TYRECT B
Thyristor converters YGMP and YJMF

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TYRECT B
Thyristor convertors YGMF and YJMF

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1 TRANSPORT AND STORAGE

The convertor is supplied in a suitable packing for transport. If the convertor is to be stored for a short or long period it is advisable to keep it in its transport packing.

2 POSITIONING

The convertor is designed to be used in ordinary industrial surroundings free from electrically-conducting dust and corrosive gases.

2.1 Converters in VSG- or GJB-cubicles

The cubicles can be placed on the floor with a cable duct beneath them. The cable duct should be at least 400 mm deep. The cubicles must be positioned at least 10 cm from a wall to allow free movement of cooling air at the rear. The free space above the cubicles must be at least 30 cm.

2.2 Installation of non-enclosed convertors

A non-enclosed convertor must be installed vertically with the mains module at the top. It can be installed in a cubicle or suspended directly on a wall (with protection against accidental contact). No special types of cubicle or special installation methods are required, but the following points must be remembered:

A. The thyristor bridge of the convertor requires a supply of cooling air (25-150 A: convection cooling; 300 A: forced cooling, built-in fan). If the convertor is to be able to accept its rated load (see Catalogue YT 22-13 E) the temperature of the cooling air must be less than 40 °C measured 10 cm below the thyristor bridge.

The free passage area for the air before and after the convertor (inlet and outlet of cubicle) should be greater than 500 cm (see Fig. 3.1.). The outlet of the cubicle must be above the upper edge of the convertor.

Avoid positioning beneath the convertor any apparatus that dissipates large quantities of heat.

B. A free space of at least 10 cm must be left above and below the convertor and at least 5 cm must be left at the sides. See Fig. 2.1.
A: Mains module  
B: Convertor module  
C: Polarity reversing module (YJMF)  
D: Other equipment  

Fig. 2.1 Installation instructions for convertors

3 EARTHING

The convertor or cubicle has a connection terminal for protective earthing.

If the zero line of the control and regulating circuit board is to be connected to earth which should be avoided if possible, it should be connected via an earthing filter consisting of a 1 kΩ resistor in parallel with a 10 µF capacitor.

4 POSITION OF WIRING

Power cables should not be positioned closer than 10 cm to the control and regulating circuit board of the convertor.

Signal cables must be positioned as far as possible from cables that might cause interference, such as power cables, contactor and relay operating cables (minimum distance 10 cm). Signal cables must be screened (see connection diagrams).
The convertor must be connected to the power supply via load switches and fuses. The fuses must be of the "anti-surge" type and dimensioned with a view to the rated current of the convertor, as shown in the table below. Convertors supplied in VSG-cubicles are already fitted with the correct load switches and fuses.

<table>
<thead>
<tr>
<th>Convertor rated current $I_{dN1}$</th>
<th>Fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 A</td>
<td>35 A</td>
</tr>
<tr>
<td>50 A</td>
<td>100 A</td>
</tr>
<tr>
<td>100 A</td>
<td>200 A</td>
</tr>
<tr>
<td>150 A</td>
<td>315 A</td>
</tr>
<tr>
<td>300 A</td>
<td>500 A</td>
</tr>
</tbody>
</table>

If two or more convertors are to be connected in parallel to the same mains, the values of the reactances between the common connection point and each convertor are to be min. 10 µH per phase. A complete unit containing 3 reactors on an apparatus plate is available from ASEA.

Note: Convertors in VSG-cubicles are already equipped with reactors.

Reactor unit for convertor 25-50A YT 295 000-CU
Reactor unit for convertor 100-300A YT 295 000-CV

Other aspects of the connection of the convertor are shown in the diagrams on pages 5 and 6 for YG6F and YJMF respectively. The diagram on page 7 is for convertors in a VSG- or GJB-enclosure.

NB: The rotor and field circuits of the d.c. motor should not be connected at this stage; they are connected during commissioning.
1) External interlocking. When this contact is open the converter is switched off. If this function is not required connect a jumper between terminals 1 and 5.

2) External interlocking. The converter is back when this is open. If the function is not required, fit a jumper.
Connecting YJMF

1) External interlocking. When this contact is open the convertor is switched off. If this function is not required connect a jumper between terminals 1 and 5.

2) External interlocking. The convertor is back when this is open. If the function is not required, fit a jumper between terminals 6 and 7.
Connecting a converter in a VSG- or GJB-enclosure.

Field supply
Phase forward/back
Operations

External Filter

Signal zero
Speed reference value 94kΩ 20ms
Speed reference value 94kΩ 20ms
Speed reference value 440kΩ 25ms
Current reference value 94kΩ 20ms
Stabilised

Power supply connection

Electronics Division, ASEA, S-721 83 Västerås Sweden

Installation
TYRECT B
Thyrister convertors YGMF and YJMF

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Commissioning
Commissioning covers phase sequence checking, setting of the protective devices and, where necessary, adjustment of the control system. On delivery the control system settings are satisfactory for normal operating conditions. If the control performance of the converter has to be optimised the control system is adjusted as described in Section 4 below.

For commissioning it is assumed that the converter has been installed and connected in accordance with installation instruction YT 224-331 E. The d.c. motor must not be connected.

Section 6 shows a commissioning report on which adjustments, connections etc. made in conjunction with initial commissioning should be noted.

NB. If the converter is equipped with accessories the instructions for the accessories must be studied before commissioning of the converter begins.

The voltage to which the converter is connected is dangerous and great care must therefore be taken at every stage. Wherever there is a risk of contact with live parts the supply to the converter must be disconnected (loadswitch etc.).

The following equipment is required for commissioning the converter:

- 1 multimeter, 0-1000V, \(\geq 10 \text{k}\Omega/V\) d.c. (e.g. AVO meter or UNIGOR)
- leads with banana plugs and insulated crocodile clips.

If the converter has no desired value potentiometer, "ON" button and "OFF" button the following are also required:

- 1 potentiometer, 5 k\(\Omega\), 0-5 W
- 1 "ON" button with make contact for 110 V, 1 A
- 1 "OFF" button with break contact for 110 V, 1A

to be connected in accordance with connection instruction YT 224-331 E.

If the control system is to be adjusted as described in Section 4 below, the following are also required:

- 1 capacitor \(\geq 10 \mu F, \geq 15\) V
- Resistance decades R1 and R2 (Fig. 2.1)
- Capacitor decade C1 (Fig. 2.1)
- Soldering iron and solder
3 PHASE SEQUENCE CHECK

Before connecting the d.c. motor to the convertor, check that the convertor is connected to the network with the correct phase sequence as follows:

a. Connect terminal 35 and jumper H and short-circuit capacitor C70/71 on the control circuit board (see Fig. 4.1, page 4).

b. Connect the multimeter (1000 V d.c. range) to the d.c. terminals of the convertor. Note: Digital multimeter must not be used.

c. Connect the reference potentiometer between +10 V and -10 V.

d. Set the desired value potentiometer to 0 % for YGMF or 50 % for YJMF.

e. Start the convertor with the "ON" button. Turn the desired value potentiometer from 0 to 100 % and note the instrument reading.

If the phase sequence is correct the instrument reading should vary with the desired value as shown in Fig. 3.1.
Fig. 3.1 Output voltage of converter for varying desired value with correct phase sequence (YGMF and YJMF)

If the phase sequence is incorrect, reverse two of the incoming phases and repeat the procedure.

Remove the jumper between terminals 9 and 12 and the short circuit across C 53.

Connect the rotor circuit of the motor to the d.c. terminals of the converter. Unless the control system is to be adjusted, connect the field circuit of the motor as well.

4 ADJUSTMENT OF THE CONTROL SYSTEM

Fig. 4.1 Control circuit board
Normally adjustment of the control system is not required. It is set up before delivery to give satisfactory control performance for most operating conditions. Where the control characteristics of the convertor has to be optimised the system is adjusted as described below.

4.1 Current limit

In all TYRECT B convertors the actual value of the convertor is 5 V at the rated current $I_{dN1}$.

The maximum load current that may be drawn from the convertor, the current limit, is set to $1.2 \times I_{dN1}$ on delivery. This setting can be altered either by changing resistors R 152 and R 153 on the regulating circuit board (see Fig. 4.1) or connecting two external resistors between terminal 1 (+10 V) and terminal 20, and between 2 (-10 V) and 19 on the control circuit board. Note that if the alternative with external resistors is used, R 152 and R 153 must be completely removed. The values of resistors R 152 and R 153 for the required current limit are calculated as follows:

$$R_{152} = R_{153} = \frac{I_{dN1}}{I_{dm}} \times 31 \text{ (kΩ)}$$

where $I_{dN1}$ = rated current of convertor (A) and $I_{dm}$ = current limit (A)

On delivery the resistors are 27 kΩ, 1/4 W, 2 %.

The values of the two external resistors must be equal. They are calculated for the required current limit as follows:

$$R_y = \left( \frac{I_{dN1}}{I_{dm}} \times 21 \right) -1.0 \text{ kohm}$$

Note the value of resistors R 152 and R 153 or, alternatively, of the external resistors on the Commissioning report in Section 6; note also the current limit.

4.2 Current regulation

The gain of the current regulator is adjusted as follows:

a. Short-circuit capacitors C 70 and C 71 (see Fig. 4.1).

b. Unsolder resistor R 13 and connect resistor decade R2 instead of it.
c. Connect the multimeter (0.5 V a.c. range) in series with a capacitor (10 μF, ≥ 15 V) to jumper H (amplifier output) and terminal 41 (0 V) on the regulating circuit board. 
\[ R \cdot C \approx 500 \, \text{ms} \]

d. Set the resistor decade R 2 to position 1 (0.68 kΩ), the desired value potentiometer to 0 % for YGMB or 50 % for YGMA and start the convertor with the "ON" button.

e. Turn the desired value potentiometer to 100 % for about 1 second and check that the motor does not rotate (if it does the rotor must be locked). Note the meter deflection when the potentiometer is turned up. The pointer should be deflected slightly, the deflection being of the order of a few millivolts.

f. Set resistor decade R 2 to position 2 (1.2 kΩ) and then quickly turn the desired value potentiometer to 100 % (remember to allow the motor to cool down for at least 30 seconds between each operation). The deflection of the pointer should now have increased by a factor of 2 to 2.5 over the first setting. Continue in the same way testing positions 3, 4 etc. on resistor decade R 2 until the deflection increases by significantly more than a factor of 2.5 from one step to the next on the decade (at this stage the gain has become so high that the current regulator self-oscillates for continuous current). Having found this setting, move back two positions on the decade.

<table>
<thead>
<tr>
<th>Example</th>
<th>Setting</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meter deflection (V)</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>20</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

Changing from position 4 to position 5 on the resistor decade R 2 in the example above results in an increase in the meter reading by a factor of 6 . The final setting is therefore 3 (2.2 kΩ) i.e. two positions back from position 5.

g. If the current regulator cannot be made to self-oscillate this may be due to the fact that the rated current of the motor is too low relative to that of the convertor. If this is the case, solder a 2.2 kΩ (0.25 W, 10 %) resistor into position R 13.

h. Switch off the convertor with the "OFF" button and disconnect the mains voltage.

i. Disconnect the resistor decade and solder a resistor R 13 (0.25 W, 10 %) into position with the resistance obtained at f above.
j. Note the actual value of R 13 in the Commissioning report in Section 6.

4.3
Speed regulation (with tachogenerator)
If the d.c. motor is voltage-regulated, proceed to Section 4.4. Connect the field of the d.c. motor as described in Installation instruction YT 224-331 E.

4.3.1
Matching the actual value of the motor speed
The output voltage $U_{TG}$ of the tachogenerator at the working speed (rated speed) $n$ of the motor is calculated as follows:

$$U_{TG} = k \times n$$

where the constant $k$ depends on the type of tachogenerator; see below.

<table>
<thead>
<tr>
<th>Tachogenerator</th>
<th>$k$ (V. min/rev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEB type ED 2510</td>
<td>0.100</td>
</tr>
<tr>
<td>Radio Energie type REO 444</td>
<td>0.060</td>
</tr>
<tr>
<td>Hübner type TDFO2</td>
<td>0.060</td>
</tr>
<tr>
<td>TGRB 1-5</td>
<td>0.025</td>
</tr>
</tbody>
</table>

The actual value of the motor speed (tachogenerator voltage) at rated speed is matched to a suitable level by removing one or more jumpers on the control circuit board in accordance with the table below.

<table>
<thead>
<tr>
<th>$U_{TG}$ (V)</th>
<th>Jumper to be removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>- (potentiometer R 191 is set to 10 divisions)</td>
</tr>
<tr>
<td>13-24</td>
<td>D</td>
</tr>
<tr>
<td>23-60</td>
<td>D, C</td>
</tr>
<tr>
<td>45-150</td>
<td>D, C, B</td>
</tr>
<tr>
<td>75-300</td>
<td>D, C, B, A</td>
</tr>
</tbody>
</table>

If two alternatives are possible according to the table, the higher range should be used.

Note in the Commissioning report in Section 6 which jumpers have been removed.
4.3.2 Adjustment of the speed regulator

a. Remove any locking that may have been fitted to the rotor of the motor.

b. Unsolder resistor R 190 and connect the resistor decade R 1 instead of it. Capacitors C 70 and C 71 must still be short-circuited.

c. Set the resistor decade to position 5 (120 kΩ).

d. Set the desired value potentiometer to 0 % (YGMF) or 50 % (YJMF), switch on the mains voltage and start the convertor with the "ON" button.

e. Turn the desired value potentiometer to 10 % (YGMF) or 60 % (YJMF). Check that the motor rotates slowly. If the motor runs away, that is, accelerates to full speed, the tachogenerator or the motor field is connected with incorrect polarity. If the motor overspeeds with the correct direction of rotation it is the tachogenerator that is connected with incorrect polarity. On the other hand if the motor overspeeds with incorrect polarity the polarity of the supply to the motor field must be reversed. If the motor speed can be continuously varied by means of the desired value potentiometer, but the motor rotates in the wrong direction, the polarity of both the tachogenerator and the motor field must be changed.

f. Connect a multimeter to control circuit board terminals 10 (0 V) and 7 (actual value of speed). Select a suitable d.c. range.

Start the convertor and turn the desired value potentiometer to 100 %. Using potentiometer R 191 (on the control circuit board) adjust so that the meter shows the voltage \( U_{TG} \) calculated in Section 4.3.1. Switch off the convertor.

g. Move the meter to terminals 12 and 10 (+) on the control circuit board (measuring range 12 V d.c.) and set resistor decade R 1 to position 1.

Start the convertor and turn the desired value potentiometer to about 90 %. The motor must be without load. The meter pointer should show a small deflection of the order of less than 2 V.

Produce a step in the speed reference value by briefly turning the desired value potentiometer to 100 % and then back to 90 %. Check that the meter pointer resumes its original position without hunting.
Repeat the "step procedure" with the resistor decade R 1 set to positions 2, 3 etc. until the instrument pointer begins to hunt on returning to the initial position (90 %). At this stage the speed regulation system has begun to self-oscillate because of excessive gain in the regulator. On YJMF (contactor pole changing) the pole changing contacts will operate, opening and closing repeatedly. Reduce the gain to the correct amount by moving back two positions on resistor decade R 1.

Example. If the speed regulation circuit begins to self-oscillate at position 10 on resistor decade R 1 the final position must be 8, that is, 820 kΩ.

h. Switch of the convertor and disconnect the voltage. Remove resistor decade R 1 and solder in a resistor R 190 with the resistance obtained at g above. Note the value of R 190 in the Commissioning report in Section 6.

i. Remove capacitors C 70 and C 71 (and the jumpers across them) and connect capacitor decade C 1 (see Section 2 TEST EQUIPMENT) instead of them.

j. Apply voltage and start the convertor. Perform the same step procedure as for adjustment of R 190 (item g above).

Example. If the speed regulation system starts to self-oscillate at position 6 of capacitor decade C 1, the final position will be position 4, i.e. C 70 = C 71 = 4.7 µF.

k. Switch of the convertor and disconnect the voltage. Remove capacitor decade C 1 and solder in capacitors C 70 and C 71 with the capacitance obtained at j above.

Note the values of capacitors C 70 and C 71 in the Commissioning report in Section 6.

4.4 Voltage regulation If the speed regulation system has been adjusted, this section (4.4) is omitted.
With voltage regulation the speed regulator of the convertor acts as a voltage regulator. The actual value of the voltage is taken from the d.c. output terminals of the convertor via the voltage measuring module. The voltage measuring module is connected to terminal 7 (-) and 10 on the control circuit board (in the cubicle version the connection is made to terminal block 7 (-1 and 10). The ratio of the voltage measuring module is 600:35.

Example. For a convertor with rated d.c. voltage $U_{d1} = 440\, \text{V}$, the actual value of the voltage $U_{act1}$ at $U_{d1}$ is

$$U_{act1} = 440 \cdot \frac{35}{600} \approx 25.7\, \text{(V)}$$

Remove jumpers C and D on the control circuit board.
Connect the d.c. motor field in accordance with Installation instruction YT 224-331 E.

4.4.1 Adjustment of the voltage regulator

The procedure for adjustment of the voltage regulator is exactly the same as that described in Section 4.3.2, Adjustment of the speed regulator. Under item 4.3.2 e replace tachogenerator by voltage measuring module and in item 4.3.2 f adjust R 191 so that the instrument shows the actual value of the voltage $U_{act1}$ calculated as described above.

4.5 Polarity reversing

The polarity reversing regulator is adjusted as follows:

a. Set the desired value potentiometer to 50 % and start the convertor. Increase the desired value to about 80 % and alter the desired value quickly to about 70 % and observe the polarity reversing contacts. These must operate twice, once when braking begins and again when braking ends. If the contactors operate more than twice, resistor R 3 on the control circuit board must be replaced (the hysteresis in the polarity reversing flip-flop is too small).

b. Switch off the voltage. Replace resistor R 3 (2.2 kΩ, 0.5 W) with a 3.3 kΩ, 0.25 W resistor and repeat the procedure described above. If the polarity reversing contactors still operate more than twice when the desired value is reduced, use a 3.9 kΩ resistor for R 3.
c. Note the value of R 3 in the Commissioning report.

4.6
Ramp unit

4.6.1
Connection and setting of the ramp (acceleration) time

The built-in ramp unit is bypassed on delivery, see Fig. 4.2.

![Diagram of a ramp unit](image)

Fig. 4.2 Ramp unit

If the ramp function is required, proceed as follows:

Switch off the supply to the converter and unsolder jumper G on the control circuit board. Solder in jumpers E and F, see Fig. 4.1. The ramp unit changes the sign and the desired value potentiometer must therefore be connected with the opposite polarity to that shown in the Connection instruction YT 224-331 E.

The acceleration time or ramp time can be changed by replacing resistor R 6 on the control circuit board. On delivery the value of R 6 is 1 kΩ giving an acceleration time of 3·3 seconds, i.e. the time from 0 to 100 % output signal from the ramp unit for a step change of 0 to 100 % of the desired value.

The value of resistor R 6 with respect to the ramp time is calculated as follows:

\[
R_6 = \frac{3}{t_{\text{ramp}} - 0.3}
\]

where \(R_6\) is in kohms and \(t_{\text{ramp}}\) is the ramp time expressed in seconds.
If no resistor is connected, i.e., \( R_S = \infty \), the ramp time will be 0.3 seconds. \( R_S \) should not be made lower than about 300 \( \Omega \), giving a ramp time of 10 seconds.

Note the value of \( R_6 \) on the Commissioning report.

4.6.2  Checking the ramp time

The ramp time can be checked as follows:

a. Disconnect the field and rotor of the d,c, motor and connect a multimeter (25 V d,c. range) to outputs 10 (-) and 13 (+) of the control circuit board.

b. Apply the voltage but do not switch on the convertor. Turn the desired value potentiometer to 100 %.
   The meter reading should then be about 10 V.

c. Short-circuit terminals 10 and 15 on the control circuit board. This short circuits the ramp unit, the output of the convertor is reduced and the multimeter shows 0 V.

d. Remove the short circuit between terminals 10 and 15 and note the meter reading. The pointer should move from 0 V to about 10 V (same reading as under item b above) during the ramp time \( t_{ramp} \). If a precise ramp time is required the multimeter should be replaced by a recorder (or oscilloscope).

5.  SETTING PROTECTIVE DEVICES

5.1  Thermal overload protection for d,c. motor

The thermal protection consists of a relay RVZP 10 which, via a current transformer measures the load current on the a,c. side of the convertor. The relay, which is mounted in the power supply module, see Fig. 5.1, must be set as follows:

\[
I_{prot} = \frac{I_d \cdot 0.816}{k \cdot 3}
\]

where \( I_d \) = rated current of d,c. motor

\( k \) = ratio of current transformer

\( I_{prot} \) = setting of relay
46 Thermal overload protection for d.c. motor

48 Direct-on-line starter for external fan motor

Fig. 5.1 Power supply module (50 A)

The current transformer ratio and the setting of the relay for different converter sizes is given in the table below.

<table>
<thead>
<tr>
<th>Converter rated current ( I_{dml} ) (A)</th>
<th>Current transformer ratio ( k )</th>
<th>Relay setting ( I_{prot} ) (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25</td>
<td>( I_d/92 )</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>( I_d/184 )</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>( I_d/368 )</td>
</tr>
<tr>
<td>150</td>
<td>150</td>
<td>( I_d/552 )</td>
</tr>
<tr>
<td>300</td>
<td>300</td>
<td>( I_d/1104 )</td>
</tr>
</tbody>
</table>

Note \( I_{prot} \) in the Commissioning report.
5.2 Direct-on-line starter for external fan motor

The direct-on-line starter is mounted in the power supply module, see Fig. 5.1. It must be set for the rated current of the fan motor (see rating plate).

6 COMMISSIONING REPORT

6.1 Regulating system (control circuit board)

Current limit

\[ I_{dm} = \ldots \text{ A} \]
\[ R 152 = R 153 = \ldots \text{ k}\Omega \]

Current regulation

\[ R 13 = \ldots \text{ k}\Omega \]

Speed regulation

\[ U_{TG} = \ldots \text{ V} \]

Potentiometer R 191 set to: \ldots \text{ divisions}

Jumpers removed:

\[ R 190 = \ldots \text{ k}\Omega \]
\[ C 70 = C 71 = \ldots \text{ \mu F} \]

Voltage regulation

\[ U_{act1} = \ldots \text{ V} \]

Potentiometer R 191 set to: \ldots \text{ divisions}

\[ R 190 = \ldots \text{ k}\Omega \]
\[ C 70 = C 71 = \ldots \text{ \mu F} \]

Polarity reversing

\[ R 3 = \ldots \text{ V} \]

Ramp unit

Ramp time: \ldots \text{ s}

\[ R 6 = \ldots \text{ k}\Omega \]

6.2 Protections

Thermal overload protection for d.c. motor.

Setting \( I_{prot} = \ldots \text{ A} \)

Direct-on-line starter for external fan motor.

Setting \( I_{prot} = \ldots \text{ A} \)
TYRECT B
Thyristor converters YGMF and YJMF

1 STARTING
Connect mains voltage (load switch or equivalent).
Cancel any external interlocking and press the ON-button.

2 RUNNING
Set the required speed with the desired value potentiometer
YGMF 0-100 % and YJMF 50-0 % for reverse running and
50-100 % for forward running.

3 STOP
Press the OFF-button or open one of the external
interlocks.

4 TRIPPING
After tripping due to overcurrent the converter can
be started again by means of the ON-button as soon as
the overcurrent relay (item 46) has been reset.
## TYREXT B
Thyristor converters YGMP, YJMF

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<td>5 FAULT TRACING DIAGRAMS</td>
<td>14</td>
</tr>
</tbody>
</table>
TEST EQUIPMENT

1 - Universal instruments, 0-1000 V DC and AC,
   >10 kohms/V DC (e.g. AVOmeter or UNIGOR)

1 - Oscilloscope of simple design with facilities
   for synchronizing of horizontal trace with
   mains frequency ("Line" triggering).
   NOTE: the oscilloscope must be fed via an
   isolating transformer (two-winding transformer)

1 - Potentiometer of good quality, 5 kohms > 0.5 W,
   linear, e.g. 5248 2051-450.

1 - Soldering iron

Relevant circuit diagrams, apparatus lists, manual.

INVESTIGATION OF TRIGGER AND CONTROL PCB

2.1 Speed regulator, voltage regulator

If a fault is suspected in the speed regulator the following
simple steady-state test will decide whether this is the case.

On the trigger and control circuit board disconnect the leads
from 22-27 inclusive.

Make a jumper connection between terminals 9 and 12.

Connect the outer terminals of a 5 kohm potentiometer to
terminals 1 and 2 of the board and the centre tap to
terminal 8.

If the normal reference potentiometer is located near the
convertor it may be used in a corresponding manner. If an
extra potentiometer is used the normal potentiometer should
be disconnected.

Switch on the main voltage to the convertor.

Check that the voltages across terminals 5+ and 11 and 11+
and 6 respectively on the board are approximately 25 V and
across 1+ and 11 and 11+ and 2 respectively are 10 V.
Connect an instrument to test terminal 12 (output of speed regulator) and 11 (0 V). Start the convertor. Turn the potentiometer from one end position to the other and observe the instrument deflection. This should follow the turning of the potentiometer so that the output voltage from the speed regulator is equal to \(-0.75 \times\) input voltage (potentiometer voltage) i.e. if the input voltage is \(+4\) V the output voltage will be approximately \(-3\) V. The maximum output voltage of the speed regulator is determined by the setting of the current limit as given by the following:

\[
\text{Output voltage} = 5 \cdot \frac{I_{\text{dm}}}{I_{dN1}} \text{ V}
\]

where \(I_{\text{dm}}\) = set current limit
\(I_{dN1}\) = rated direct current of convertor

Check that the limits are correct.

Allow the potentiometer to remain turned fully to one end and switch off the convertor. The output voltage should now be limited to approx. 0 V by the phase back.

If the tests now carried out on supply voltages, controllability and phase-back have given correct results the regulator is, in all probability, fault-free. Restore the connections and settings to their original positions.

2.2 Current regulator

If a fault is suspected in the current regulator the following checks should be carried out.

Undo the connections to terminals 22–27 inclusive on the trigger circuit and control board. Make jumper connections between terminals 9 and 12 and between terminals 35 and the jumper connection H on the trigger circuit and control board.

Connect the outer connections on a 5 kohm potentiometer to terminals 1 and 2 of the board and the centre tap to terminal 8. If the normal reference potentiometer is located near the convertor it may be used instead. If an extra potentiometer is used the normal potentiometer should be disconnected.
Check that voltages between terminals 5 (+) and 11 and 11 (+) and 6 are approximately 25 V and between 1 (+) and 11 and 11 (+) and 2 are 10 V.

Connect the instrument to terminal 11 on the control circuit board (output of current regulator) and jumper connection H. Turn the potentiometer from one end position to the other and note the instrument deflection. This should follow the turning of the potentiometer so that the output voltage from the current regulator is equal to 0.75 x input voltage (potentiometer voltage), i.e. if the potentiometer voltage is +4 V the output voltage should be approximately +3 V.

The output voltage of the current regulator is limited in the positive direction to approximately 6-7 V (YJMF) or 10-11 V (YGMF) and in the negative direction to approximately 10-12 V. Check this!

Allow the potentiometer to remain fully turned in the positive direction (i.e. approximately +6 V output voltage from the regulator) and switch off the convertor. The output voltage should now change to approximately -10 V on account of phase-back in conjunction with switching off.

If the tests carried out on the supply voltages, controllability and phase-back have given the correct results, the regulator is in all probability fault-free.

Restore the connections and settings to their original positions.

2.3 Trigger Pulse Generator

The following simple test of the function of the trigger pulse generator under full phase advance can be made with the universal instrument (a more thorough check requires use of an oscilloscope):

Undo the connections to terminals 22-27 inclusive on the trigger circuit and control circuit board.

Measure accurately the voltage across terminal 5 (+24 V) and 11 (0 V) on the board and note the result. Term the measured voltage $U_{+24}$.

Check in turn the voltages across terminal 5 and terminals 27, 22, 25, 26, 23 and 24. The voltages obtained should be:

$$\frac{U_{+24}}{3} \pm 3\%$$
If the result is incorrect at any of the voltages checked replace the trigger circuit and control circuit board.

With the oscilloscope (triggered on line) check the phase position and appearance of the trigger pulses. The oscilloscope should be connected between terminal 5 and in turn to terminals 27, 22, 25, 26, 23 and 24. A result in accordance with Fig. 2.1 should be obtained.

Fig. 2.1 Appearance of trigger pulses and phase position with respect to each other for an intact trigger pulse determinator.

If the measurements give the correct result the trigger pulse determinators may be considered to be fault-free.

Restore the connections to their original positions.

2.4 Armature Reversal Regulator (YJMF)

The armature reversal regulator should be checked in the following manner.

Undo the connections to terminals 22-27 inclusive on the trigger circuit and control circuit board. Make a jumper connection across terminals 9 and 12.

Connect the outer connections on a 5 kohm potentiometer to terminals 1 and 2 of the board and the centre tap to terminal 8.
If the normal reference potentiometer is located within reach it may be used instead. If an extra potentiometer is used the normal potentiometer should be disconnected.

Check the voltages between terminal 1 (+) and 11 and 11 (+) and 2 respectively on the board. They should be 10 V.

Connect an instrument (A) between terminal 12 (+) (output of speed regulator) and 11 (0 V). Start the convertor by means of the ON pushbutton. Turn the potentiometer between the end positions and note the instrument deflection. It should follow the reference value from the potentiometer with the opposite polarity and reduced by a factor 0.75. E.g., +4 V in (reference) should give approximately -3 V out as long as one stays within the limits given under point 2.1.

Connect an instrument (B) between terminal 18 (+) and 11. When the potentiometer is rotated from 0 to 100% and 100 to 0% respectively the instrument deflection should vary as shown in Fig. 2.2.

Note that the armature reversal contactors should operate a few times when the potentiometer is turned from 0 to 100%.

If the armature reversal contactors are not operated check the connection between the armature reversal contactors and terminals 16 and 17 on the board.

![Diagram](image)

**Fig. 2.2**

Move instrument A from terminal 12-11 to terminal 16 (+) - 11. (Instrument B should still be connected to terminals 8 and 11).
Turn the potentiometer between the end positions and note the deflection of the instrument. It should vary in accordance with Fig. 2.3.

![Diagram of instrument A and B](image)

**Fig. 2.3**

Move instrument A from 16-11 to terminal 17 (+) -11.

Turn the potentiometer between the end positions and note the deflection of the instrument. It should vary in accordance with Fig. 2.4.

![Diagram of instrument A and B](image)

**Fig. 2.4**
Connect an instrument to terminal 21 (+) and 11. Turn the potentiometer between the end positions and note the instrument deflection. It should show 0 V the whole time except for a jerk in the pointer just visible every time the armature reversal contactors are operated, (feedback). Switch off the convertor by means of the OFF pushbutton. The instrument should then show approximately 13 V.

If the armature reversal regulator functions in accordance with the tests it may be considered to be fault-free. In the event of a defect replace the entire trigger circuit and control circuit board.

3 CHECKING OF THYRISTORS

The correct functioning of a thyristor can be checked in the following manner:

Undo the connections to the gate and cathode (see Fig. 3.1). The thyristor may be allowed to remain in the heat sink until it has been determined that it must be replaced.

![Diagram of thyristor connections]

Thyristor in convertors with rated current 100, 150 and 300 A

Thyristor in convertors with rated current 25 and 50 A.

Fig. 3.1 Thyristors

With the universal instrument measure the resistance between the anode and cathode of the thyristor. If there is a short circuit (resistance 0 ohm or nearly 0 ohm) the thyristor must be replaced.
Measure the resistance between the cathode (auxiliary cathode) of the thyristor and the gate. Use a measuring range for measurement of low-resistance values. If the instrument shows 0 ohms then there is a short circuit between the gate and cathode and the thyristor must be replaced. Use a torque spanner, see the end of this section!

If the instrument has a small deflection (10-200 ohms) check the thyristor in a connection as shown in Fig. 3.2, i.e. connect the anode of the thyristor via a 24 V lamp (5 W) to terminal 5 (+24 V) on the trigger and control circuit board of the convertor, the gate of the thyristor via a make contact (B) and a resistor (120 ohms, 5 W) to terminal 5 and the cathode of the thyristor to terminal 11 (0 V). Note that the line voltage should be connected to the convertor and that the convertor must not be started by means of the ON pushbutton. If the lamp lights up when the cathode is connected to terminal 11 the thyristor is short-circuited and must be replaced. If the lamp does not light up, close contact B for an instant. The thyristor should then fire and the lamp should light up. If this is not the case the thyristor must be replaced. This check reveals most defective thyristors.

![Fig. 3.2 Connection for checking of thyristors](image)

![Fig. 3.3 Connection for checking of the off-state voltage (A) and reverse blocking voltage (B) of a thyristor](image)

If a faulty thyristor is still suspected, a test equipment as shown in Fig. 3.3 must be used. The test procedure is as follows:

Connect the thyristor which may remain in the heat sink to the test equipment in accordance with Fig. 3.3 alt. A. Increase the direct voltage from 0 V and upwards so that a current of 5 mA flows through the thyristor. Read the voltage on the voltmeter. This "off-state voltage" for the thyristors in convertors for 220 V supply should be 500 to 700 V, for
380 V and 415 V supply greater than 1000 V, for 440 V supply greater than 1100 V and for 500 V supply should be greater than 1200 V. If the off-state voltage withstand is too low there is a risk that the thyristor will fire incorrectly with a fuse failure as a probable result and the thyristor should be replaced.

If the thyristor shows satisfactory off-state voltage the reverse voltage should be checked also. Connect the thyristor in the manner shown in Fig. 3.3 alt. B (polarity reversed) and follow the same procedure as before until the current through the thyristor is 5 mA. Read the voltage (= reverse voltage) on the voltmeter. The same limits of reverse voltage apply as for off-state voltage.

NOTE! When replacing thyristors in convertors with rated current 25 and 50 A a torque spanner set to 2 Nm should be used. For other thyristors the torque is obtained when the spring snaps above the yoke.

4

USE OF FAULT TRACING DIAGRAMS

4.1 Procedure

In the following it is presupposed that the fault has arisen in a convertor which has already been commissioned, i.e. faulty connections and similar faults may be eliminated.

When a fault occurs in the convertor equipment the fault symptom must be established, e.g. does the motor run away? Do high speed fuses blow on starting? Does the motor start? etc. When the fault has been determined find the fault tracing diagram which suits the symptoms in question.

Start in the "start box" with the text which agrees with the main fault symptom and proceed in the direction of the arrow to the next block. This may either be a "measuring block" or a "symptom block". If it is a measuring block carry out the measurements given. If the result of the measurement agrees with that given in the block proceed in the direction of the "RIGHT" arrow to the next block. If the result is incorrect proceed in the direction of the "WRONG" arrow. In this manner follow the diagram until you end in a block where a possible cause of the fault is stated.

The procedure is the same even in the case where the first block is a symptom block. If the symptom given agrees with the actual symptom, proceed in the direction of the "RIGHT" arrow, otherwise in the direction of the "WRONG" arrow.
Certain boxes have the heading "ON". This means that the convertor is started.

It should be pointed out that the fault tracing diagrams do not cover all faults which may occur, but should be considered as an aid when looking for "normal" faults.

<table>
<thead>
<tr>
<th>Fault Symptoms</th>
<th>Fault Symptom</th>
<th>Fault Tracing Diagram No.</th>
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<tbody>
<tr>
<td>4.2 Fault Symptoms</td>
<td>Convertor does not start</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Main contactor does not close</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Motor does not start</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Main contactor is closed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High speed fuses blown</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Commutator of motor sparks during service</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>On starting convertor with reference set to 0% the motor runs away to full speed</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Motor rotates in only one direction 1)</td>
<td>6</td>
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</tbody>
</table>

1) Applies only to convertors type YJMF.
4.3 Abbreviations Used in Fault Tracing Diagrams

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
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<tbody>
<tr>
<td>acc.</td>
<td>acceleration</td>
</tr>
<tr>
<td>A-reg.</td>
<td>Armature Reversal Regulator</td>
</tr>
<tr>
<td>AC sup.</td>
<td>AC supply</td>
</tr>
<tr>
<td>aux. cont.</td>
<td>auxiliary contactor</td>
</tr>
<tr>
<td>aux. trafo.</td>
<td>auxiliary transformer</td>
</tr>
<tr>
<td>block un.</td>
<td>blocking unit</td>
</tr>
<tr>
<td>btw.</td>
<td>between</td>
</tr>
<tr>
<td>ca</td>
<td>circa (approx.)</td>
</tr>
<tr>
<td>Cap.</td>
<td>capacitor</td>
</tr>
<tr>
<td>conn.</td>
<td>connection(s)</td>
</tr>
<tr>
<td>Cont. PCB</td>
<td>control and trigger circuit printed circuit board</td>
</tr>
<tr>
<td>Conv.</td>
<td>convertor</td>
</tr>
<tr>
<td>Fan. cont.</td>
<td>fan contactor</td>
</tr>
<tr>
<td>field cont.</td>
<td>field contactor</td>
</tr>
<tr>
<td>I-feedb.</td>
<td>current feedback</td>
</tr>
<tr>
<td>I-lim.</td>
<td>current limit</td>
</tr>
<tr>
<td>I-reg.</td>
<td>Current regulator</td>
</tr>
<tr>
<td>Inter.</td>
<td>interlock</td>
</tr>
<tr>
<td>main cont.</td>
<td>main contactor</td>
</tr>
<tr>
<td>MM</td>
<td>Mains module</td>
</tr>
<tr>
<td>min. field</td>
<td>minimum current relay for field</td>
</tr>
<tr>
<td>n-reg.</td>
<td>speed regulator</td>
</tr>
<tr>
<td>op. circ.</td>
<td>operating circuits</td>
</tr>
<tr>
<td>PB</td>
<td>pushbutton(s)</td>
</tr>
<tr>
<td>ph. back</td>
<td>phase back</td>
</tr>
<tr>
<td>ph. forw.</td>
<td>phase forward</td>
</tr>
<tr>
<td>Power sup.</td>
<td>power supply</td>
</tr>
<tr>
<td>prop.</td>
<td>proportional</td>
</tr>
<tr>
<td>ref.</td>
<td>reference</td>
</tr>
<tr>
<td>short</td>
<td>short circuit</td>
</tr>
<tr>
<td>steer volt.</td>
<td>steering voltage</td>
</tr>
<tr>
<td>sup. circ.</td>
<td>supply circuits</td>
</tr>
<tr>
<td>term.</td>
<td>terminal(s)</td>
</tr>
<tr>
<td>TG</td>
<td>tacho-generator</td>
</tr>
<tr>
<td>TPG</td>
<td>trigger pulse generator</td>
</tr>
</tbody>
</table>

Fault tracing
trafo. = transformer
Uout = output voltage
volt = voltage
5

FAULT TRACING DIAGRAMS

Fault Tracing Diagram No. 1

Conv. does not start. Main cont. does not close.

Check line voltage 230

Fault lies before conv.

Check 110 V AC voltage M1-M6

Check op. fuse 39

Short in op. circ.

Fault on trafo. 18 or its conn.
Fuse 41 or 42 blown

Check 380 V AC M1-M6

Check fuse 41 and 42

Short in op. circ. or trafo. 38

Fault on trafo. 38 or its conn.

Relay 51 picks up

Check link 1-5 on mk

Make link across terms.

Fault on "ON" or "OFF" PB or its conn.

Check conn. to relay 51 coil and supply volt. to relay

Conv. has tripped. Check cause. Reset tripped relays.

Relay 51 defective. Replace relay

R = right

W = wrong

Continued on next page
Fault tracing

- Field cont. 49 closes
  - Check conn. btw. 49x92 and term. 1 on MM
    - Check 110 V AC volt. btw. 49x92 and term. 1 on MM
      - Fault on field cont. 49
    - Check cables and inter. across relay 51
      - Check cables to 49x92
        - Check cables and inter. across field cont. 49
          - Check 160 V supply between main cont. 50x92 and 40x1
            - Fault on main cont. 50

R = right
W = wrong
Fault Tracing Diagram No. 3

High speed fuses blown.

ON

High speed fuses blow on closing conv.

W

ON

High speed fuses blow after some time in service.

R

ON

Motor Imsa greater than 18mA, e.g. for frequent acc. on I-lim.

W

ON

Knock on cont. PCB during service.

R

W

If fuse blows, replace cont. PCB.

R

Check DC side regarding short.

R

Check supply volt. 224 V and ±10 V.

W

See Fault Tracing Diagram No. 2

R

Check current feedback signal

R

Check A-reg. according to point 2.4

W

Replace cont. PCB

TO

Check ph. forw. -24 V on cont. PCB term. 3

W

See Fault Tracing Diagram No. 2

R

Check I-reg. according to point 2.2

W

Replace cont. PCB

Continued on next page
Fault tracing

Check TFG according to point 2.1

Replace cont. PCB

Check n-reg. according to point 2.1

Replace cont. PCB

Check field current magnitude

Replace defective thyristors

Check thyristors according to point 3

Consult a conv. specialist

R = right

W = wrong
Fault Tracing Diagram No. 4.

Motor commutator sparks in service.

ON
Motor runs up to normal speed.

W
Check phase fuses

R
Check fuses 40, 41, 42.

W
Replace defective fuses

R
Check TPG according to point 2.1

W
Replace cont. PCB

R
Check thyristors according to point 3

W
Replace defective fuses

R
Check field exciter DC voltage

W
Replace defective semi-conductors

R
Reduce R13 on cont. PCB.

W
Check TPG according to point 2.1

R
Check thyristors according to point 3

R = right
W = wrong
ON = conv. started

Fault tracing
Fault Tracing Diagram No. 5

On starting conv. with ref. 0% motor runs away to full speed.

OK

Volts. across cont. PCB terms 7 and 10 are proportional to 70 volts when motor rotates.

R

OK enclosed design

Volts. across terms 7 and 10 proportional to 70 volts when motor rotates.

W

Fault on 70 or conn. to it.

R

Fault in conn. btw. terms 7-10 on cont. PCB.

Check that speed ref. is 0 V.

W

Check ref. potentiometer and its conn.

R

Check n-reg. according to point 2.1

W

Replace cont. PCB.

R = right
W = wrong
OK = conv. started
Fault Tracing Diagram No. 6

Motor rotates in only one direction.
R

Check n-reg. according to point 2.1.
W

Replace cont. PCB

Check A-reg. according to point 2.4.

R
W

Replace cont. PCB

Check l-reg. according to point 2.2

R
W

Replace cont. PCB

Check conn. btw. cont. PCB and thyristor module
R

Check thyristors according to point 3.
R

Consult a conv. specialist.
R = right
W = wrong
TYRECT B
Thyristor convertors YGMF and YJMF

1
GENERAL

The converter contains no components that are subject to what is normally understood by wear. Maintenance is therefore of a preventive nature.

2
POINTS TO BE CHECKED

The converter should be inspected at regular intervals and the following checks should be carried out.

How often the checks should be performed depends largely on the environment (vibration, moisture, dust, smoke etc.) in the vicinity of the converter.

a. Check that the path of the converter cooling air is free and that the cooling fins of the thyristors are not blocked by dust and dirt. Clean them if necessary.

b. Check the settings of protection relays.

c. Check all cable connections and flat pin contacts; check tightness of nuts and bolts.

d. Check cooling fans (only fitted to convertors rated at 300 A).

Remember the risk of electric shock

The supply voltage to the converter must be switched off for checks a and c.