t_w = 20°C$	R_a	Ohm	6,7		2,58	1,7	1,857		1,875	0,918	1,257	0,752	1,127	0,49	0,32	0,19	0,44	0,2
winding inductance	L_a	mH	40,0		18,0	12,9	18,7		20,6	8,483	26,8	15,0	25,9	12,1	6,7	5,26	13,5	6,0
el. time constant $t_w = 20°C$	T_{el}	ms	6,0		6,98	7,6	10,1		11,0	9,24	21,32	19,95	22,98	25,46	20,94	27,68	30,68	30,0
mech. time constant $t_w = 20°C$	T_m	ms	7,7		5,2	4,1	7,7		6,9	5,7	5,1	5,4	4,5	4,5	8,2	7,0	6,2	6,2
therm. time constant	T_{th}	min	70		85	110	120		130	130	320	260	220	180			300	
max. theoretical acceleration	α_{max}	rad/s^2	17700		19500	18580	9880			9900	6150	6080	7460	6080	2590	2590	2790	2770
rotor inertia	J	kgm^2	1,5538 $\times 10^{-3}$		2,895 $\times 10^{-3}$	4,37 $\times 10^{-3}$	5,88 $\times 10^{-3}$		11,56 $\times 10^{3}$	11,56 $\times 10^{-3}$	25,36 $\times 10^{-3}$	25,36 $\times 10^{-3}$	37,6 $\times 10^{-3}$	37,6 $\times 10^{-3}$	135 $\times 10^{-3}$	194 $\times 10^{-3}$	258 $\times 10^{-3}$	258 $\times 10^{-3}$
dimensions flange		mm	116Ø				142Ø				190Ø				260Ø			
dimensions length		mm	310		392	470	366		484	484	489	489	590	590	550	635	960	960
mass	m	kg	13		18,3	25	23		37,8	37,8	58,6	58,6	80	80	115	157	190	190

Note:
M_0 = torque at standstill
t_w = temperature of winding
t_a = ambient temperature

2.1.3 Spezifische Motordaten

	Symbol	Einheit	SD-□3				SD-□4					SD-□5				SD-□6			
			031. 030-		050. 030-	068. 030-	095. 030-	070. 030-	092. 020-	140. 020-	140. 030-	180. 020-	250. 015-	250. 020-	380. 012-	380. 020-	480. 020-	720. 020-	960. 010-	960. 015-
Dauerdrehmoment t_w = 140°C	M_0	Nm	3,1		5,0	6,8	9,5	7,0	9,2	14,0	14,0	18,0	25	25	38	38	48	72	96	96
Nenndrehzahl	n_N	min^{-1}	3000		3000	3000	3000	3000	2000	2000	3000	2000	1500	2000	1200	2000	2000	2000	1000	1500
Nennstrom bei M_0 $n \geq 0$; Δt_w = 100 K	I_0	A	3,25		5,3	7,5	8,8	7,5	6,0	9,8	13,5	11,7	12,9	17,2	15,4	22,8	29,7	44,9	30,8	46,9
Spitzenstrom; bei t_U = 20°C	I_{max}	A	24		47	57	54	50	31	66	92	62	64	84	93	112	180	262	192	286
Drehmomentenkonstante t_U = 40°C; Δt_w = 100 K	k_m	Nm/A	0,955		0,94	0,91	1,08	0,933	1,53	1,429	1,037	1,54	1,94	1,46	2,46	1,70	1,62	1,60	3,12	2,05
Spannungskonstante t_U = 40°C; Δt_w = 100 K	k_U	Vs/rad	0,960		0,97	1,07	1,08	1,004	1,55	1,462	1,04	1,58	2,08	1,57	2,60	1,75	1,68	1,68	3,2	2,17
Wicklungswiderstand t_w = 20°C	R_a	Ohm	6,7		2,58	1,7	1,8	1,857	3,7	1,875	0,918	1,46	1,257	0,752	1,127	0,49	0,32	0,19	0,44	0,23
Wicklungsinduktivität	L_a	mH	40,0		18,0	12,9	11,2	18,7	32,9	20,6	8,483	15,0	26,8	15,0	25,9	12,1	6,7	5,26	13,5	5,3
Elektr. Zeitkonstante t_w = 20°C	T_{el}	ms	6,0		6,98	7,6	6,2	10,1	8,9	11,0	9,24	10,3	21,32	19,95	22,98	25,46	20,94	27,68	30,68	23,3
Mech. Zeitkonstante t_w = 20°C	T_m	ms	7,7		5,2	4,1	4,2	7,7	6,7	6,9	5,7	5,1	5,1	5,4	4,5	4,5	8,2	7,0	6,2	6,2
Therm. Zeitkonstante	T_{th}	min	70		85	110	75	120	100	130	130	120	320	260	220	180			300	220
Max. theoretische Beschleunigung	α_{max}	rad/s^2	17700		19500	18580	16190	9880			9900		6150	6080	7460	6080	2590	2590	2790	2770
Rotor Trägheitsmoment	J	kgm^2	1,5538 $\times 10^{-3}$		2,895 $\times 10^{-3}$	4,37 $\times 10^{-3}$	4,37 $\times 10^{-3}$	5,88 $\times 10^{-3}$	5,88 $\times 10^{-3}$	11,56 $\times 10^{-3}$	11,56 $\times 10^{-3}$	11,56 $\times 10^{-3}$	25,36 $\times 10^{-3}$	25,36 $\times 10^{-3}$	37,6 $\times 10^{-3}$	37,6 $\times 10^{-3}$	135 $\times 10^{-3}$	194 $\times 10^{-3}$	258 $\times 10^{-3}$	258 $\times 10^{-3}$
Abmessungen Flansch		mm	116⌀					142⌀					190⌀				260⌀			
Abmessungen Länge		mm	310		392	470	470	366	366	484	484	484	489	489	590	590	550	635	960	960
Masse	m	kg	13		18,3	25	25	23	23	37,8	37,8	37,8	58,6	58,6	80	80	115	157	190	190

Hinweis:

M_0 = Stillstandsdrehmoment
t_w = Wicklungstemperatur
t_U = Umgebungstemperatur

2.2 Tacho

EMF at t_a=20°C	V/1000 rpm = 2.7 V / 1000 rpm ± 5 %
min. terminal resistance	R_{min} = 20 kOhm
voltage ripple	< 1.5 %

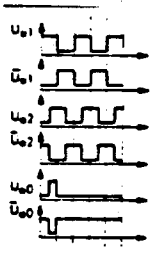
2.3 Disk Brake

	motor types SD-□3	SD-□4	SD-□5	SD-□6
holding torque, M_{BR} [Nm]	4.5	9	36	80
conn. voltage, U_{BR} [V]	24 V DC ± 10 %			
nom. current, I_{BR} [A]	0.6	0.63	1.36	1.8
inertia, J_{BR} [kgm²]	0.106×10^{-3}	0.360×10^{-3}	3.18×10^{-3}	18.75×10^{-3}
power consumpt. P_{BR} [W]	14	15	32	43
weight m_{BR} [kg]	0.6	1.1	3.5	9.0

2.4 Built-in Incremental Encoder Type ROD 426

(make Dr.J.Heidenhain)

built-in encoder ROD 426

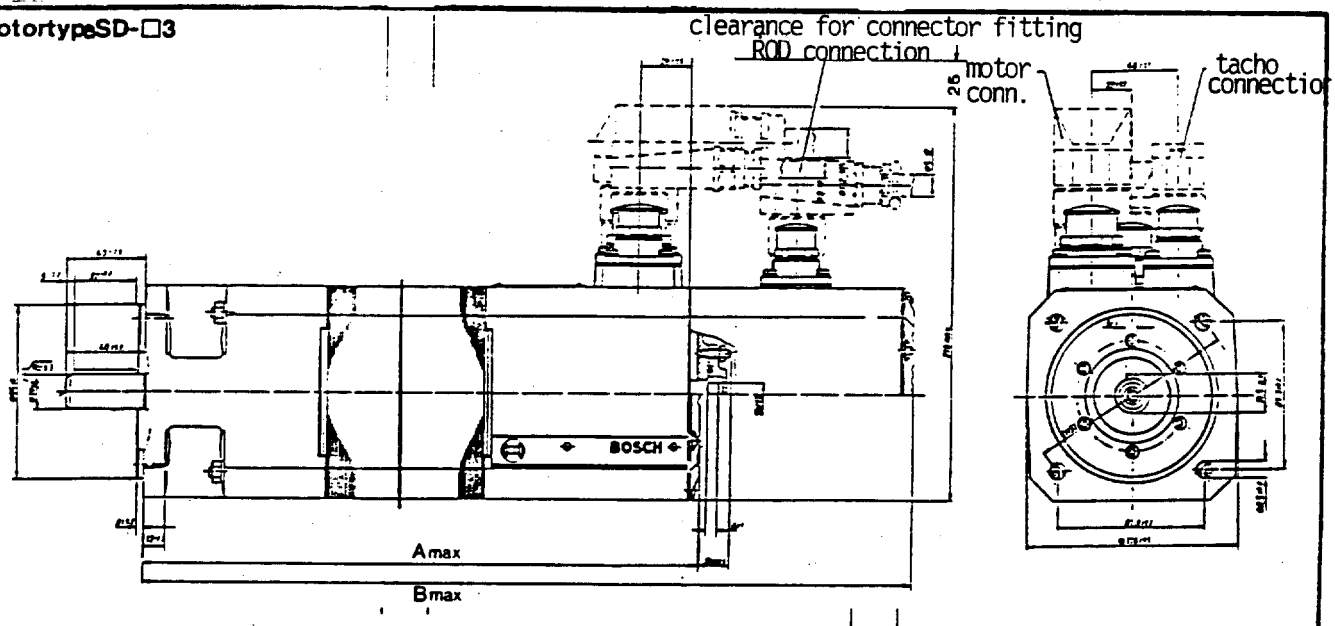
maximum speed	12,000 rpm
operating temp. range	0°C to 50°C
storage temp. range	-30°C to +80°C
light source	miniature lamp 5 V / 0.6 W
voltage supply	Up = +5 V, +5 % I ≦ 220 mA (zero load)
output signals	TTL compatible
signal sequence	 Rectangular pulse sequences U_{a1} and U_{a2} as well as the inverted signals $\overline{U_{a1}}$ and $\overline{U_{a2}}$. U_{a2} lagging behind U_{a1} during clockwise rotation (view onto shaft).
switching times	≦ 0.2 µs time delay of signal U_{a0} with respect to signals U_{a1} and U_{a2} ≦
frequency range	0 to 100 kHz
max. load on output	I_{source} ≦ -40 mA I_{sink} ≦ 40 mA
short-circuit protection	for short periods (≦3 sec) all outputs against 0 V, 1 output continuously at an ambient temp. ≦ 25°C
reference pulse	standard feature
max. cable length	to the associated electronics: 50 m, with a differential input amplifier at the input of the electronics, which must not affect the nominal value of the supply voltage to the ROD 426.

Recommended plug connections (ROD 426)

Pin	signal	colour
1	Ua1	brown 0.14 Ø
2	$\overline{\text{Ua1}}$	green
3	Ua2	grey
4	$\overline{\text{Ua2}}$	pink
5	+5 V el.	blue
6	UaØ	red
7	$\overline{\text{UaØ}}$	black
8		violet
9	+5 V lamp	brown 0.5 Ø
10	0 V el.	white 0.14 Ø
11	screen	
12	0 V lamp	white 0.5 Ø

2.5 Dimension Drawings - Servodyn Motors

MotortypeSD-□3

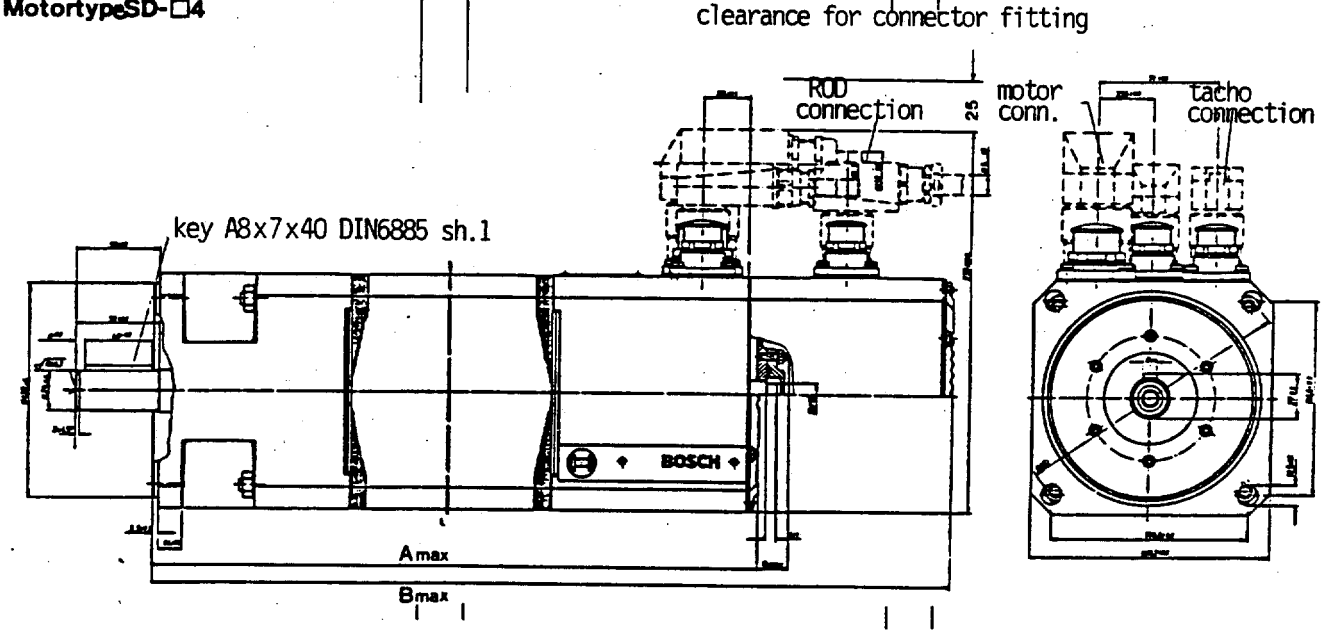


SD-A3: Canon connector system, max. overall height 212 mm

type	motor length [mm] Amax	Bmax	weight [kg] for motor length A
SD-B3.031.	310	426	17
SD-B3.050.	392	508	19
SD-B3.068.	470	586	25

fig. 2/2

MotortypeSD-□4

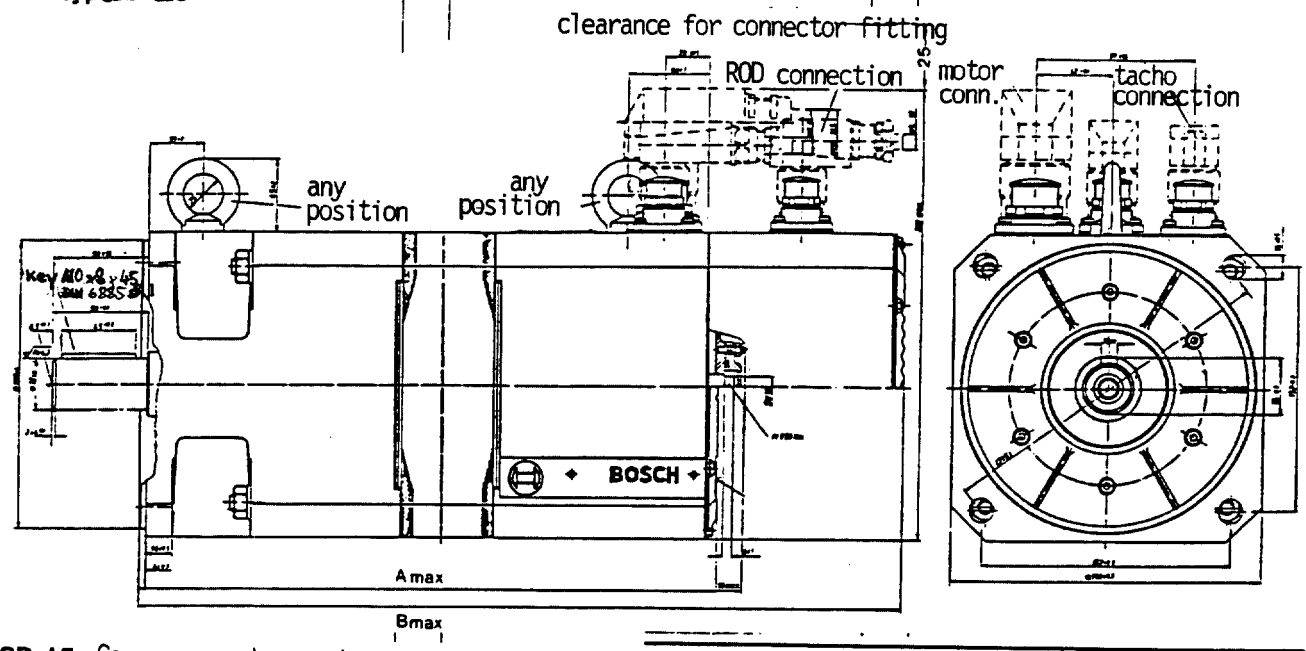


SD-A4. Canon connector system overall height 225 mm

type	motor length [mm] Amax	Bmax	weight [kg] for motor length A
SD-B4.140.	484	600	38
SD-B4.070.	366	482	22

fig. 2/3

Motortype SD-□5

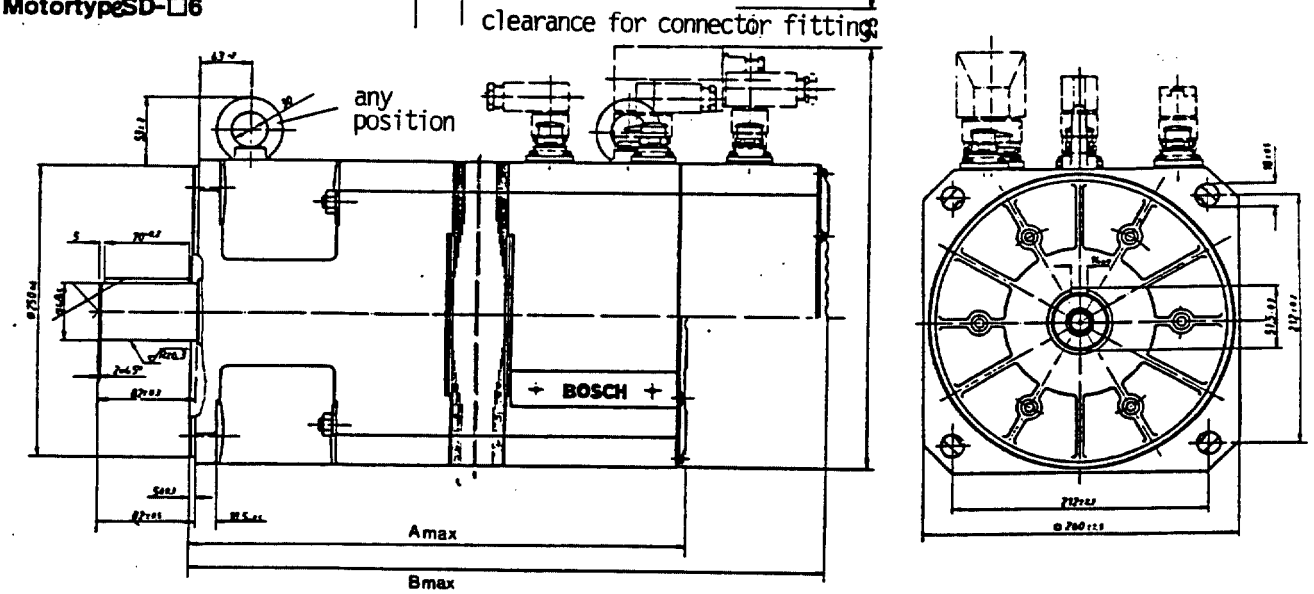


SD-A5: Canon connector system
max. overall height 275 mm

type	motor length [mm] Amax	Bmax	weight [kg] for motor length A
SD-B5.250.	489	605	60
SD-B5.380.	590	706	80

fig. 2/4

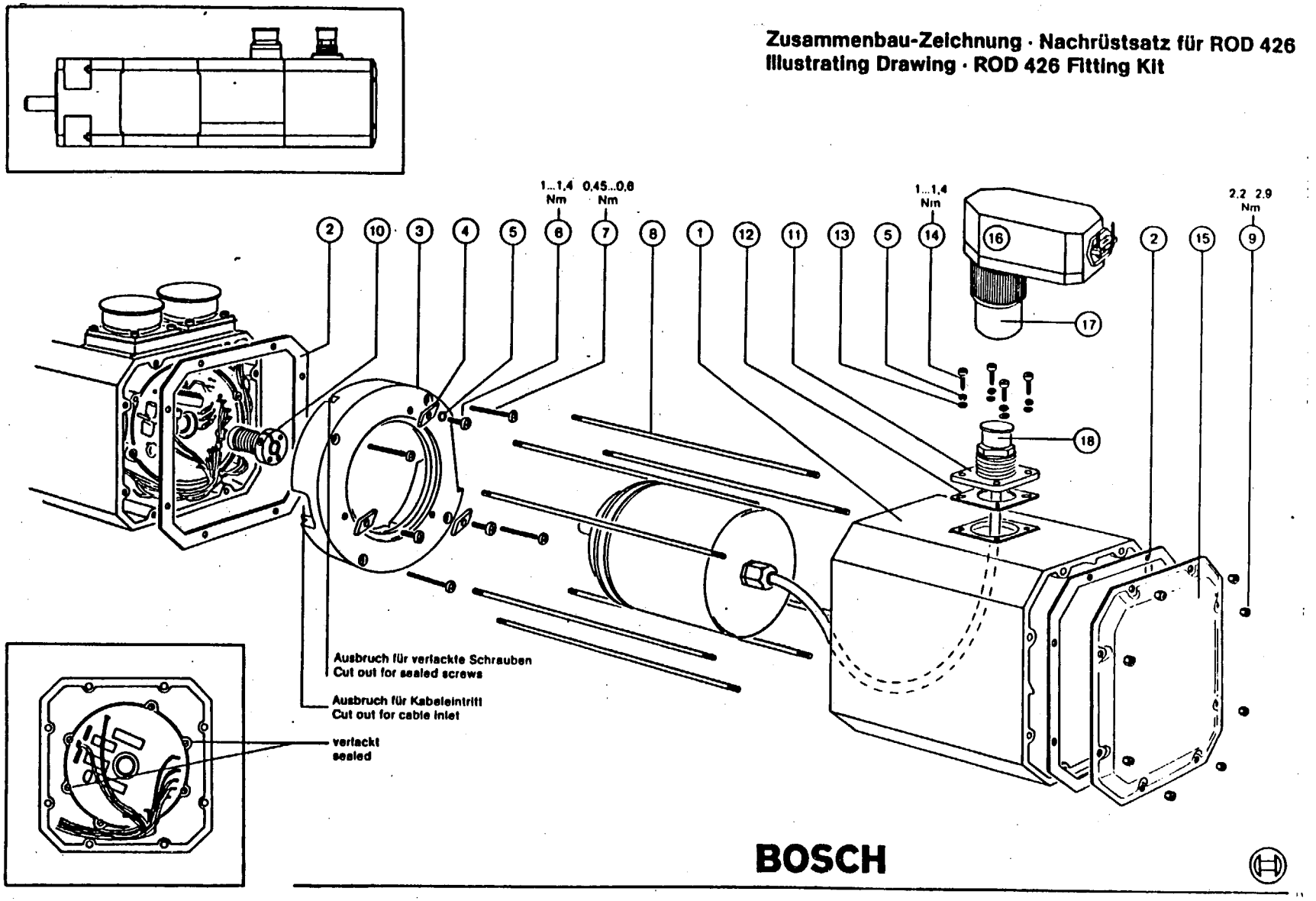
Motortype SD-□6



type	motor length [mm] Amax	Bmax	weight [kg] for motor length A
SD-A6.480.	550	665	115
SD-A6.720.	635	750	157
SD-A6.960.	745	860	190

fig. 2/5

2.6 Drawing illustrating assembly of fitting kit for ROD 426



Note: For the assembly please observe our "Assembly Instructions" P.-No. 3736!

fig. 2/6

3. Construction of the Inverter System

Bosch inverter systems are of modular construction.
At least one supply module and one servo module are required to make up one functional unit.

The supply module generates a DC link voltage, various supply voltages (for logic and driver circuits) and the cycle signals from the mains voltage (3x380 - 3x415 V).

A further function of the supply module is the analysis of the fault signals, which are routed to it from the different SM-modules. The built-in ballast circuit converts the energy fed back by the motors during braking into heat.

In the associated inverter stage (servo module) voltages and currents are generated under the control of the rotor position monitoring of the machine in such a way that the machine can provide the required torque at any speed.

The individual modules are connected to each other with plug-in cables, which are part of the equipment.

On an installation with several motors up to 5 SM-modules can be connected to one supply module, depending on the size of the modules.

Since the mechanical construction and the electrical connection to the supply module correspond with those of the ASM system (inverter system for standard asynchronous motors) it is possibl to combine the two (for instance 3 axis modules plus one inverter module for the main spindle).

4. Technical Data

4.1 Supply Module

4.1.1 DC Link

type	VM 60	VM 60 EB
nominal current	60 A	
peak current (for 5s)	150 A	
surge current (for 1ms)	1500 A	
connection voltage	3x380V -10% to 3x415V +10%*	
DC link voltage	480 - 800 V DC (depending on operating condition)	
mains frequency	50 - 60 Hz	
heat loss	max. 400W (depending on operating condition)	max 1500 W (depending o op. conditio

*For other connection voltages a transformer is required

4.1.2 Logic

current supply	via switching power supply from the DC link
control input	+24V ±15% current consumption depends on the number of servo modules, see also 6.1.4, for start-up of switching power supply, for supply of "diagnostics" option
control outputs	ready 1 and ready 2 H = +24V, max. 100 mA (display via green LED ±15V stable, max. 30 mA, short-circuit proof

4.1.3 Protective Features

The option "diagnostics" provides a status display via red LEDs and the output of an interface signal (with 0V).

Max. load +24VDC, 20 mA per output or 1x100mA at one output

overvoltage DC link	(U> 800V - 820V)	V1	
undervoltage DC link	(U< 350V - 370V)	V2	
logic fault	(±15V voltage supply cycle frequency)	V3	LED display
ambient temperature	≧ (56°C ±2.5%)	V4	
ballast cct overload		V5	

4.2 Servo Module

4.2.1 Power Unit

type	SM 6/10	SM 10/18	SM 20/30	SM 35/70	SM 50/100
nom. current at $T_{amb.}$ = 35°C $T_{amb.}$ = 55°C	6 A	10 A	20 A	35 A 35 A	50 A 45 A
peak current (2s)	10 A	18 A	30 A	70 A	100 A
supply voltage	min. 24 V < U_N < 715 V max.				
analogue regulating range	> 1:100,000				
heat loss	130 W	190 W	250 W	300 W	400 W

4.2.2 Control Unit

Voltage supply of the logic and the driver stages is via plug-in connectors X8 and X9.

Control inputs; plug-in connector X6:

command, differential input	+10V to -10V, internal reduct possible to +7.5V to -7.5V
enable	+24V (display via green LED)
torque reduction (reduction of the limit current in range 1:5)	digital H=+24V, L=0V or analogue 0 to 10V see section 6.2.6

Control signals from motor, plug-in connector X5:

rotor position encoder	digital signal
motor temperature monitoring	thermistor, admissible range +2°C (-20°C) to 140°C
tacho voltage	analogue +10V to -10V voltage constant 2.7V/1000 rpm ±5% adjusting range of input amplifier: 80 to 120%

4.2.3 Protective Features

The option "diagnostics" provides a status display via red LEDs and the output of an interface signal J_24V, active 0V. Max. load 20 mA per output or 1x100mA on one output.

commutation and tacho monitoring	V1	LED display
module fault*	V2	
module overload I^2t	V3	
motor temperature	V4	
option: stall monitoring or speed monitoring	V5	

* only on SM 35/70 and SM 50/100

4.3 General Data

4.3.1 Cooling

All units have forced ventilation.

ventilators	2 axial blowers, mounted at the top of the module
connection voltage	1x230V (220V)/50-60Hz or 2x115V/50-60Hz
current consumption	approx. 0.1 A for 230V approx. 0.15 A for 115V

4.3.2 Other Data

Ambient conditions:

max. ambient temperature	for operation -25°C to +55°C for transport and storage -25°C to +85°C
max. altitude for operation	1000 m above sea level
protection standard	IP 00 to DIN 40050 and IEC 144
admissible humidity	class F to DIN 40040

4.4 Information for Applications

4.4.1 Recommended Module-Motor Combinations

These are the recommended module-motor combinations (Servodyn inverter system with Bosch Servodyn motor):

module type	motor type	motor torque [Nm]	speed [rpm]
SM 6/10	SD-□3	3,1	3000
SM 10/18	SD-□3	5,0/6,8	3000
	SD-□4	7,0	3000
	SD-□4	14,0	2000
SM 20/30	SD-□3	6,8	3000
	SD-□4	7,0/14,0	3000
	SD-□4	14,0	2000
	SD-□5	25,0	1500
	SD-□5	25,0	2000
	SD-□5	38,0	1200
SM 35/70	SD-□5	38,0	2000
	SD-□6	48,0	2000
	SD-□6	96,0	1000
SM 50/100	SD-□6	48,0	2000
	SD-□6	72,0	2000
	SD-□6	96,0	1000
	SD-□6	96,0	1500

4.2.2 Option DC Link

The use of additional capacitors to support the DC link is necessary under the following conditions:

condition	required capacitor module
combination of SM-module with an ASM-module (module for standard asynchronous motors) connected to one supply module	KM 1100; 1100 µF / 1050 V
more than 3 SM-modules of the size SM 6/10 or SM 10/18 connected to one supply module	KM 1100; 1100 µF / 1050 V
more than 2 SM-modules of the size SM 20/30 connected to one supply module	KM 1100; 1100 µF / 1050 V
- for all ASM 100 - for more than one SM 35/70 - as a rule for SM 50/100	KM 2200; 2200 µF / 1050 V

KM 1100: 3xELKO3300µF; 350V Bosch; 3xwire-wound resistor 20kOhm/8W
KM 2200: 6xELKO3300µF; 350V Bosch; 6xwire-wound resistor 20kOhm/8W

4.2.3 Option DC Link Rapid Discharge

Additional discharge resistors can be built into the circuit via contactors to provide the possibility of a rapid discharge of the capacitor modules when the drive is switched off. This will reduce the time constant from > 1min to < 10 ms for the KM 1100.
For circuit diagram, dimensions of resistors see section 6.2.3 DC link wiring.

4.4.4 Option External Ballast Resistor

For applications with high inertia and/or high speeds there is the danger that the energy, which is fed back into the DC link during braking, can no longer be absorbed by the capacitor or the built-in ballast resistor.

By using a supply module with external ballast resistor the maximum admissible energy can be increased considerably. The external ballast resistor is connected at X45 term. 1 and 2. Connection see section 6.1.6, dimensions see 4.5.1.

Hint for application: possible braking energy and braking cycle.

The energy of rotation which is stored in the moving masses is calculated as follows:

$W_{rot} = \frac{1}{2} J\omega^2$ [Ws]

J = total inertia [kgm²]
ω = angular velocity [rad/s]
W_{rot} = energy of rotation [Ws]

The following limit values must be observed:

VM 60-150: internal ballast resistance

- with SM module $W_{rot\ max}$ = 7000 Ws
- with ASM module $W_{rot\ max}$ = 8000 Ws

VM 60-150-EB: external ballast resistance

- with SM module $W_{rot\ max}$ = 28,000 Ws
- with ASM module $W_{rot\ max}$ = 34,000 Ws

The energy can be taken away with different cycle times (braking cycle) depending on the ballast resistor (internal or external).

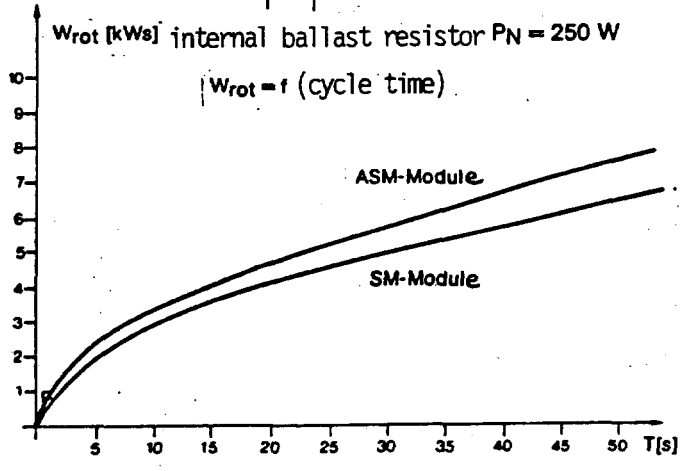


fig. 4/1

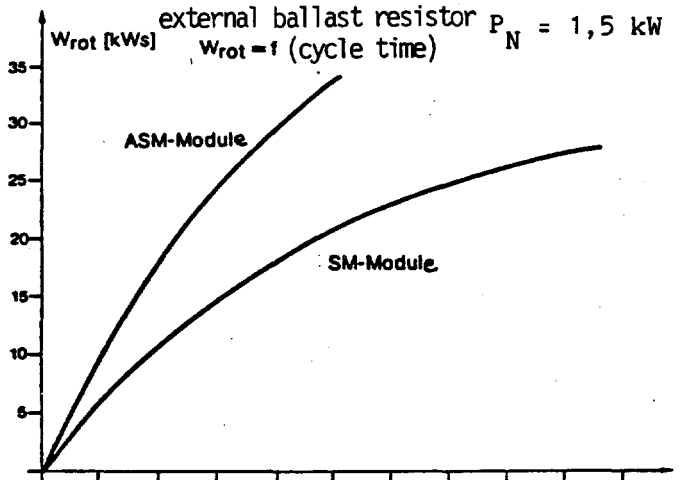


fig. 4/2

4.4.5 Option Axis Switching

The "Axis Switching" module makes it possible to operate up to three Servodyn motors with just one servo module. When using this option it must be ensured that the motors which are to be controlled by the axis switching module must be compatible with the selected servo module.

The axis switching ensures that no more than one axis is selected at any one time, and it switches the following current circuits:

- tacho signal
- speed regulator outputs
- commutation
- motor temperature sensor and
- regulator enable

(see connections P.-No. 3616)

4.4.6 Start-up Switching Option Module

To minimize installation time a start-up switching module can be used instead of the start-up resistors R01-R03 (see dimension drawings 4.5.1 and electrical connections - supply module 6.1.2).

4.4.7 Option Tacho and Stall Monitoring

The use of this option in conjunction with the diagnostics module allows the monitoring and analysis of the following operating conditions:

- drive stalled	diagnostic V1 (X7.2)
- tacho voltage failure	ready 2 switches unit off
- speed monitoring $n>n_x$	diagnostic V5 (X7.6)
- speed monitoring $n<n_x$	

4.4.8 Option Ramp Generator

This additional module makes it possible to limit the length of the acceleration and deceleration ramp of the command, thereby defining the acceleration and braking time of the motor (t_{min} = 5 ms, T_{max} = 10 s).
The two ramps can be adjusted separately (adjustment range see connections, section 6.2.10 and dimension drawing in section 4.5.1).
The module is designed to clip onto a top hat rail and it can be supplied with a $\pm$15 V auxiliary voltage from the VM supply module.

4.5 Dimension Drawings

4.5.1 Supply Module (VM)
Servo Module (SM)
Capacitor Module (KM)

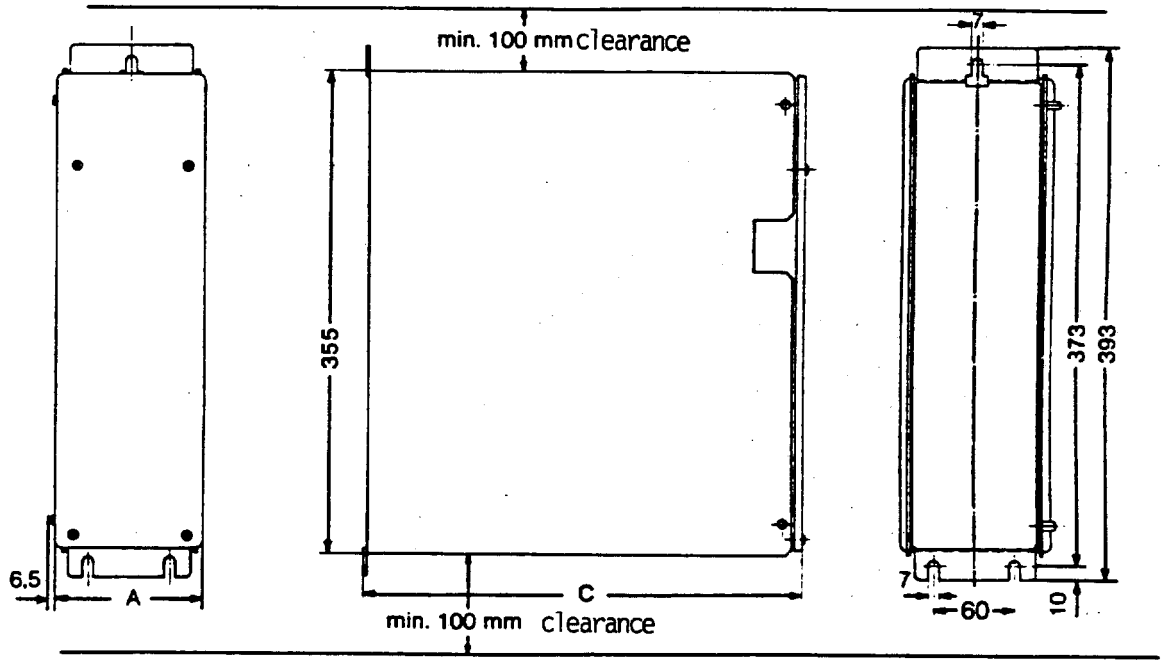


fig. 4/3

	A	C
VM 60 SM 6/10 SM 10/18 SM 20/30	109	325
SM 35/70 SM 50/100	134	325
KM 1100	109	190
KM 2200	109	325

DC Link Capacitor

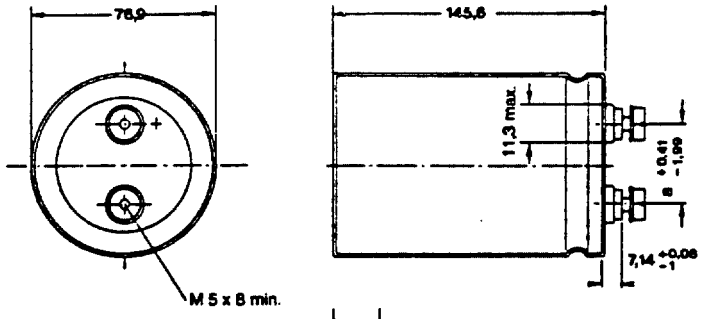
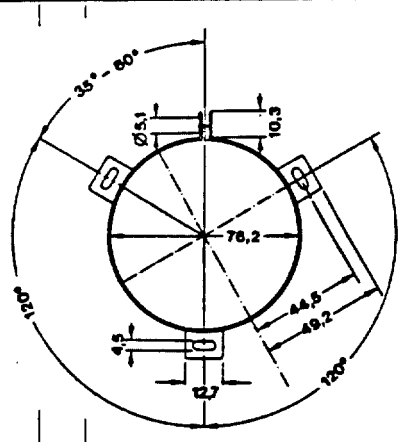
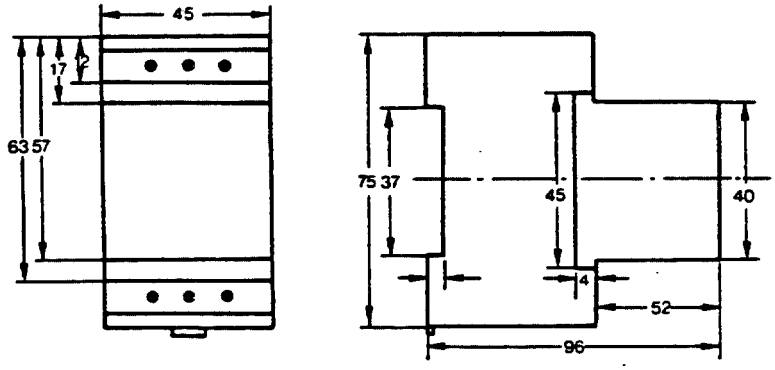


fig. 4/4

mounting bracket



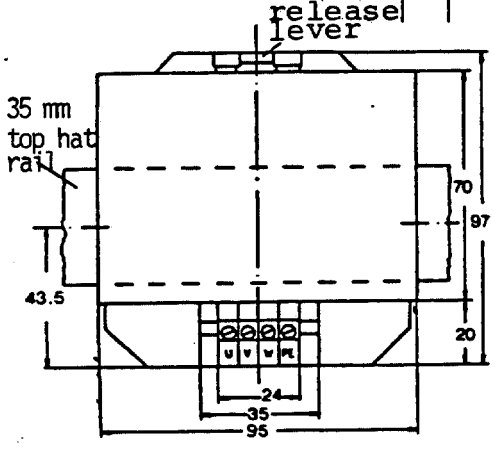
Start-up Switching Power Supply

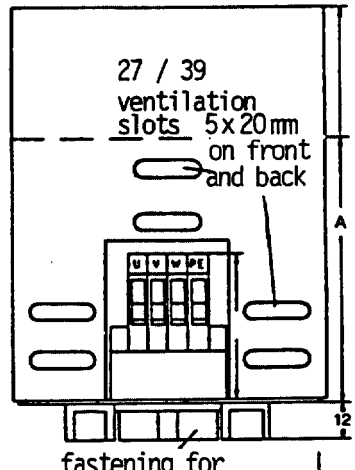


clip-on fastening for
35 mm top hat rail to
DIN EN 50022

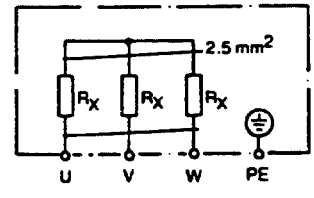
fig. 4/5

Short-circuit Braking Module





fastening for
top hat rail



dimension A see
selection table section 6.2.2

fig. 4/6

part no.	105-913544	105-913545	105-913546	105-913547
R_X (±10%)	8R2/57 Ws	3R3/293 WS	5R6/261 Ws	3R3/785 Ws
max. conn. size	4 mm²			
test voltage	2500 V AC			
max. ambient temperature	55°C			
dimension A	80 mm	80 mm	80 mm	120 mm
tolerance	±1 mm (alle Maße)			
mounting	clip-on fastening to 35 mm top hat DIN rail			
protection standard	IP 20			

External Ballast Resistor

resistance: 20 Ω
nom. power: 1.5 kW/55°C amb. temp.
surge load: 40 A for 200

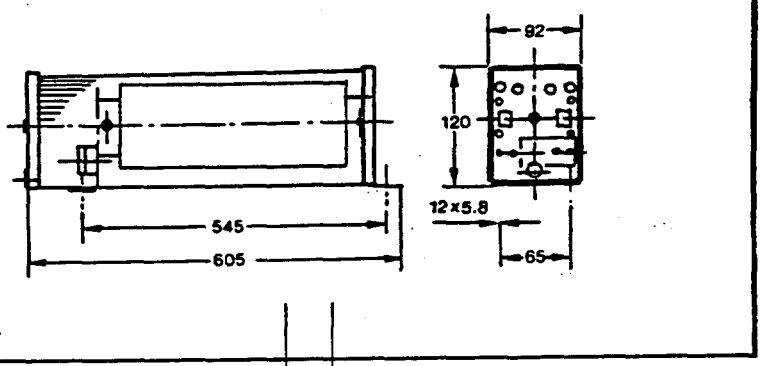
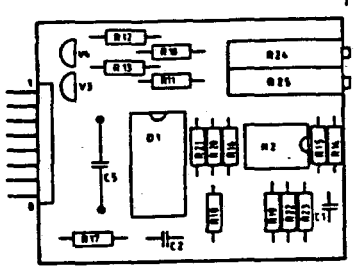
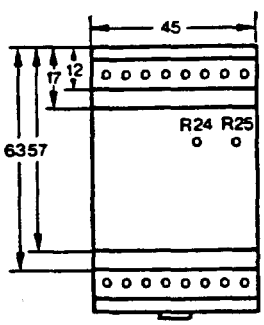


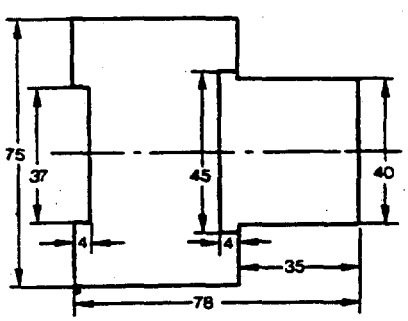
fig. 4/7

Ramp Generator

Components:







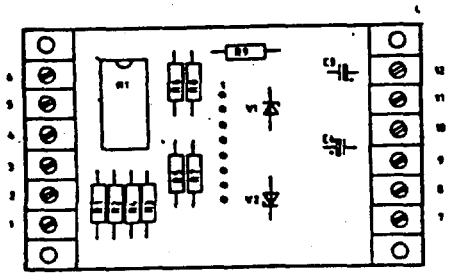


fig. 4/8

clip-on fastening for 35 mm top hat rail to DIN EN 50022

Adjustment of time constant T:
R24 = accleration
R25 = braking
for R24/R25: left stop T_{min}
right stop T_{max}

5. Mounting Instructions

5.1 Configuration and Mounting Position

The modules must be mounted vertically with the ventilators at the top.

The modules are mounted with three screws or bolts each (recommended size: M6) onto an even surface. The distances between the mounting holes are to be as follows:

(example for 1 supply module and 1 servo module)

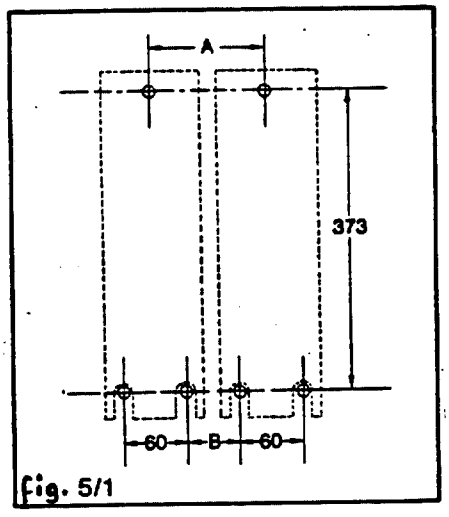


fig. 5/1

Sizes:

type of unit	size
VM 60 SM 6/10 SM 10/18 SM 20/30 KM 1100 KM 2200	I
SM 35/70 SM 50/100	II

possible combinations of sizes	dimension A [mm]	dimensio B [mm]
I - I	111	51
I - II	123.5	63.5
II - II	136	76

As a rule the following applies:

Within each inverter group (1 supply module and up to 5 servo modules) the supply module must be mounted furthest to the right (see also fig. 5/2).

When using screws to mount the modules they can be screwed in first. The modules are then simply slotted into the screws, which are then tightened.

The modules are joined with the M4 threaded spacer bolts, which are supplied with the accessories. They are placed into holes provided into the front part of the side panels and fastened.

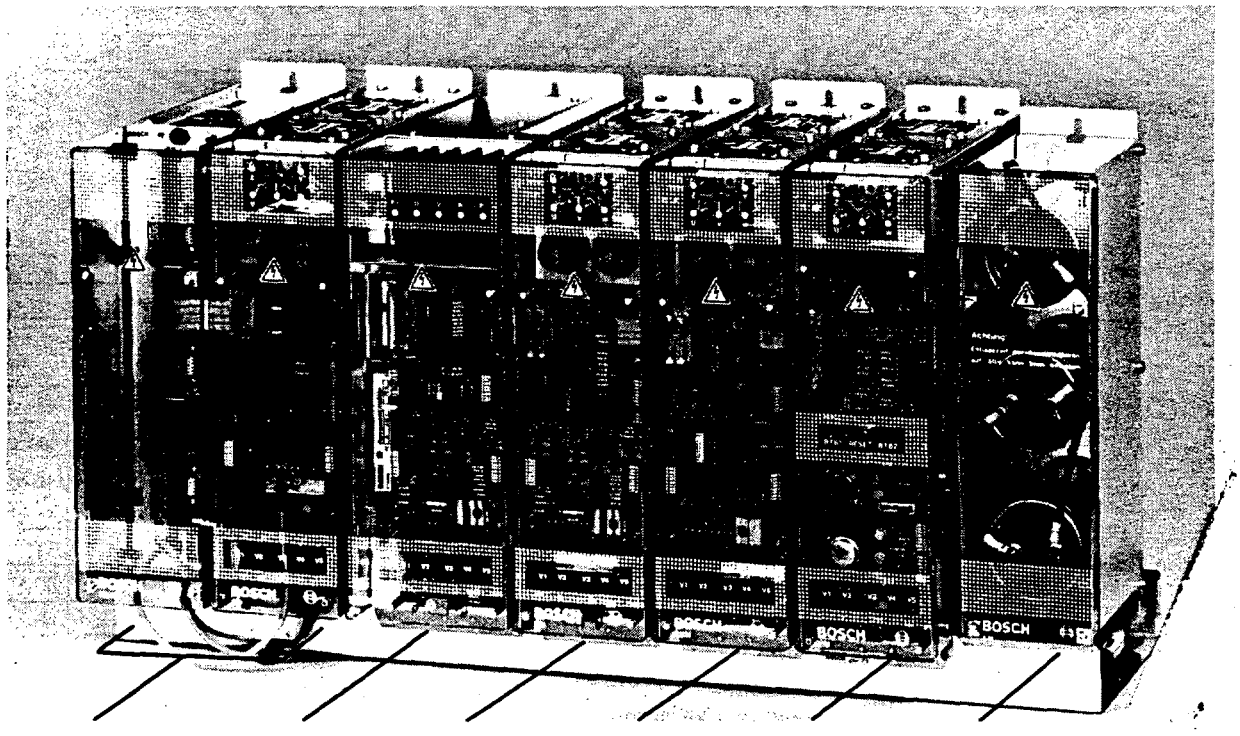
5.2 Cabinet

The modules must be built into switchgear cabinets, which conform to protection standard IP 54 or IP 44 (with dust filters in front of the air inlet and outlet).

The flow of cooling air through the modules, which goes upwards, must not be impeded by other components or parts of the cabinet. In addition there must be a clearance of at least 100 mm above and below the modules.

No clearance is required at the side.

The air temperature within the cabinets must not exceed +55°C.



Combination	Servo Module	Servo Module	ASM Module	Supply Module	Capacitor Module
Axis Switching with Servo Module	SM 35/70 SM 50/100	SM 6/10 SM 10/18 SM 20/30	ASM 20 ASM 40 ASM 100*	VM 60	KM 1100

* size = SM 50/100

fig. 5/2

5.3 Connection Cables

Connection cables, which go to terminal board X3 and the PE connection, must be combined in a flexible conduit, which must be routed along the right of the ventilators at the top of the module with the 3 plastic cable clamps (supplied with the accessories).

The ventilator plate has three threaded inserts (M4) to attach the cable clamps.

6. Electrical Connection

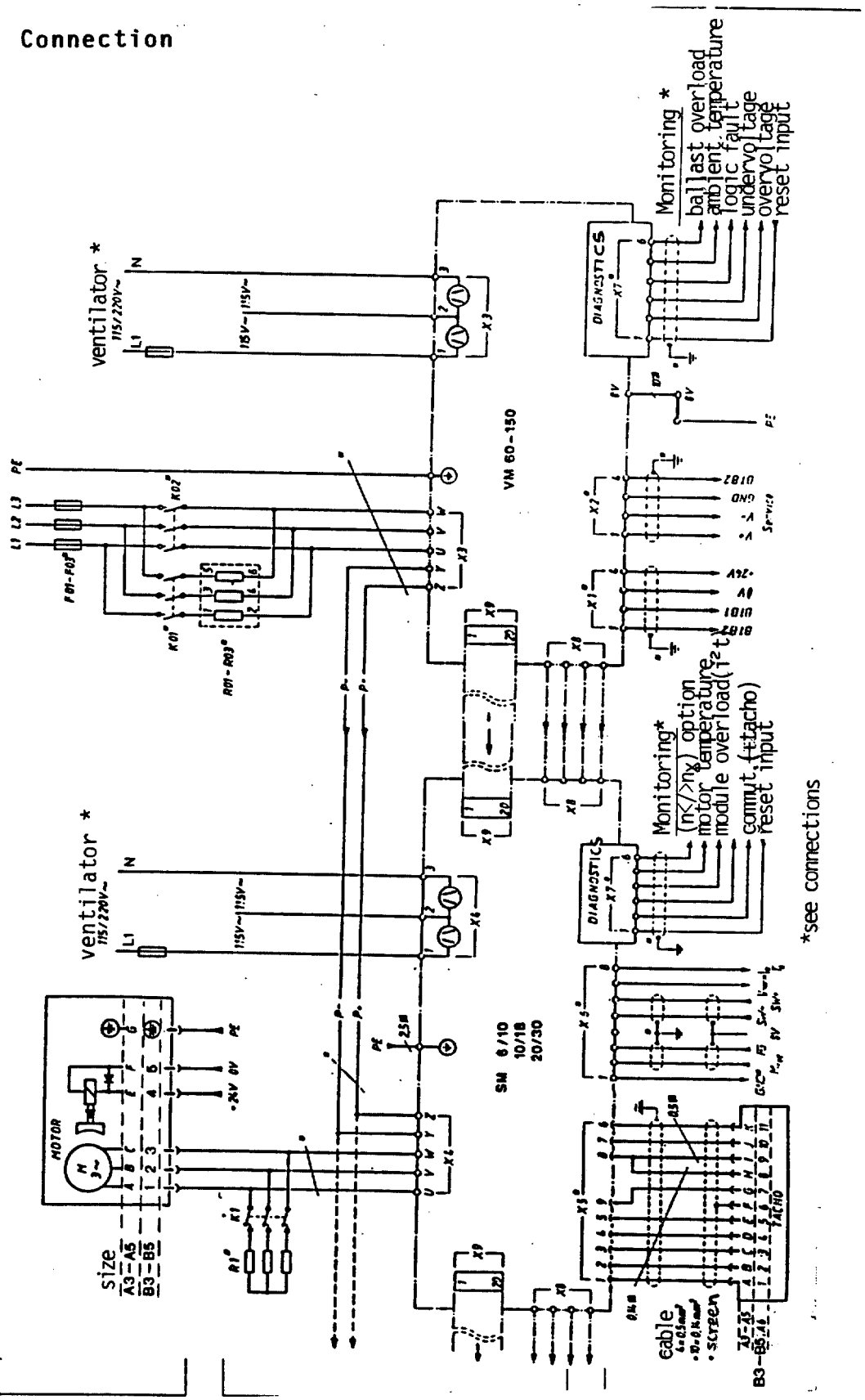


fig. 6/1

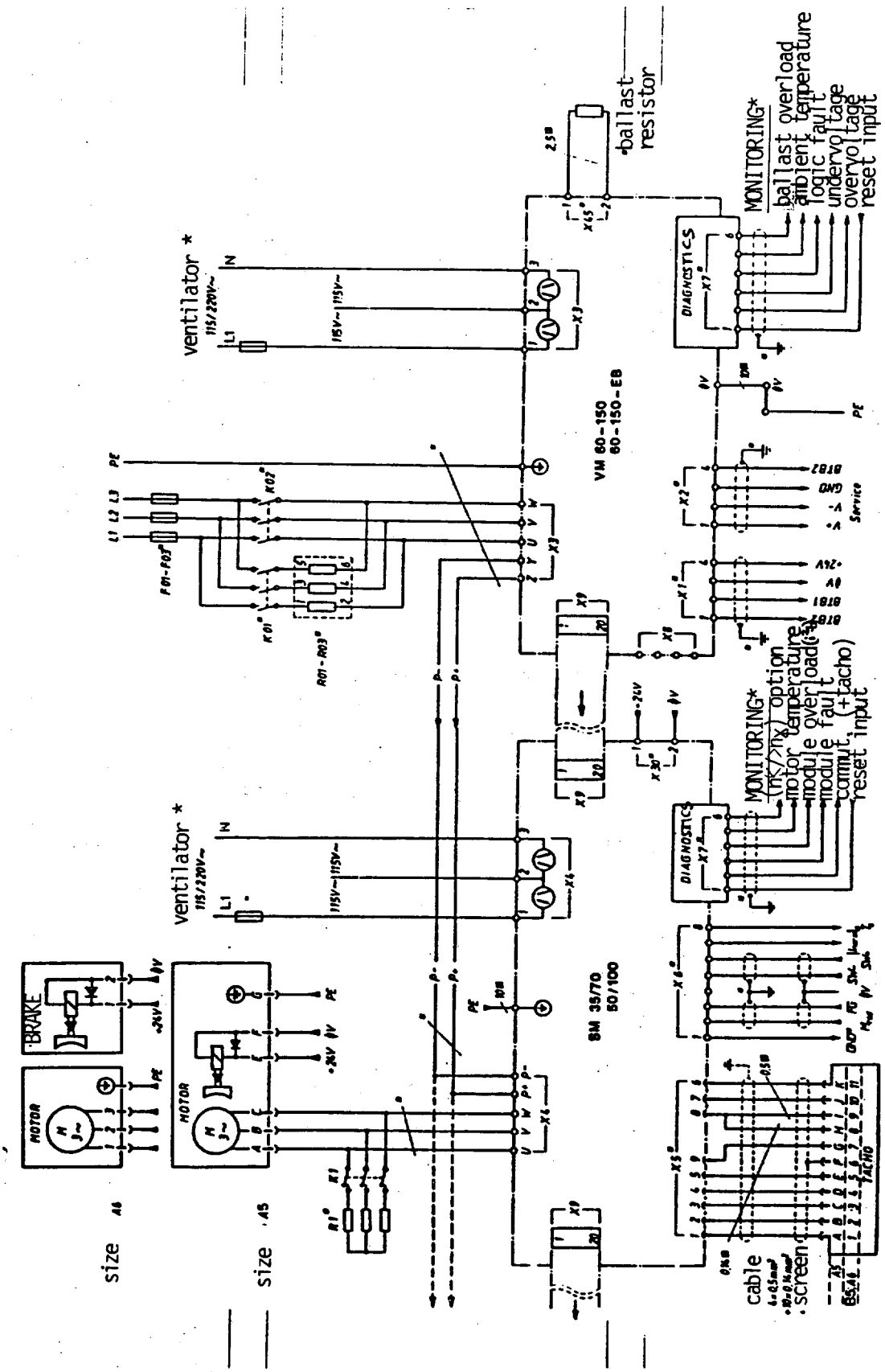

ventilator *
ballast resistor
MONITORING*
ballast overload
ambient temperature
logic fault
undervoltage
overvoltage
reset input
VM 60-150
60-150-EB
DIAGNOSTICS
ventilator *
MONITORING*
(inv./rly.) option
motor temperature
module overload(s)
module fault
commut. (+tacho)
reset input
SM 35/70
80/100
BRAKE
MOTOR
MOTOR
size A6
size A5
cable
screen

fig. 6/2

6.1 Supply Module

6.1.1 Ground

The supply module has one connection each for ground and "0V".

Ground:
M5 threaded stud, located at the top right front (next to X3).
Connection size to PE busbar: 6 mm².

0 V connection:
6.3 mm Faston connector, located bottom right front (next to X2).
Serves as reference potential for the electronics.
Cable core size: 4 mm², blue.

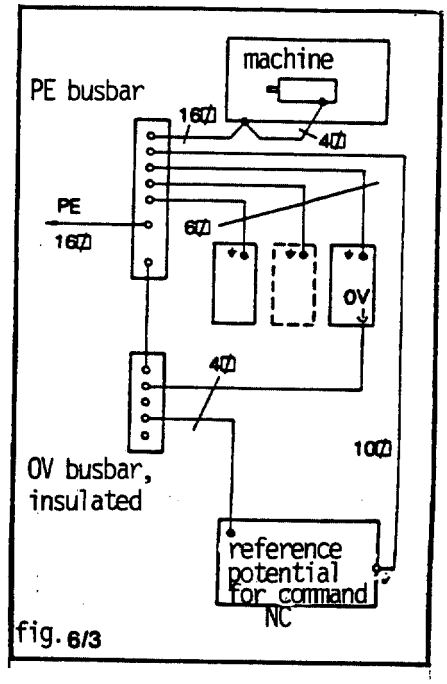


fig. 6/3

6.1.2 Mains Connection

The mains connection is made according to the circuit diagram below (fir. 6/4). For mains voltages of 3 x 380 V or 3 x 415 V (±10%) no transformer is required.

If the mains voltage is lower than 380 V or higher than 415 V an autotransformer (YO circuit) is required for voltage adaptation.

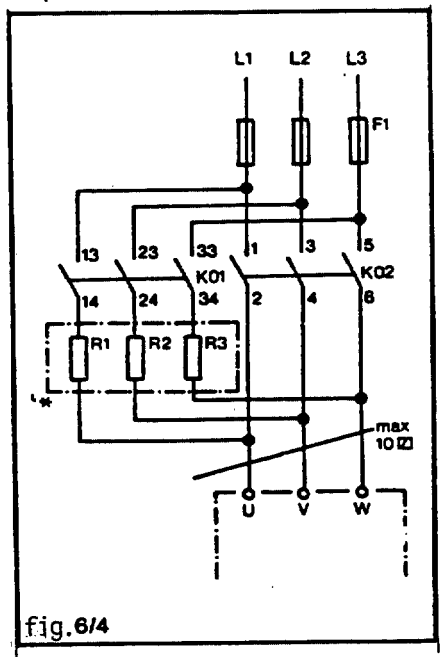


fig. 6/4

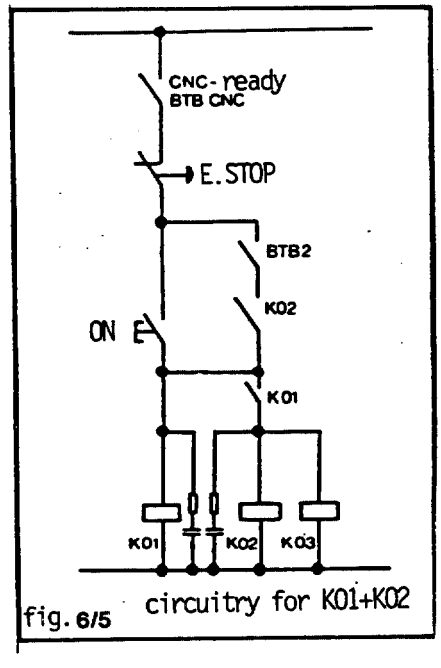


fig. 6/5 circuitry for K01+K02

Note:
Make sure to use the provided nuts when connecting the cable shoes at the power connections!
Do not undo the nuts on the terminal board!

* see note on "Recommended Components"

Recommended Components

F1 (mains fuse)
characteristic Silized 50 A

K 01 (loading contactor)
auxiliary contactor, max. load 16 A, for instance Siemens 3TH8

K 02 (main contactor)
power contactor, max. load according to the fitted fuse F1 for instance Siemens 3TB4

K 03 (additional contactor)
(short-circuit braking)
auxiliary contactor in parallel with K 02, for instance Siemens 3TH8.

R1-R3 (load resistors)
2 x 5.1 Ohm 8 W (Bosch no.: 121-902776, or start-up switching module (Bosch No.: 105-913274), see section 4.4.6

Note: When using a KM 2200 in the DC link, the load resistors R1-R3 with 2.5 Ohm/16 W each can be retained, but it must be ensured that there is a switching delay of 50 msec for contactor K02 against K01. Alternatively two start-up switching modules can be fitted in parallel, without additional time delay between the contactors.

6.1.3 Ventilator Connection

The module ventilator can be connected either to 230V/220V or to 115 VAC. For connection values see section 2.3.1.

A 3-pole terminal block is provided for this purpose at the front of the module (max. connection size: 1.5 mm²).

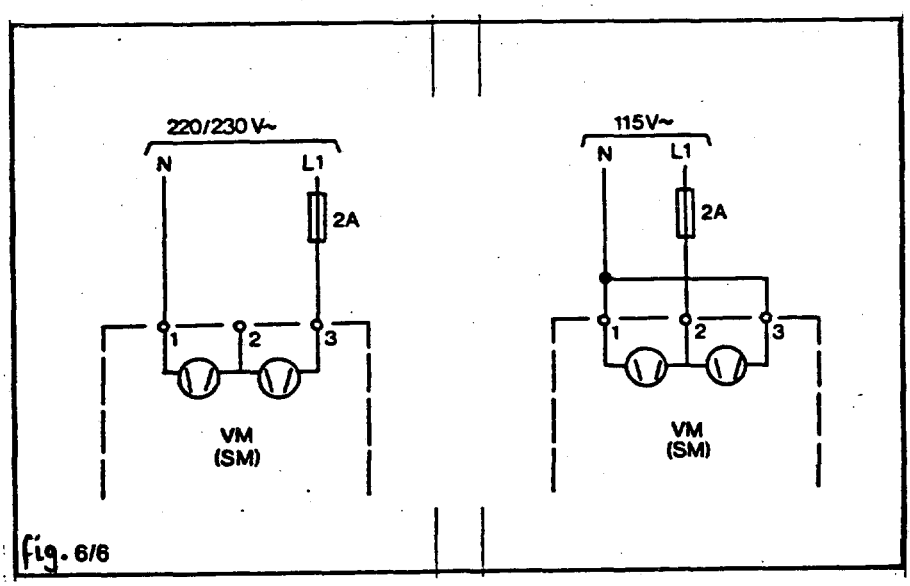


fig. 6/6

6.1.4 Terminal Strip X1-VM

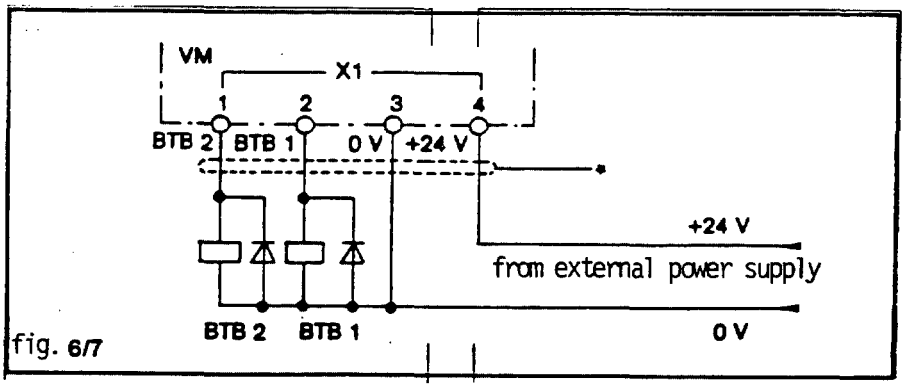


fig. 6/7

Ready 2 (BTB 2): **X1/1**
Output H = +24V, L = 0V, I_{max} = 100 mA (display via green LED). The signal goes to +24V immediately after switching on the main voltage if the following conditions are fulfilled:

- no overvoltage
- no undervoltage
- no logic fault
- no overcurrent.

If one of these conditions fails the signal immediately goes to 0V (L) level.

The Ready 2 (BTB 2) signal must be incorporated into the interlock circuit of contactors K01 and K02 (see fig. 6/4).

Ready 1 (BTB1): **X1/2**
H = +24V, L = 0V; I_{max} = 100 mA (display via green LED). The signal goes high immediately after switching on the supply voltage, provided that the temperature monitoring has not been triggered. If the ambient temperature rises above 56°C Ready 1 (BTB 1) immediately goes low. Approx. 1 minute later the internal allow of all connected modules is also switched of

It must be ensured that all drives come to a stop within this time since they go out of control afterwards!

External supply +24V: **X1/4** **VM 60**
0V: **X1/3**

in addition for SM 35/50, SM 50/100

+24V: **X30/1**
0V: **X30/2**

A supply voltage of +24V DC (±15%) must be provided for the start-up of the switching power supply and as supply for the diagnostics modules (option). It must be ensured that the voltage never (not even momentarily!) exceeds the level of +40V. The rise time must not exceed 100 ms.

This condition is fulfilled if either a stabilised 24 V power supply or a B6 rectifier with a smoothing capacitor of at least 4700 µF and a supply voltage of 3 x 10/18 V is used.

	VM	SM					ASM		
	60	6/10	10/18	20/30	35/70	50/100	20	40	100
current consumption	0,5	0,2	0,2	0,2	0,85	1,0	0,2	0,2	1,3

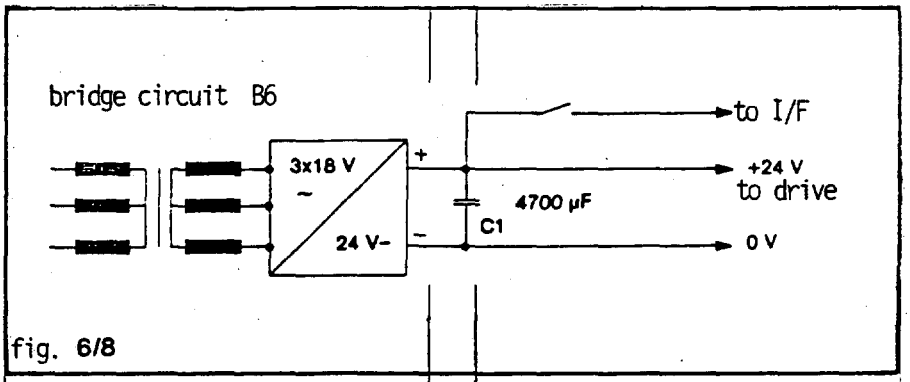


fig. 6/8

6.1.5 Terminal Strip X2-VM

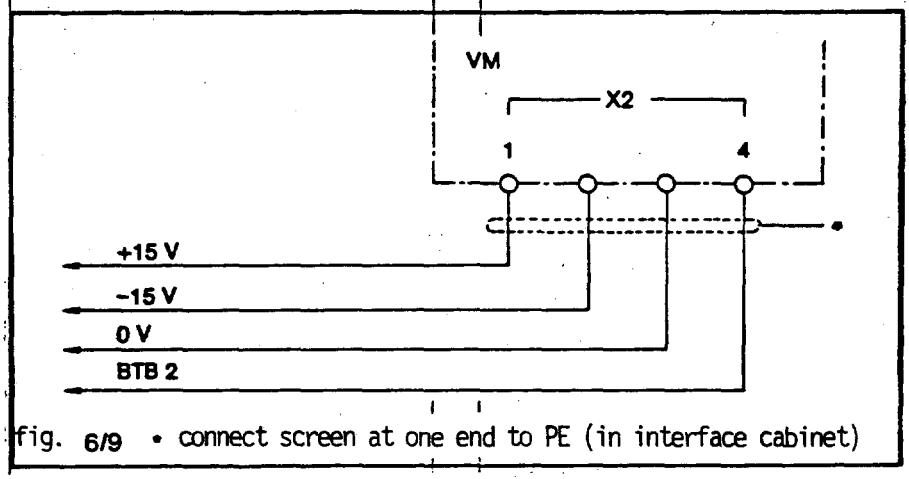


fig. 6/9 • connect screen at one end to PE (in interface cabinet)

Auxiliary voltages **V+:** **X2/1 (+15V)**
V-: **X2/2 (-15V)**
0V: **X2/3 (0V)**

Output ±15V (stable), max. 30 mA, short-circuit proof.
For command generation, service purposes etc.

Ready 2 (BTB 2): **X2/4**
For service purposes (in parallel with X1/1)

6.1.6. Option "External Ballast Resistor" Terminal Strip X45-VM

Connection for the external ballast resistor on X45 term. 1 and 2. Only possible on VM 60-150-EB. Terminal strip on the right side panel of the supply module.
Connection size 2.5 mm², max. cable length 10 m.

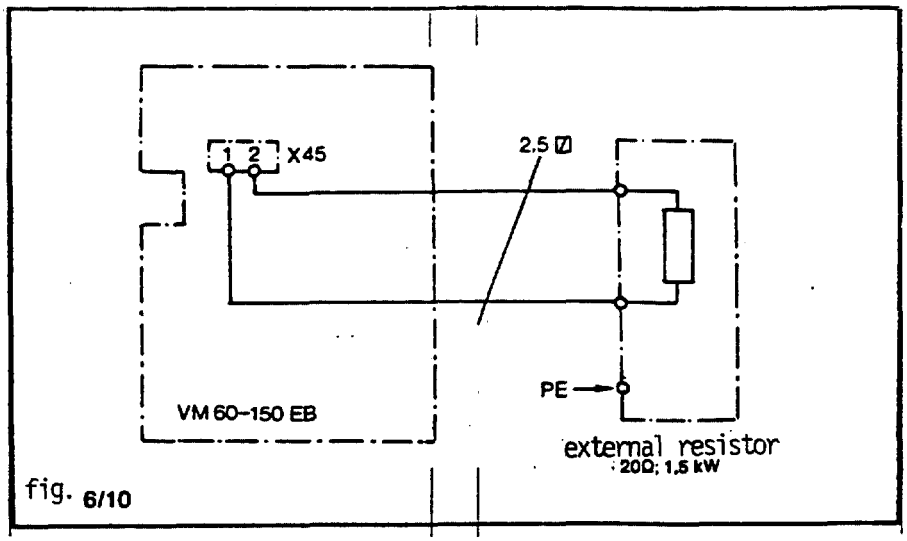


fig. 6/10

6.1.7 Option "Diagnostic Module" Terminal Strip X7-VM

The "Diagnostics" board is plugged into connector X10 at the underneath of the regulator board and fastened with M3 nuts at the spacer bolts.
Signal level: H = +24V, L = 0V, 20 mA per output or 1 x 100 mA on one output.

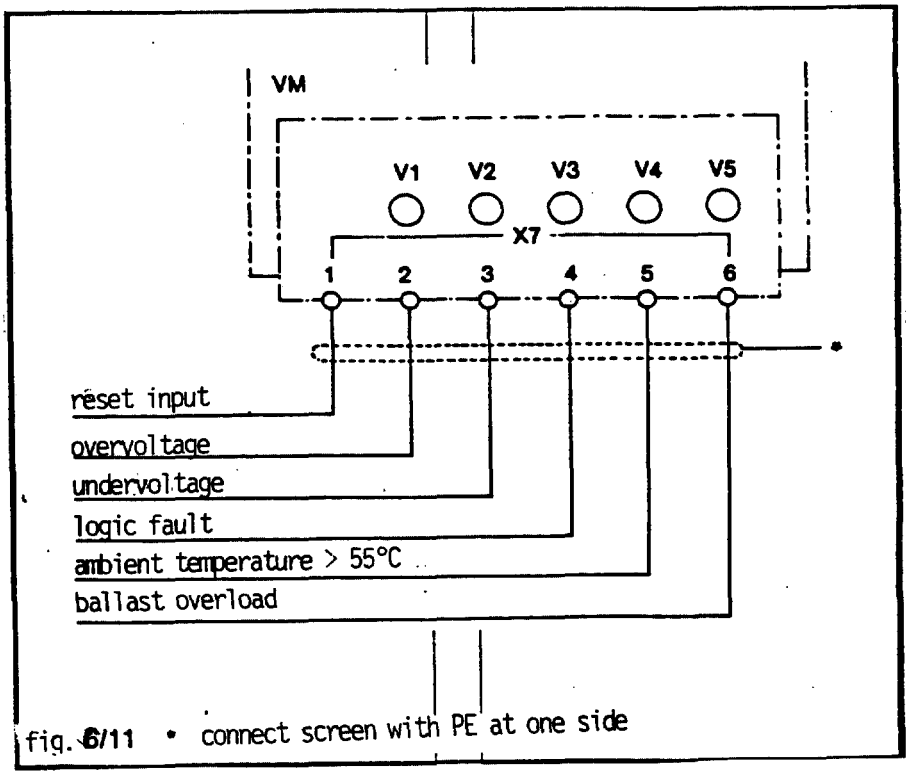


fig. 6/11 * connect screen with PE at one side

Reset Input **X7/1**
The fault signals on terminals 2, 3 and 4 cause the signal "Ready 2" (BTB 2) to be switched off.They remain stored even when the unit is switched off, for as long as the external +24V is present on X1/4. The stores can be reset via the reset input (H = +24V) or via the "Reset" button on the supply module. The relevant LEDs on the diagnostic module will then go out.

Overvoltage: **X7/2**
OV level when the DC link voltage rises above 800 V (for function see Ready 2). The red LED V1 is on.

Undervoltage: **X7/3**
OV level when the DC link voltage drops below 360 V (for function see Ready 2). The red LED V2 is on.

Logic fault: **X7/4**
OV level when the cycle frequency or the internal +15V are not in order (for function see Ready 2). The red LED V3 is on.

Ambient temperature **X7/5**
OV level when the ambient temperature $\geq$56°C (for function see Ready 1). The red LED V4 is on.

Ballast circuit overload: **X7/6**
OV level when the ballast circuit is overloaded. When overload is recognized this causes the ballast switch to be inhibited. Additional feedback of energy can cause the unit to be switched off by the overvoltage monitoring (see overvoltage X7.2). The red LED V5 is on (not stored).

6.2 Servo Module

6.2.1 Ground

Each servo module (SM) has a connection for ground (M5 threaded stud, at the top right front). It is to be connected to the PE busbar with the following cable sizes: 2.5 Ø for SM 6/10, 10/18, 20/30; and 6 Ø for SM 35/70, 50/100 (see also section 6.1.1, fig. 6/3).

6.2.2 Motor Connection

The brushless servo motors are connected at terminals U, V and W of the associated servo modules. At the motors themselves the connection is made by plug-in connectors.

motor size: SD-□3;□4;□5
servo module: SM 6/10;
10/18;20/30

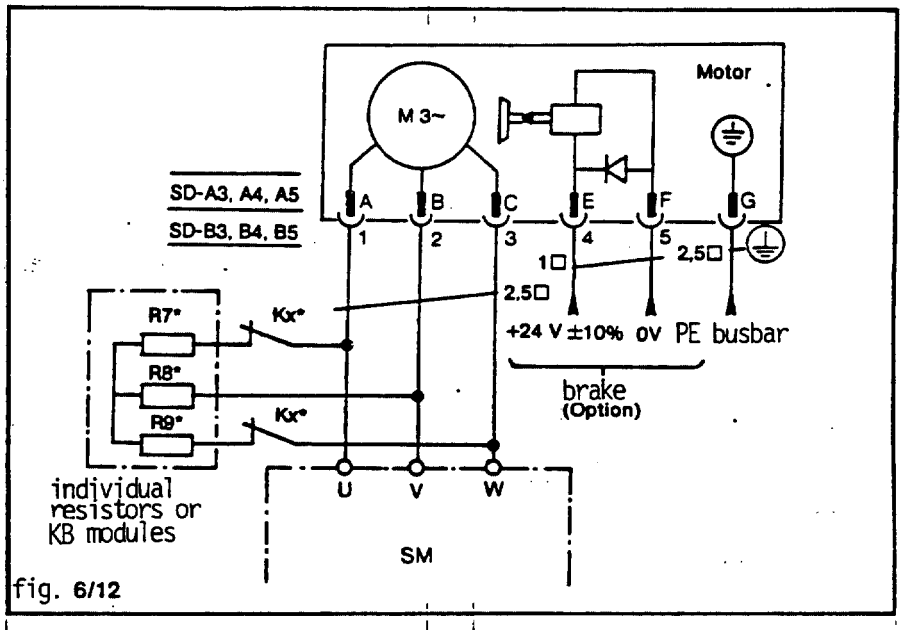


fig. 6/12

motor size: SD-□6
servo module: SM 35/70;50/100

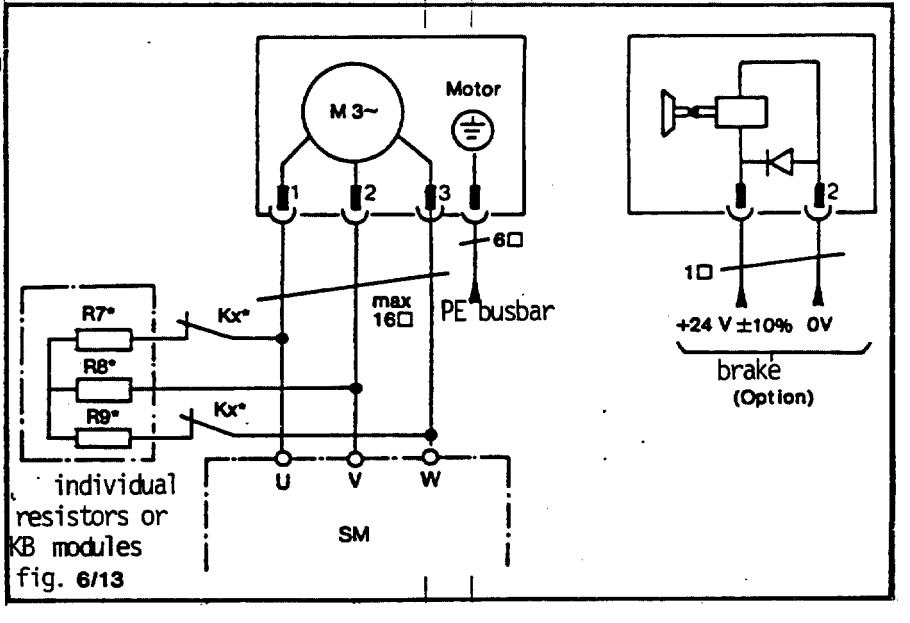


fig. 6/13

motor type	connection size
SD-□3	1,5Ø
SD-□4	1,5Ø
SD-□5.250.015	1,5Ø
SD-□5.250.020	2,5Ø
SD-□5.380.012	2,5Ø
SD-□5.380.020	4Ø
SD-□6.480.020	6Ø
SD-□6.720.020	16Ø
SD-□6.960.010	10Ø
SD-□6.960.015	16Ø

* short-circuit braking for E.STOP

Kx:
Contact or auxiliary contact of contactors K01 or K02 (see 6.1.2 mains connection) or of an auxiliary contactor, which is switched in parallel with K02 (K03).
Type of contact: normally closed, nominal current 16 A, for instance Siemens, series 3TH8.

R7-R9:
Individual braking resistors or braking resistor module.

Selection table for R7-R9; individual resistors (precondition: total inertia = 2 x motor inertia)

type of motor	resistance [Ohm]	min. energy [Ws] *KB	dimensions [mm]	Bosch part number
SD-□3.031.030	8,2	57	ø 16 x 50	120-913119
SD-□3.050.030 SD-□3.068.030	3,3	293	ø 16 x 50	120-913120
SD-□4.070.030	5,6	261	ø 16 x 50	120-913121
SD-□4.140.020 SD-□4.140.030 SD-□5.250.015	3,3	293	ø 16 x 50	120-913120
SD-□5.250.020 SD-□5.380.012 SD-□5.380.020	3,3	785	ø 16 x 100	120-913122
SD-□6.480.020 SD-□6.720.020 SD-□6.960.010 SD-□6.960.015	1,0	4085	ø 24 x 100	120-913455

* KB = short-time operation - must be specified when ordering the resistor!

Selection table for braking resistor module

part no.	105-913544	105-913545	105-913546	105-913547
R_x (±10%)	8R2/57 Ws	3R3/293 WS	5R6/261 Ws	3R3/785 Ws
max. connection size	4 mm²			
test voltage	2500 V AC			
max. ambient temperature	55°C			
mounting	clip-on fastening for top hat DIN rail			
protection standard	IP 20			

*for dimension drawing see 4.5.1

Disk Brake Option
The disk brake is designed as a pure holding brake; it must therefore be released for as long as the axis allow is present on the relevant servo module.

The brake is applied when there is no voltage present at its connections.

The brake is released for as long as a voltage of +24 V DC ±10% is present at its connections.

For the current consumption of the brake see the section Technical Data Brake.

6.2.3 DC Link Wiring

The DC link voltage for the supply of the servo modules is available at connections Z (P+) and Y (P-) of the supply module.

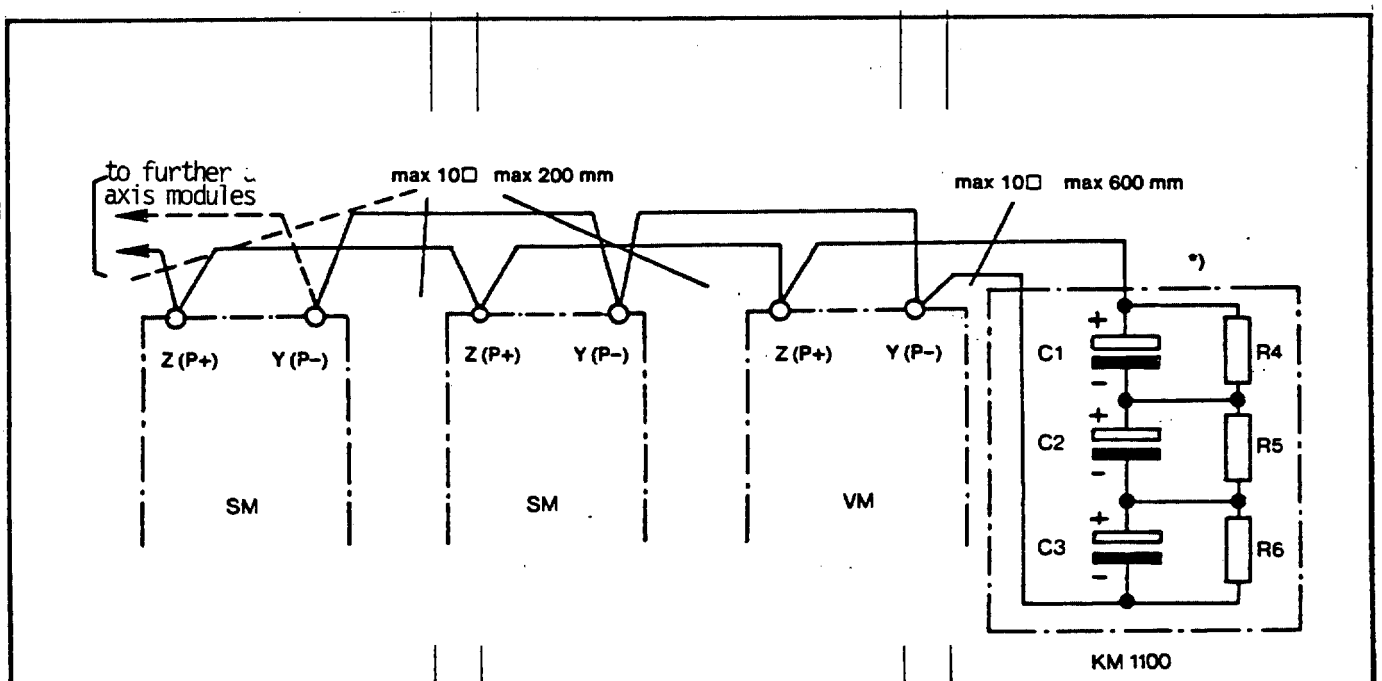


fig. **6/14** DC link wiring with 2 servo modules

* The capacitor circuit KM 1100 shown above is only required if axis module combinations as listed in 4.4.2 are used.

Capacitor Circuit - type KM 1100

Components:

C1 - C3	one Elko 3300 µF/350V each Bosch no.: 067-910660 (1100 µF/1050V in total)
R4 - R6	20 kOhm/8W wire-wound resistor each Bosch no.: 121-912655
or	
capacitor module KM 1100	Bosch no.: 425-044929 (incorporates C1-C3 and R4-R6)

Capacitor Circuit - type KM 2200 (no picture)

Components:

C1 - C6	one Elko 3300µF/350V each Bosch no.: 067-910660 (2200µF/1050V in total)
R4 - R9	one wire-wound resistor 20 kOhm/8W each Bosch no.: 121-912655
	or
capacitor module KM 2200	Bosch no.: 425-047521

Hint regarding wiring:
In order to avoid unwanted oscillation the connection cables between supply module and servo module/capacitors must be kept as short as possible. The cable lengths specified in fig. 6/14 must not be exceeded.

Resistor circuit for fast DC link voltage discharge

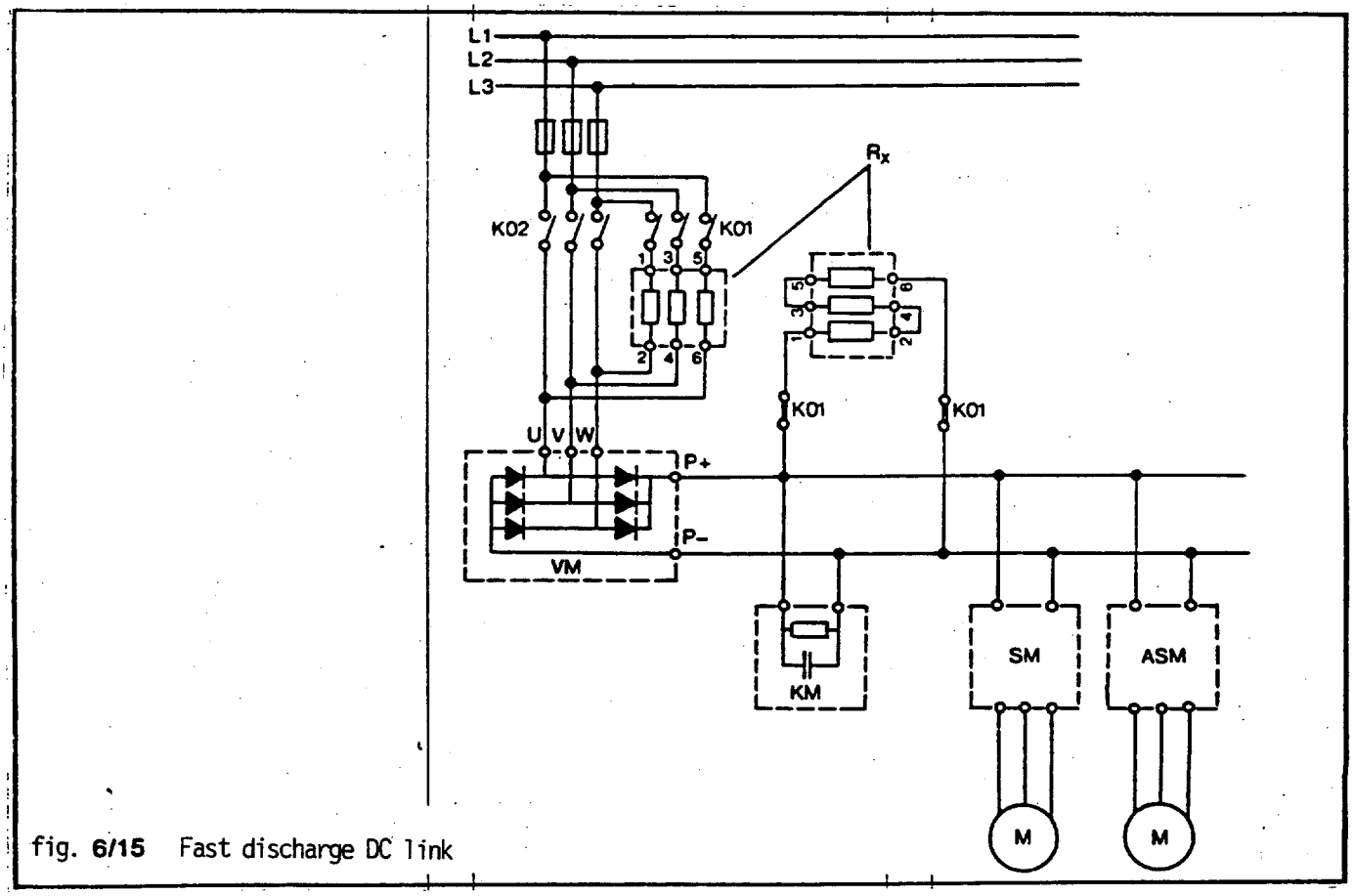


fig. **6/15** Fast discharge DC link

Rx = 3 x 2.5Ω,16W or start-up switching module (Bosch no. 105-913274 (2.5.1)). Contactor contacts K01 in series, since DC link voltage 750 V.

6.2.4 Ventilator Connection See section 6.1.3 (connection diagram as for supply module).

6.2.5 Connection Plug X5: Control Signals from the Motor

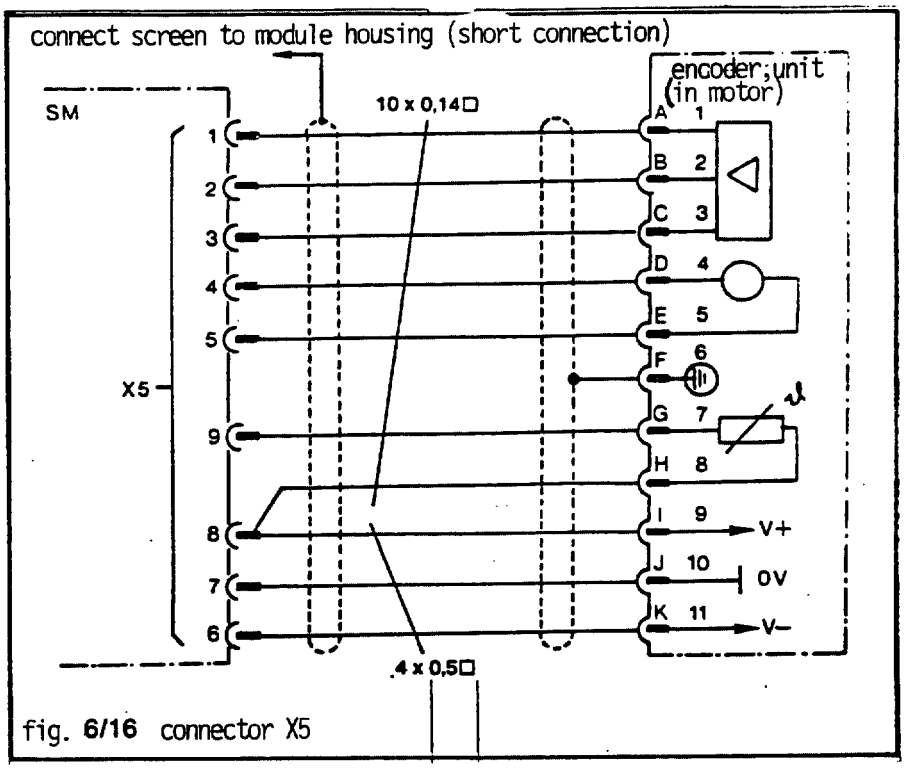


fig. 6/16 connector X5

signal	connections Canon	Souriau	colour	function in encoder unit
A	A	1	grey white	rotor position encoder for
B	B	2	violet	commutation control
C	C	3	green	
tacho	D	4	yellow	brushless DC tacho
N	E	5	brown white	V = 2.7V / 2000rpm ±5%
screen	F	6	-	screen connected to PE in the motor
ϑ	G	7	grey	thermistor for motor
ϑ	H	8	white	temperature monitoring
V+	I	9	red	voltage supply +15V DC
GND	J	10	black	for tacho and encoder
V-	K	11	blue	

Connection cable X5-encoder: special cable 10x0.14 Ø + 4x0.5 Ø screened. Max. cable length: 100 m.

Bosch supply the above type of cable (by the meter) under part no. 070-903499.

6.2.6 Terminal Strip X6

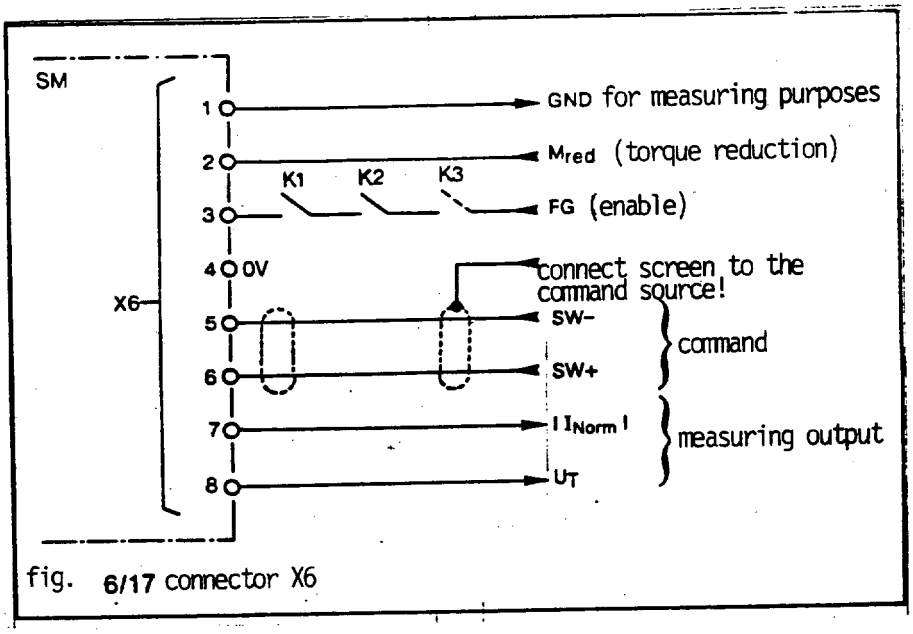


fig. 6/17 connector X6

Individual Signals

M_{red} - Torque Reduction
Input, digital, H=+24V, L=0V, or analogue 0 to 10V/2.2 kOhm.

By providing input signal M_{red} the fixed current limit of the particular module can be reduced.

When using the digital signal input with H=+24V to X6/2 and adjusting R25 (speed regulator card) the following reduction values can be achieved:

R25 [kOhm]	UN* [V]	reduction to % I_{limit}
0,3	0,6	8
0,7	0,8	9
1	1	13
1,5	1,5	19
2,7	2	25
3,7	2,5	31
4,7	3	38
6	3,5	44
7,5	4	50
9,5	4,5	56
11	5	63
14	5,5	69
17	6	75
22	6,5	81
27	7	88
37	7,5	94

*UN = voltage of current regulator input (test point on speed regulator card)

When using the analogue input by soldering in a wire link at R25 on the speed regulator and providing a variable voltage the following reduction values can be achieved:

voltage at "M_{red}" [V]	reduction to % I_{limit}
4	74
5	66
6	58
7	49
8	41
9	33
10	25
12	11 max. reduction

Enable (FG):
Digital input, H=24V, L=0V, display via green LED on speed regulator card:
- If the signal on X6.3 is high, and if Ready 1 and Ready 2 are present, the output stage and the regulators are enabled.
- In series with the enable input there must be a normally open contact of contactors K01 and K02, see section 6.1.2, and a normally open contact of each short-circuit braking contactor. This ensures that the enable is switched off during short-circuit braking.
- If the axis can be braked or clamped, the enable signal FG must be switched off while the brake or the clamping is active.

Command (SW):
Analogue input, -10V to +10V / 10 kOhm
- The command input is realised as a differential input.
- The connection for the command signal must always be 2-pole, i.e. terminals 5 and 6 must be connected.
- The range for the maximum command voltage is ±7.5V to +10V.
- If the cable is routed via intermediary terminals or plug connections the screen must be laid via a separate connector which is not earthed.
- The reference potential of the command source (for instance CNC) must have 0V level (connection to 0V busbar, see section 6.1.1).

Tacho Voltage (U_T):
Measuring output, short-circuit proof, 2.7V / 1000 rpm

Standard Current Value ($|I_{Norm}|$):
Measuring output, short-circuit proof, 0...10V;
10V ≙ unit peak current.

6.2.7 Connection Cables X8 and X9

The accessories pack of each servo module contains a 20-core ribbon cable and a 4-core cable.

The ribbon cable is used to link the X9 connectors (top left on the regulator cards) of the individual servo modules and of the supply module.

The 4-pole connectors X8 are located at the underside of the servo and supply modules (only on SM 6/10; 10/18;20/30). The 4-core cables provide the connection between them. All connectors are coded to avoid incorrect connection.

On modules SM 35/70 and SM 50/100 there are no X8 connectors.; supply via X30 instead (see 6.2.9).

6.2.8 Option "Diagnostic Module" Terminal Strip X7-SM

The"Diagnostic" board is plugged into connector X10 at the underside of the regulator baord, and fastened at the spacer bolts with M3 nuts.

Signal level: H=+24V, L=0V, max. 20 mA per output or 1 x 100 mA on one output.

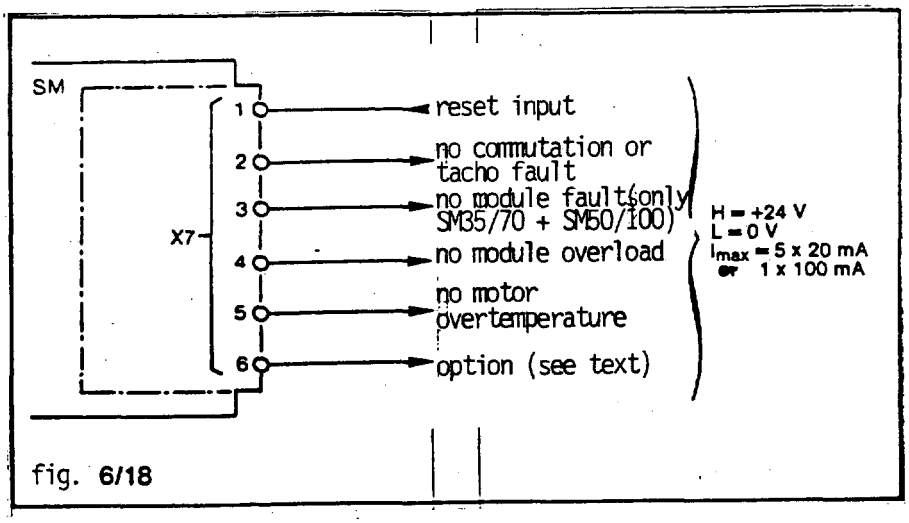


fig. 6/18

Reset Input X7/1
The fault signals on terminals 2, 3 and 4 cause the ready signal "Ready 2" (BTB2) to be switched off, and the signal on term. 5 causes "Ready 1" (BTB1) ot be switched off.

The fault signals remain stored even when the unit is switched off, as long as the external +24V supply voltage is present at X1/4 on the supply module. The stores can be reset via the reset input (+24V signal) or with the "RESET" button on the supply module.

Commutation Encoder Fault X7/2
The signal goes low when an inadmissible signal combination is generated by the commutation encoder in the motor.

In addition, if option "Tacho Monitoring" is used: signal goes low when tacho cable breakage is detected or if the stall monitoring has been triggered.

Module Fault X7/3
(only on SM 35/70 and SM 50/100)
The signal goes low when the DC link fuses fail, when the unit peak current is reached, or when there is a power supply failure.

Module Overload X7/4
The signal goes low when the servo module is loaded with an excessive effective current (see section 4.2.1 Technical Data).

Motor Overtemperature X7/5
The signal goes low when the motor winding temperature goes outside the admissible range , or if a cable breakage disrupts the monitoring function

Servo Module	admissible range
047456 - SM 6/10 LN 047457 - SM 10/18 LN 047458 - SM 20/30 LN	-24°C to +140°C
all other types	+ 2°C to +140°C

Speed Monitoring X7/6
Only effective if option "Tacho Monitoring" is used. One of the two following functions can be activated by a link on the "Tacho Monitoring" board:
- speed monitoring I:
  low when speed exceeds a certain speed value
- speed monitoring II:
  low when speed falls below a certain speed value

6.2.9 Terminal Strip X30

External Voltage Supply +24V X30/1
0V X30/2
Required only for servo modules SM 35/70 and SM 50/100.
Current consumption: SM 35/70 = 0.85 A; SM 50/100 = 1.0 A.

6.2.10 Option Ramp Generator

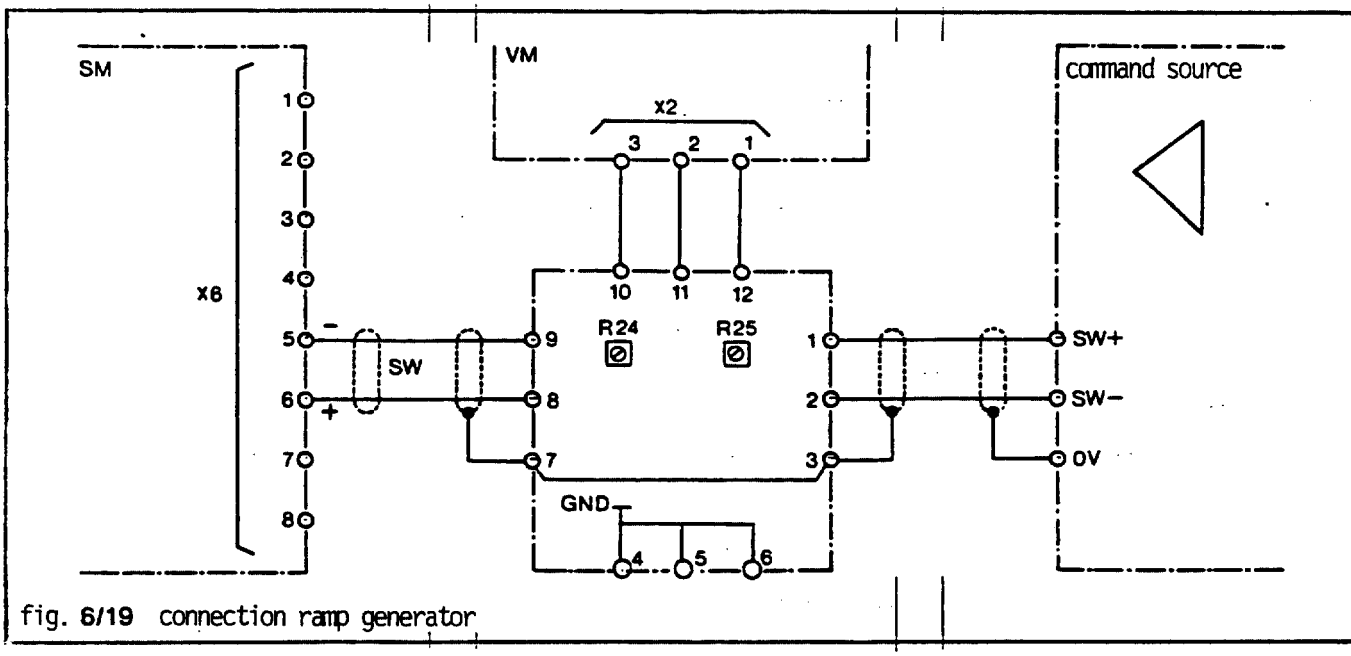


fig. 6/19 connection ramp generator

Adhere to the above connection diagram; take note of the screening for the command cables!

Adaptation of the generator time constant to the required ascending or descending ramp through different values of capacitor C5 on the board (see dimension drawing, section 4.5.1) according to the following table:

C5 [µF]	time constant T [msec]
0,01	1,1 ... 11
0,047	6 ... 60
0,1	11 ... 110
0,47	60 ... 600
1	110 ... 1100

Example: command step 10 V
rise time: 5 sec

$$\frac{5\ \text{sec}}{10\ \text{V}} = \frac{500\ \text{msec}}{\text{V}}$$

--> 0.470 µF

The ramps for acceleration and braking can be set separately with trimmers R24 and R25.

7. Integration Instructions

7.1 Safety Instructions

7.1.1 The power electronics of servo modules and supply modules have a physical connection to the mains!

This means that all connection points of terminal strip X3/X4 - connections Z(P+), Y(P-), U, V, W - can carry dangerously high voltages of up to 500 V against earth! The same applies to the capacitors in the DC link!

Once the drive has been switched off at the mains it can take up to 5 minutes until the hazardeous voltages are reduced (residual charge of the capacitors).

7.1.2 During the course of a normal integration the taking of measurements at the points mentioned in 7.1.1 can be avoided

Should it become necessary to take such measurements with an oscilloscope or a recorder in order to solve a problem, the following instructions must be followed in every case:

- Voltages may only be measured via a suitable differential input!
- The simultaneous measuring of high voltages and logic signals is not admissible!
- To measure currents either a current measuring probe or a measuring transformer with physical separation must be used!

7.2 Preparing the Integration

7.2.1 Drive Components

All component parts of the drive package and their organisation must be checked:

- motors
- supply modules
- servo modules — see type label or printing
- additional parts, such as capacitors, resistors etc.

7.2.2 Mounting of Modules and Elecctrical Connection

Check whether the units are mounted according to the mounting instructions (see section 5.)

On the basis of the machine tool builder's (MTB's) circuit diagrams check whether the complete drive wiring adheres to the connection instructions.

Important Advice:
We stress the fact that all warranty claims become void if the connection or mounting instructions are not adhered to!

7.2.3 Preoptimisation of "Speed Regulator"

As a rule Bosch inverters of the Servodyn range are supplied with the following standard optimisationµ

function	position	unit	value
P-portion speed regulator	R17	kOhm	300
I-portion speed regulator	C9	µF	0.022
tacho adaptation	R14	kOhm	3.9
current limitation	R18	kOhm	wire link
torque reduction	R26	kOhm	12
1:1 gain on speed regulator	JP1		plug-in link

Before the beginning of the integration R14 for the tacho voltage must be checked.

Depending on the rapid speed R14 must then be adjusted according to the following equation:

$Rx = 2.7\ kOhm \times n_{max} \times 10^{-3} - 1\ kOhm$

with n_{max} = motor speed at rapid (rpm)

R14 = nearest standard value to Rx.

7.3 Integration

7.3.1 Voltage Supply

- Remove fuses on mains side for supply module.
- Unplug plug X1 (see fig. 5/2) on the supply module.
- Disconnect one coil connection at contactor K01 (see connections 6.1.2).
- Switch on voltage (main switch).
- There must be +24V present at X1/4 of the supply module measured against X1/3.

Note:
If the voltage on X1/3 and X1/4 exceeds the value of +40V this can cause the fuse F1 (2A, fast) on the control logic of the supply module to blow (safety feature)!.

This can happen during switch-on, if a simple external 24V supply with B6 rectifiers without smoothing is used. In this case an ELKO capacitor with at least 4700 µF should be connected across the output terminals (24V).

- Measure the mains voltage at the main fuses with a multimeter. Admissible range: 340 V to 455 V.
- Switch on drive. Contactors KO1 and KO2 must **not** pull in!
- Switch off main switch.
- Plug in X1 on the supply module.
- Reconnect coil connection at KO1.
- Switch on main switch.
- Switch on drive.
- KO1 and KO2 must pull in, for as long as the button is pressed, and they must drop when it is released.
- Switch off main switch.
- Reinsert fuses.

7.3.2 Ready

- Switch on main switch, do not give enable signal.
- Switch on drive.
- The green ready LEDs "BTB 1" and "BTB 2" on the supply module must be on.
  If these signals are not present fuse "F1" in the supply module might have blown (see section 7.3.1).
- KO1 and KO2 must remain pulled in when the switch-on button is released.

7.3.3 Command Adjustment

On terminals X6/5 and X6/6 of the servo module introduce the command voltage which will occur during future operation as maximum value.
Admissible range: $\pm$7.5V to $\pm$10V.
Adjustment on the speed regulator. Use pot. R7 to set the voltage at test point SW (command) to 7.5V against "0V" (turning in counter-clockwise direction --> higher voltage at test point "SW").

7.3.4 Direction of Motor Rotation

On motors with disk brake the brake must be released before switching on the enable!

- Set command to 0V.
- The plug-in link "JP1" on the speed regulator board must be closed.
- Give the enable signal (green LED on speed regulator on).
- Carefully increase the command value until the axis starts to move.
- Observe the direction of rotation!
  A reversal of the direction of rotation is possible by swapping the command connections at X6/5 and X6/6.
- Switch off enable.
- Remove JP1 (speed regulator) .

7.3.5 Speed Adjustment

- Give enable signal.
- Introduce exactly 50% of the max. command during future operation on X6/5 and X6/6 (command input).
- Measure the speed (preferably with a manual tachometer).
- Set the speed to exactly 50% of the maximum speed with pot. R13 (speed regulator board) (clockwise turn --> lower speed).
- If it is not possible to measure the speed with a separate tachometer, the approximate speed can be determined by measuring the tacho voltage.
  At test point "T" (speed regulator board) there is a voltage of 2.7 mV/rpm ±5%, i.e. for a speed of 1000 rpm the tacho voltage is approx. 2.7 V.

7.3.6 Speed Drift

- Short-circuit terminals X6/5 and X6/6, command 0V.
- The motor drift can be reduced to a minimum with pot. R15 (speed regulator board).

  Note:
  Without the positional servo loop being active it is usually not possible to reduce the drift completely to "0".
- Remove short-circuiting of term. X6/5 and X6/6 and reconnect command.

7.3.7 Optimisation of Speed Regulator

In 90% of all applications the standard optimisation of the speed regulator (R17 = 300 Kohm, C9 = 0.068 µF) is appropriate for the operation of machine tool axes. Should there be any problems the optimisation can be checked as follows:

- Switch off main switch.
- Connect an RC-decade instead of components R17 and C9. Starting values: R = 300 kOhm; C = 0.068 µF.
- Connect oscilloscope to test point "UN" (speed regulator board).
- Switch on main switch and drive. Give enable signal.
- Introduce changing command values as E-function. Time constant approx. 10% below the time constant expected during future operation.
  Example:
  Planned KV factor: KV = 1
  Time constant: T_m = 60 ms
  Set the command to 55 ms for the optimisation.
- The command value must be such that the speed regulator output (test point "UN" on speed regulator board) operates slightly below the limit (limit lies around 8V).
- The regulator output signal test point "UN" can be influenced as follows by modifying the values of R17 (P-portion) and of C9 (I-portion):

If the P-portion is chosen too large or the I-portion too small the speed regulator becomes instable:

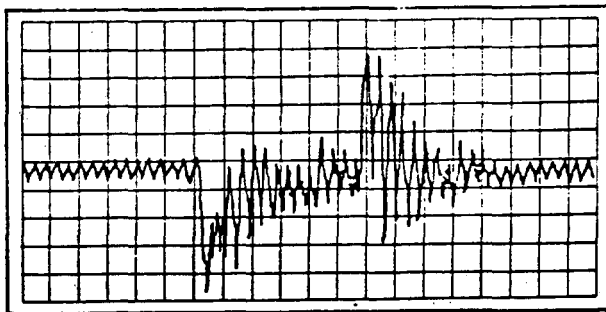


fig.7/1

The instability is mainly due to the excessively amplified tacho ripple.

If the P-portion is too small the speed regulator will also be unstable, but with a very low frequency.

fig.7/2

If the I-portion is too large the speed regulator is stable, but its response will be too sluggish due to the resulting high time constant combined with a low P-amplification.

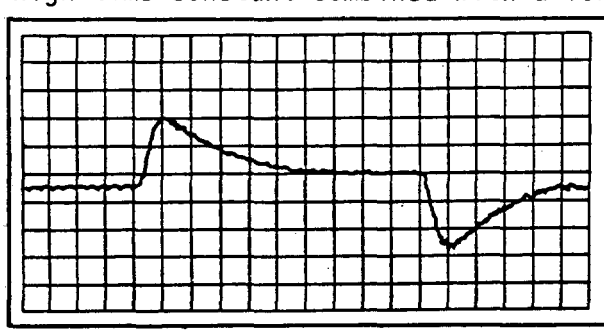


fig.7/3

When the speed regulator has been adjusted correctly the signal has the following characteristics:

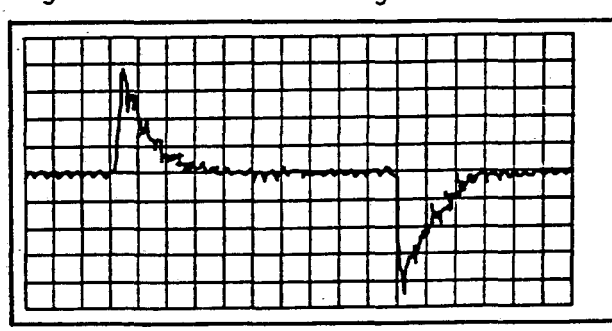


fig.7/4

Once the optimum values have been established solder in components with these values for R17 and C9.

7.3.8 Adjustment with the Positional Servo Loop Active

- Connect final command input.
- Switch on drive, give enable signal.
- Introduce "0V" command.
- Adjust balance (following error) to "0" with the potentiometer provided for this purpose on the CNC (on some types of CNC this adjustment is made by machine parameter input!).
- Drive the axis at a defined speed (for instance 1 m/min) and measure the following error (LAG). The following error depends on the KV-factor and the axis velocity:

$$LAG = \frac{V}{KV} = [mm]$$

V = axis velocity [m/min]
KV = KV-factor [10^3/min]
LAG = following error [mm]

Example:

$$V = 1 \frac{m}{min}$$

$$KV = 1.2 \frac{10^3}{min}$$

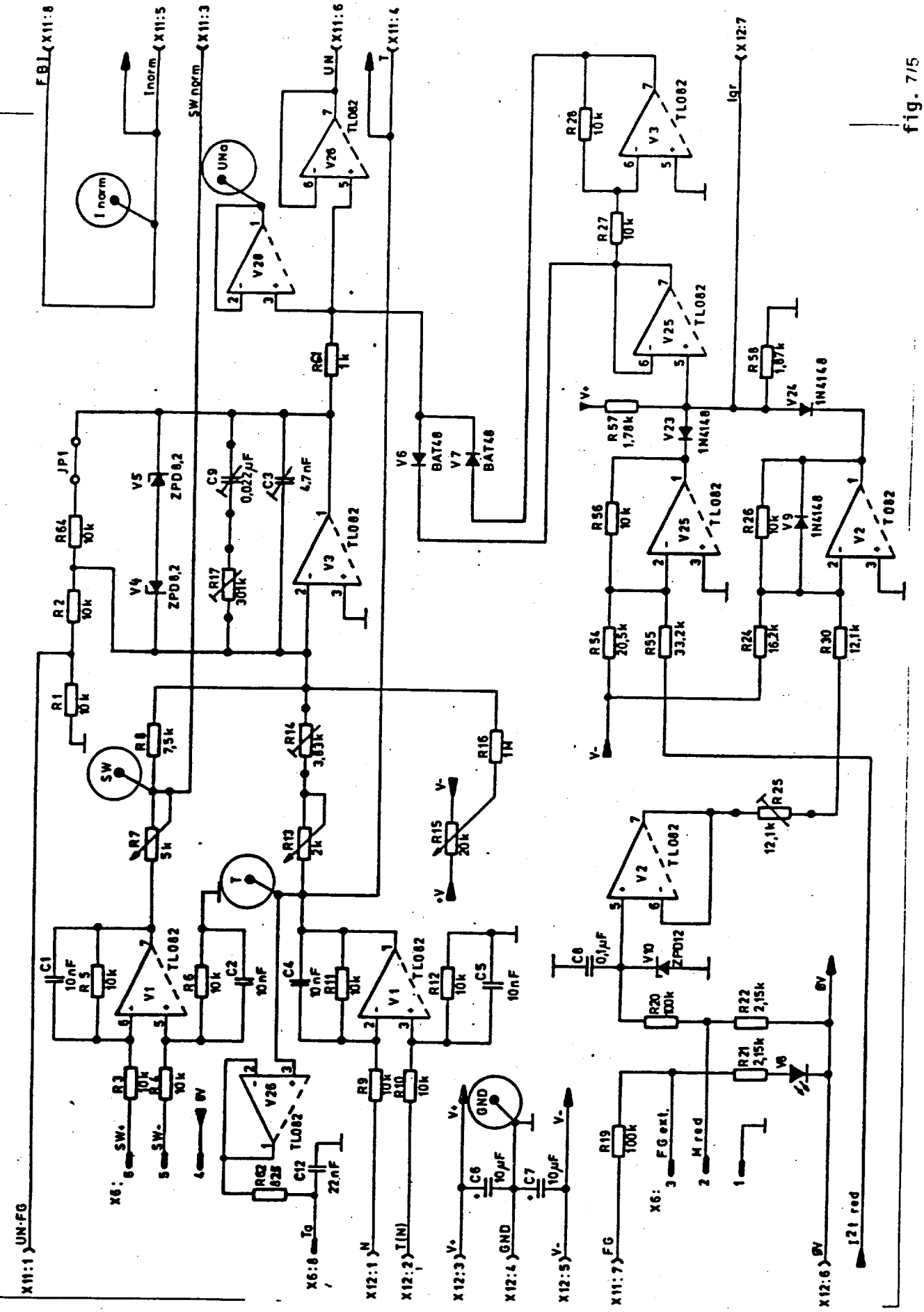
$$LAG = \frac{V}{KV} = \frac{1}{1.2} = \mathbf{0.83\ mm}$$

The lag must be adjusted on the CNC with the appropriate potentiometer or via parameter input.

7.3.9 Special Instructions

- All measurements on the speed regulator are to be taken against reference point GND on the speed regulator board.
- Test points on speed regulator board:

test point	function	voltage level
SW	normalised command	-7.5V to +7.5V (7.5V = rapid)
T	tacho voltage	+2.7 mV/rpm ±5%
U_N	speed regulator output	-8V to +8V (8V = current limit)
I_{NORM}	normalised motor current	-8V to +8V (8V = current limit)


7.4 Circuit Drawings - Speed Regulator
fig. 7/5
X11:1 UN-FG
X11:8 FBI
X11:5 Inorm
X11:3 SW norm
X11:6 UN
X11:4 T
X12:7 Igr
X6: SW+ SW- 8V
X6:8 To
X12:1 N
X12:2 I(N)
X12:3 V+
X12:4 GND
X12:5 V-
X11:7 FG
X12:6 8V
X6: FG ext. M red
I21 red
TL082
ZPD8,2
ZPD12
BAT48
1N4148

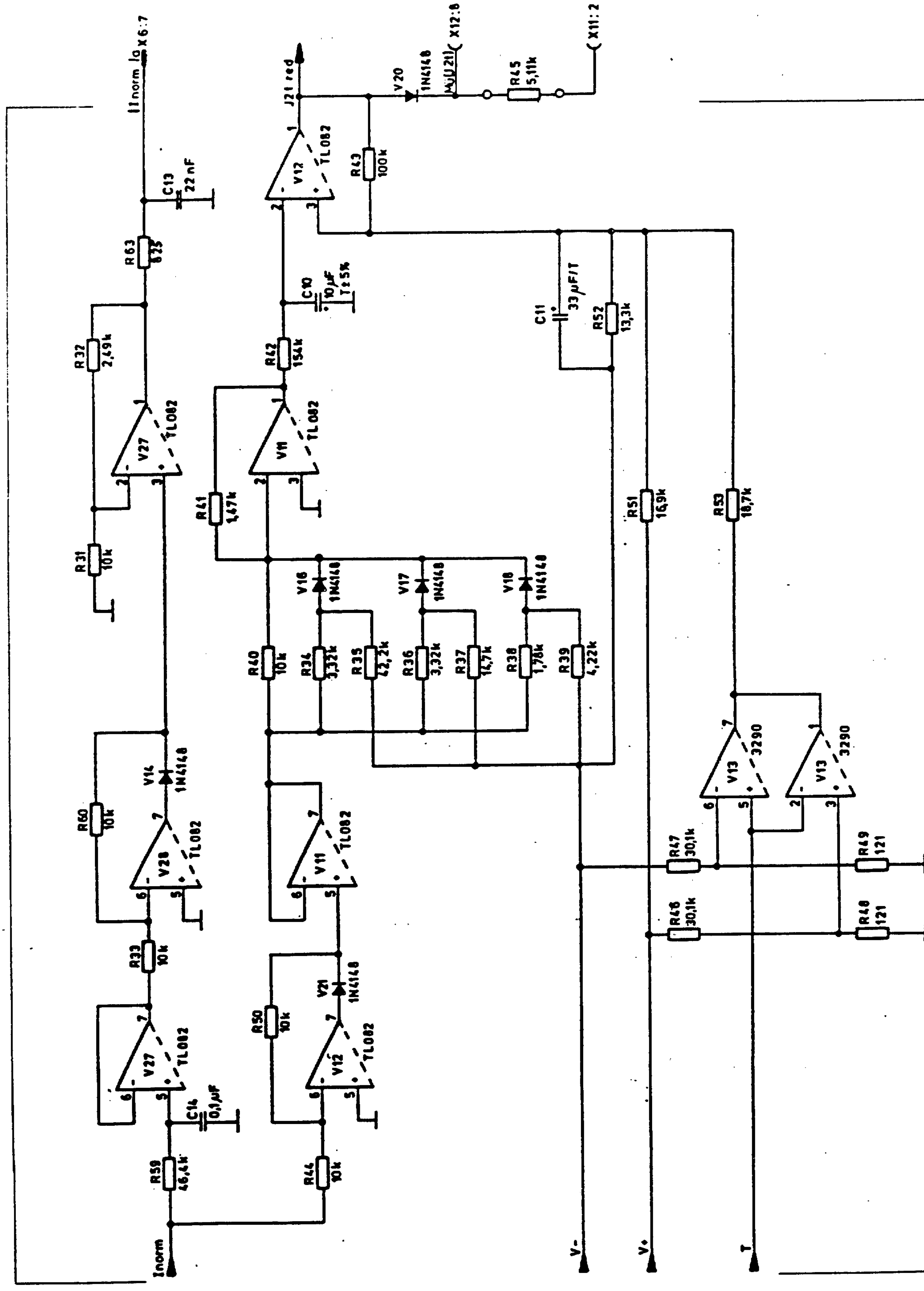


fig. 7/6

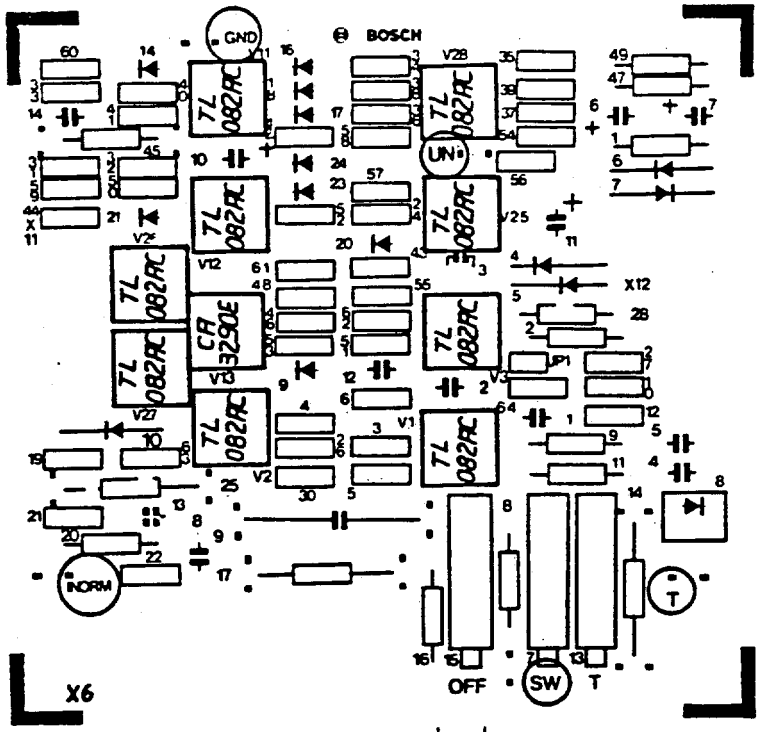


fig. 7/7

8. Listing of Available Modules

Description	Part Number/Code
supply module VM 60	225-046009
supply module VM 60 EB (external ballast resistor)	225-044062
servo module SM 6/10	221-046219
servo module SM 6/10 LN	221-047456
servo module SM 10/18	221-046068
servo module SM 10/18 LN	221-047457
servo module SM 20/30	221-046069
servo module SM 20/30 LN	221-047458
servo module SM 35/70	221-047019
servo module SM 50/100	225-046843
capacitor module KM 1100 (1100 µF-1050 V)	425-044929
capacitor module KM 2200 (2200 µF-1050 V)	425-047521
DC link capacitor 3300 µF - 350 V (3 off)	067-910660
discharge resistor 20 kΩ - 10 W (3 off)	121-912655
start-up switching module	105-913274
diagnostic module	425-043517
tacho monitoring	421-044476
axis switching 'SMAU'	053-046220
command ramp generator	300-047432
braking resistor 8.2 Ω, 57 Ws (KB)	120-913119
braking resistor 5.6 Ω, 261 Ws (KB)	120-913121
braking resistor 3.3 Ω, 293 Ws (KB)	120-913120
braking resistor 3.3 Ω, 785 Ws (KB)	120-913122
braking resistor 1.0 Ω, 4085 Ws (KB)	120-913455
external ballast resistor	121-913499
ROD fitting kit, motor size 3	104-912561
ROD fitting kit, motor size 4	104-912562
ROD fitting kit, motor size 5	104-912563
ROD fitting kit, motor size 6	104-913425
adaptor kit ROD 426 / resolver size 11	104-912839
coupling for ROD 426 or 456	159-913224
set of accessories: motor connection size A3 motor connection size A4 motor connection size A5 motor connection size A6	

Set of accessories: with connector, connection cable, cable clamp, servo modules	421-044713
set of accessories: supply module	421-044712
plug 'diagnostics' X7, 6-pin	093-909916
plug 'command' X6, 8-pin	093-908779
connection cable, X5 - encoder, 10 x 0.14⊠ + 4 x 0.5⊠	070-903499
connection cable, X8 - driver supply	070-043890
connection cable, X9: for SM 6/10, 10/18,20/30	070-043889
connection cable, X9: for SM 35/70, 50/100	070-046975
2-core command cable	070-903990
fuses:	
SM 6/10, 10 A, type E 16	080-912989
SM 10/18, 16 A, type E 16	080-911725
SM 20/30, 25 A, type E 16	080-911724
SM 35/70, 100 A, A 621 CP URG	080-908629
SM 50/100, 100 A, A 621 CP URG	080-908629

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