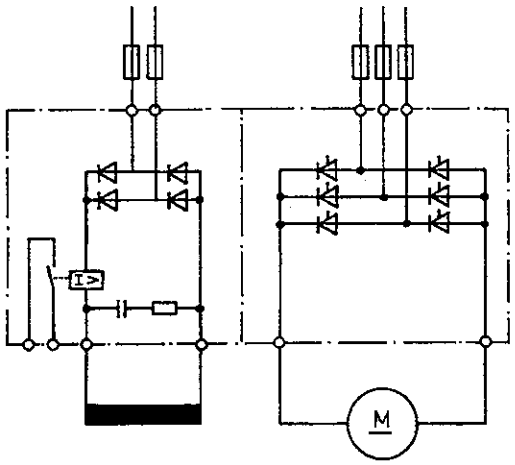
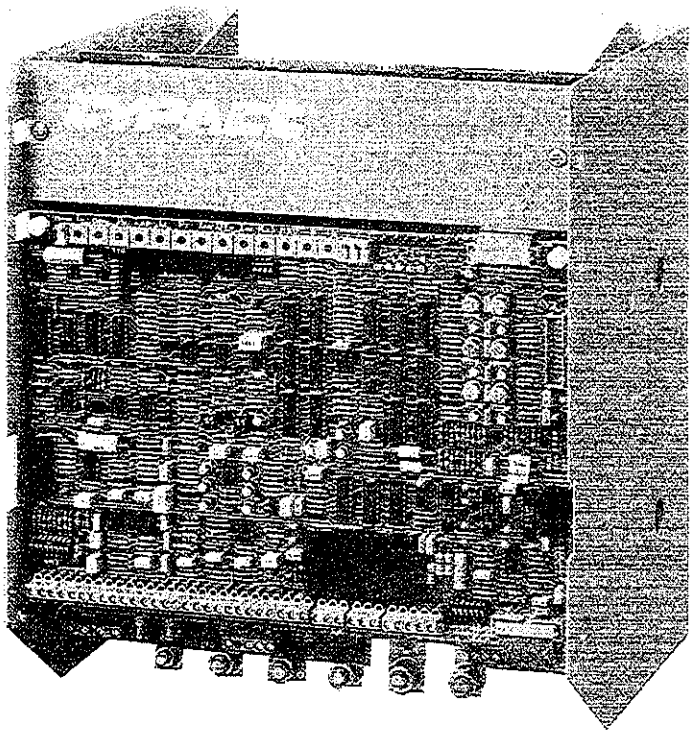
INSTRUCTION MANUAL

Converters

TYPACT

TPy3...2B
Converters for single and two quadrant operation





Contents

Modification:

1. General

The power section of the TPy3...2B consists of two fully-controlled three-phase bridges for the armature supply of d.c. shunt-wound motors of medium and high ratings. An uncontrolled Graetz bridge (B2) with protective circuit and field current relay is available for the field supply.
The various cards of the regulator section are divided according to functions. They are connected to each other and to the power section via a ribbon-type cable.

— Ry32(+e) (front card)	ESE 1609	Regulator, actuating logic, LED displays, calibration components, modulator and synchronization
— ROy	ESE 1639	Only on TPy3...2B(+e)
— Sy3	ESE 1592	Regulator supply and voltage stabilization
— PTy32	ESE 1610	Trigger circuits with pulse transmitters
— Py32-0	ESE 1636	Summation - TSE - circuit
Py32-1	ESE 1611	Fuse monitoring for the power section
Py32-2	ESE 1634	
— Fy...	ESE 1616	Field rectifier with protective circuit and field current relay.
	ESE 1638	

The two ranges, TPy3-415/480...-2B and TPy3-500/600...2B differ in the voltage stability of their power sections. The regulator sections are identical. Converters up to a rated current of 500A are built as compact units. The power section is a separate unit, and is connected to the regulator section via plug-in connectors. Units from 110A rated current upward, are fan-cooled. See 2.8 for dimensions.
Devices with type suffix «+e» have a combined armature field current converter.

2. Technical data

2.1 Mains connection

Series TPy3...2B converters can be connected directly to the following mains systems:

Type	Mains system 50/60 Hz	
TPy3-415/480-...-2B	3×230V —10% ... 240V +10%	
	3×380V ±10%	→ Standard
	3×415V ±10%	
TPy3-500/600-...-2B	As above, additionally:	
	3×440V —10% ... 460V +10%	
	3×480V —10% ... 500V +10%	→ Standard

The converters are matched to the mains voltage via the switches SW-U, SW-V and SW-W on the Sy3 card. Only one voltage range may be selected at any one time; the positions of the three switches must agree. The position of the switch SW6-1...3 on the Ry32 card depends on the mains frequency.

f	SW6-1...3	
50Hz ±4%	OFF	→ Standard
60Hz ±4%	ON	

Power and regulating sections may be energized at the same time.

Modification:

As supplied, the power units are interconnected via the bridges, CV-U, CV-V and CV-W on the Py32... card. It is recommended however, that the power and regulator sections are fed separately, so that the information provided by the LED and any possible fault indication via the relay is maintained, even if the motor is not switched on. In this case, CV-U, CV-V and CV-W on the Py32-... should be removed. The regulator is then supplied via the terminals, 1U, 1V, 1W on Py32-...

Common incoming supply

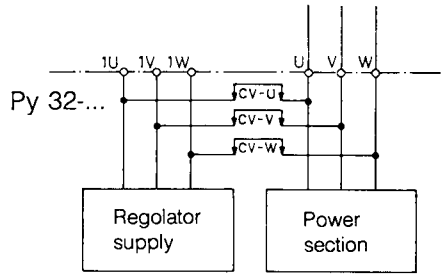


Fig. 2.1.1

Separate incoming supply

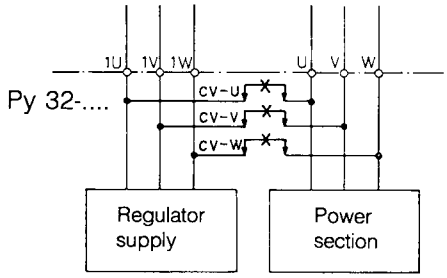


Fig. 2.1.2

The phase rotation must be the same as for the power section. The direction of the rotating field is as required.

2.2 Rated d.c. voltage

The magnitude of the rated d.c. voltage depends on the mains supply voltage U_{LN} and the operating mode. (1Q = single quadrant operation, 2Q = two quadrant operation).

U_{LN}	U_{dN} 1Q*	2Q**, 4Q***	Converter
3×220V	260V	230V	TPy3-415/480- ... -2B(+e)
3×240V	280V	250V	
3×380V	460V*	400V	
3×415V	480V	440V	
3×440V	510V	460V	TPy3-500/600- ... -2B(+e)
3×460V	530V	480V	
3×480V	560V	500V	
3×500V	600V	520V	

* 440V at mains voltage fluctuations to —10% ULN.

** Type suffix «+e».

*** Type suffix «+e» in conjunction with 4Q field converters TPey...4B.

2.3 Rated d.c. current

Converter type	Rated d.c. current I_{dN}
TPy3-.../...- 20 -2B	20 A
TPy3-.../...- 40 -2B	40 A
TPy3-.../...- 70 -2B	70 A
TPy3-.../...- 110L-2B	110 A
TPy3-.../...- 140L-2B	140 A
TPy3-.../...- 185L-2B	185 A
TPy3-.../...- 280L-2B	280 A
TPy3-.../...- 350L-2B	350 A
TPy3-.../...- 420L-2B	420 A
TPy3-.../...- 500L-2B	500 A
TPy3-.../...- 900L-2B	900 A
TPy3-.../...-1200L-2B	1200 A
TPy3-.../...-1600L-2B	1600 A
TPy3-.../...-2000L-2B	2000 A
TPy3-.../...-2500L-2B	2500 A
TPy3-.../...-3000L-2B	3000 A

Modification:

The current limiter is set ex-works to the rated d.c. current I_{dN}. The level of the maximum current can be reduced separately via the potentiometer "I_{dN}" on the Ry 32 card. If the maximum required armature current lies considerably below the d.c. rated current of the converter, we recommend adjustment in accordance with the table below. The calibration elements are located on the Py32-... card and are accessible from the front after lifting the regulator card (I_{max} = required maximum current value). Fine tuning is via potentiometers "TA" on the Py32-... card.

Converter		Standard	If required
TPy3 - ... / ... - 20 - 2B	R1	180 Ω	Remove R1
	R2	not fitted	
	R3	not fitted	$R5 = \frac{4000\ V}{I_{max}} - 25\ \Omega\ (\pm 25\ \Omega)$
	R4	not fitted	
	R5	not fitted	
TPy3 - ... / ... - 40 - 2B	R1	180 Ω	Remove R1 and R2
	R2	180 Ω	
	R3	not fitted	$R5 = \frac{4000\ V}{I_{max}} - 25\ \Omega\ (\pm 25\ \Omega)$
	R4	not fitted	
	R5	not fitted	
TPy3 - ... / ... - 70 - 2B	R1	not fitted	Remove R3
	R2	not fitted	
	R3	47 Ω	$R5 = \frac{4000\ V}{I_{max}} - 25\ \Omega\ (\pm 25\ \Omega)$
	R4	not fitted	
	R5	not fitted	
TPy3 - ... / ... - 110L - 2B	R1	180 Ω	Remove R1 ... R3
	R2	180 Ω	
	R3	47 Ω	$R5 = \frac{4000\ V}{I_{max}} - 25\ \Omega\ (\pm 25\ \Omega)$
	R4	not fitted	
	R5	not fitted	
TPy3 - ... / ... - 140L - 2B	R1	not fitted	Remove R3 and R4
	R2	not fitted	
	R3	47 Ω	$R5 = \frac{4000\ V}{I_{max}} - 25\ \Omega\ (\pm 25\ \Omega)$
	R4	47 Ω	
	R5	not fitted	
TPy3 - ... / ... - 185L - 2B	R1	180 Ω	Remove R1 ... R4
	R2	180 Ω	
	R3	47 Ω	$R5 = \frac{4000\ V}{I_{max}} - 25\ \Omega\ (\pm 25\ \Omega)$
	R4	47 Ω	
	R5	not fitted	
TPy3 - ... / ... - 280L - 2B	R1	not fitted	Remove R3 and R4
	R2	not fitted	
	R3	39 Ω	$R5 = \frac{8000\ V}{I_{max}} - 5\ \Omega\ (\pm\ 5\ \Omega)$
	R4	39 Ω	
	R5	not fitted	
TPy3 - ... / ... - 350L - 2B	R1	not fitted	Remove R2 ... R4
	R2	47 Ω	
	R3	39 Ω	$R5 = \frac{8000\ V}{I_{max}} - 5\ \Omega\ (\pm\ 5\ \Omega)$
	R4	39 Ω	
	R5	not fitted	
TPy3 - ... / ... - 420L - 2B	R1	56 Ω	Remove R1 ... R3
	R2	47 Ω	
	R3	39 Ω	$R5 = \frac{8000\ V}{I_{max}} - 5\ \Omega\ (\pm\ 5\ \Omega)$
	R4	not fitted	
	R5	not fitted	
TPy3 - ... / ... - 500L - 2B	R1	56 Ω	Remove R1 ... R4
	R2	47 Ω	
	R3	39 Ω	$R5 = \frac{8000\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$
	R4	39 Ω	
	R5	not fitted	

Modification:

Converter		Standard	If required
TPy3 - ... / ... - 900L - 2B	R1 R2 R3 R4	not fitted not fitted 13 Ω 13 Ω	Remove R3 and R4 $R^* = \frac{7750\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$
TPy3 - ... / ... - 1200L - 2B	R1 R2 R3 R4	8,06 Ω not fitted 13 Ω not fitted	Remove R1 and R3 $R^* = \frac{7750\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$
TPy3 - ... / ... - 1600L - 2B	R1 R2 R3 R4	8,06 Ω 8,06 Ω not fitted not fitted	Remove R1 and R2 $R^* = \frac{7750\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$
TPy3 - ... / ... - 2000L - 2B	R1 R2 R3 R4	8,06 Ω 8,06 Ω 13 Ω not fitted	Remove R1 ... R3 $R^* = \frac{7750\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$
TPy3 - ... / ... - 2500L - 2B	R1 R2 R3 R4	8,06 Ω 8,06 Ω not fitted 13 Ω	Remove R1, R2 and R4 $R^* = \frac{9300\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$
TPy3 - ... / ... - 3000L - 2B	R1 R2 R3 R4	8,06 Ω 8,06 Ω 8,06 Ω not fitted	Remove R1 ... R3 $R^* = \frac{9300\ V}{I_{max}} - 5\ \Omega\ (\pm 5\ \Omega)$

2.4 Field supply

An uncontrolled d.c. rectifier with protective circuit is available for connection of the motor field.

Max supply voltage : U_{LN} = 415V
D.C. field voltage output : U_f = 0,9 U_{LN}
Maximum field current : I_f = 4A with TPy3-.../...- 20 ... 70 -2B
= 10A with TPy3-.../...- 110L... 500L-2B
= 25A with TPy3-.../...- 900L...2000L-2B
= 30A with TPy3-.../...-2500L...3000L-2B

When the field current is flowing, the contact (250V, 3 A, AC-11) between the terminals 53 and 54 on card Fy... is closed.
In the TPy3-.../...-900L...3000L-2B the card Fy 30 carries the field current adaptation.

I_f	Switch	Resistances
15 ... 25 (30) A	>15 A	R1+R2
7,5 ... 15 A	≤15 A	R1+R2
< 7,5 A	≤15 A	R2 (Remove R1)

2.5 Fuses

If a fuse blows, this is recognized and indicated. See 5.10.

2.5.1 Regulator supply

A.C. side = F7, F8, F9 on Sy3:
3 off L 1055/0.25 (6×32 mm; 250 mA fast)
D.C. side = F1, F2 on Sy3:
2 off FF 19230/1,6 (5×20 mm; 1,6 A superfast)

2.5.2 Protective circuit

F11, F12, F13 on Py32-...:
3 off Navy/Omega (6×32 mm; 4 A fast)

Modification:

2.5.3 Power section (fuse location)

Code A Armature circuit, a.c. side, external
Code B Armature circuit d.c. side, external (with two quadrant operation only)
Code C Armature circuit, internal
Code D Field circuit, external

Converter	Code	Qty.	EUROPA Jean Müller	USA Gould Shawmut	USA Bussmann
TPy3 - ... / ... - 20 - 2B	A	3	gRD2/20	A70P 25	FWP 25
	B	2	gRD2/25	A70P 25	FWP 25
	D	2	gRD2/ 6	A60X5	FWP 5 (FWH 5)
TPy3 - ... / ... - 40 - 2B	A	3	gRD3/35	A70P 40	FWP 40
	B	2	gRD3/50	A70P 50	FWP 50
	D	2	gRD2/ 6	A60X5	FWP 5 (FWH 5)
TPy3 - ... / ... - 70 - 2B	A	3	gRD3/63	A70P 80	FWP 80
	B	2	S00üf1/80/80A/660V	A70P 80	FWP 80
	D	2	gRD2/ 6	A60X5	FWP 5 (FWH 5)
TPy3 - ... / ... - 110L - 2B	A	3	S00üf01/80/100A/660V	A70P 100	FWP 100
	B	2	S00üf1/80/125A/660V	A70P 150	FWP 150
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 140L - 2B	A	3	S00üf1/80/125A/660V	A70P 150	FWP 150
	B	2	S00üf1/80/160A/660V	A70P 175	FWP 175
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 185L - 2B	A	3	S00üf1/80/200A/660V	A70P 175	FWP 175
	B	2	S00üf1/80/200A/660V	A70P 200	FWP 200
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 280L - 2B	A	3	S1üf1/110/250A/660V	A70P 300	FWP 300
	B	2	S1üf1/110/315A/660V	A70P 350	FWP 350
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 350L - 2B	A	3	S1üf1/110/315A/660V	A70P 350	FWP 350
	B	2	S2üf1/110/400A/660V	A70P 400	FWP 400
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 420L - 2B	A	3	S2üf1/110/400A/660V	A70P 400	FWP 400
	B	2	S2üf1/110/500A/660V	A70P 500	FWP 500
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 500L - 2B	A	3	S2üf1/110/500A/660V	A70P 500	FWP 500
	B	2	S2üf1/110/630A/660V	A70P 600	FWP 600
	D	2	gRD2/16	A60X15	FWP 15 (FWH 15)
TPy3 - ... / ... - 900L - 2B	C	6	170L 7036 (630A)	—	—
	D	2	gRD2/30	—	—
TPy3 - ... / ... - 1200L - 2B	C	6	170L 7077 (800A)	—	—
	D	2	gRD2/30	—	—
TPy3 - ... / ... - 1600L - 2B	C	6	170L 7696 (1000A)	—	—
	D	2	gRD2/30	—	—
TPy3 - ... / ... - 2000L - 2B	C	12	170L 7074 (2 x 700A)	—	—
	D	2	gRD2/30	—	—
TPy3 - ... / ... - 2500L - 2B	C	12	170L 7077 (2 x 800A)	—	—
	D	2	gRD3/35	—	—
TPy3 - ... / ... - 3000L - 2B	C	12	170L 7696 (2 x 1000A)	—	—
	D	2	gRD3/35	—	—

2.6 Ambient conditions

Operating temperature : 0-40°C, or up to 55°C provided I_{dN} is reduced by 1.25% per Kelvin temperature increase.

Storage temperature : −15°C... +65°C.

Altitude : Up to 1000 m above sea level. Above this I_{dN} must be reduced by 1.2% per 100 m.

Climate : In accordance with DIN 40 046 sheet 5.

Modification:

2.7 Regulation (feedback network)

— Speed regulation with subordinate current regulation
  a) Constant torque in the armature range
  b) Constant output in the field range in conjunction with the field current converter

— Facility for torque regulation (current regulation)

2.7.1 Regulating range

Tachometer regulation : 1:1000 (typically)
Armature voltage regulation : 1:20 (typically)
Use of the APSy speed regulation adapter is recommended where very wide regulating ranges are involved. This can be fitted on the back of the Ry32 regulator card.

2.7.2 Accuracy

Tachometer regulation : ±0.001% in relation to n_{max} when changing from idling to full load
: ±0.07% in relation to n_{act} with mains voltage fluctuations of ±10%
: ±0.2% in relation to n_{act} with temperature fluctuations of ±10K

Armature voltage regulation : The above data are still valid, but then relate to the armature voltage and not the speed. Experience has shown the speed error to be approximately ±2% n_{max} and is largely dependent on the technical data of the motor.

2.7.3 Actual value

Speed : — Voltage from d.c. current tachometer, three-phase current tachometer with rectifier or a.c. current tachometer
— Armature voltage with high-impedance decoupling of power and regulator section via internal differential amplifiers with RxI compensation.

Current : — Internal via transformers on the a.c. side.

2.8 Dimensions

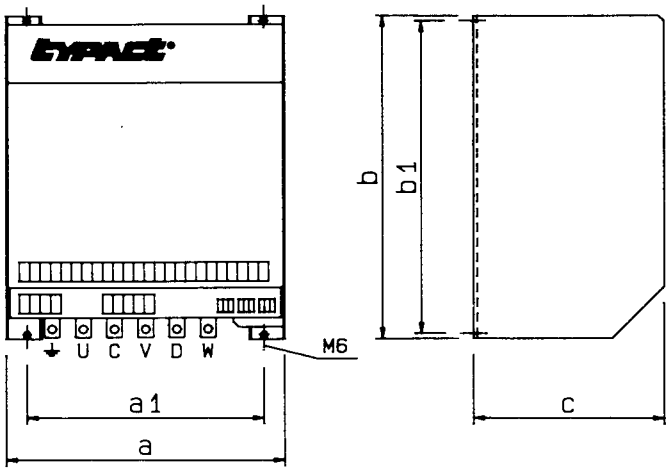
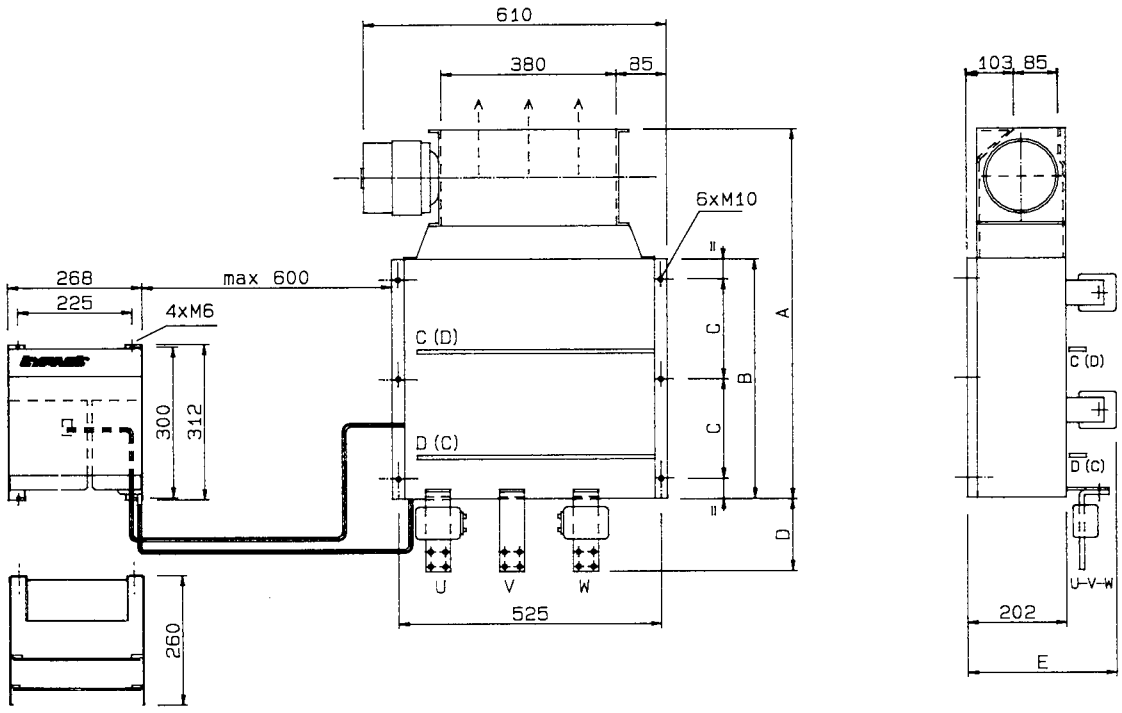


Fig. 2.8.1

Device rated current I_{dN}(A)	External dimensions (mm) Width a × Height b × Depth c			Fixing dimensions (mm) a1	b1
20 A	268	312	156	225	300
40 A	268	312	192	225	300
70 A	268	312	260	225	300
110 A	268	312	260	225	300
140 A	268	312	260	225	300
185 A	268	312	260	225	300
280 A	308	340	293	275	325
350 A	308	340	293	275	325
420 A	308	340	293	275	325
500 A	308	340	293	275	325

Modification:



Rated current of the device I_{dN}	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
900 A	560	300	125	145	310
1200 A	560	300	125	145	310
1600 A	740	480	200	150	310
2000 A	740	480	200	150	310
2500 A	965	700	300	150	333
3000 A	965	700	300	150	333

2.9 Weights and power losses

Rated current of the device I_{dN}	Weight* (kg)	Max. power losses* (W) at U_{LN} = 230V (220/240)	415V (380)	500V (440/460/480)
20 A	7,4	89	103	113
40 A	8,4	153	167	177
70 A	10,6	205	219	229
110 A	12,5	388	412	427
140 A	12,5	461	485	500
185 A	12,5	547	571	586
280 A	23	884	908	923
350 A	23,5	1098	1122	1137
420 A	24,5	1147	1171	1186
500 A	24,5	1249	1278	1286
900 A	67,5/10,8	3196/68	3241/68	3270/68
1200 A	67,5/10,8	3875/68	3946/68	3993/68
1600 A	74,5/11,0	5637/68	5708/68	5755/68
2000 A	84,5/11,0	5582/68	5653/68	5700/68
2500 A	127/12,5	8080/102	8209/102	8293/102
3000 A	127/12,5	7869/102	7998/102	8082/102

* Details for devices ≥ 900 A: power section/regulator section + field supply.

Modification:

2.10 Cooling

Fan data

Rated current of the device I_{dN} (A)	Throughput (m^3/h)	Mains voltage single phase a.c. (V)	Rated current (A)
20 ... 70	—	—	—
110 ... 185	160	220/240V, 50/60 Hz	0,12
280 ... 500	320	220/240V, 50/60 Hz	0,24
900 ... 2000	1590	220V, 50 Hz*	2,3
2500 ... 3000	1590/160**	220V, 50 Hz*/220 ... 240V, 50/60 Hz**	2,3/0,12**

* 230/240V and/or 60 Hz, please enquire. ** Power section/regulator section + field supply.

3. Special features

- LED indication for supply voltage, enable, current limitation and faults
- Collective fault indication via potential-free contacts and static signal 0V or +24V
- Micro switches for easy matching and commissioning (see 14)
- Regulator can be enabled directly from a programmable controller (+15V... +24V)
- Internal, high impedance decoupling of power and regulator section during armature voltage regulation
- Mounting facility for up to four supplementary cards on the back of the Ry32 regulator card. Internal connections via ribbon-type cables and plugs X (see 9)
- Facility for connecting a field converter via a ribbon-type cable and plug J (see 8). A decoupling amplifier for the armature voltage is fitted as standard (terminal 25)
- The absolute value stage (terminals 1 and 2) facilitates the use of an a.c. current tachometer (only with single quadrant operation) and makes an actual value conversion during reversing operations superfluous
- Zero speed indication via potential-free contact and static signal 0V/+24V. Switching threshold infinitely adjustable
- Voltage supply independent of field rotation.

4. Fitting and electrical connections

4.1 Fitting

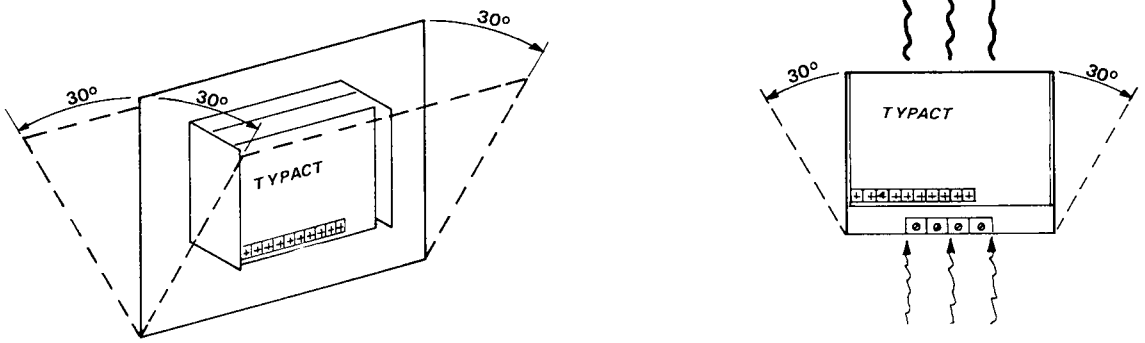


Fig. 4.1.1

Devices with high heat losses should not be mounted below the converter. After a few days' operation the screws of the terminal strips should be tightened.

Modification:

4.2 Electrical connections

4.2.1 General

The converter is connected as shown in fig. 4.2.2, 4.2.3 or 4.2.5. Fuses as detailed in Section 2.5.3 should be provided for the protection of the thyristors and the field d.c. rectifier.
If the power and regulating sections are fed separately, the bridges CV-U, CV-V and CV-W should be removed from the Py32-... card.
The overload relay is fitted on the mains supply side and should be set to $0{,}82 \times I_{dN} \times F$.

I_{dN} = motor rated current (arithmetically mean value)

F = form factor permitted by the motor manufacturer.

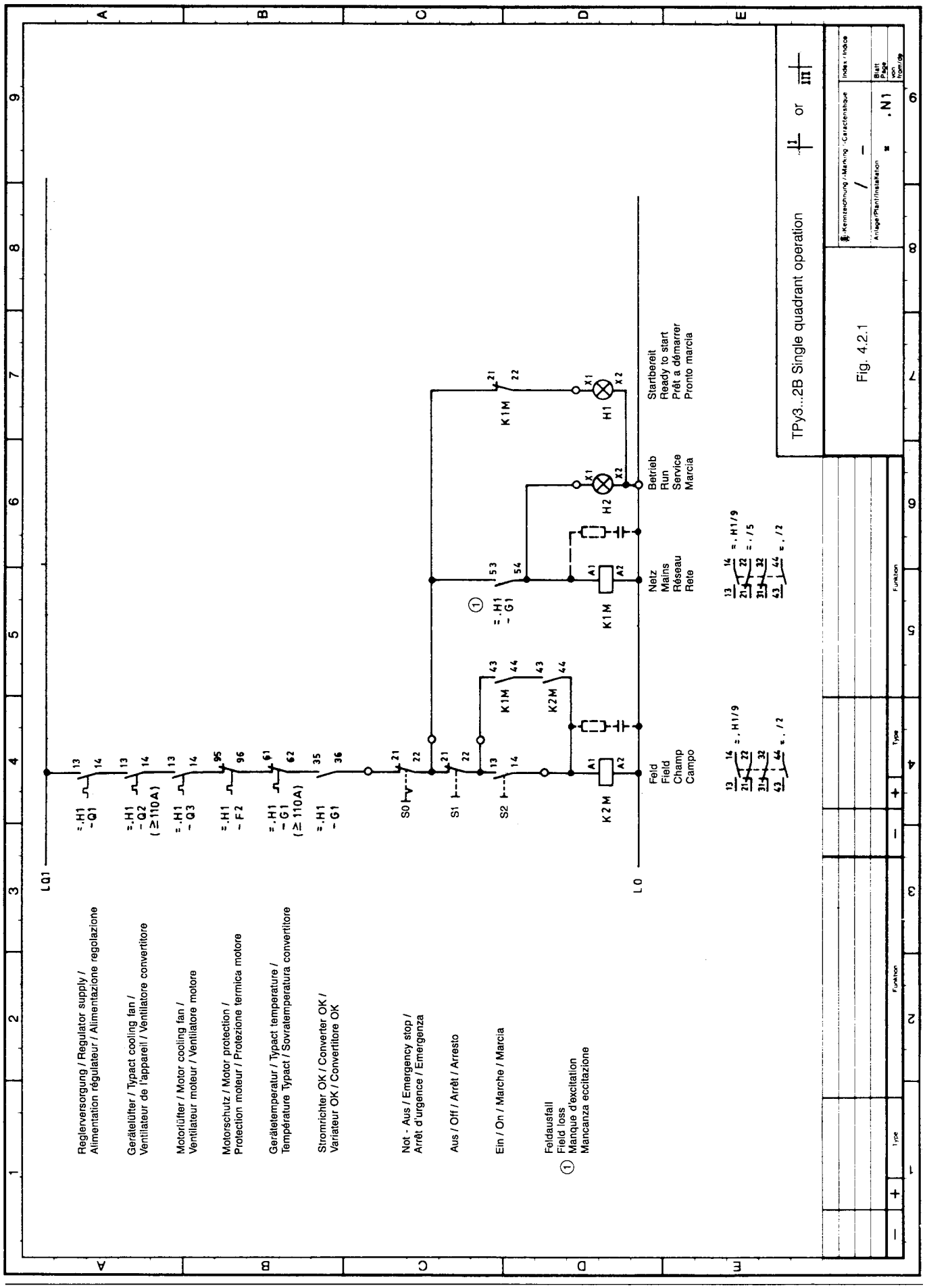
All the wires connected to the regulator section (with the exception of the potential-free contacts) should be screened, one end being connected to the regulator reference point, the other being insulated by means of a sleeve. Where multi-core screened cables are used, one cable should not carry more than one function (for example reference value or actual value or enable). The wiring in lengthy connections should be twisted.
If the wiring to the regulator section is laid in the same channel as the power and control section wiring, it is recommended that an RC link be provided in parallel with the individual contactor coils.
The terminals are suitable for cables without ferrules.
In order to minimise reactive effects in the mains, and mutual interference between converters, VDE 0160, part 2 recommends the use of mains chokes with a relative short-circuit voltage U_{SC} = 4% (L1 in Fig. 4.2.2, 4.2.3 or 4.2.5).
In most cases, the armature circuit does not require a smoothing choke, but this should always be checked, bearing in mind the maximum permissible form factor of the motor and the armature inductance.

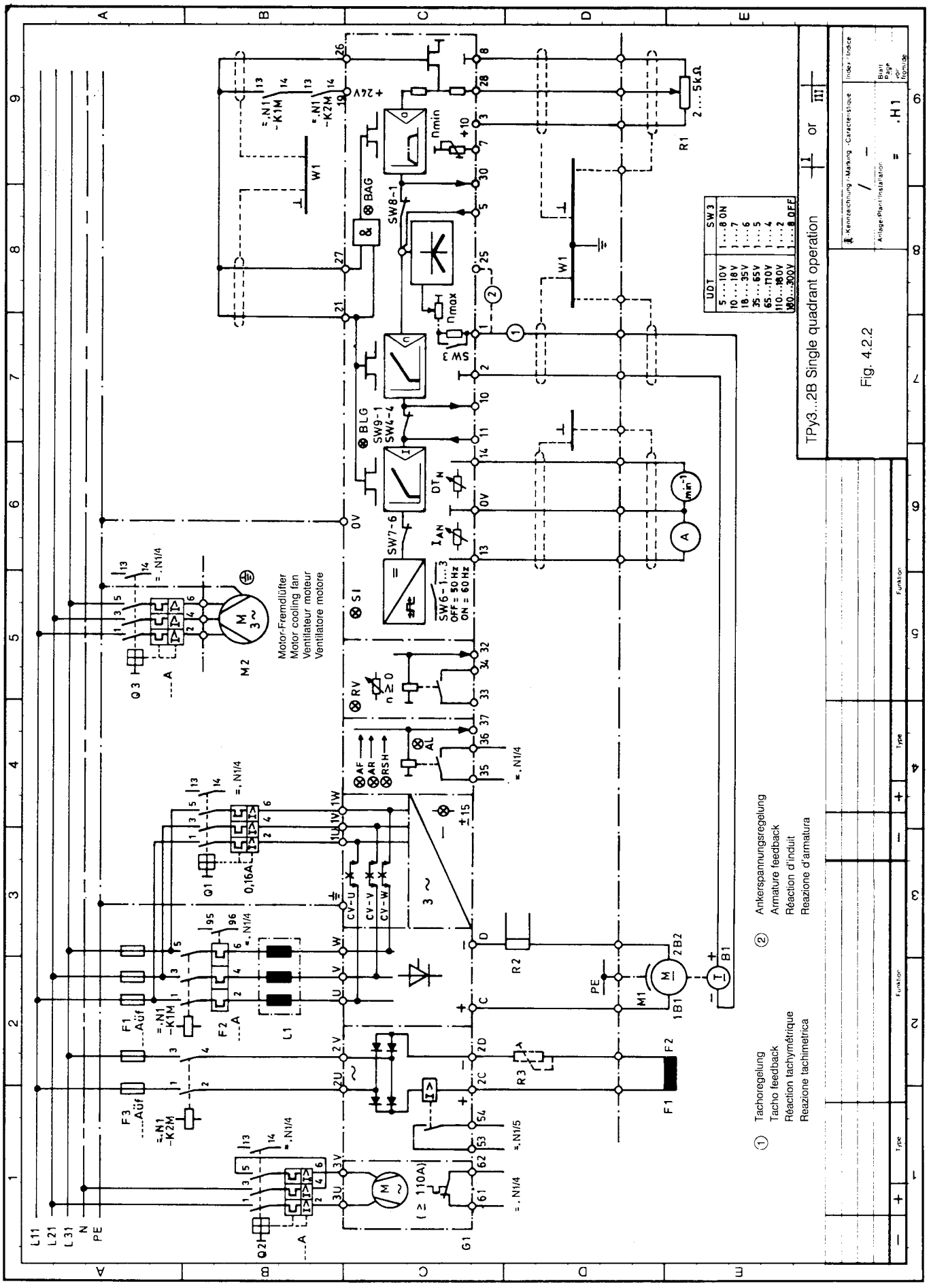
4.2.2 Single quadrant operation

In single quadrant operation there is only one direction of power flow: from the mains to the motor.
It is therefore immaterial, whether reversing or non-reversing operation is involved.
Connection is in accordance with Figs. 4.2.1 and 4.2.2 (non-reversing). Reversing operation without regenerative braking is possible.
Reversing is achieved by switching the d.c. side in the armature or field circuit. When switching in the field circuit, the field rectifier must have protection against excessive voltage peaks (for example resistor parallel to the field, RC combination, U-diodes...). The motor must not be reversed unless it is stationary, and the regulator is blocked.
Additional measures in the actual value circuit (terminals 1 and 2) are not required, because of the integral absolute value stage.

Modification:

Modification:





Modification:

4.2.3 **Two-quadrant operation**

Please note: For two quadrant drives, the following conditions must be fulfilled:

- — Converter with type-suffix "+e" (= regulator card Ry32e)
- — A d.c. tachometer must be used, which will change the voltage polarity at terminals 1 and 2 when the motor is reversed.
- — The armature voltage to DIN 40 030 for four quadrant drives must be established. (See also table under 2.2).
- — Fuses in the armature circuit in accordance with the table under 2.5.3 code B for converters up to I_{dn} = 500 A.

During operation in the second or fourth quadrant of the speed/torque diagram, energy is fed back into the mains (regenerative braking). This braking must not be interrupted by opening the mains contactor K1M, or commutation of the thyristors will no longer be mains-controlled and fuses may be blown. K1M may be de-energized only when the following two conditions are met:

1. If speed (n) = 0 (indication via relay contact between terminals 33 and 34, or static signal at terminal 32 = 0V). The potentiometer n ≥ 0 should be turned fully anti-clockwise.
2. Following prior regulator blocking, (no voltage at terminal 21).

During braking, the current set on the current limiter flows. Braking is not speed-controlled.
The absolute value stage must be bypassed (SW4-2 OFF, SW4-3 ON).

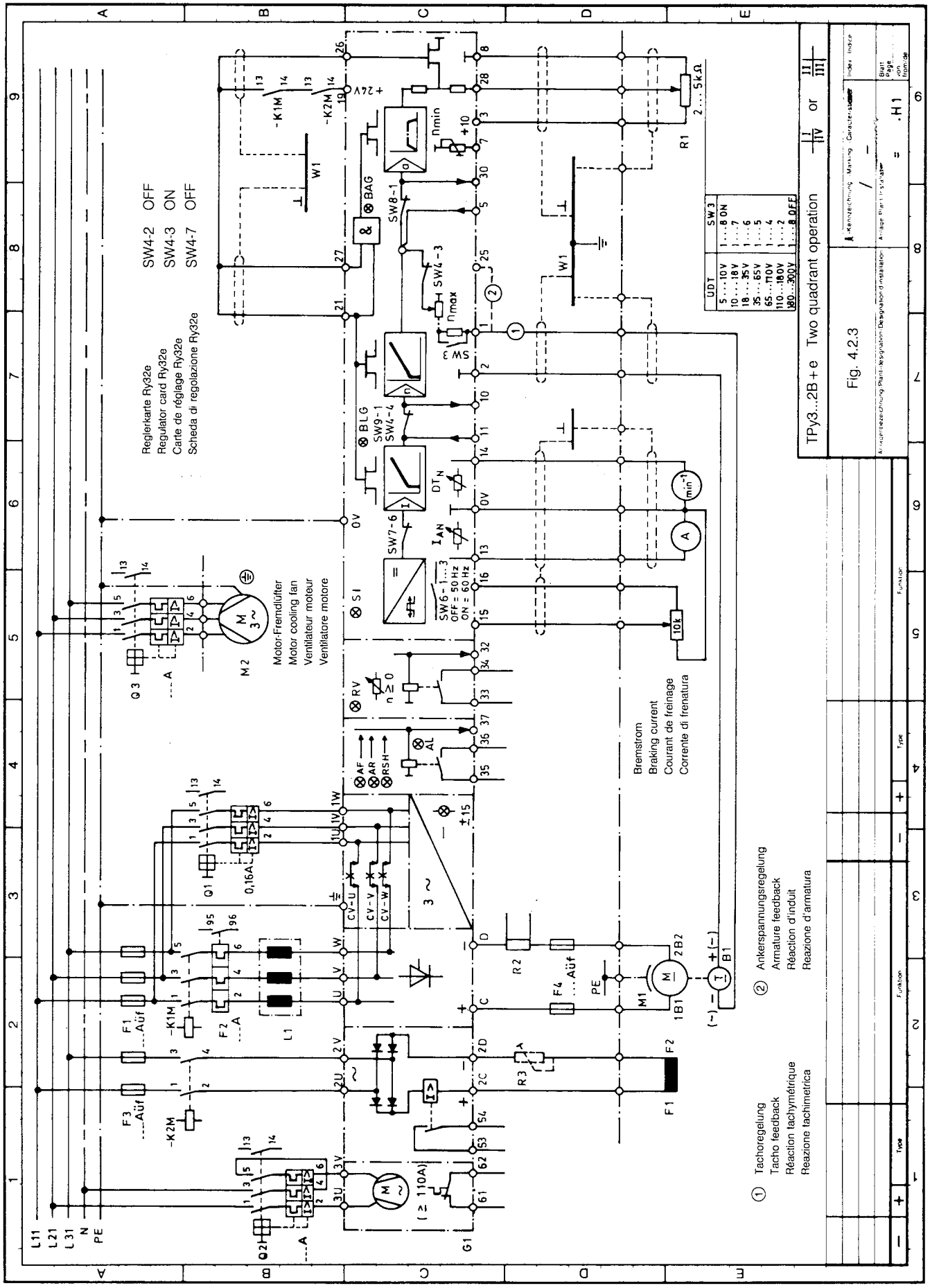
There are two types of two quadrant drive:

1. Operation in quadrants 1 and 4 or 3 and 2 (converter connected as in Fig. 4.2.3); the relevant torque direction is maintained and the motor is driven by the load in the opposite direction to its inherent direction of rotation (e.g. decoiling machine). Actuation is dependent on the overall system control because operation in the quadrants mentioned above is not possible with a single motor.

   Please note the remarks above, concerning de-energization conditions.
2. Operation in quadrants 1 and 2 or 3 and 4 (connection as in Fig. 4.2.4 and 4.2.5); the motor's direction of rotation is maintained and the torque direction is reversed by switching in the armature or field circuit. (For example to brake large centrifugal masses when switching off).

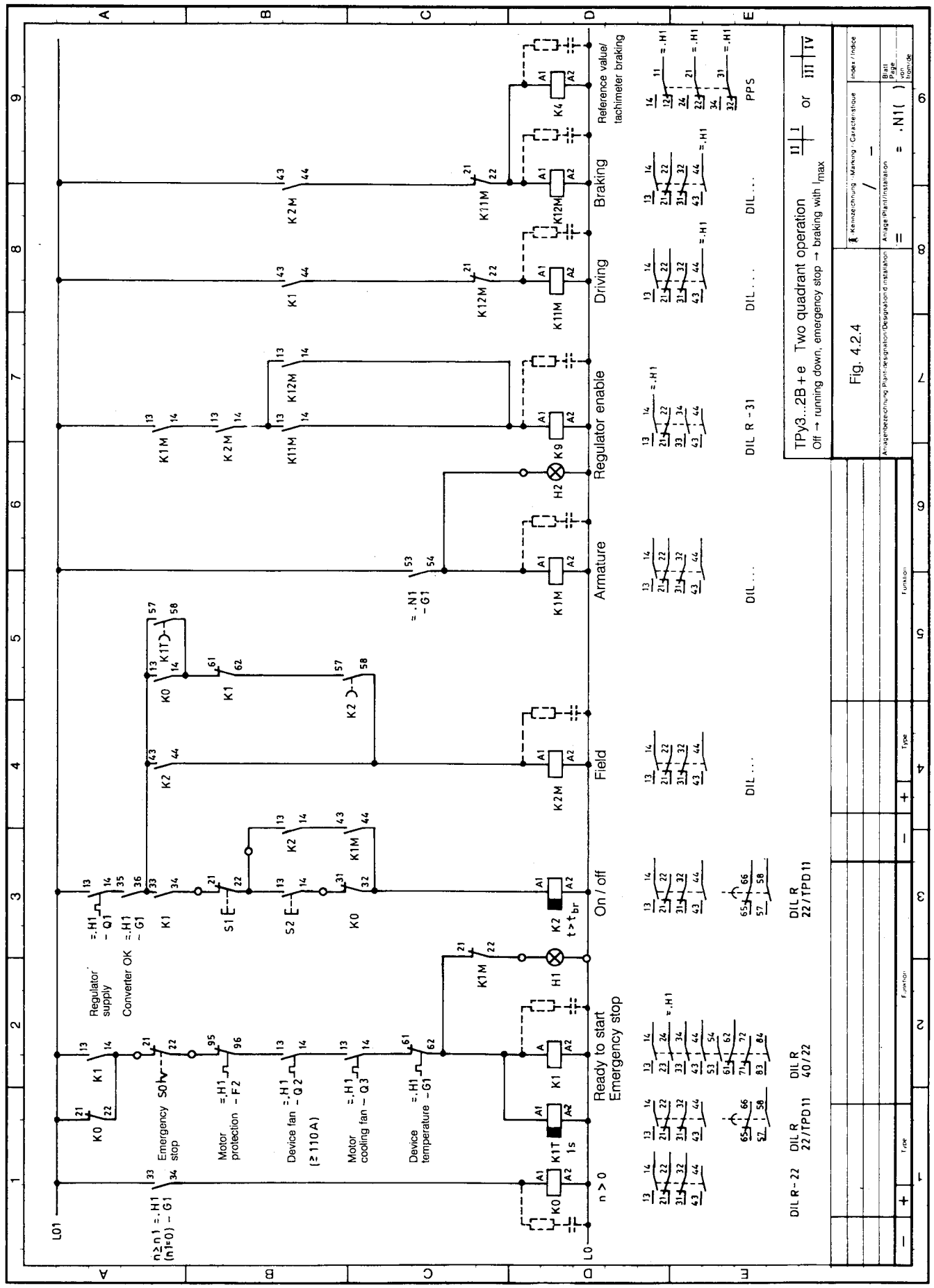
During switch-over the regulator has to be blocked, and is not enabled until after switch-over. In the event of field reversal, a protective circuit for the field rectifier has to be provided.

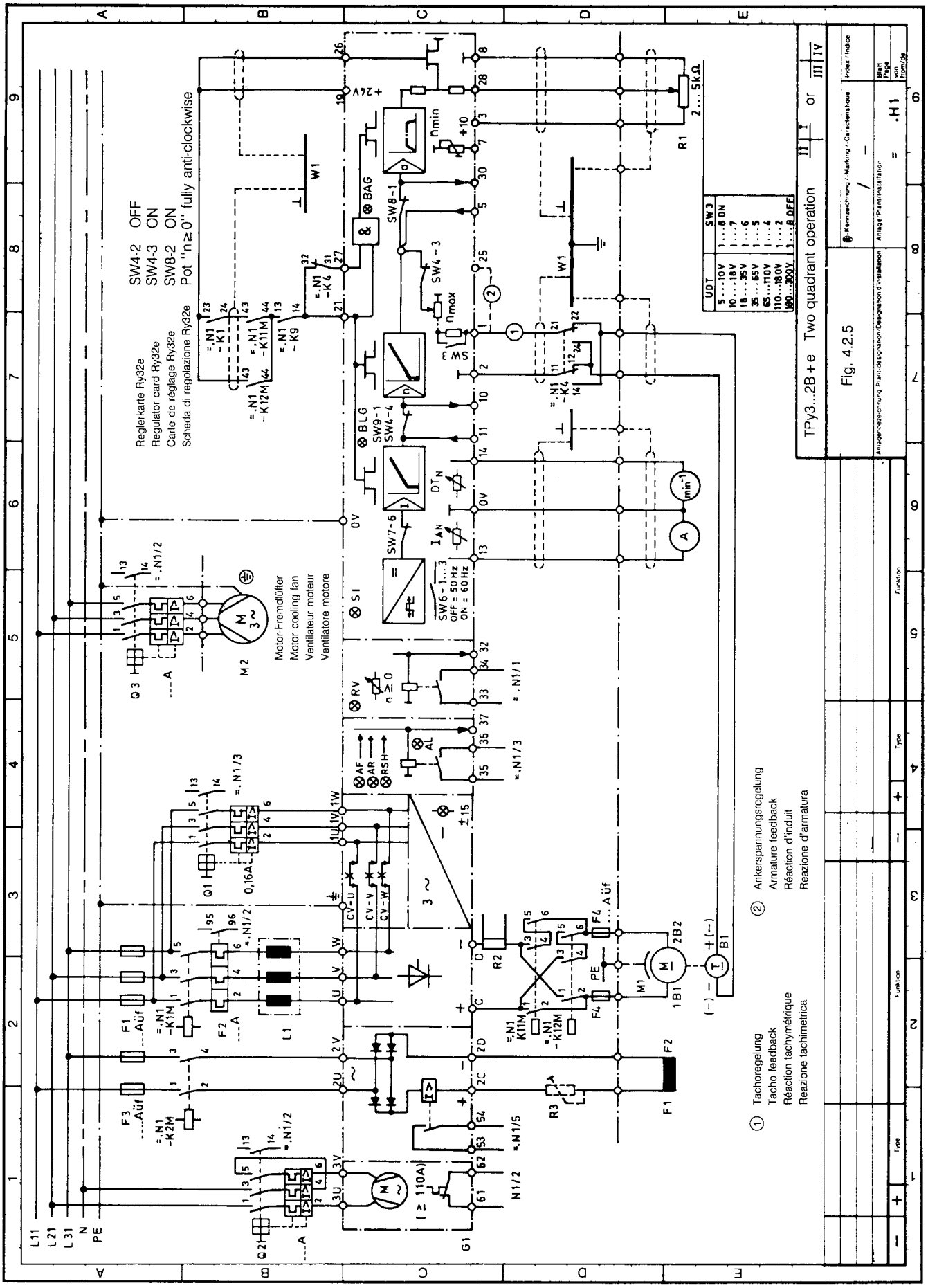
Modification:



Modification:

Modification:





Modification:

5. Converter circuits

5.1. Internal power supply

The power supply is on the Sy3 card. The mains supply unit consists of three single-phase transformers of 14 VA each. The primary windings are delta-connected, and are matched to mains voltage by means of switches SW-U, SW-V and SW-W (see 2.1). One of the three secondary windings at a time supplies the synchronization voltage for the modulator (55V a.c.), the other two supplying two theree-phase bridges for generation of the regulator supply voltages. For fusing, see 2.5.1.

±10V ±5% Highly stabilized, short-circuit proof
Maximum residual ripple: 3 mVpp
Thermal stability: ≤100 ppm/°C
Symmetry tolerance: ≤1%
In the event of a short-circuit, LED "RSH" lights up

±15V ±4% Stabilized, short-circuit proof
Maximum residual ripple: 5 mVpp
In the event of an overload, LED "AR" lights up

+24V Unstabilized
Maximum residual ripple: 50 mVpp
Tolerance +19...+28 V, depending on mains voltage and load

Voltage	Termination		Add. load capacity
0V = Reference potential	Terminals Bus X Bus J	2, 8, 0V 8, 10 4, 5*	
+10V	Terminals	3, 31**	50 mA
−10V	Terminals	4, 22***	50 mA
+15V	Terminal Bus X Bus J	+15 16 1*	200 mA − I_{+10}
−15V	Terminal Bus X Bus J	−15 9 6*	200 mA − I_{-10}
+24V	Terminals Bus X Bus J	19, +24 1 10*	200 mA − I_{+15} − I_{+10}

* With TPy3...2B+e
** With R217 = Bridge
*** With R218 = Bridge

The load capacity as stated in the table relates to unloaded output terminals of the converter, and a mains undervoltage of 10% in relation to the rated value of the converter supply voltage.

5.2 Enable

Enablement is through application of a voltage of +15 ... +24V to the appropriate terminals.
The inputs are protected against polarity reversal. Negative voltage, 0V and missing signal are interpreted as "blocking".

Modification:

5.2.1 **Regulator enable**

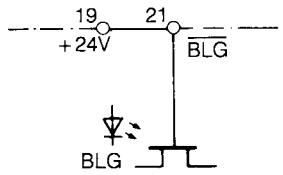


Fig. 5.2.1.1

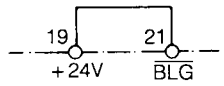


Fig. 5.2.1.2

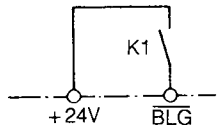


Fig. 5.2.1.3

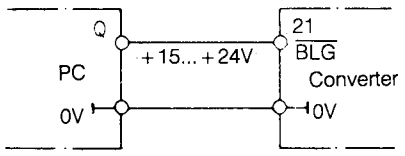


Fig. 5.2.1.4

Connection: Terminal 21 ($\overline{BLG}$)

If the regulator is blocked, the LED "BLG" lights up.

There are several enable possibilities:

1. Bridge between +24V (terminal 19) and terminal 21 (see Fig. 5.2.1.2).
   This is possible only if voltage is applied simultaneously to the power and regulator section. The regulator is enabled approximately 200 ms after switching on, thus allowing the supply voltages to build up.
2. Enable via contact (see Fig. 5.2.1.3)
   Regulator enable without delay by closing the contact of K1. The contacts must not be closed before voltage is applied to the power section (terminals U, V and W). The regulator is blocked when the contacts are opened.

3. Enable with programmable controller (see Fig. 5.2.1.4)
   A voltage of +15V... +24V applied to terminal 21 enables the regulator. 0V of PC and the converter are interconnected. Enable conditions are the same as in 2.

5.2.2 **Enable ramp function generator**

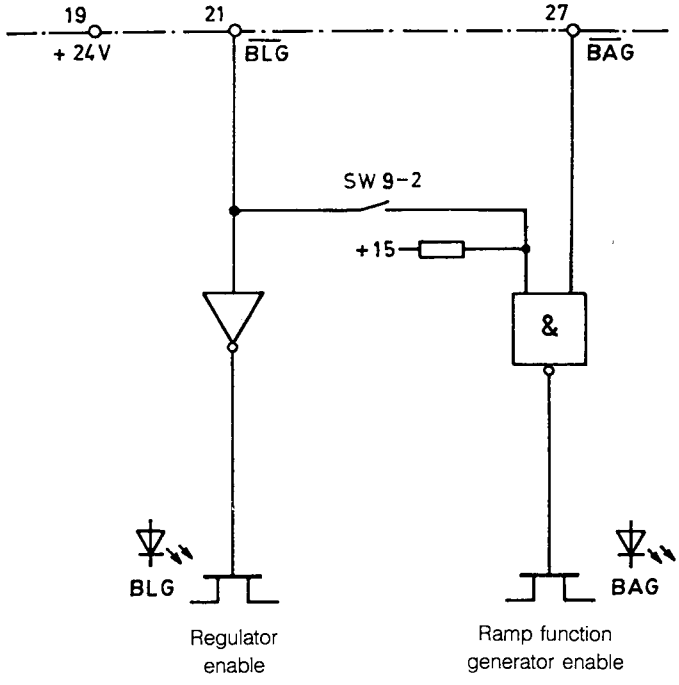


Fig. 5.2.2.1

If the internal reference value generator is used, it must be enabled via terminal 27 ($\overline{BAG}$). When the ramp function generator is blocked, the LED "BAG" lights up.
As supplied, the ramp function generator enable is coupled to the regulator enable (SW9-2 = ON), i.e., generator enable only with voltage at terminal 21 and 27 (see Fig. 5.2.2.1).
If an independent generator enable is required, the SW9-2 should be switched to the OFF position.
Enable facilities as under 5.2.1.

Modification:

5.2.3 **Reference value enable**

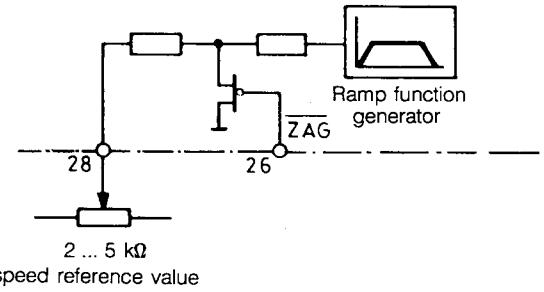


Fig. 5.2.3.1

With voltage applied to terminal 26 ($\overline{ZAG}$) the speed reference value (terminal 28) is connected to the input of the ramp function generator. Reference value enable is essential when operating with ramp function generator.
For function and interaction of $\overline{BLG}$, $\overline{BAG}$ and $\overline{ZAG}$ see 5.4.1.
Enable facilities as under 5.2.1.

5.3 **Actual value circuit**

Maximum actual value voltage : 300V
Input current at n_{max} : Approximately 3 mA
Actual value matching through appropriate setting of the miniature switch SW3-... (see table under 14.1). Fine tuning via the potentiometer n_{max} on the Ry32 card.

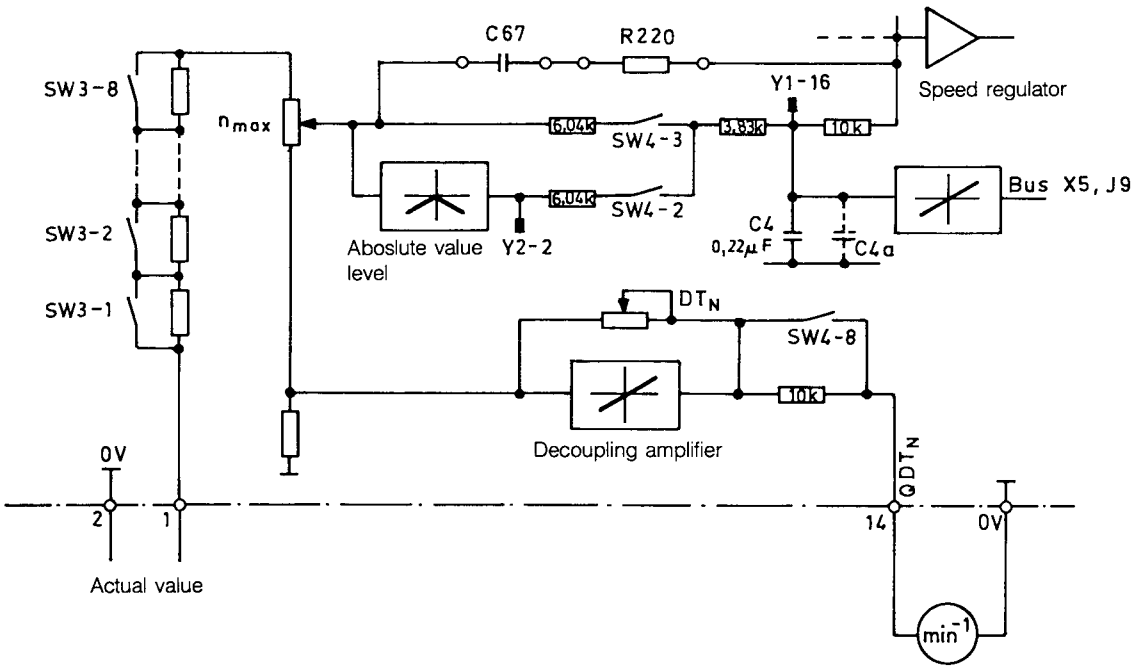


Fig. 5.3.1

Modification:

The time constant of the input filter (determined by C4 or C4a) is not dependent on the actual value voltage. If the motor is likely to be subjected to sudden loads it is recommended that a D-component be provided in the actual value circuit. (Remove C4; fit R220 and C67 onto Ry32).
Since the values are closely related to the specific application, they must be established at the commissioning stage. Appropriate fitting locations are provided.

The behaviour of the actual value circuit depends on the position of the switches SW4-2 and SW4-3.

1. SW4-2 ON, SW4-3 OFF = Standard on TPy3...2B
   The actual value input behaves in the manner of a rectifier. The voltage at the test point Y1-16 is always negative. A.C. tachometers can also be connected.
2. SW4-2 OFF, SW4-3 ON = Standard on TPy3...2B + e
   The voltage at Y1-16 has the same polarity as at terminal 1. **This switch position is essential with two quadrant drives,** because in this application, the tachometer voltage or the E.M.F. have the effect of a reference value during braking operation and must have positive polarity.

5.3.1 Tachometer regulation

— Connection in accordance with Fig. 5.3.1.1
— Matching to tachometer voltage in accordance with table under 14.1
— Single quadrant operation: d.c. and a.c. tachometers can be used as actual value transmitters
— Two quadrant operation: only d.c. tachometers (For connection see Figs. 4.2.3 and 4.2.5)

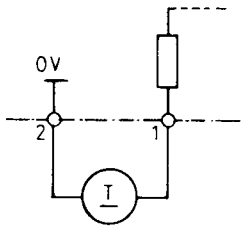


Fig. 5.3.1.1

5.3.2 Armature voltage regulation with high-impedance decoupling

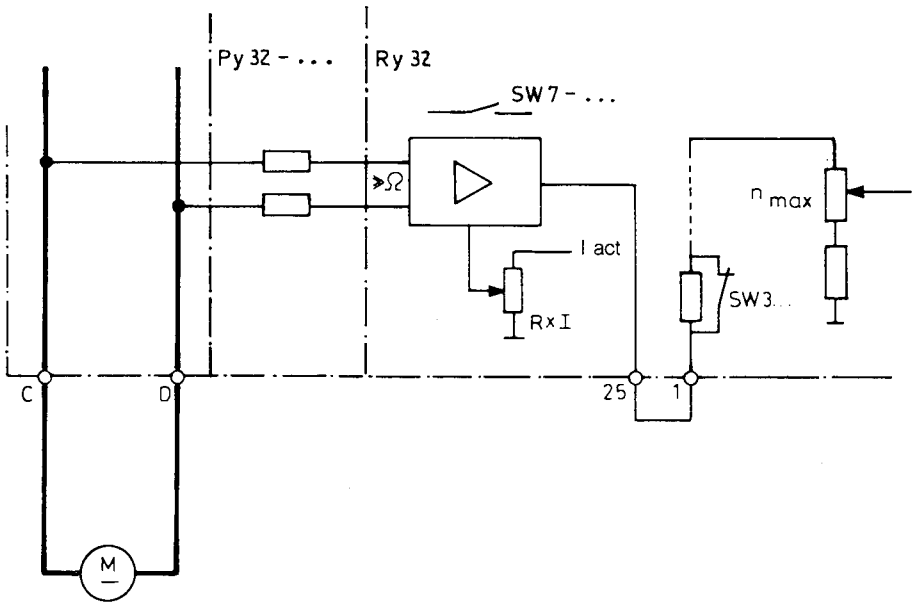


Fig. 5.3.2.1.

— Connection as in Fig. 5.3.2.1
— SW3-1...8 in the ON position
— Matching to the mains voltage with SW7 in accordance with the table overleaf.

The armature voltage is fed back to the actual value input via high-impedance resistors and a differential amplifier. By this means, the regulator sections can be de-coupled without the need for d.c./d.c. transformers or multi-couplers.

After the signal has been filtered and decoupled, the actual value signal is available as a voltage of approximately 10V maximum (terminal 25). This signal and the actual value input are connected via an external bridge between terminals 25 and 1.

During armature voltage regulation, the motor speed at a constant armature voltage decreases as the load increases. This load-dependent decrease of the speed can be reduced by means of the built-in RxI compensation (potentiometer RxI).

Modification:

Matching of the decoupling amplifier:

U_{LN}			Q_{EN} = 10 V at U_{dN} = *	
230/240 V	AC	SW7-1	267 V	DC
380 V	AC	SW7-2	429 V	DC
415 V	AC	SW7-3	467 V	DC
440/460 V	AC	SW7-4	508 V	DC
480/500 V	AC	SW7-5	553 V	DC

* RxI compensation not taken into account.

The position of the SW7 depends on the mains voltage U_{LN}. Only one micro-switch of SW7 may be closed. The amplifier may also be matched to other mains voltages (for example from an ancillary transformer). In this case SW7-1...5 should be switched to the OFF position, and R90 fitted.

Rating:

$$R90 = 10\ k\Omega \left(\frac{490\ V}{U_{LN}} - 1 \right)$$

U_{LN} = Voltage at terminals U, V, W of the power section of the converter.

5.3.3 Speed signalling

The switching threshold for the speed signal can be infinitely adjusted using potentiometer "n≥0". There are two alternatives:

1. SW8-2 = ON setting range 0.3...10% n_{max}
2. SW8-2 = OFF setting range 3...100% n_{max}

Signal: — Via a potential-free contact (220 V a.c., 3A) between terminals 33 and 34.
— Via a static signal 0V/+24V, 10 mA at terminal 32
— Via the LED "RV" on card Ry32

Below the switching point
— the contact is open
— the static signal is 0V
— the LED "RV" lights up

Above the switching point
— the contact is closed
— the static signal is approximately +24V
— the LED "RV" does not light up.

Note: When using speed regulator matching, the position of the potentiometer "n≥0" determines the threshold for recognition of n_{act} (see 5.6).

The speed signal decay is delayed, the delay time τ being determined by the resistor R180.

$$\tau = 1{,}35 \times R180$$

τ [ms] R180 [kΩ]

Standard: R180 = 47 kΩ
$\tau \approx 65$ ms

Modification:

5.3.4 Speed indication

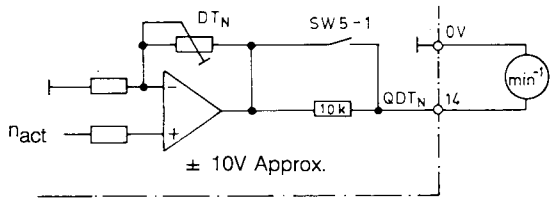


Fig. 5.3.4.1

A signal, directly proportional to the actual value, is available at terminal 14 of the converter for connection of a speed indicator. The polarity of terminal 14 corresponds to that of terminal 1

SW4-8 ON : Voltage signal
0V ... approximately ±10V maximum on terminal 14, load capacity: 3 mA

SW4-8 OFF: Connection of an mA meter with 1 mA at full-scale deflection. The deflection of the pointer at n_{max} can be calibrated using potentiometer DT_N.
Scale in rpm, m/s. %...

5.4 Reference value circuit

The magnitude of the reference value voltage determines the speed of the motor under control.

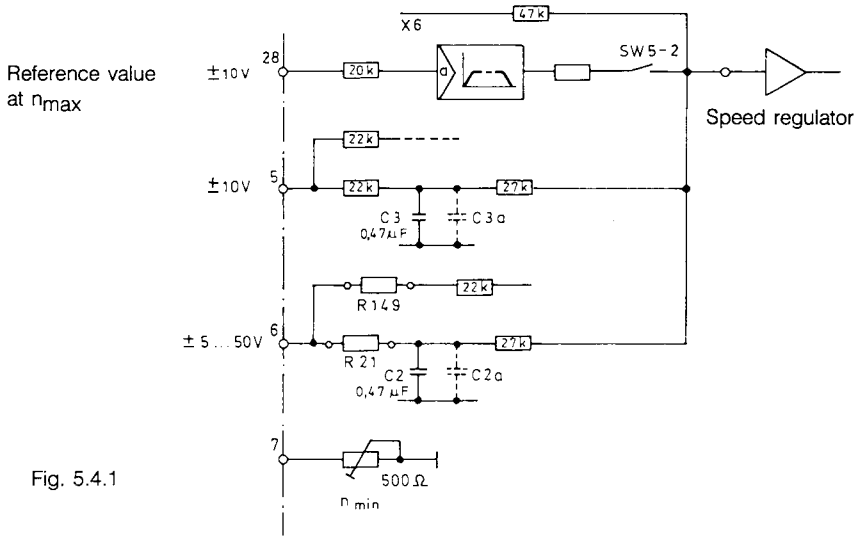
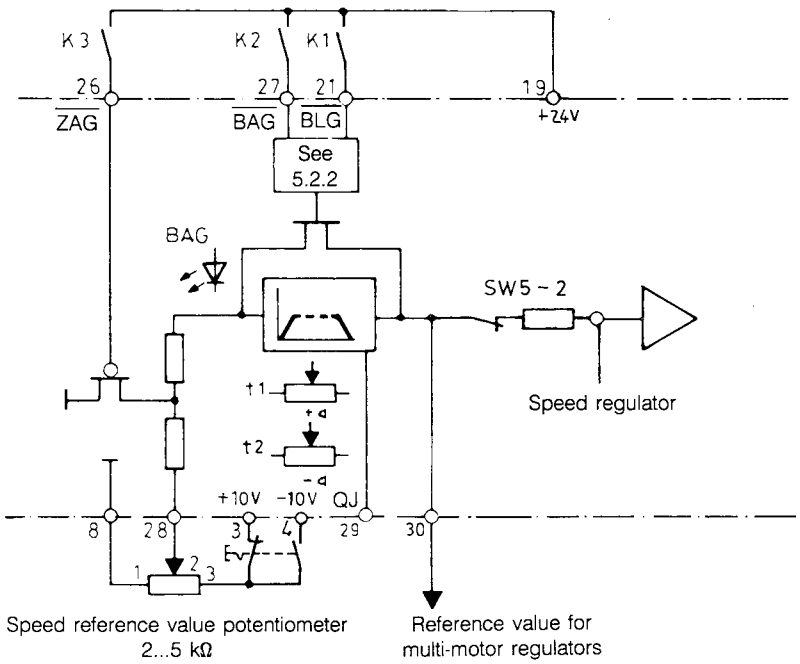


Fig. 5.4.1

5.4.1 Operation with ramp function generator



K1 = Regulator enable
K2 = Ramp function generator enable
K3 = Reference value enable

Fig. 5.4.1.1.

Modification:

The ramp function generator is used to delay changes in the reference value voltage and thus to achieve run-up and run-down processes of predetermined duration. Wiring is in accordance with Fig. 5.4.1.1.
Input : Terminal 28 ±10 V maximum, 0.5 mA maximum
Output : Terminal 30 ±10 V maximum, 4 mA maximum (+ internal reference value input via SW8-1).
On the converter as supplied, the ramp function generator output is connected to the input of the speed regulator via SW8-1.
The run-up time is determined by resistors R142A, R142B, R142C and the position of the potentiometer "+a"; the run-down time by R141A, R141B, R141C and the position of "—a".

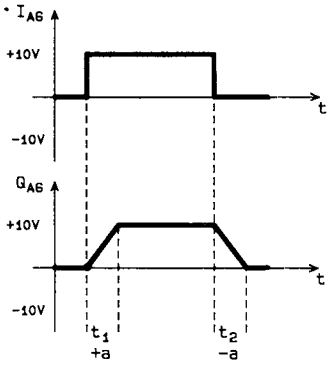


Fig. 5.4.1.2

	STANDARD	NO STANDARD	
	□ $t_1 = t_2$ 0,5...5s	□ $t_1 = t_2$ 3...30s	□ $t_1 = t_2$ 15...150s
R141a = 4.7MΩ R142a = 4.7MΩ			
R141b = 1.2MΩ R142b = 1.2MΩ			
R141c = 220kΩ R142c = 220kΩ			

If the run-up time is to be set externally, the supplementary card AGy should be used. This is fitted inside the unit, at the back of the Ry32 regulator card.

Mode of operation	Enable voltage on terminals	Function
Run-up; operation	21, 26, 27	Motor runs up to the required speed in the ramp time set on potentiometer "+a".
Controlled run-down	21, 27	Motor runs down to zero speed in the ramp time set on potentiometer "—a". Pre-requisite: The set run-down time is longer the run-down time without ramp function generator.
Uncontrolled run-down	—	The motor runs down. The time is determined by centrifugal mass, friction and the speed at the moment of switching off.

For enable facilities, see 5.2.

During transition processes (speed changes), on coiling machines and the like, a voltage signal is available at terminal 29 for the actuation of the inertia compensation.
Motor accelerates → approximately —10V; load capacity: 4 mA maximum
Motor decelerates → approximately +10V; load capacity: 4 mA maximum

5.4.2 Operation without ramp function generator

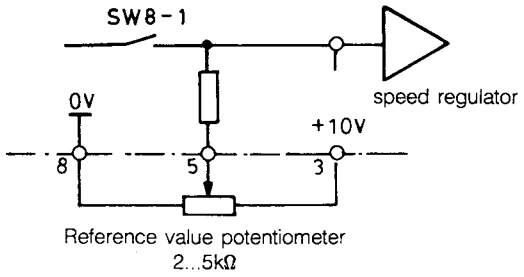


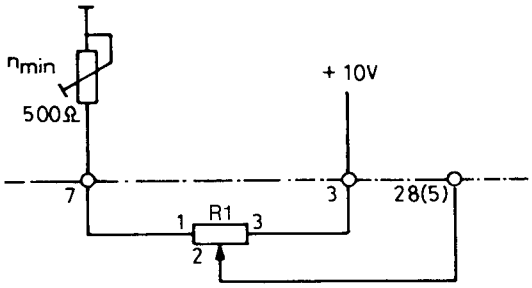
Fig. 5.4.2.1

— Connection as in Fig. 5.4.2.1.
— SW8-1 in the OFF position.
— Reference value input: ±10 V maximum, 0.65 mA maximum (terminal 5)

The motor speed follows the setting on the potentiometer.
Transition times from one speed to another during reference value changes are determined by the set current-limitation and the motor load. Terminal 6 is available for reference and correction values from external source (see 5.4.5).

Modification:

5.4.3 Minimum speed



R1 = reference value potentiometer 2...5kΩ

Fig. 5.4.3.1

If the circuit is connected as shown in Fig. 5.4.3.1, and the reference value potentiometer is turned anti-clockwise to its fullest extent, a basic speed can be set, using the potentiometer "n_{min}" on card Ry32. The maximum value of this will depend on the resistance of the selected reference value potentiometer.

R1 = 2kΩ : n_{min} ≤20% n_{max}
R1 = 5kΩ : n_{min} ≤ 9% n_{max}

5.4.4 Independent creep speed

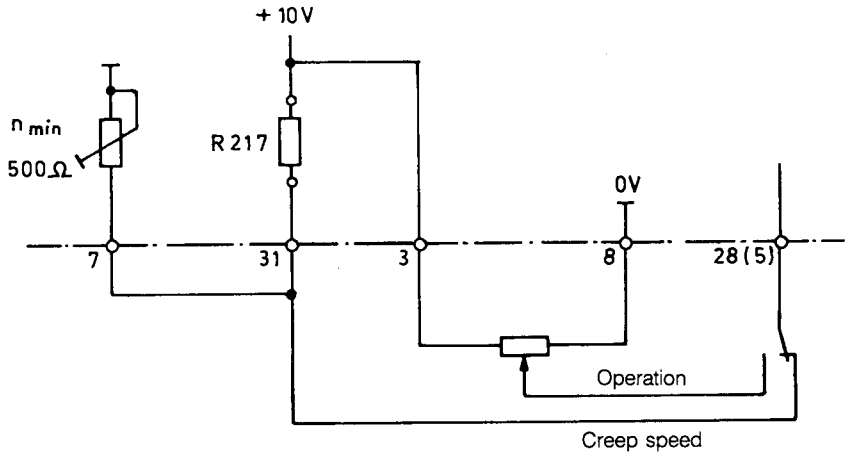


Fig. 5.4.4.1

If the circuit is connected as shown in Fig. 5.4.4.1, a creep speed can be set, using potentiometer "n_{min}" on card Ry32. The possible range depends on the rating of R217. The load capacity of the +10V power supply has to be taken into consideration (see 5.1).

$$R217 = \frac{U_{max} \times 500\Omega}{n_s} - 500\Omega \qquad \text{(1/4 Watt)}$$

n_s = Creep speed when potentiometer "n_{min}" is turned clockwise to its fullest extent
Standard: R217 = 4,7kΩ → n_s = 0...9,5% n_{max}

5.4.5 External reference and correction values

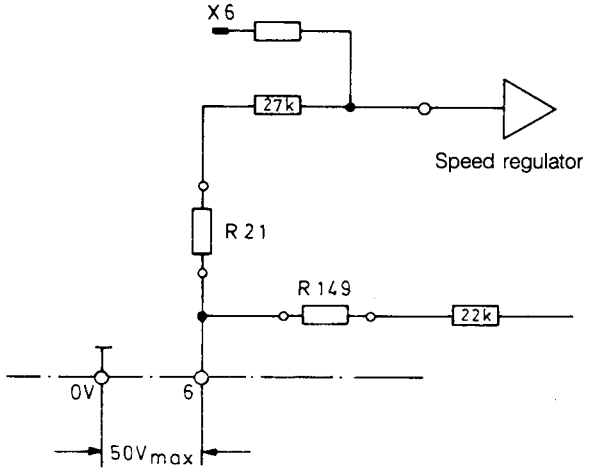


Fig. 5.4.5.1

Modification:

The influence of the voltage on terminal 6 is determined by R21, which as supplied, has a resistance of 22 kΩ. This corresponds to a maximum external input reference value of 10V. In all other applications R21 has to be exchanged and rated in accordance with the formulae below.

Please note: When using terminal 6 and the required speed regulator matching, R149 must be rated accordingly (see 5.6).

Maximum load of the external voltage source: 0.65 mA.

1. External reference values

   U_6 must be a positive voltage.
   Input matching is via R21

Rating:

$$R21 = \frac{U_{6max}}{0{,}2\ mA} - 27\ k\Omega \qquad \text{(1/4 Watt)}$$

2. Correction values

   Rating depends on the degree to which the correction value is to influence the reference value. The correction figure, as a percentage of the speed, is to be inserted in the following formula:

$$R21 = \frac{U_{6max} \cdot 100\%}{0{,}2\ mA \cdot ...\%} - 27\ k\Omega \qquad \text{(1/4 Watt)}$$

3. If the reference or correction value comes from an internal supplementary card, it is switched to the speed regulator input via internal bus connection to terminal 6. No external connection is necessary to terminal 6.

5.5 Current limitation

The current limitation is set ex-works to the rated current of the device (I_{dN}). This value may be reduced (see also 2.3). When the current as set on the current limitation potentiometers is reached, the LED "I_{dN}" lights up.

5.5.1 Internal current limitation

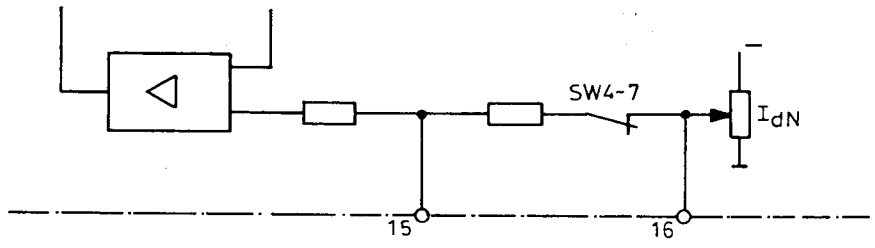


Fig. 5.5.1.1

— SW4-7 ON = Standard
— Current limitation is set with the potentiometer "—I_{dN}" on card Ry32 (see 6.3.1).

5.5.2 External current limitation

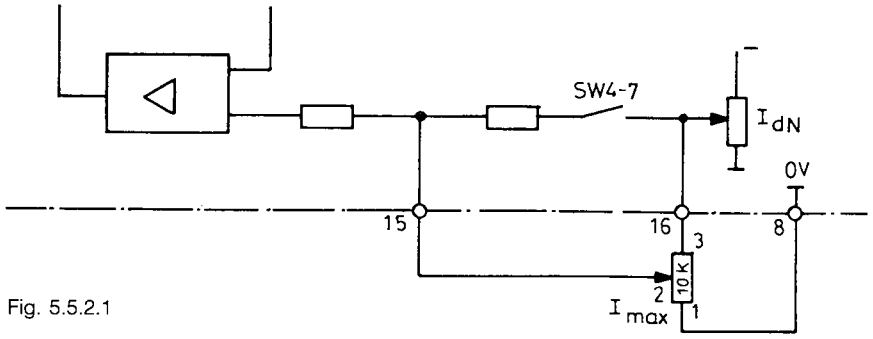


Fig. 5.5.2.1

Modification:

— Switch SW4-7 to the OFF position
— Connect circuit as in Fig. 5.5.2.1
— The setting of the internal potentiometers "—I_{dN}" determines the current when the external potentiometer "I_{max}" is turned fully clockwise.

5.5.3 Current indication

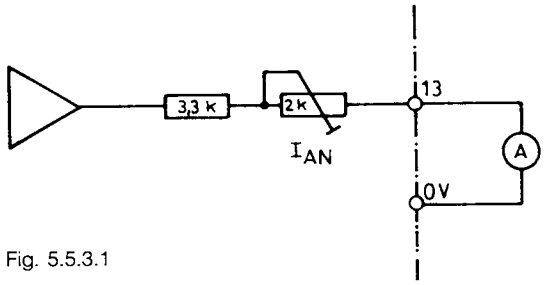


Fig. 5.5.3.1

A signal which is proportional to the actual value of the current is available at terminal 13 of the converter, for connection of an ammeter (positive voltage).
We recommend the use of a mA-meter registering 1 mA at full scale deflection, the scale being appropriately calibrated. The deflection of the pointer can be set with the potentiometer "I_{AN}" on card Ry32 (see 6.3.1).

5.5.4 Negative direction of torque with TPy3...2B + e

When operating TPy3...2B + e units in conjunction with four quadrant field current converters, the current limitation for the negative torque direction can be set separately on card ROy.

a) Internal current limitation

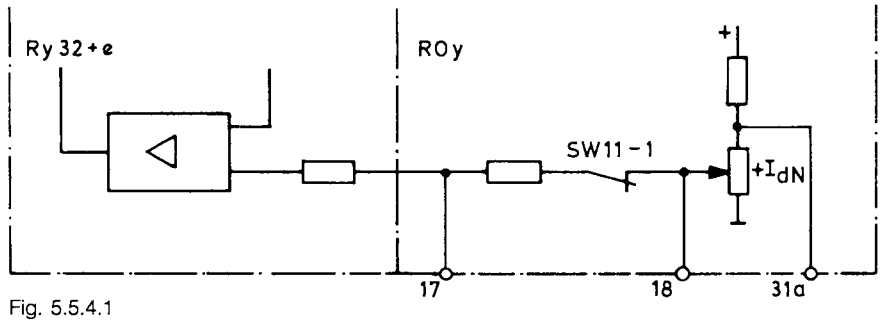


Fig. 5.5.4.1

— SW11-1 on card ROy = ON → standard
— Setting of the current limitation with potentiometer "+I_{dN}" on card ROy

b) External current limitation

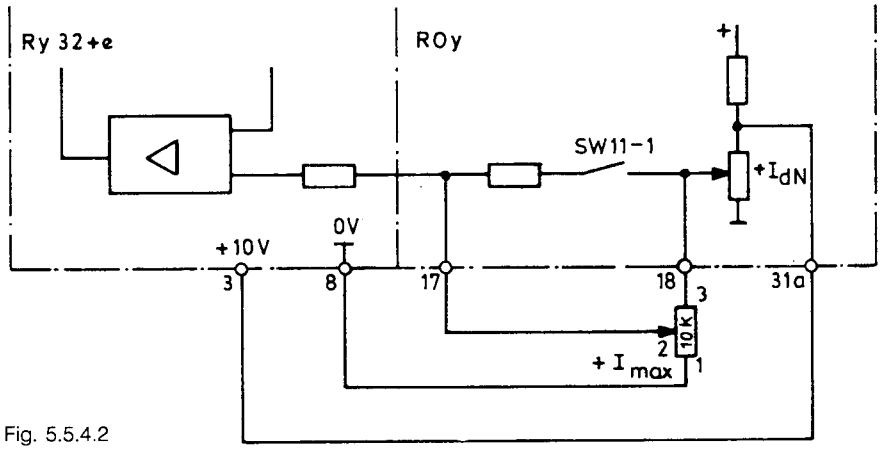


Fig. 5.5.4.2

— Switch SW1-11 on card ROy to the OFF position
— For connection see Fig. 5.5.4.2
— The position of the internal potentiometer "+I_{dN}" determines the current when the external potentiometer "+I_{max}" is turned fully clockwise.

Modification:

5.6 Speed regulator

The speed regulator can be operated as PI or P regulator as required. A voltage of +15V ... +24V at terminal 21 (see 5.2.1) will enable the regulator.

Measuring point Y1-1 → 0V = I-component enabled
→ +15V = I-component blocked

LED "BLG" lights up → regulator blocked
LED "BLG" does not light up, LED "±15" lights up → regulator enabled.

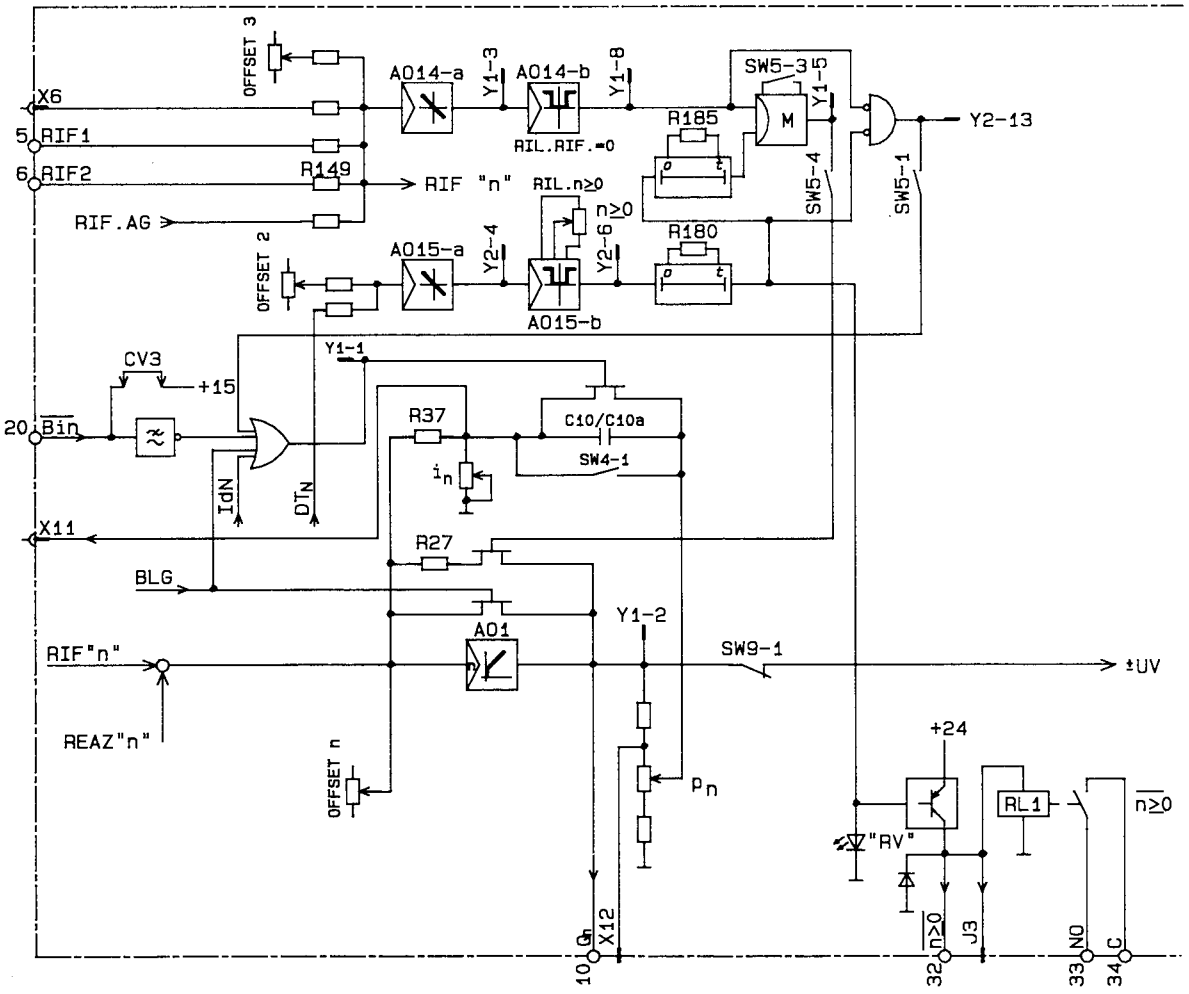


Fig. 5.6.1 Speed regulator

Modification:

1. PI-characteristic = standard version
   — SW4-1 OFF
   — CV3 = bridge
   — Calibration of P-amplification with potentiometer "p_n" on card Ry32
   — Calibration of I-amplification with potentiometer "i_n" on card Ry32.

2. P-characteristic
   — SW4-1 ON
   — Potentiometer "i_n" on card Ry32 fully clockwise
   — Calibration of amplification with potentiometer "p_n" on card Ry32.

3. PI-and P-characteristic
   — SW4-1 OFF
   — Remove CV3 bridge
   — No voltage at terminal 20 → P-characteristic
   — +15...+24V at terminal 20 → PI-characteristic

Please note: If the current as set on the current limiter flows, the speed regulator always has P-characteristic.

P- and I-components can be calibrated separately.

P-component : The minimum amplification K_{pmin} is 2,4 as standard, and is determined by R37. K_p can be set between 1 and 9,3 K_{pmin} via the potentiometer "p_n". If required, R37 can be exchanged.

$$K_{pmin} = \frac{R37}{50\ k\Omega}$$

Standard: R37 = 120 kΩ

I-component : The minimum time constant T_{min} is 60 ms and is determined by C10. T_I can be set between 1...10 T_{Imin} with the potentiometer "i_n". The supplementary capacitors C10a can be fitted in order to increase T_I. The following applies:

$$T_{Imax} = 120\ (5 + C10a)$$

T (ms) C (μF)

Note: The output signal of the speed regulator is available on terminal 10. It should not be transmitted beyond short distances within the control panel. Wiring should be screened. If lengthy connections are unavoidable, we recommend the use of an Ay-type P-amplifier for decoupling in order to avoid external influences on the reference current value.

Speed regulator matching is provided as standard, but as supplied, is switched off. The following speed regulator behaviour is achieved by switching in the individual matching components.

SW5-4 ON → R27 is switched in parallel to the speed regulator feedback when $n_{ref} = 0$ and $n_{act} \leq n1$. The parallel switching of the resistor is time-delayed (under the influence of R180 and R185), switching off is undelayed.
This reduces the amplification factor of the speed regulator, and helps protect it from excessive voltages arising at its output, should a high P-component in the feedback circuit result in an offset drift occurring when the speed regulator is enabled. (Parallel switching when SW5-4 ON and 0V at Y1-5).

SW5-3 OFF → The parallel switching of R27 is cancelled, if the speed reference value $\neq 0$ and/or $n_{act} \geq n1$.

SW5-3 ON → The parallel switching of R27 is cancelled only if the speed reference value $\neq 0$.

SW5-1 ON → I-component of the speed regulator feedback is blocked when $n_{ref} = 0$ and $n_{act} \leq n1$.
In this case the capacitors of the n-regulator feedback are shorted out.
This prevents
   — The offset drift of the speed regulator leading to restarting of the motor from standstill if the regulator is enabled.
   (Blocking of the I-component when SW5-1 ON and 0V at Y2-13).

Modification:

Note: The response threshold "n1" for the n_{act} recognition is dependent on the setting of the potentiometer "n ≥ 0". SW8-2 has to be set to the ON position (see 5.3.3).

When using terminal 6 as input for the preset value or correction value, the value of the resistor R149 has to be checked, and changed if necessary.

Terminal 6 reference value input

$$R149 = \frac{U6}{0{,}5\ mA} - 22\ k\Omega$$

Terminal 6 correction input

$$R149 = \frac{U6 \times 100\%}{0{,}5\ mA \times ...\%} - 22\ k\Omega$$

Please note: If the motor to be regulated has to produce a torque when it is at a standstill, SW5-1 and SW5-4 are to be switched to the OFF position.

Where very wide speed regulation ranges are involved, we recommend the use of a supplementary card APSy, through which the speed regulator amplification is related to the speed.

Standard: R27 = Bridge
R149 = Bridge (≙ reference value 10V at terminal 6)

5.7 Current regulator

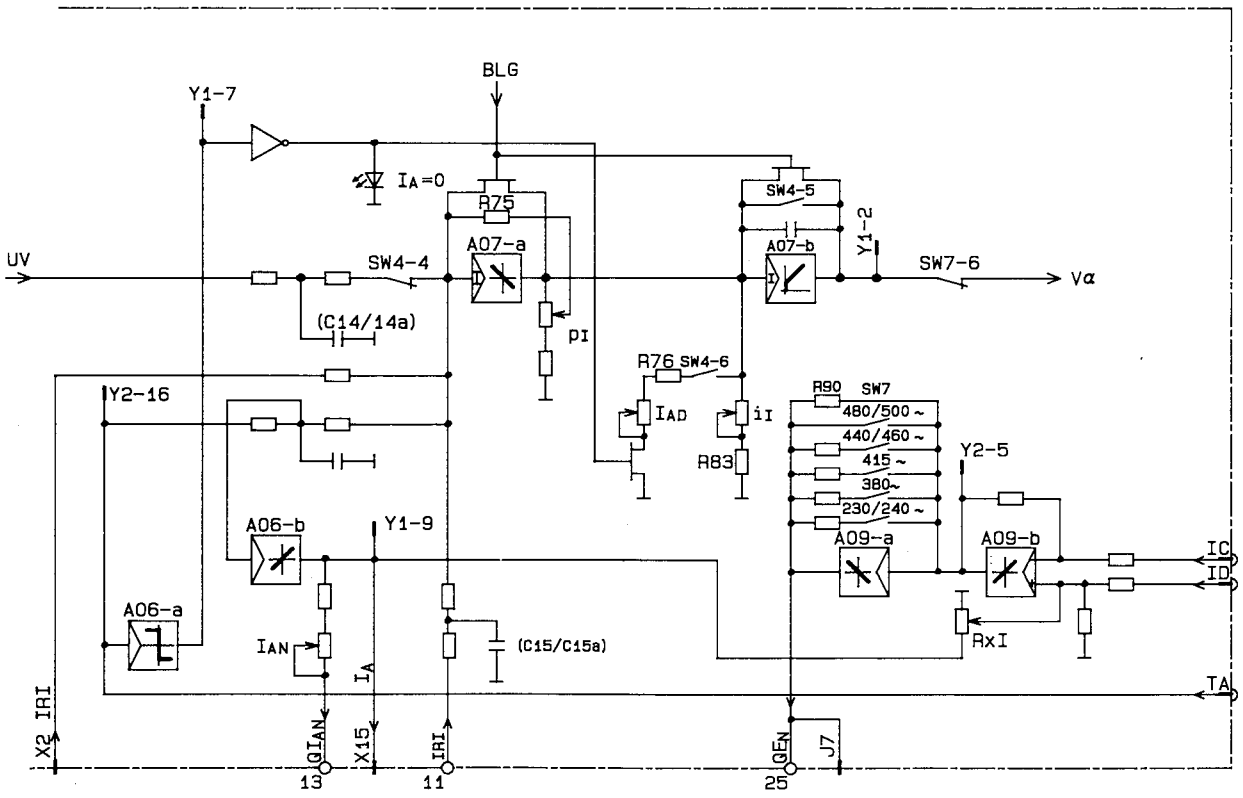


Fig. 5.7.1 Current regulator

Modification:

The current regulator is a PI regulator with power-dip matching. P- and I-components can be calibrated separately.

P-component : The minimum amplification K_{pmin} is 0,1 as standard and is determined by R75. K_p can be set between 1 and 9 × K_{pmin} with the potentiometer "p_I". If required, R75 can be exchanged.

$$K_{pmin} = \frac{R75}{112\ k\Omega}$$

Standard: R75 = 12 kΩ

I-component : SW4-5 ON = I-component switched off
SW4-5 OFF = I-component activated = standard
The minimum time constant T_{Imin} is determined by R83. Potentiometer "i_I" provides infinite adjustment of T_I. The following applies:

$T_{Imin} = 0{,}47 \times R83$
$T_{Imax} = 0{,}47 \times (R83 + 50\ k\Omega)$

T [ms]
R83 [kΩ]

Standard: R83 = 10 kΩ Pot. "i_I" = 50 kΩ → T_I = 4,7...28 ms

If required, the value of R83 can be changed.

Power-dip matching: SW4-6 ON = power-dip matching activated = standard
SW4-6 OFF = power-dip matching switched off
The effect of the power dip matching is determined by R76 and increases as this latter is reduced.
Standard: R76 = 220Ω.
Infinite adjustment is possible using potentiometer "I_{AD}".

A signal of +15...+24V at terminal 21 enables the regulator. When the regulator is blocked the LED "BLG" lights up.
In the majority of cases the current reference value comes via SW4-4 from the output of the speed regulator. When the reference value is set externally: connect negative polarity to terminal 11. Switch SW4-4 to the OFF position. The internal current limitation is inoperative in this case. Take care that the device rated current I_{dn} is not exceeded. Terminal 11: —10V maximum; 0.6 mA maximum.

5.8 Current regulation

The LED "I_{dN}" lights up in this mode of operation.

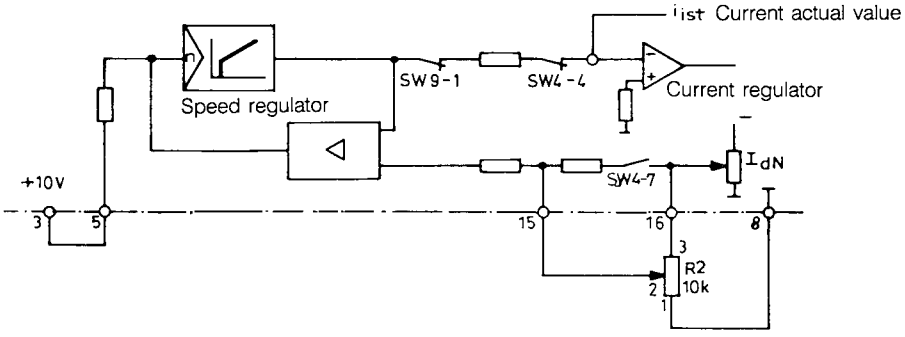


Fig. 5.8.1 Current regulation

Modification

— SW4-7 OFF
— Connect potentiometer R2 for the current reference value in accordance with Fig. 5.8.1
— With the external reference value potentiometer R2 turned fully clockwise, (maximum rated current of the device), the current can be set on the potentiometer "—I_{dN}" on card Ry32.

In order to provide the option of current or speed regulation, connect the circuit as shown in Fig. 5.8.2.

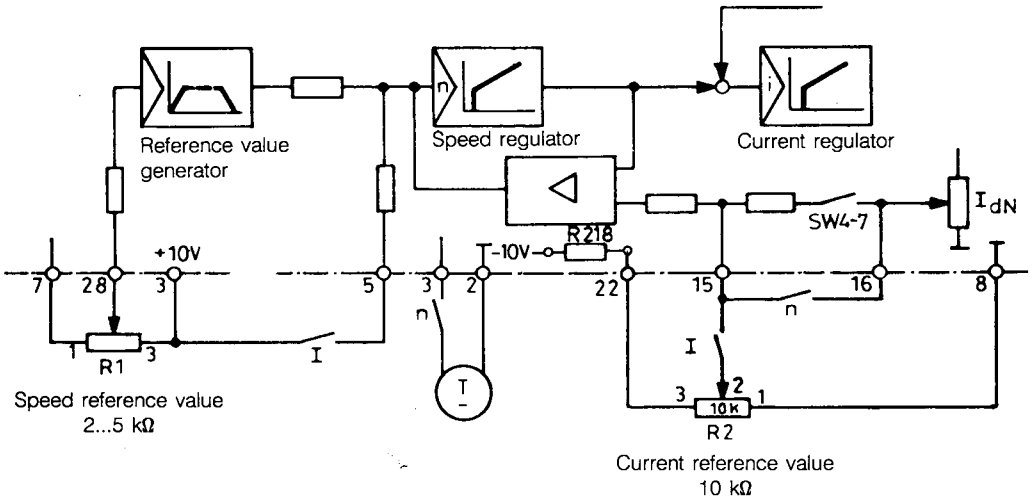


Fig. 5.8.2 Current and speed regulation

n = contacts closed for speed regulation
I = contacts closed for current regulation

— SW4-7 OFF
— Speed (n) regulation:
  — Relevant contacts closed
  — Reference value via potentiometer R1
  — With R1 turned fully clockwise speed can be set using potentiometer "n_{max}" on card Ry32.

I-regulation:
  — Relevant contacts closed
  — Reference value via potentiometer R2
  — The maximum value is determined by the rating of R218 (voltage splitter with R2)
  — The maximum current permissible is the rated converter current I_{dN} (R218 = bridge).

5.9 Trigger stage

The thyristors of the power section are actuated via a pulse chain, in order to ensure a reliable trigger, even with inductive loads.
Total lenght of the pulse chain: 2 ms
Pulse duration : 75 μs at the beginning of the chain, 45 μs thereafter.
Mains frequency matching is via SW6.
Maximum and minimum trigger angles are factory calibrated.

Modification:

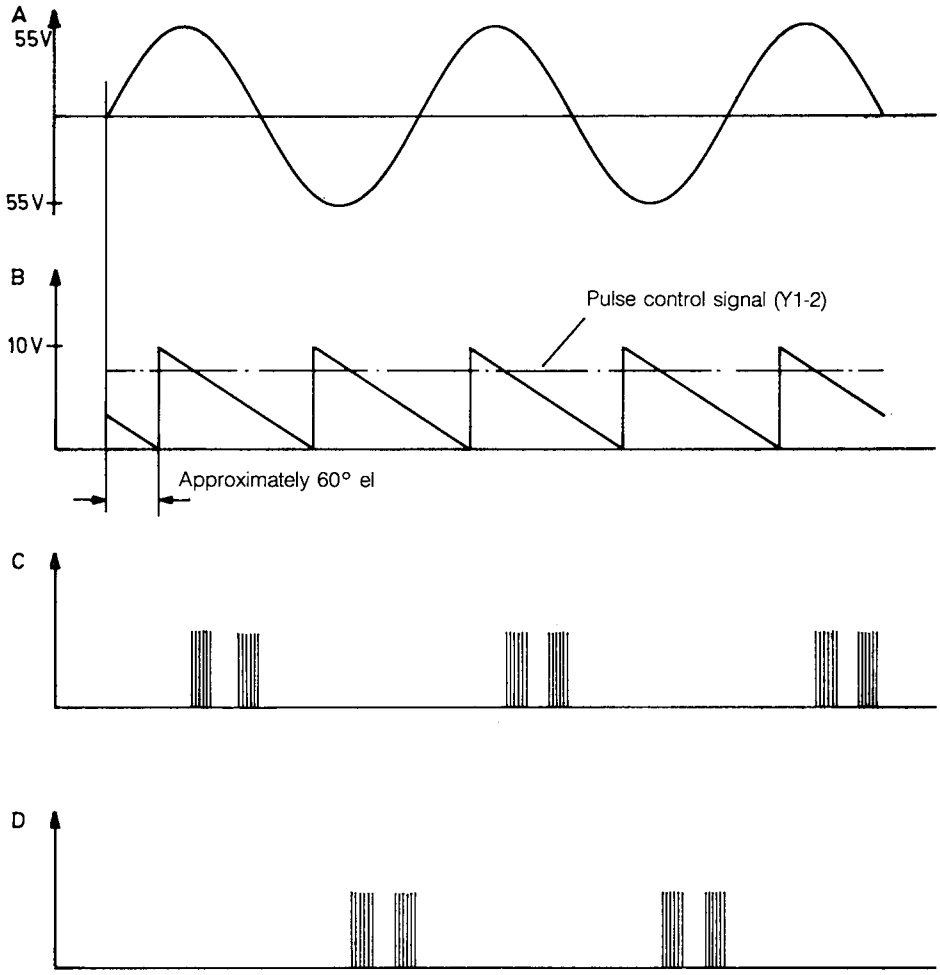


Fig. 5.9.1. Determination of the moment the thyristor is triggered

Signal A Synchronization voltage
Signal B Saw-tooth pulses (comparison with pulse control signal)
Signal C Pulses positive half-wave
Signal D Pulses negative half-wave

Phase	Measuring points for			
	A	B	C	D
U	Y3-5	Y3-4	Y3-8	Y3-12
V	Y3-16	Y3-3	Y3-1	Y3-20
W	Y3-17	Y3-2	Y3-7	Y3-19

Modification:

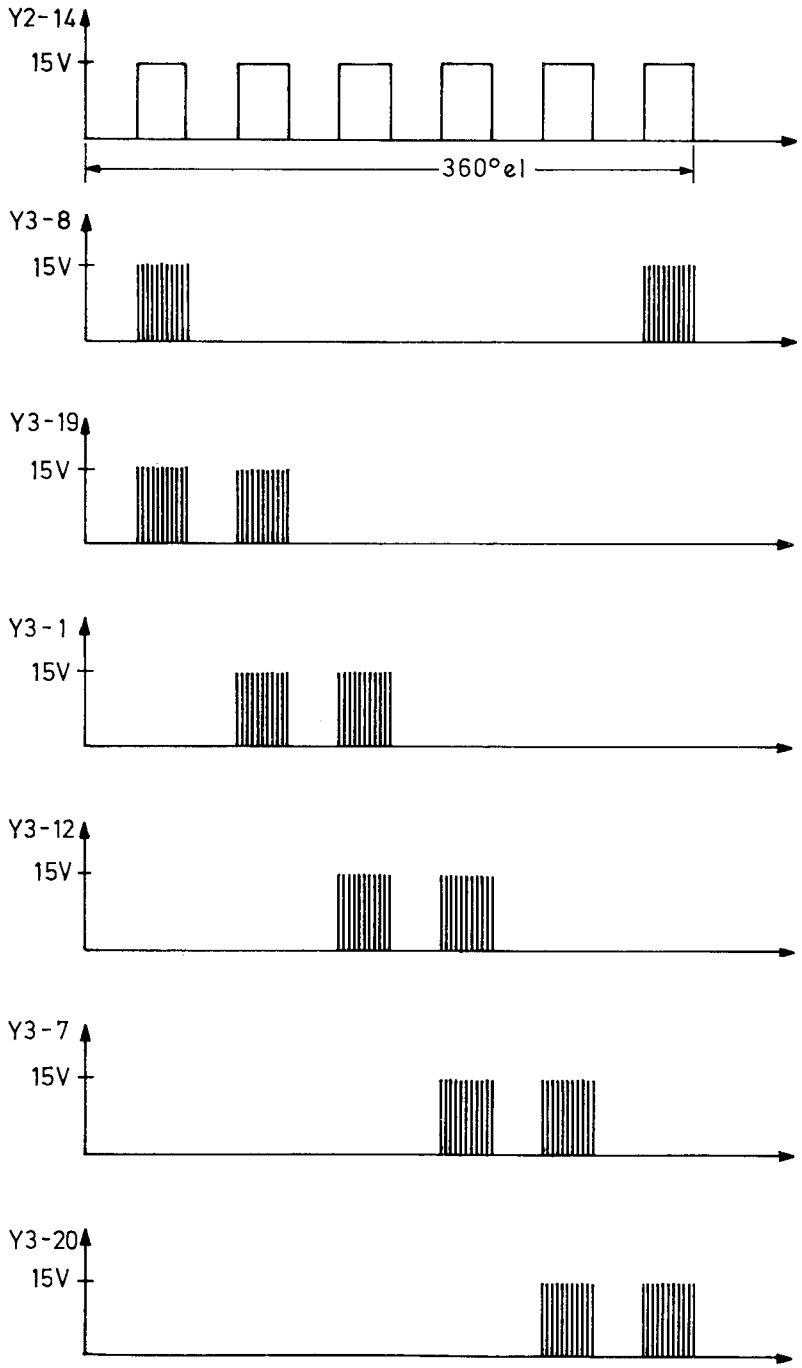


Fig. 5.9.2 Trigger sequence

Phase	Thyristor	Actuation	Pulses
U	T 1 T 4	Y3-8 Y3-12	Y3-9 Y3-10
V	T 2 T 5	Y3-1 Y3-20	Y3-6 Y3-15
W	T 3 T 6	Y3-7 Y3-19	Y3-13 Y3-11

Modification:

5.10 Control circuits

There are three control circuits within the TPy3...2B converters:
- AF LED "AF" lights up to indicate a blown fuse or fuses in the power section. The function of AF is switched off when SW5-2 is ON.
- RSH LED "RSH" indicates a short-circuit of the reference values or overload.
- AR LED "AR" lights up to indicate:
  - Blown fuse in the regulator supply (on the a.c. and d.c. side)
  - Mains undervoltage
  - Overload on the supply voltages

Converters OK*:
- Contact between the terminals 35 and 36 (250V a.c., 3 A, AC-11) closed
- Static signal on terminal 37 = +24V (load capacity: 10 mA)
- LED "AL" does not light up

* Supply voltage present on terminals 1U, 1V, 1W.

If one or more of the above mentioned faults should occur:
- Contact between terminals 35 and 36 opens
- The static signal on terminal 37 = 0V
- The LED "AL" and the LED allocated to the fault lights up
- Regulators are blocked and ignition pulses are suppressed.

This status is stored. To reset: switch off the regulator supply at 1U, 1V, 1W and switch on again.

The converters TPy3- ... / ... -900L ... 3000L-2B have internal fuses in the mains circuit and are self-monitoring. If all the fuses are in order the contact between terminals 83 and 84 (250V a.c., 2 A) is closed. If one or more fuses blow, it opens.
The "AF" control circuit monitors the protective circuit. Converters from 110 A rated current upwards have a device to monitor the temperature of the heat sink. If the temperature becomes excessive, the potential-free contact between terminals 61 and 62 opens.

6. Commissioning instructions

The circuit must be connected as shown in fig. 4.2...

6.1 Assembly test

Before switching on the following are to be checked:
- Correct connection of all wiring (4.2.1)
- If power and regulator sections are supplied separately:
  - CV-U, CV-V and CV-W should be removed (2.1)
  - Phase rotation (2.1)
- Fuse type (2.5.3)
- Setting of the overload relay (4.2.1)
- Mains voltage (2.1.)
- Matching to the mains frequency using SW6 (2.1)
- Position of the micro switches (14.)
- Rating of the n-actual value input (table under 14.1)
- Matching of the field current for units ≥ 900 A (2.4)

Modification:

6.2 Checking the auxiliary voltages

— Regulator blocked (disconnect wiring on terminal 21)
— Switch on system
— Check the voltages supplied by the converter, in accordance with table under 5.1
— Potentiometer "n_{min}" on card Ry32 fully anti-clockwise
— 0 volts must be present on terminal 1 of the preset value potentiometer and a voltage of +10V at terminal 3
— If the preset value potentiometer is turned fully anti-clockwise, 0V must be present at terminal 5 or 28 of the converter (without or with ramp function generator). If it is turned fully clockwise this voltage must be +10V
— When the motor is at operating temperature, calibrate the field using any available field resistor
— Switch off motor, reconnect wires to terminal 21.

6.3 Commissioning

— Set reference value potentiometer R1 to approximately 20% of the reference value
— Switch on motor
— If the motor accelerates out of control, switch off main switch and check actual value connection. (Voltage polarity at terminal 1 against 0V? Matching with SW3...? With SW4-2 OFF and SW4-3 ON: is the voltage at terminal 1 negative? If not, change polarity of the actual value voltage).

6.3.1 Current limitation, current indication

During this setting the current is measured via a moving coil instrument in the armature circuit (possibly with shunt), since the output for current indication (terminal 13) is not calibrated until the commissioning stage. The converter rated current I_{dN} is set ex-works. Under no circumstances must the set figure be exceeded. If a reduction or resetting should be necessary, proceed as follows:

— Switch off motor
— Turn potentiometer "$-I_{dN}$" on card Ry32 fully anti-clockwise
— Disconnect motor field. Motor must not rotate during this setting; block if necessary
— Bridge out control terminals 53 and 54 of the converter (field current relay)
— Turn reference value potentiometer fully clockwise
— Switch on motor
— Set the required current on the potentiometer "$-I_{dN}$" on card Ry32
— An ammeter connected to terminal 13 is now calibrated, using potentiometer "I_{AN}" (see 5.5.3)
— For armature voltage regulation with high-impedance decoupling, the R×I compensation now has to be calibrated (see 6.3.2), otherwise:
— Switch off motor
— Remove bridge between terminals 53 and 54
— Connect field

6.3.2. R×I-compensation for armature voltage regulation with high-impedance decoupling

This calibration is carried out only for armature voltage regulation with high-impedance decoupling, and takes place after the current limitation has been set.

— First set current limit (see 6.3.1)
— Switch off motor
— Match to the input voltage with SW7 (see 5.3.2)
— Connect voltmeter between terminal 25 and 0V
— Switch on motor
— With potentiometer R×I on card Ry32, set 0V at terminal 25
— Switch off motor
— Remove bridge between terminals 53 and 54
— Connect field

• Modification:

6.3.3 Rated motor speed, speed indication

See also 5.3.
- Check position of switch SW3-... in accordance with table under 14.1
- Turn trimmer "n_{max}" on card Ry32 fully anti-clockwise
- Turn reference value potentiometer fully anti-clockwise
- Switch on motor
- Slowly turn reference value potentiometer R1 to the right-hand stop
- Set the required speed by turning the trimmer "n_{max}" clockwise
- A speed indicator connected to terminal 14 is now calibrated using potentiometer "DT_N" (see also 5.3.4).

6.3.4 Minimum speed

- Turn reference value potentiometer R1 fully anti-clockwise
- Switch on motor
- If circuit is connected as in Fig. 5.4.3.1 the minimum speed can be set using the potentiometer "n_{min}" on card Ry32.

6.3.5 Ramp function generator

The run-up and run-down times are determined by means of resistors R141A, B, C and R142A, B, C (see 5.4.1). Timers can be set in the ratio 1:12, using potentiometer "+a" and "−a".

6.3.6 Speed signalling

If speed signalling is required, proceed as follows:
- Select the setting range in accordance with 5.3.3
- Turn potentiometer "n≥ 0" fully anti-clockwise → LED "RV" lights up
- Run up motor to the speed at which signal is required
- Turn potentiometer "n≥0" clockwise until LED "RV" extinguishes.

6.3.7 Offset adjustment speed regulator

If the motor rotates while the reference value potentiometer R1 is turned fully anti-clockwise and n_{min} function is not in use, this is because the speed regulator is offset. Adjust as follows:
- Disconnect all reference and correction value wires
- Connect reference value input (terminal 5 or 28) with 0V
- SW4-1 ON
- Connect voltmeter between terminal 10 (speed regulator output) and 0V
- Switch on converter
- Turn potentiometer "p_n" on card Ry32 fully clockwise
- Set 0V on card Ry32 using trimmer "OFFSET"
- Switch off converter
- SW4-1 OFF
- Remove terminal 5 or 28 with 0V bridge
- Reput "p_n" in the previous position
- Reconnect reference and correction value cables.

If the motor should still rotate although the reference value potentiometer is fully anti-clockwise, this is because of the residual resistance of the wiring between terminal 1 of the reference value potentiometer and 0V. In this case R27 on card Ry32 must be bridged and SW5-4 must be switched to ON. In this case, the motor cannot generate any torque if $n_{ref} = 0$ and $n_{act} = 0$ (see 5.6).

6.3.8 Recognition of offset adjustment $n_{act} = 0$

The adjustment is made ex-works. If a subsequent adjustment should become necessary, proceed as follows:
- Connect voltmeter between measuring point Y2-4 and 0V
- With regulator energized and motor stationary, set 0V on Y2-4 using trimmer "OFFSET 2".

Modification:

6.3.9 Recognition of offset adjustment $n_{ref} = 0$

The adjustment is made ex-works. If a subsequent adjustment should become necessary, proceed as follows:
- Disconnect all reference and correction value cables
- Connect reference value input (terminal 5 or 28) to 0V
- Connect voltmeter between metering point Y1-3 and 0V
- Switch on motor
- Set 0V on Y1-3 using trimmer "OFFSET 3"
- Switch off motor
- Remove terminal 5 or 28 to 0V bridge
- Reconnect reference and correction value wires.

6.3.10 Stabilization of speed regulator

If the speed should oscillate, this can be eliminated in most cases by adjusting the potentiometers "p_n" and "i_n" on card Ry32, in which case, the relevant component will increase as the potentiometer is turned clockwise. If this is not enough, the converter must be tuned (see 6.4).

6.4 Tuning

In tuning the converter, the time constants of the speed and current regulators must be matched to the motor parameters. The regulators should react as quickly as possible, without overshooting, to the reference variations and the dynamic load variations. The regulator amplification can be regulated via the potentiometers "p_n", "i_n", "p_I", "i_I", and "I_{AD}". Tuning starts with the current regulator.

6.4.1 Current regulator

- Disconnect motor field, motor must not rotate, block if necessary
- Bridge control terminals 53 and 54 of the converter (field current relay)
- Potentiometer "i_n" turned fully clockwise
- Potentiometer "p_n" turned fully clockwise
- Potentiometer "p_I" turned fully anti-clockwise
- Potentiometer "i_I" turned fully clockwise
- Potentiometer "I_{AD}" turned fully anti-clockwise
- SW4-1 ON = P-amplification speed regulator
- SW4-6 ON = matching switched in
- The ramp function generator is to be blocked and the slide of the preset value potentiometer is to be connected to terminal 5
- Disconnect other reference or correction value terminals
- Connect store oscilloscope or chart recorder to metering point Y2-16
- Connect external switches S1 and S2 as in Fig. 6.4.1.1.

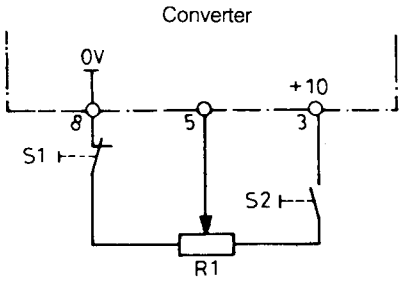


Fig. 6.4.1.1

Modification:

6.4.1.1 **Calibration with continuous current**

- — Turn external potentiometer R1 fully anti-clockwise
- — Switches S1 and S2 closed
- — Switch on motor
- — Set current dip limit via R1 (setting is maintained during tuning)
- — Actuate S1 and record actual current value
- — Check whether the current gain is as fast as possible, but without overshoot (Fig. 6.4.1.1.1)
- — If current gain is too slow (Fig. 6.4.1.1.2) turn potentiometer "p_I" clockwise and check new setting
- — If overshoot occurs (Fig. 6.4.1.1.3) turn potentiometer "p_I" anti-clockwise and check new setting
- — If the setting of the potentiometer "p_I" does not lead to an optimum result, the setting range can be modified by changing the value of R75. In this case the regulator gradient increases as the R75 values increase, and vice versa.
- — Follow this by turning potentiometer "i_I" slowly anti-clockwise until current fluctuations occur, then turn back slightly
- — If the setting of the potentiometer "i_I" does not lead to an optimum result, the setting range can be modified by changing the value of R83. In this case the regulator gradient increases as the R83 values increase, and vice versa
- — Switch off motor.

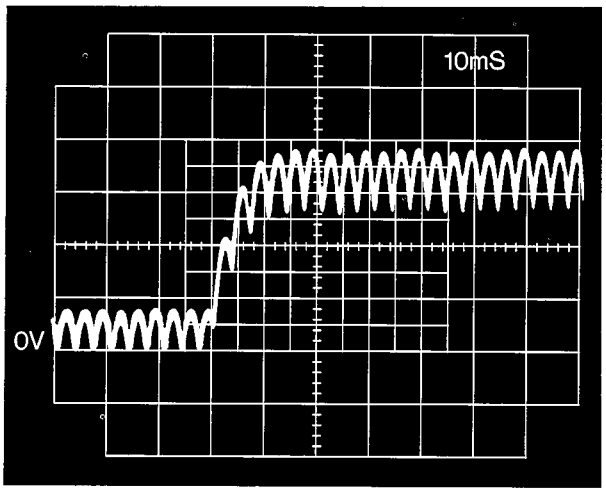


Fig. 6.4.1.1.1 Ideal

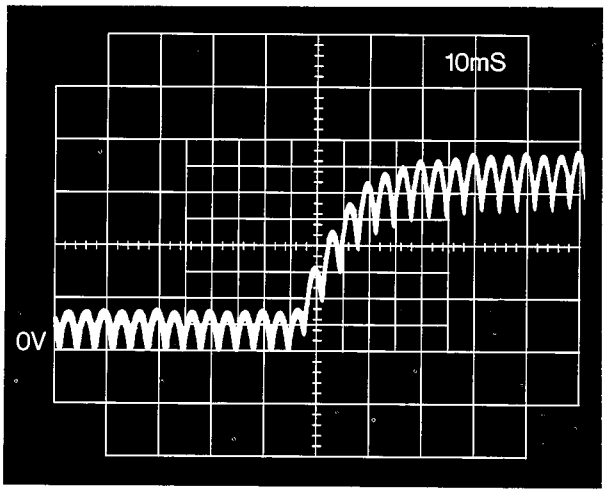


Fig. 6.4.1.1.2 Increase too slow

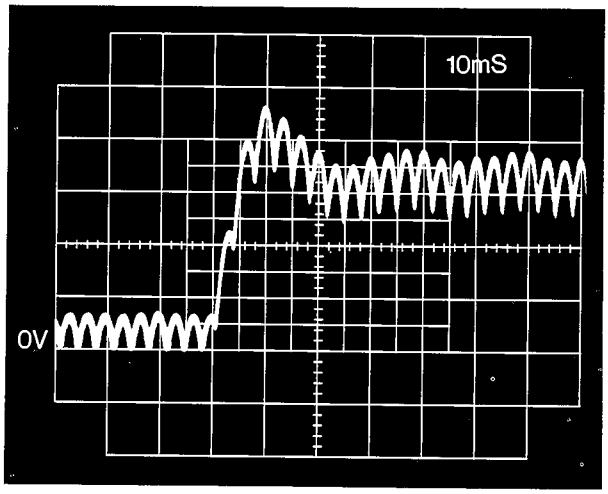


Fig. 6.4.1.1.3 Regulator too steep

Modification:

6.4.1.2 **Calibration with discontinuous current**

— Turn potentiometer "I_{AD}" fully anti-clockwise
— External switch S1 closed, S2 not actuated
— R1 same setting as before (fully anti-clockwise)
— Switch on motor
— Using switch S2, switch reference voltage on and off, and record actual current value
— Check whether che current gain is as fast as possible, but without overshoot (Fig. 6.4.1.2.1)
— If the gain is too slow (Fig. 6.4.1.2.2) turn potentiometer "I_{AD}" clockwise and check new setting
— If overshoot occurs (Fig. 6.4.1.1.3) turn potentiometer "I_{AD}" anti-clockwise and check new setting.
— If adjustment of the potentiometer "I_{AD}" does not lead to an optimum result, the setting range can be modified by changing the value of R76. The rate of gain increases as the value of R76 is reduced.

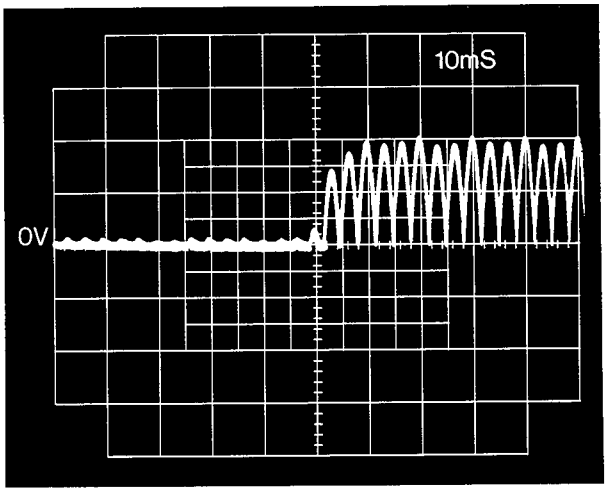


Fig. 6.4.1.2.1 Ideal

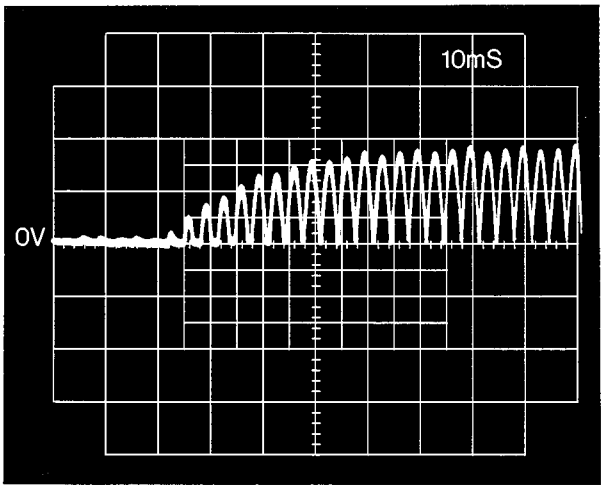


Fig. 6.4.1.2.2 Increase too slow

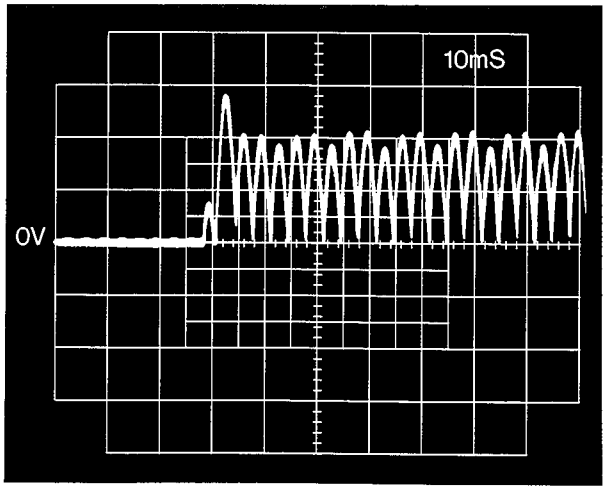


Fig. 6.4.1.2.3 Matching too steep

Modification:

6.4.1.3 **Checking the overall setting**

— S1 open
— Switch on motor
— Using switch S2, switch reference voltage on and off, and record actual current value
— No overshooting must occur (see Fig. 6.4.1.3.1)
— If overshooting should nevertheless occur, turn potentiometer "I_{AD}" anti-clockwise

— Switch off motor
— Disconnect oscilloscope or chart recorder
— Remove bridge between control terminals 53 and 54
—Connect motor field

(The following is omitted if speed regulator is to be calibrated):

— SW4-1 OFF
— Disconnect external switches
— When using the ramp function generator: connect reference value and generator enable
— Connect other preset or correction values

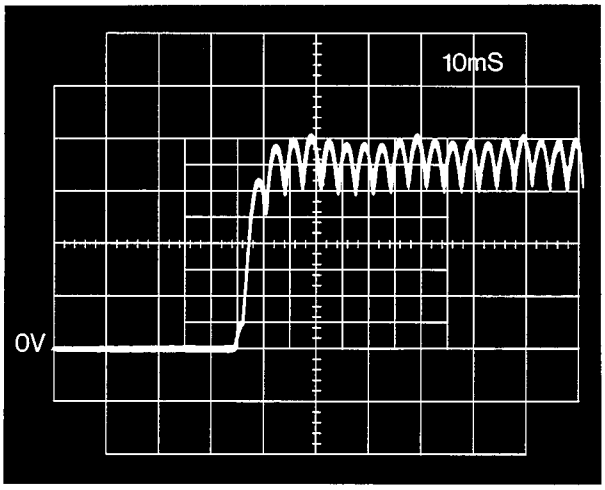


Fig. 6.4.1.3.1 Ideal overall setting

6.4.2 **Speed regulator**

— SW4-1 ON
— Block ramp function generator if fitted, connect slide of reference value potentiometer R1 to terminal 5
— Disconnect all other reference or correction values
— Potentiometer "i_n" on card Ry32 turned fully clockwise
— Potentiometer "p_n" on card Ry32 turned fully anti-clockwise
— Connect reference value potentiometer as shown in Fig. 6.4.1.1
— S1 closed
— S2 open
— Oscilloscope or chart recorder: Channel 1 at measuring point Y1-16 (speed actual value)
Channel 2 at measuring point Y2-1 (output speed regulator)
Reference point: 0V
— Turn external potentiometer R1 fully clockwise
— Switch on motor
— Close S2, taking note of signals
— Using potentiometer "p_n", set the amplification so that the speed (Y1-16) does not overshoot and the signal to Y2-1 does not undershoot
— SW4-1 OFF
— Turn potentiometer "i_n" slowly anti-clockwise until motor starts to oscillate then ease back slightly
— Switch off motor
— Disconnect oscilloscope or chart recorder and external switches
— Connect reference and correction values, and ramp function generator enable wires to their original terminals.

Modification:

7. Fault tracing

The following list shows a number of possible faults. These can be attributed in part to user errors, which can be eliminated with the aid of the measures described in the foregoing.

a) Motor does not rotate

a1) External fuse on the a.c. side has blown (LED "AF" lights up)

- Current regulator gain too steep → turn potentiometer "p_I" and/or "I_{AD}" anti-clockwise or optimise regulator
- Thyristor faulty. There must be a resistance of several MΩ between the anode and the cathode. To check, switch off system and disconnect motor
- Earth fault in the armature circuit
- When power and regulator sections are fed separately, regulator has been enabled before voltage was applied to U, V and W

a2) External fuse on the d.c. side has blown (only with two quadrant operation)

- Main contactor K1M or main switch has been opened during braking mode
- Earth fault in the armature circuit
- Current regulator gain too steep → turn potentiometer "p_I" and/or "I_{AD}" anti-clockwise or optimise regulator

a3) Main contactor open

- Check energization criteria (motor protection, control circuits, etc.)

a4) Main contactor closed, external fuses o.k.

- Is motor connected properly?
- LED "±15V" does not light up → no supply voltage, regulator fuse blown
- LED "I_{dn}" lights up → interruption in the armature circuit, no field, motor mechanically braked, current limitation too low
- Is regulator enabled? LED "BLG" must not light up
- Are SW4-4 and SW7-6 ON?
- During operation without ramp function generator: is reference value present at terminal 5?
- During operation with ramp function generator: is reference value present at the generator input (K1 and terminal 28) and is SW8-1 ON? (see 5.4.1)
  Are ramp function generator and reference value enabled? Is input voltage present?

b) Motor does not reach full speed

- Potentiometer "n_{max}" is set incorrectly and/or SW3-... is coded incorrectly
- LED "I_{dN}" lights up → motor drawing maximum current, relieve load on motor or increase current limitation (maximum I_{dN}) check field current
- Are all six thyristors of a bridge actuated? Six pulses must occur per mains cycle (20 ms at 50 Hz, 16,7 ms at 60 Hz)

c) Motor runs up too slowly

- LED "I_{dN}" lights during acceleration → motor draws maximum current while accelerating. Relieve load on motor or increase current limitation (maximum I_{dN}), check field current
- LED "I_{dN}" does not light up → ramping time too long. Try using the direct input of the speed regulator (terminal 5) for the reference value

d) Motor can be regulated only in the upper speed range

- No 0V connection to the reference value potentiometer

e) Motor runs in the right direction, but cannot be regulated

- No actual value input
- Actual value has incorrect polarity (terminal 1). Note: Only when SW4-2 OFF and SW4-3 ON.
- Phase sequence between power and regulator section incorrect (see 2.1).
- No 0V connection to the reference value potentiometer

Modification:

f) Motor rotates in the wrong direction, but can be regulated

- Reverse polarity of field connections
- With two quadrant motors: reverse polarity of tachometer connection as well.

g) Motor rotates in the wrong direction, and cannot be regulated

- Reverse polarity of motor field.

8. Plug J for the connection of a four quadrant field converter

The plug J is available for the connection of a four quadrant field converter on card Ry32e (only with TPy3...2B + e).

Designation	I/Q	Function		ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
J 1	Q	+15V	Supply voltage	5	A9	2	E6
J 2	Q	Q_n	Speed regulator output ±10V max. 1 mA max. including terminal 10	1	C9	1	E6
J 3	Q	$\overline{n \geq 0}$	Speed signal +24V : n > potentiometer "n ≥0" 0V : n < potentiometer "n ≥0" 10 mA maximum including terminal 32	6	D9	1	E9
J 4, J 5	—	0V	Reference potential	5	B9	2	E7
J 6	Q	−15V	Supply voltage	5	B9	2	E7
J 7	Q	QE_N	Standardised EMF output, high-impedance decoupled. Approximately ±10V max., 3 mA max. including terminal 25	2	C9	2	E5
J 8	I	$\overline{BIE}$/ $\overline{AE}$	Block I-regulator 0V → Blocking +15V → Enable 1 mA max.	5	C1	2	A1
J 9	Q	DT_N	Standardised n-actual value ±10V max., 4 mA max. Including bus X 5	1	E3	1	E5
J 10	Q	+24V	Supply voltage	5	C9	2	E6

Modification:

9 Bus connection X for the connection of optional equipment

When supplementary internal cards are fitted, the signal exchange between card and converter and the supply is via bus X (connection via 16-pole ribbon-type cable).

Designation	I/Q		Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
X 1	Q	+24V	Voltage supply	5	C9	2	E5
X 2	I	IRI	Input current regulator, —10V max. Internal current limitation inoperative Input resistance 112 kΩ	2	A3	2	E1
X 3	Q	$I_A = 0$	Logic signal, load capacity 3 mA 0V → Armature current flowing +15V → No armature current	2	E2	2	E1
X 4	Q	I_{dN}	Logic signal, load capacity 3 mA 0V → Current limitation level reached +15V → Current limitation level not reached	1	E5	1	C1
X 5	Q	DT_N	Standardised actual value voltage, 10V max., 4 mA max. Negative or positive, as terminal 1	1	E3	1	E5
X 6	I	RIF_X	Supplementary speed-regulator for reference and correction values, input resistance 47 kΩ	1	A1	1	C1
X 7	—		Not occupied	—		—	
X 8, X 10	—	0V	Regulator reference point	5	B9	2	E6
X 9	Q	—15V	Voltage supply	5	B9	2	E7
X 11, X 12	Q		Points of speed-regulator feedback for switching on the APSy adapter for high regulating ranges	1 1	A6 A7	1 1	C1 E6
X 13	Q	$\overline{BL}$	Logic signal to enable the cards, 3 mA max. 0V → Blocking +15V → Enable The signal is coupled with the command at terminal 21 of the converter and the on-delay when the voltage is applied to the regulator section	5	A1	2	A2
X 14	I	$\overline{BLA}$	Input for blocking the regulator with an external signal 0V → Blocking +15V → Enable	5	A1	2	A1
X 15	Q	I_A	Output current actual value, approx. +2V max. Load capacity: 4 mA max. depending on the connection at terminal 13.	2	E8	2	E2
X 16	Q	+15V	Voltage supply	5	A9	2	E6

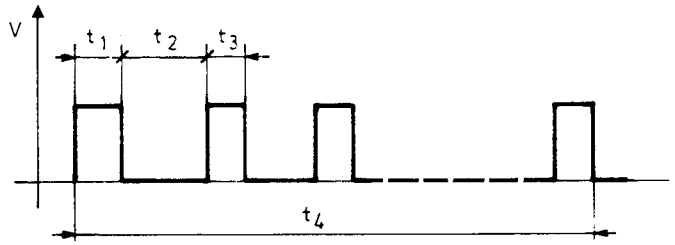
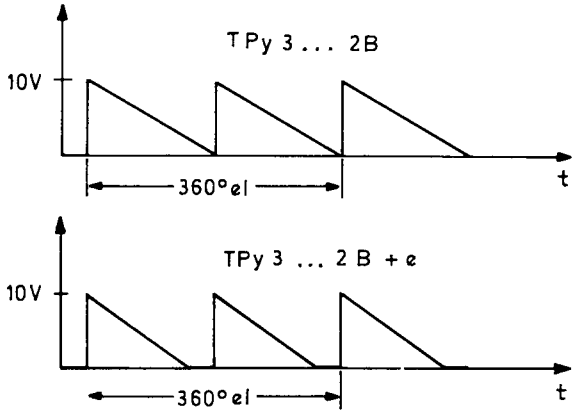
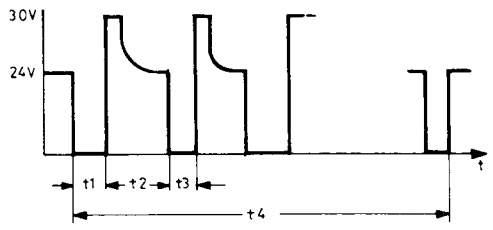
Modification:

10. Test points available

10.1 Regulator card Ry32

Designation	Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
Y1-1	Block I-component speed regulator 0V → Enable +15V → Blocking	1	A8	1	B5
Y1-2	Pulse control signal = output I regulator (positive d.c. voltage)	2	B6	2	C5
Y1-3	Output summation amplifier speed reference values for recognition of speed reference value = 0-recognition Speed reference value ≠ 0 approx. ± 10V max. The polarity is opposite to that of the reference value	6	B3	1	A6
Y1-4	(Only with TPy3...2B+e) Output I max amplifier (+) Motor not within current limitation → approx. —15V Motor within current limitation → > 0V	1	E6	1	E6
Y1-5	Actuation of speed regulator matching 0V → n (speed) reference value = 0 and n (speed) actual value < n1 If SW5-4 is in the ON position, R27 is switched in parallel with the speed regulator feedback +15V → speed reference value ≠ 0 and/or speed actual value > n1	6	B7	1	A7
Y1-6	Not occupied	—		—	
Y1-7	Actuation signal of dip matching of the current regulator 0V → $I_A \neq 0$ +15V → $I_A = 0$	2	D2	2	C1
Y1-8	Speed regulator matching, recognition of speed reference value Approx. +15V → speed reference value ≠ 0 Approx. —15V → speed reference value = 0	6	B4	1	A6
Y1-9	Armature current smoothed and amplified, approx. +2V max.	2	D8	2	D2
Y1-10...13	Not occupied	—		—	
Y1-14	Output I_{max} amplifier (—) Motor not within current limitation → approx. +15V Motor within current limitation → < 0V	1	D6	1	D5
Y1-15	Output P-amplifier of the current regulator approx. 10V max. Value depends on the regulator deviation between reference and actual value currents, and the position of potentiometer "p_I".	2	B4	—	
Y1-16	Speed actual value, approx. —2V max.	1	C4	1	D4
Y2-1	Output speed regulator TPY3...2B : approx. —10V max. TPy3...2B+e : approx. ±10V max.	1	C8	1	C6
Y2-2	Output absolute value stage for speed actual value, approx. —4V max.	1	D4	—	
Y2-3	Output of the first ramp function generator amplifier +13 to +15V → ramping downwards —13 to —15V → ramping upwards	4	B6	1	A2
Y2-4	Output of the input amplifier for the speed actual value recognition of the speed regulator matching. The voltage at Y2-4 is always positive (+ 10V max.)	6	D3	1	B6
Y2-5	Output of the decoupling amplifier for the armature voltage	2	D7	2	D6
Y2-6	Speed actual value recognition of the speed regulator matching Approx. +15V n>n1 Approx. —15V n<n1 n1 can be set, using potentiometer "n≥0" (5.3.3)	6	D4	1	B6
Y2-7	Fault indication "AR" 0V → Fault +15V → No fault	5	E4	2	B4

Modification:

Designation	Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
Y2-8	Pulse blocking 0V → Blocking +15V → No blocking	5	B7	—	
Y2-9	Fault indication "RSH" 0V → Fault +15V → No fault	4	D1	1	B1
Y2-10	Fault indication "AF" 0V → No fault +15V → Fault	5	C6	2	B4
Y2-11...12	Not occupied	—		—	
Y2-13	Actuation of the speed regulator matching 0V → speed reference value = 0 and speed actual value < n1 With SW5-1 = ON the I-component of the speed regulator is blocked +15V → speed reference value ≠ 0 and/or speed actual value > n1	6	A5	1	A8
Y2-14	Actuation pulses generated by the logic (see Fig. 5.9.2)	3	D6	—	
Y2-15	Input amplifier for fault recognition "AR" ok = approx. 10V at Y2-15	5	E3	—	
Y2-16	Current actual value, unsmoothed = measuring point at current regulator optimisation, approx. +2V max.	2	C1	2	D1
Y3-1	Actuation pulses generated by the logic for thyristor T2 (see Fig. 5.9...) 	3	A7	—	
Y3-2	Sawtooth voltage of the actuation IC for phase L3 (see Fig. 5.9.1) 	3	D2	—	
Y3-3	As Y3-2, but for phase L2 (see Fig. 5.9.1)	3	B2	—	
Y3-4	As Y3-2, but for phase L1 (see Fig. 5.9.1)	3	A2	—	
Y3-5	Synchronization voltage approx. 55V a.c., same phase position as voltage U/V at the power section	3	B1	2	C7
Y3-6	Trigger pulses for thyristor T2 (see Fig. 5.9.2) 	3	B9	2	C7

Modification:

Designation	Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
Y3-7	As Y3-1 but for thyristor T3 (see Fig. 5.9...)	3	B7	—	
Y3-8	As Y3-1 but for thyristor T1 (see Fig. 5.9...)	3	A7	—	
Y3-9	As Y3-6 but for thyristor T1 (see Fig. 5.9.2)	3	A9	2	C7
Y3-10	As Y3-6 but for thyristor T4 (see Fig. 5.9.2)	3	B9	2	C7
Y3-11	As Y3-6 but for thyristor T6 (see Fig. 5.9.2)	3	E9	2	D7
Y3-12	As Y3-1 but for thyristor T4 (see Fig. 5.9...)	3	A7	—	
Y3-13	As Y3-6 but for thyristor T3 (see Fig. 5.9.2)	3	D9	2	C7
Y3-14	+24V - Voltage of the pulse transmitters	3	E7	2	C7
Y3-15	As Y3-6 but for thyristor T5 (see Fig. 5.9.2)	3	C9	2	D7
Y3-16	As Y3-5 but phase position as voltage V/W at the power section (see Fig. 5.9.2)	3	C1	2	C7
Y3-17	As Y3-5 but phase position as voltage W/U at the power section (see Fig. 5.9.2)	3	E1	2	C6
Y3-18	Sum of all pulses	3	C7	2	C5
Y3-19	As Y3-1 but for thyristor T6 (see Fig. 5.9...)	3	B7	—	
Y3-20	As Y3-1 but for thyristor T5 (see Fig. 5.9...)	3	B7	—	

10.2 Regulator supply Sy3

Designation	Function	ESE 1592 item	ESE 1612 sheet	ESE 1612 item
SIN U	As Y3-5 on Ry32	A3	2	A8
SIN V	As Y3-16 on Ry32	C3	2	A8
SIN W	As Y3-17 on Ry32	D3	2	B8
0V	0V = Regulator reference point	C8	2	A6
+15	+15V Voltage supply	A8	2	B6
—15	—15V Voltage supply	D8	2	A6
+24	+24V Voltage supply	A8	2	B6
—24	—24V Voltage supply	D6	2	A7

10.3 Card ROy

Designation	Function	ESE 1639 sheet	ESE 1639 item	ESE 1612 sheet	ESE 1612 item
PP1	Output absolute value stage for the current reference value, —10V max.		D3	1	C9

Only with TPy3...2B+e

Modification:

11. Terminal allocation

The terminals can also be used as measuring points (2 mm test plugs).
I = input, Q = output

11.1 Regulator card Ry32

Designation	Function	I/Q	Max. voltage	Max. current	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
1	Actual value input	I	300V	Approx. 3 mA	1	E1	1	E3
2	0V	—	—	—	1	E1	1	E3
3	+10V, short-circuit proof	Q	+10V	50 mA incl. ter. 31	4	E5	1	C1
4	—10V, short-circuit proof	Q	—10V	50 mA incl. ter. 22	4	E5	1	B1
5	Speed reference value input	I	+10V	0,65 mA	1	B1	1	C1
6	Supplementary input, speed regulator	I	±50V	0,65 mA	1	B1	1	C1
7	n_{min} or creep speed	Q	—	—	1	B1	1	D1
8	0V	—	—	—	1	C1	1	D1
10	Output speed regulator See notes under 5.6	Q	—10V	1 mA incl. J2	1	C9	1	E6
11	Input current regulator	I	—10V	0,5 mA	2	A2	2	E2
13	Connection for current indication	Q	+2V	1 mA	2	E8	2	E2
14	Connection for speed indication	Q	±10V	3 mA	1	E3	1	E5
15	External current limitation (—)	I	—10V	—	1	E8	1	E8
16	External current limitation (—)	Q	—10V	—	1	E9	1	E7
19	+24V	Q	+24V	see 5.1	5	B1	1	B1
20	Blocking I-component speed regulator Voltage = enable	I	+15...24V	1,5..3,5 mA	1	A9	1	B1
21	Regulator enable Voltage = enable	I	+15...24V	1,5...3,5 mA	5	A1	2	A1
22	—10V via R218	Q	—10V	50 mA incl. ter. 4	1	E9	1	E6
25	Output decoupling amplifier for the armature voltage	Q	—10V	3 mA incl. J7	2	C9	2	E5
26	Reference value enable Voltage = enable	I	+15...24V	1,5...3,5 mA	4	A4	1	A1
27	Ramp function generator enable Voltage = enable	I	+15...24V	1,5...3,5 mA	4	A7	1	A1
28	Input reference value generator	I	+10V	0,5 mA	4	A3	1	A1
29	Actuation inertia compensation	Q	±10V	4 mA	4	D9	1	A1
30	Output reference value generator	Q	+10V	4 mA	4	B9	1	B1
31	+10V via R217	Q	+10V	50 mA incl. ter. 3	1	E9	1	E6
32	Static speed signal 0V → n < n1 +24V → n > n1	Q	+24V	10 mA incl. J3	6	D9	1	E8
33/34	Speed signal with potential-free contact Open → n < n1 Closed → n ≥ n1	Q	250V~	3 A	6	D9	1	E9

Modification:

Designation	Function	I/Q	Max. voltage	Max. current	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
35/36	Monitoring of the control circuits Potential-free contact Closed = ok	Q	250V~	3 A	5	D9	2	A5
37	Monitoring of the control circuits Static signal +24V = ok	Q	+24V	10 mA	5	C9	2	A4
+24	Supply voltage for external cards	Q	+24V	see 5.1	5	C9	2	E5
—15	Supply voltage for external cards	Q	—15V	see 5.1	5	B9	2	E7
+15	Supply voltage for external cards	Q	+15V	see 5.1	5	A9	2	E6
0V	Regulator reference point	—	—	—	5 5	A1 B9	1 2	D1 E6

11.2 Card Py32-...

Designation	Function	I/Q	Max. voltage	Max. current (power)	ESE 1611 ESE 1634 ESE 1636	ESE 1593 sheet	ESE 1593 item
1U, 1V, 1W	Regulator supply (only with separate supply to power and regulator sections. Remove CV-U, CV-V, CV-W)	I	500V + 10%	40 VA	E4	3	A5
3U, 3V	Fan supply with 110 A ≤ I_{dN} ≤ 500 A	I	220/240V 50/60Hz	0,12 A* 0,24 A**	E7	3	A7
61/62	Thermal monitoring of the heat sinks Potential-free break contact at 110 A ≤ I_{dN} ≤ 500 A	Q	250V~	2 A	E8	3	A6

* at 110 A ≤ I_{dN} ≤ 185 A ** at 280 A ≤ I_{dN} ≤ 500 A

11.3 Armature circuit

Designation	Function	I/Q	Max. voltage	Max. current		ESE 1612 sheet	ESE 1612 item
U, V, W	Incoming supply armature circuit a.c. side (U_{LN})	I	3×415V+10%* 3×500V+10%**	I_{dN}×0,82×F		3	A5
C, D	Armature circuit, d.c. side (U_{dN}) C → +, D → —	Q	480V* 600V**	I_{dn}		3 3	E4 E6
3U, 3V	Fan supply***	I	220V, 50Hz	2,3 A		3. 3 3. 4	A7 A7
31U	Fan supply*** (at U_{LN} = 230/240V and/or 60Hz instead of terminal 3U)	I	240V 50/60Hz	2,3 A		3. 3 3. 4	A7 A7
61/62	Thermal monitoring of the heat sinks*** Potential-free break contact	Q	250V~	2 A		3. 3 3. 4	A6 A6
83/84	Fuse monitor Potential-free break contact Open = faulty	Q	250V~	2 A		3. 3 3. 4	A6 A6

* for TPy3-415/... ** for TPy3-500/... *** at I_{dN} ≥ 900 A

Modification:

11.4 Field supply Fy...

Designation	Function	I/Q	Max. voltage	Max. current	ESE 1616 ESE 1638	ESE 1612 sheet	item
2U, 2V	Field supply a.c.	I	415V +10%	4A...30A	C1, C3, C7, A2	3	A7
2C, 2D	Field supply, d.c. side 2C → +, 2D → —	Q	375V +10%	4A...30A	C3, C6, C9 D1, D2	3	E7
53/54	Contact field current relay	Q	250V~	3 A	D3, D6, D9 C8	3 3. 3	E8 E9

11.5 Card ROy

Designation	Function	I/Q	Max. voltage	Max. current	ESE 1639	ESE 1612 sheet	item
17	External current limitation (+)	I	+10V	—	A2	1	B9
18	External current limitation (+)	Q	+10V	1 mA	A2	1	B9
31a	Supply for external current limitation (+)	I	+10V	2 mA	A3	1	B9

Only on TPy3...2B+e

12. LED's

12.1 Regulator card Ry32

Designation	Colour	LED lights up if	ESE 1609 sheet	item	ESE 1612 sheet	item
RSH	Red	Short-circuit or overloading of the reference value circuit	4	C1	2	A3
AL	Red	RSH and/or AR and/or AF indicate a fault = Collective fault indication	5	E7	2	A4
AR	Red	Fuse blown on regulator supply Mains undervoltage. Supply voltages overloaded	5	D4	2	B4
AF	Red	Fuse blown on a.c. side power section at I_{dN} up to 500 A and/or protective circuit	5	C6	2	B4
SI	Red	Pulse block	3	D7	2	C5
I_{dN}	Yellow	Motor working on current limit	1	E6	1	D6
$I_A = O$	Yellow	Armature current = 0	2	D4	2	C2
RV	Yellow	Speed below the set switching threshold (potentiometer n ≥ 0)	6	D6	1	E8
BAG	Yellow	Generator blocked	4	A8	1	A4
BLG	Yellow	Regulator blocked	5	B5	2	B2
±15	Green	±15V regulator supply available	5	A8	2	A5

12.2 Field supply Fy30

Only if $I_{dN} \geq 900$ A

Designation	Colour	LED lights up if	ESE 1638	ESE 1612 sheet	item
FL	Red	No field current	D6	3. 3 3. 4	D9 D9

Modification:

13. Potentiometers

13.1 Regulator card Ry32

Designation	Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
n_{max}	Set maximum speed	1	C1	1	D3
i_n	I-amplification speed regulator I-component increases with clockwise rotation	1	A6	1	B5
n_{min}	Setting of a minimum speed	1	B1	1	D1
p_n	P-amplification speed regulator P-component increases with clockwise rotation	1	C6	1	D6
I_{AD}	Calibration of the power dip matching	2	B5	2	D3
i_I	I-amplification I-regulator I-component increases with clockwise rotation	2	A5	2	D4
p_I	P-amplification I-regulator P-component increases with clockwise rotation	2	C4	2	C3
I_{AN}	Calibration of an external armature current ammeter	2	E8	2	E2
DT_N	Calibration of an external tachometer	1	E2	1	D4
$-I_{dN}$	Setting of the internal current limitation (On TPy3...2B+e with four quadrant field current relay: current limitation for the positive direction of torque)	1	D9	1	E7
R×I	R×I compensation with armature voltage regulation	2	E7	2	E6
n≥0	Setting of the switching threshold for the speed signal. Range dependent on SW8-2	6	C3	1	B6
—a	Run-down time of the reference value generator. Range dependent on R141A, B, C	4	C6	1	B2
+a	Run-up time of the reference value generator. Range dependent on R142A, B, C	4	C7	1	B2
OFFSET n	Offset adjustment speed regulator	1	C6	1	D5
OFFSET 2	Offset adjustment, recognition of n_{act}	6	C1	1	B5
OFFSET 3	Offset adjustment, recognition of $n_{ref}=0$	6	A3	1	A4

13.2 Card Py32...

Designation	Function	ESE 1611 ESE 1634 ESE 1636	ESE 1612 sheet	ESE 1612 item
TA	Calibration of the rated armature current (see 2.3)	A9	3	C1

13.3 Card ROy

Designation	Function	ESE 1639	ESE 1612 sheet	ESE 1612 item
$+I_{dN}$	Setting of the internal current limitation for the negative direction of torque (in conjunction with four quadrant field converters)	B3	1	B9

Only on TPy3...2B+e

Modification:

14 Micro switch

14.1 Regulator card Ry32

Designation	Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
SW3-1...8	Matching of the actual value input to the maximum actual value voltage (see 5.3) Actual value | SW3 5... 10V | 1...8 ON 10... 18V | 1...7 ON, 8 OFF 18... 35V | 1...6 ON, 7...8 OFF 35... 65V | 1...5 ON, 6...8 OFF 65...110V | 1...4 ON, 5...8 OFF 110...180V | 1...2 ON, 3...8 OFF 180...300V | 1...8 OFF Armature voltage regulation: SW3-1...8 ON	1	E1	1	D3
SW4-1	Bridging out I-component of the speed regulator (see 5.6) ON: I-component bridged out OFF: I-component not bridged out	1	A6	1	B6
SW4-2	Absolute value stage in the speed actual value circuit (see 5.3) ON: active (SW4-3 OFF) OFF: inactive (SW4-3 ON)	1	C4	1	D4
SW4-3	Bypassing the abolute value stage in the speed actual value circuit (see 5.3) ON : n-actual value has the same polarity as at terminal 1 (SW4-2 OFF) OFF: Bypass inactive (SW4-2 ON)	1	C3	1	D4
SW4-4	Connection speed regulator/I-regulator (see 5.7)	2	B2	2	C2
SW4-5	Bridging out I-component of the current regulator (see 5.7) ON : I-component bridged out (P-characteristic) OFF: I-component not bridged	2	B5	2	C4
SW4-6	Power dip compensation (see 5.7) ON: Compensation switched in OFF: Compensation switched out	2	B5	2	D4
SW4-7	Current limitation (in conjunction with four quadrant field current rectifiers for positive direction of torque) ON: internal OFF: external	1	D9	1	E8
SW4-8	ON : external speed indication as voltage meter (see 5.3.4) OFF: external speed indication as ammeter with internal calibration	1	E2	1	E5
SW5-1	Speed regulator matching (see 5.6) ON : With speed reference value ≠ 0 and actual value ≤ n1, the I-component of the current regulator is blocked OFF: Function inoperative	6	A5	1	A8
SW5-2	Monitoring of fuses on the a.c. side in the power section of devices up to 500 A with protective circuit "AF". ON: inactive OFF: active	5	D4	2	B4
SW5-3	Speed regulator matching (see 5.6) ON : The function described under SW5-4 is cancelled only if the speed reference value becomes ≠0 OFF: Behaviour as described for SW5-4	6	B7	1	A7
SW5-4	Speed regulator matching (see 5.6) ON : With speed reference value = 0 and actual value ≤ n1, R27 is switched in parallel with the speed regulator feedback OFF: Function inoperative	6	A7	1	A7
SW6-1...3	Matching to mains frequency (see 2.1) 50 Hz : SW6-1...3 OFF 60 Hz : SW6-1...3 ON **Please note:** The positions of the three switches SW6-1...3 must always agree!	3 3 3	B3 A3 D3	2	C6

Modification:

Designation	Function	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
SW7-1...5	Matching of the decoupling amplifier (see 5.3.2) U_{LN} | SW7 1 2 3 4 5 230/240V | × – – – – 380V | – × – – – 415V | – – × – – 440/460V | – – – × – 480/500V | – – – – × Others* | – – – – – – = OFF, × = ON *Note maximum supply voltage, fit R90	2	B8	2	D5
SW7-6	Connection current regulator/pulse stage	3	A1	2	C5
SW8-1	Connection reference value generator/speed regulator	4	B9	1	A4
SW8-2	Range shift, speed signal (see 5.3.3) SW8-2 | Setting range, potentiometer "n≥ 0" ON | 0,3... 10% n_{max} OFF | 3...100% n_{max}	6	C1	1	C5
SW9-1	OFF: For operation of the converter in conjunction with a four quadrant field converter (only with TPy3...2B+e) ON : In all other cases	2	B1	1	C9
SW9-2	Ramp function generator enable (see 5.2.2) ON : Enable with voltage at terminals 21 and 27 OFF: Enable with voltage at terminal 27	4	A8	1	A4

14.2 Regulator supply Sy3

Note: The positions of the three switches must always agree.

Designation	Function	ESE 1592	ESE 1612 sheet	ESE 1612 item
SW-U	Matching of the regulator supply to the mains voltage	B2	2	A9
SW-V		C2	2	B9
SW-W		D2	2	B9

U_{LN}	Switch position
230V –10% ... 240V +10%	230/240
380V ±10%	380
415V ±10%	415
440V –10% ... 460V +10%	440/460
480V –10% ... 500V +10%	480/500

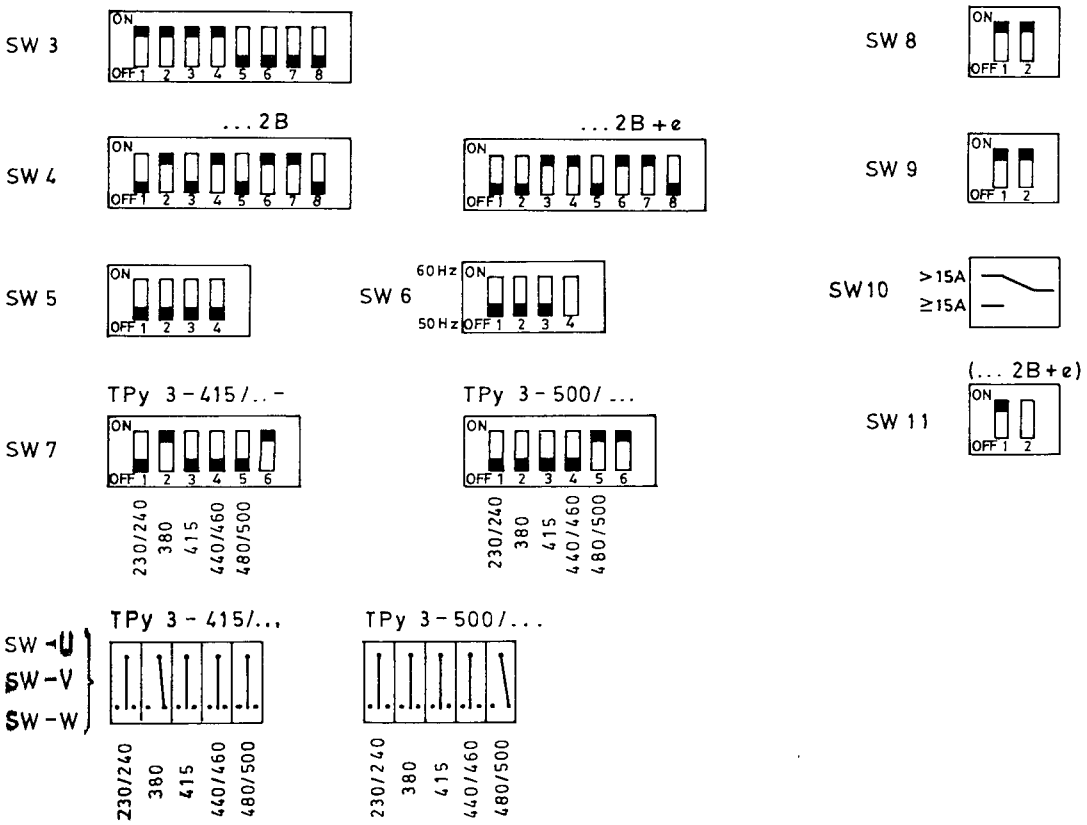
14.3 Field supply Fy30

Note: Only with devices from 900 A

Designation	Function	ESE 1638	ESE 1612 sheet	ESE 1612 item
SW10	Matching to the field current (see 2.4)	A3	3. 3 3. 4	C8 C8

Modification:

14.4 Switch positions as supplied



15 Bridges, calibration elements

15.1 Regulator card Ry32

Designation	Function		Standard	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
CV3	Enable I-component speed regulator	(see 5.6)	Bridge	1	A9	1	B2
C2a	Input filter terminal 6 speed reference value	(see 5.4)	Not fitted	1	B2	1	D3
C3a	Input filter terminal 5 speed reference value	(see 5.4)	Not fitted	1	C2	1	C3
C4a	Input filter terminal 1 speed actual value	(see 5.3)	Not fitted	1	C4	1	D4
C10a	I-component of the speed regulator	(see 5.6)	Not fitted	1	A6	1	B6
C14a	Input filter current regulator	(see 5.7)	Not fitted	2	C1	2	C2
C15a	Input filter terminal 11, I-reference value	(see 5.7)	Not fitted	2	B2	2	E3
C67	D-component speed actual value	(see 5.3)	Not fitted	1	B3	1	D4
R21	Input resistance speed reference value, i.e., speed correction value	(see 5.4.5)	22 kΩ	1	B2	1	C3
R27	R27 is switched in parallel with SW5-4 = ON when speed reference value = 0 and speed actual value of the regulator feedback ≤ n1	(see 5.6)	Bridge	1	B6	1	C5
R37	P-component of the speed regulator	(see 5.6)	120 kΩ	1	A6	1	B5
R75	P-component of the I-regulator	(see 5.7 and 6.4.1.1)	12 kΩ	2	B3	2	C3
R76	Power dip compensation	(see 5.7 and 6.4.1.2)	470 Ω	2	A5	2	D3
R83	I-component of the I-regulator	(see 5.7 and 6.4.1.1)	10 kΩ	2	A5	2	D4
R90	Matching of the decoupling amplifier	(see 5.3.2)	Not fitted	2	A8	2	D5

Modification:

Designation	Function	Standard	ESE 1609 sheet	ESE 1609 item	ESE 1612 sheet	ESE 1612 item
R141A R141B R141C	Time-determining resistors of the ramp function generator for run-down (see 5.4.1)	4,7 MΩ 1,2 MΩ 220 kΩ	4	B7	1	A3
R142A R142B R142C	Time-determining resistors of the ramp function generator for run-up (see 5.4.1)	4,7 MΩ 1,2 MΩ 220 kΩ	4	C7	1	B3
R149	Input resistor for the recognition of reference value = 0 when using terminal 6 (see 5.6)	Bridge	6	B1	1	A5
R180	Time-determining resistor for the < n1 indication and time delay when R27 is switched in parallel with the regulator feedback (see 5.6+5.3.3)	47 kΩ	6	C5	1	B7
R185	Time-determining resistor when R27 in parallel with the regulator feedback (see 5.6)	47 kΩ	6	D7	1	A7
R217	Economy resistor between terminal 31 and +10V	4,7 kΩ	1	E9	1	E9
R218	Economy resistor between terminal 22 and —10V	4,7 kΩ	1	E9	1	E9
R220	D-component actual value (see 5.3)	Not fitted	1	C3	1	D4

15.2 Card Py32-...

Designation	Function	Standard	ESE 1611 ESE 1634 ESE 1636	ESE 1612 sheet	ESE 1612 item
CV-U CV-V CV-W	Internal connection of the incoming supplies of power and regulator section (see 2.1)	Bridge Bridge Bridge	E4	3	B3
R5	Calibration of the current range (see 2.3)	Not fitted	A9	3	C1

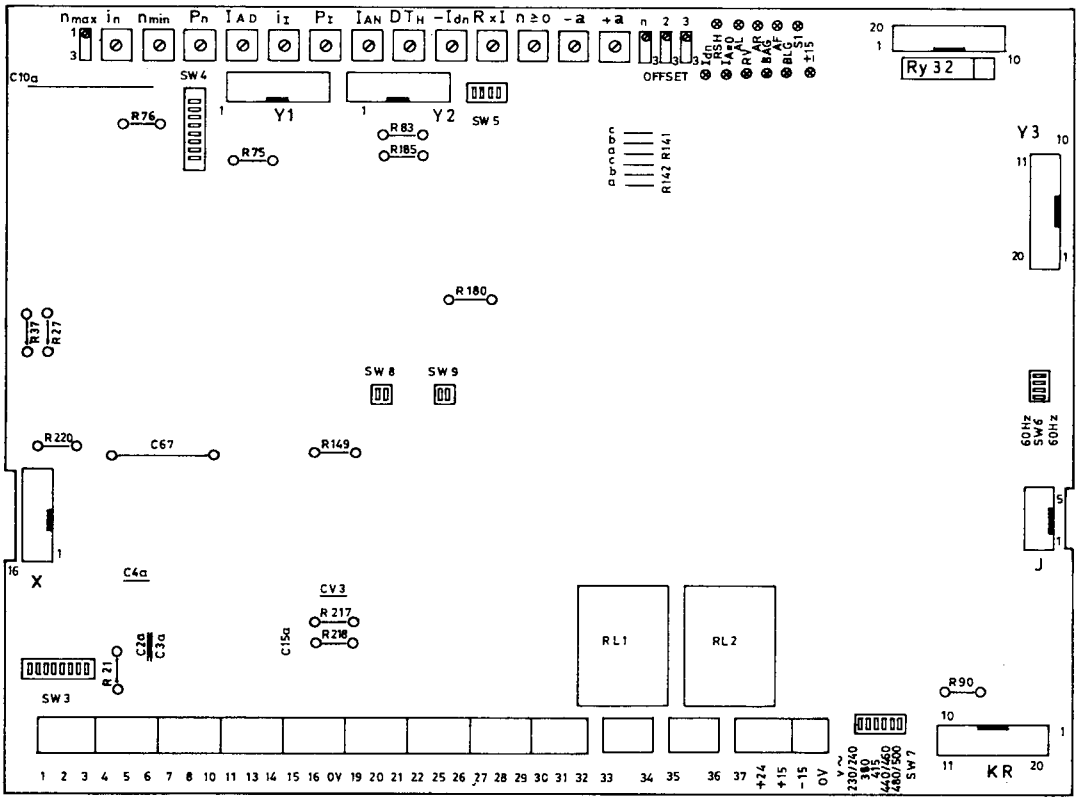
15.3 Field supply Fy30

Note: Only on devices from 900 A

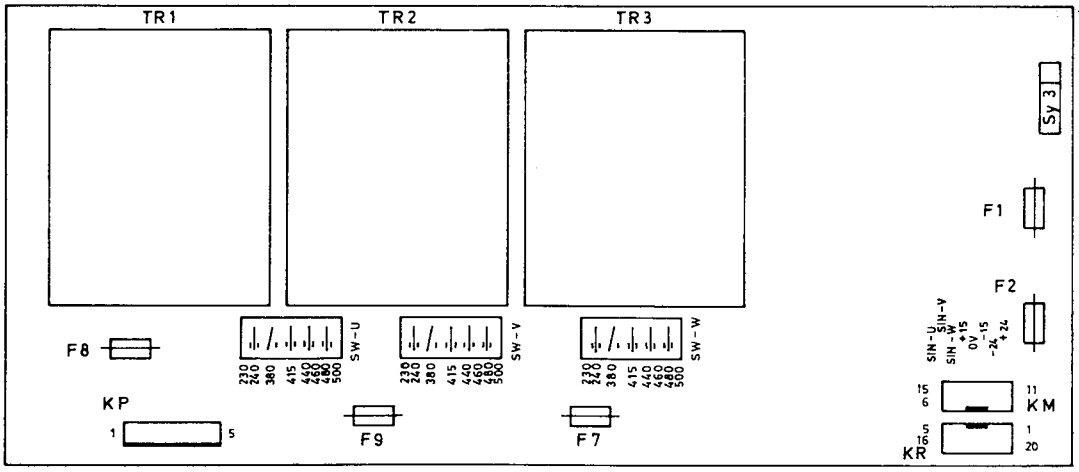
Designation	Function	Standard	ESE 1638	ESE 1612 sheet	ESE 1612 item
R1	Determines the switching point of the field current relay	27 Ω	D3	3. 3	D8
R2		27 Ω		3. 4	D8
R3		Not fitted		3. 3	D9
R4		Not fitted	D4	3. 4	D9

Modification:

16. Schematic and circuit diagram



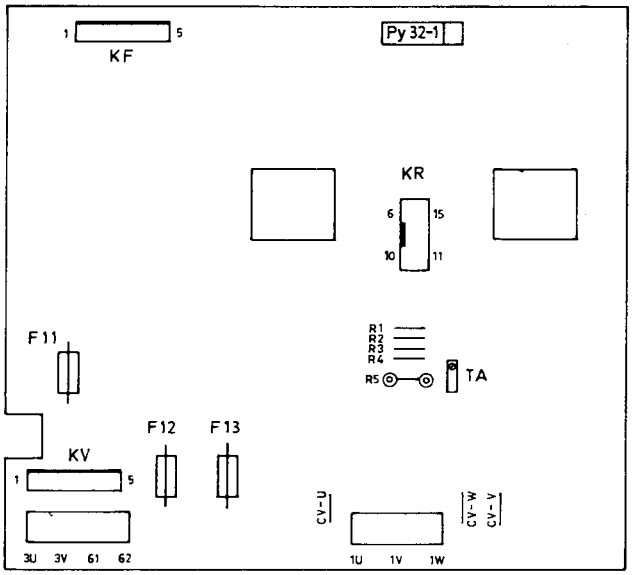
Regulator card Ry32



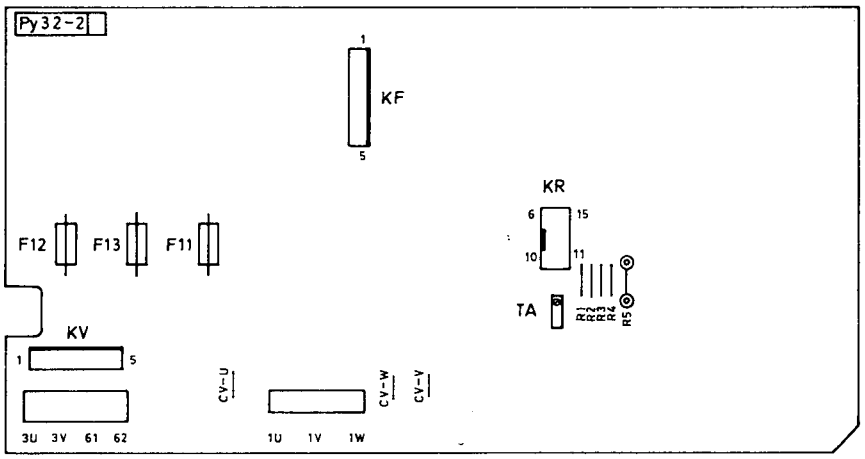
Regulator supply Sy3

Modification:

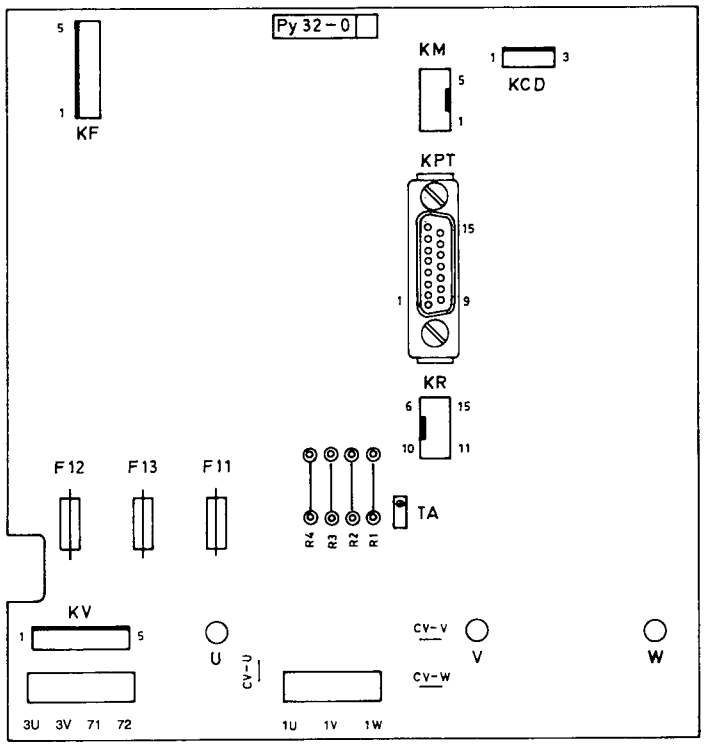
Py32-1
for devices with
I_{dN} = 20...185 A



Py32-2
for devices with
I_{dN} = 280...500 A



Py32-0
for devices with
I_{dN} = 900...3000 A



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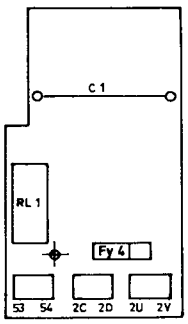
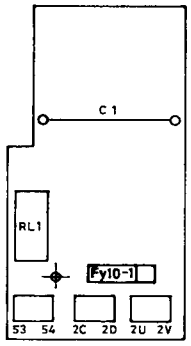
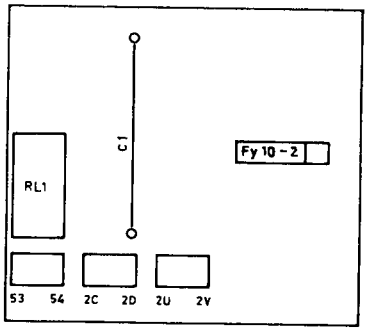


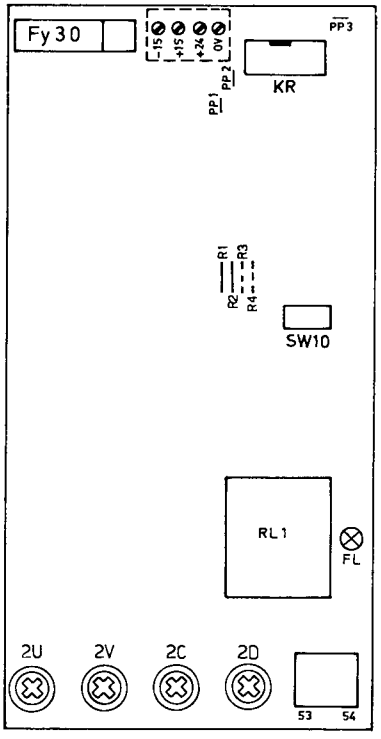
Field supply Fy4
for devices with
I_{dN} = 20...70 A



Field supply Fy10-1
for devices with
I_{dN} = 110...185 A

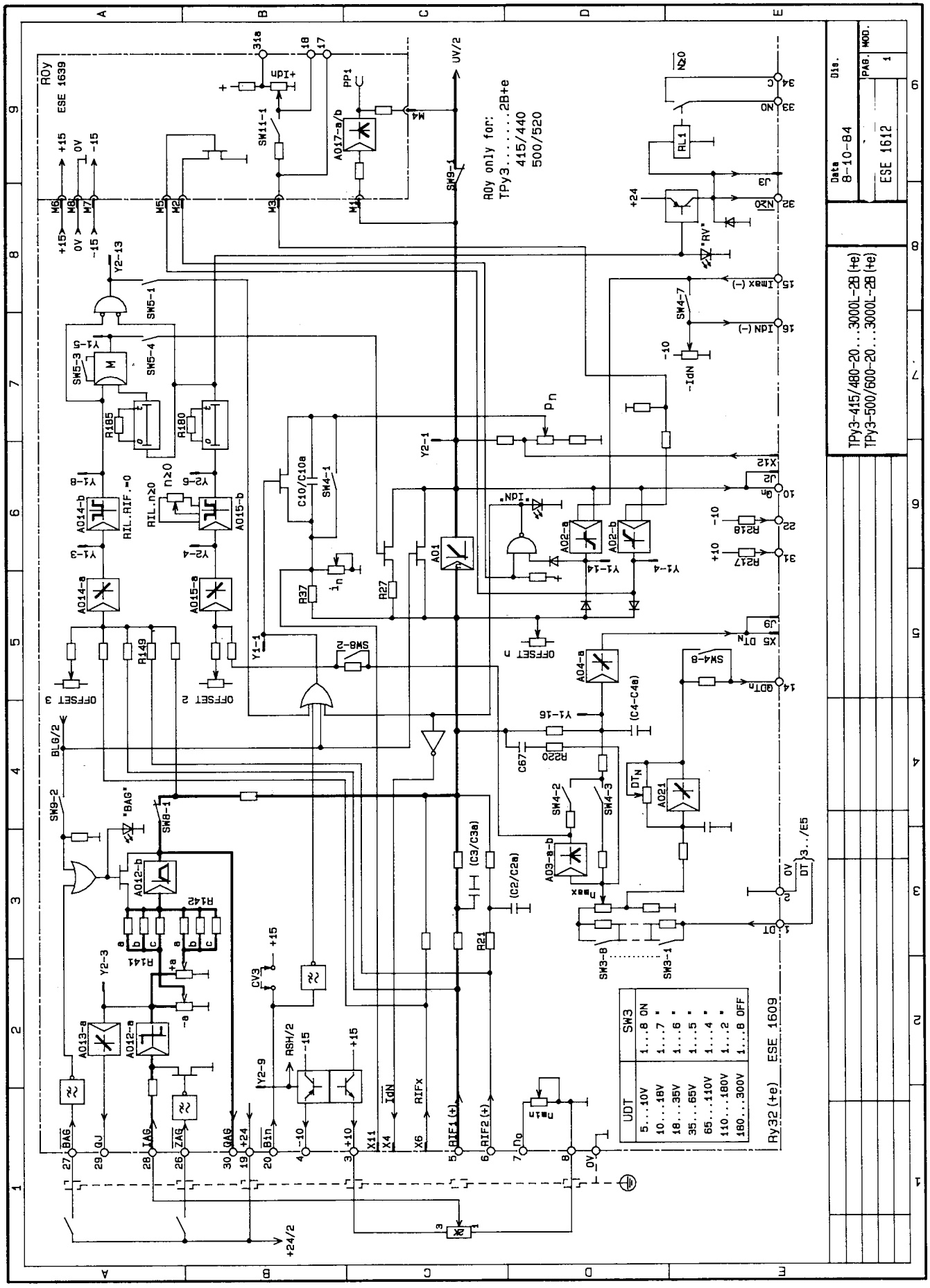


Field supply Fy10-2
for devices with
I_{dN} = 280...500 A



Field supply Fy30
for devices with
I_{dN} = 900...3000 A

Modification:



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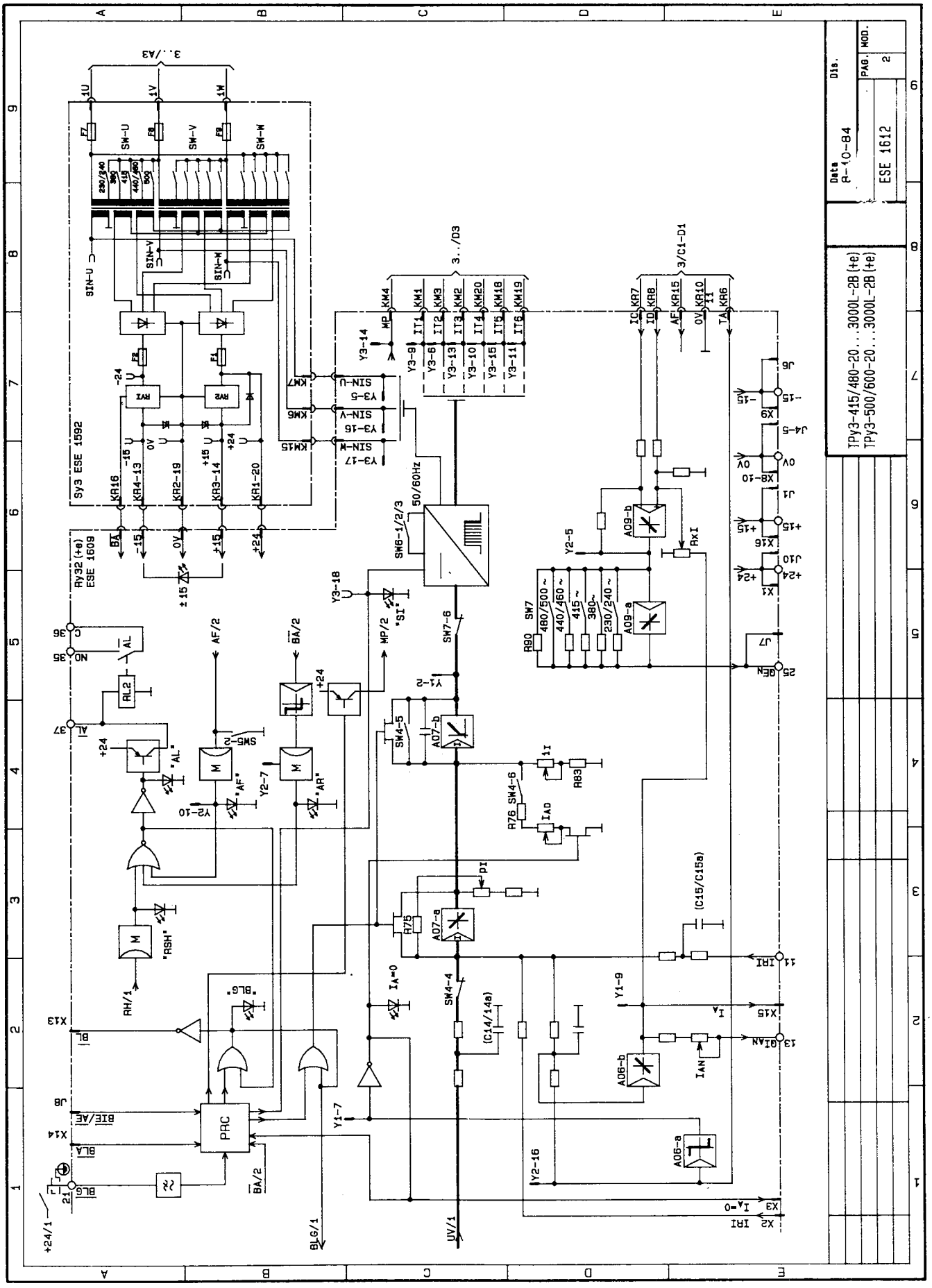

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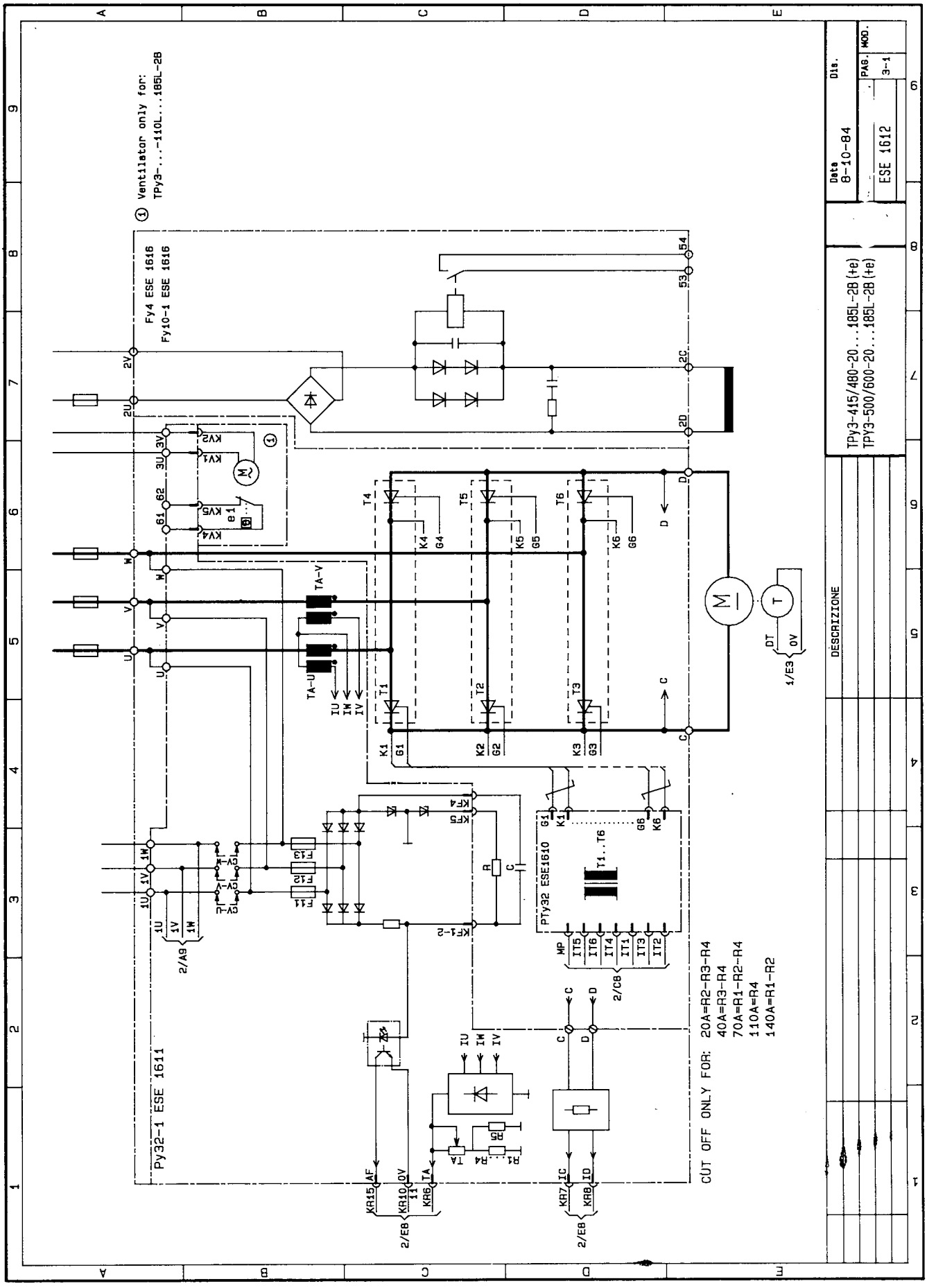

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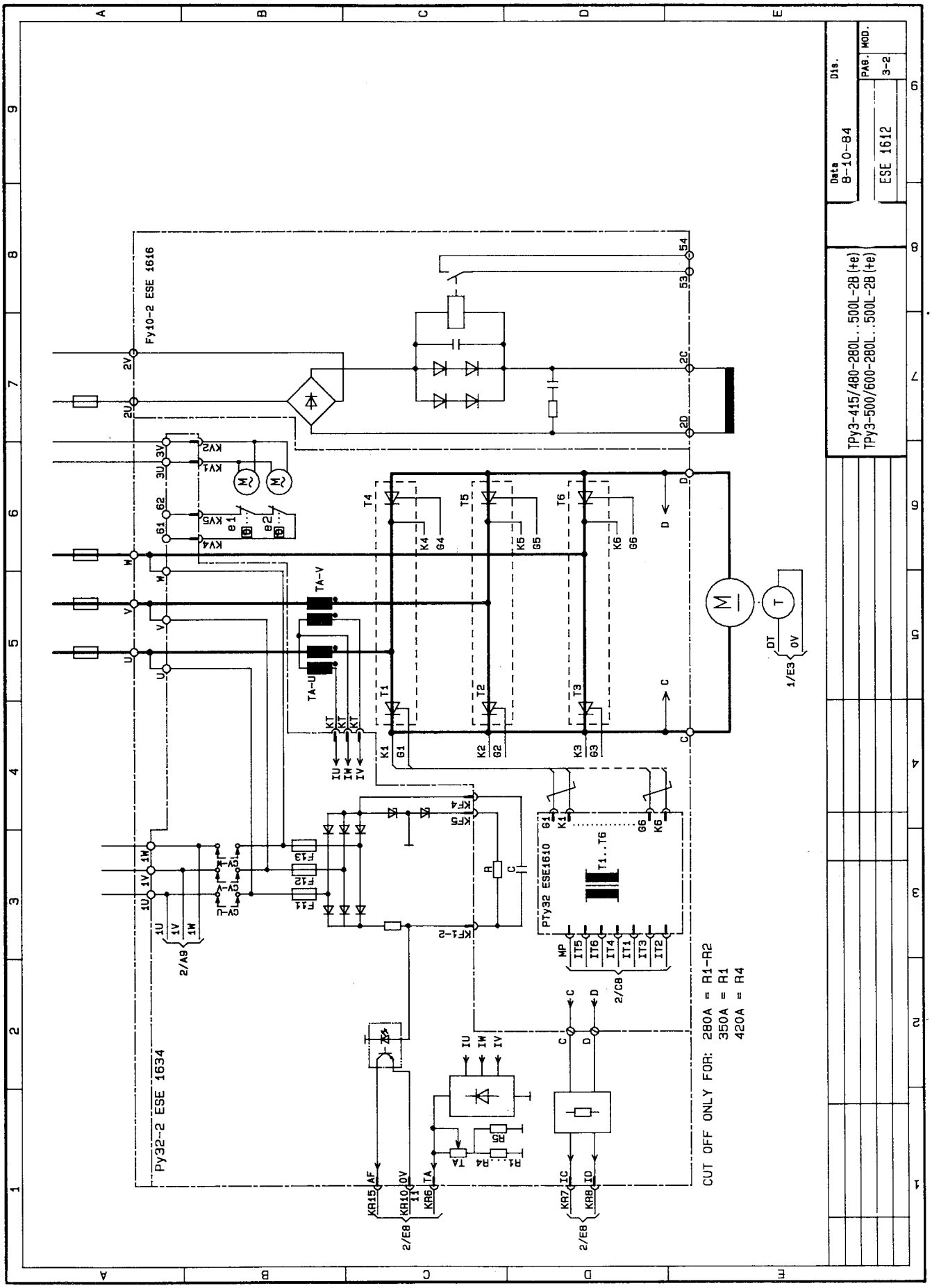

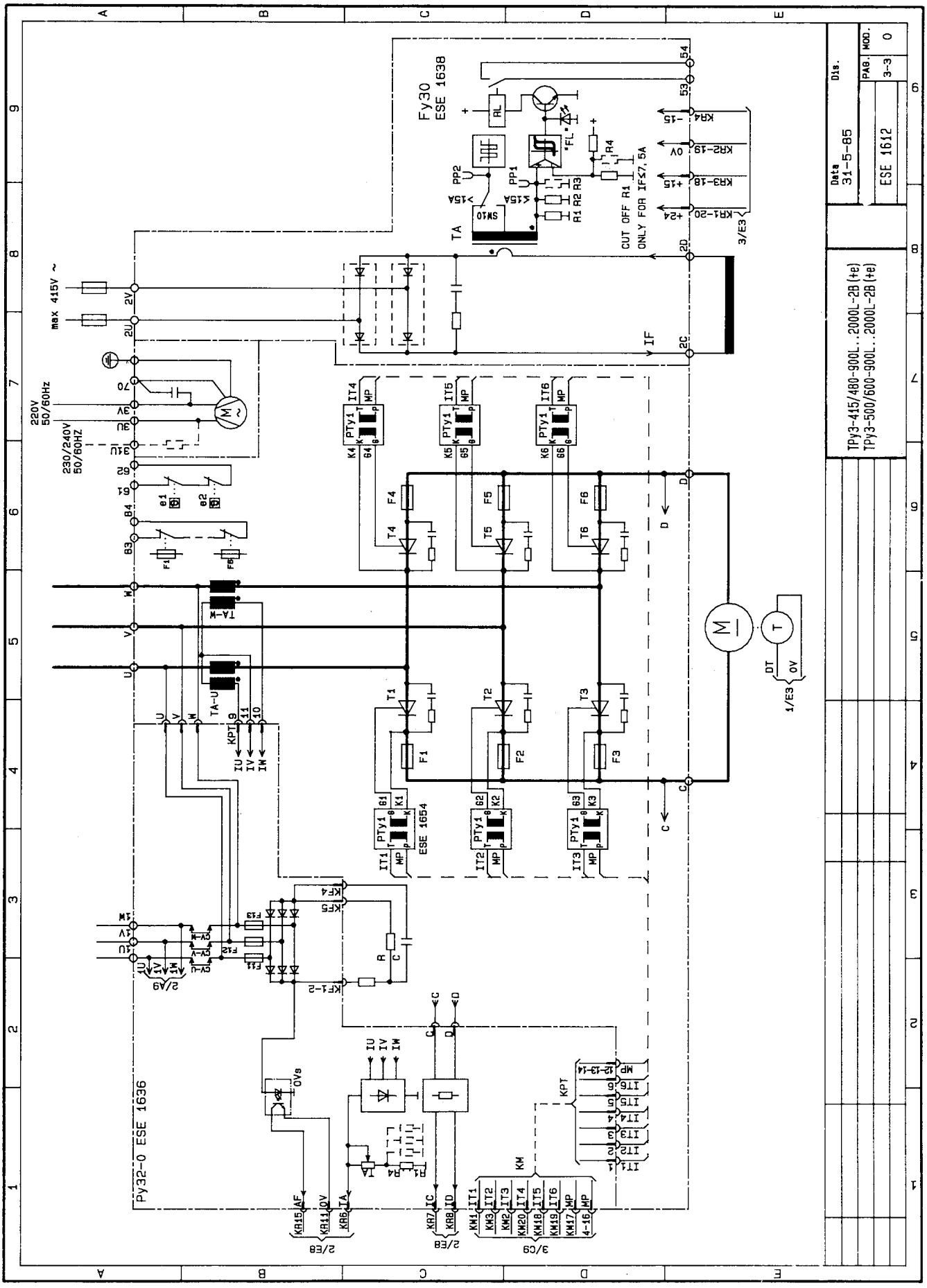

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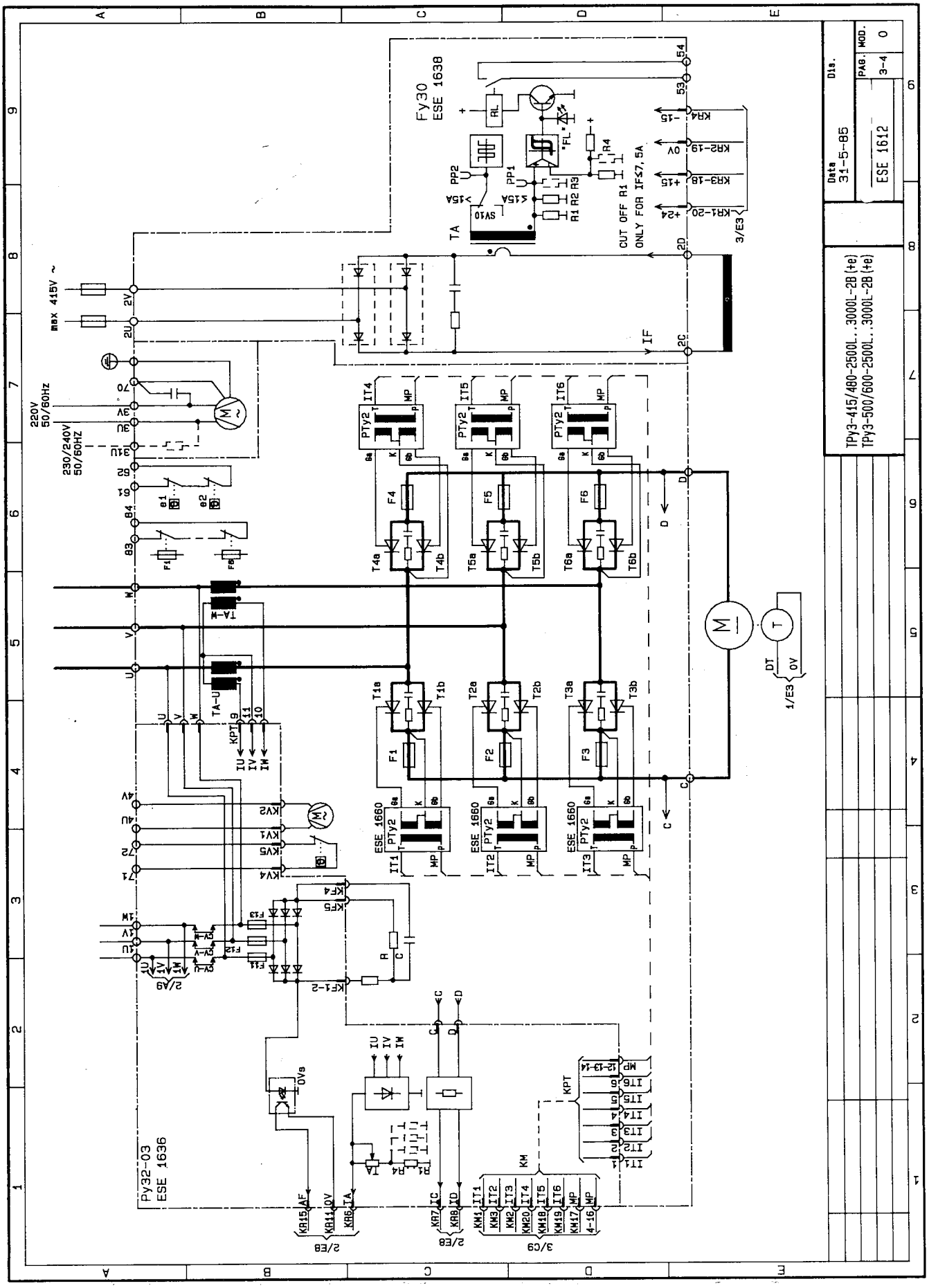

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