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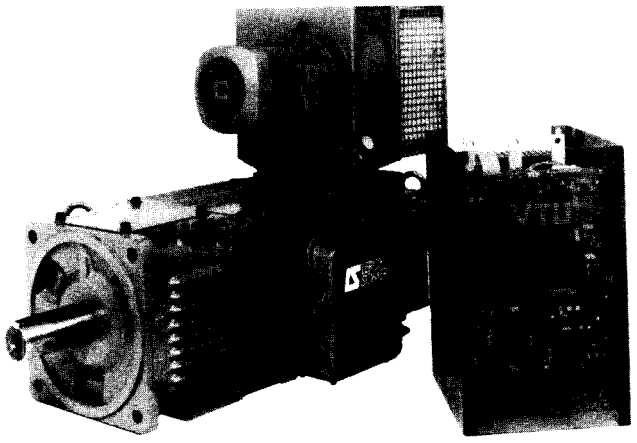
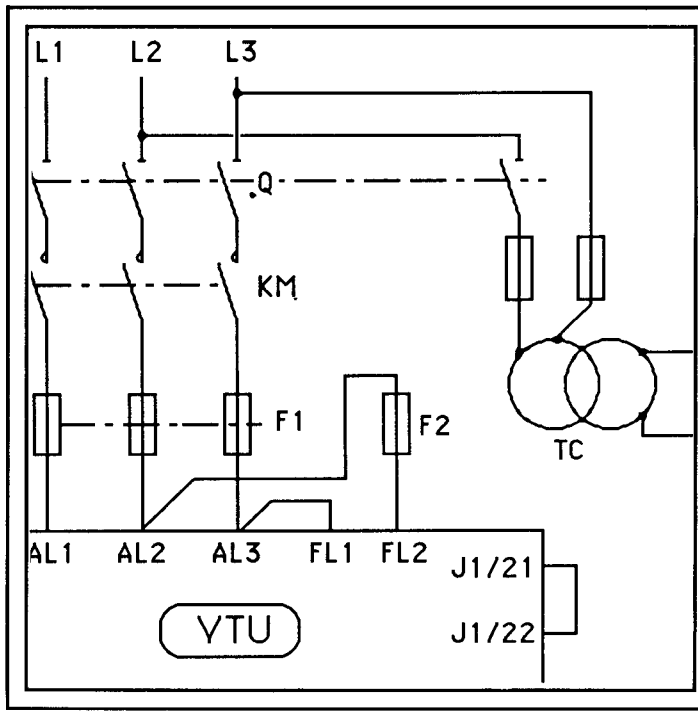





Référence 0E-235/1 - 4523 - juillet 87

# VTU

## one way three phase speed controller for D.C. motors

### installation and maintenance manual

## GENERAL

# 1. GENERAL

The VTU is a thyristor speed controller for D.C. motors.
It requires a three phase mains supply without neutral, from 220 to 460V, 50 or 60 Hz.

The power convertor controlling the supply to the motor is a 6 thyristor Graetz bridge.

The VTU can therefore operate by controlling the power from the mains to the motor or from the motor to the mains (regenerative braking mode). In the latter case, the polarity of the motor armature has to be reversed via electromechanical contactors.

## 1.1 - Electrical characteristics

A VTU controller is mainly defined by :

- Three phase supply voltage
- Nominal rectified current (direct current)

Other characteristics are outlined in table 1 on page 2.
The values given in the table are valid for a maximum ambient temperature of 40°C around the controller.

For operation in cyclical mode, the current limiting system will whistand an overload of up to 1,5 times the nominal current for 10 seconds. The load on the motor should then be reduced to a lower value for a period such that the effective current is less than the nominal current value of the controller.

## 1. 2 - Operation with or without tachogenerator

Except in special circumstances, a tachogenerator is essential in the following cases :

- Speed control range exceeding 1 to 10
- Constant power operation with field weakening linked to by armature voltage.
- Precise speed control
- Total isolation of power and control circuits.

**TABLE N° 1**

| CONTROLLER TYPE | MAINS SUPPLY THREE PHASE WITHOUT NEUTRAL | | OUTPUT TO MOTOR | | NOMINAL POWER OF MOTOR | | MOTOR FIELD VOLTAGE (V) |
|---|---|---|---|---|---|---|---|
| | NOMINAL CURRENT (A) | ARMATURE VOLTAGE (V) | NOMINAL CURRENT (A) | ARMATURE VOLTAGE* (V) | KW | Hp | |
| VTU 2 - 38 | 32 | 220/240 | 38 | 250/280 | 9/10 | 12/13 | 170/340 |
| VTU 2 - 75 | 62 | 220/240 | 75 | 250/280 | 19/21 | 26/27 | 170/340 |
| VTU 2 - 110 | 90 | 220/240 | 110 | 250/280 | 27/31 | 37/42 | 170/340 |
| VTU 2 - 170 | 140 | 220/240 | 170 | 250/280 | 42/48 | 57/65 | 170/340 |
| VTU 2 - 260 | 230 | 220/240 | 260 | 250/280 | 70/78 | 95/106 | 170/340 |
| VTU 2 - 360 | 295 | 220/240 | 360 | 250/280 | 90/100 | 122/136 | 170/340 |
| VTU 3 - 38 | 32 | 380/415 | 38 | 440/480 | 17/18 | 23/24 | 170/340 |
| VTU 3 - 75 | 62 | 380/415 | 75 | 440/480 | 33/36 | 45/49 | 170/340 |
| VTU 3 - 110 | 90 | 380/415 | 110 | 440/480 | 48/53 | 65/72 | 170/340 |
| VTU 3 - 170 | 140 | 380/415 | 170 | 440/480 | 75/82 | 102/111 | 170/340 |
| VTU 3 - 260 | 230 | 380/415 | 260 | 440/480 | 123/134 | 167/182 | 170/340 |
| VTU 3 - 360 | 295 | 380/415 | 360 | 440/480 | 158/173 | 215/235 | 170/340 |
| VTU 4 - 38 | 32 | 440/460 | 38 | 510/530 | 19/20 | 26/27 | 170/340 |
| VTU 4 - 75 | 62 | 440/460 | 75 | 510/530 | 38/40 | 52/54 | 170/340 |
| VTU 4 - 110 | 90 | 440/460 | 110 | 510/530 | 56/58 | 73/76 | 170/340 |
| VTU 4 - 170 | 140 | 440/460 | 170 | 510/530 | 87/90 | 118/122 | 170/340 |
| VTU 4 - 260 | 230 | 440/460 | 260 | 510/530 | 143/148 | 194/201 | 170/340 |
| VTU 4 - 360 | 295 | 440/460 | 360 | 510/530 | 184/191 | 250/260 | 170/340 |

The above values are valid for an ambient temperature between 0°C and 40°C around the controller.

* Maximum armature voltage in drive mode. Multiply by 0,9 to obtain the maximum armature voltage in braking mode.

### 1.3 - Speed control performance with tachogenerator

| Parameter | Range of variation | Speed error |
|---|---|---|
| Mains voltage | ± 10% | 0,2% of selected speed |
| Ambient temperature | Per °C | 0,1% of selected speed |
| Motor load | 0 to 100% | 0,1% of steady state speed |

### 1.4 - Speed control performance without tachogenerator

These depend mainly on the driven motor since the armature voltage is used for the speed control loop.

Optimum performance is obtained by compensating for the voltage drop due to the internal resistance of the motor via a special adjustment.

Speed error should be less than ± 3% of the selected speed.

NOTE : A high impedance circuit for the measurement of the armature voltage is sufficient to obtain adequate isolation between the control circuits and the mains.

### 1.5 - Operation of protective devices

The various protective devices fitted to the VTU are outlined in the following table :

| Description | Setting value | Latch | LED indicator |
|---|---|---|---|
| Instantaneous overcurrent | 2,5 In | YES | YES (CR 60) |
| Motor thermal cutout | 1,5 In | YES | YES (CR 61) |
| Mains line failure | Vn - 15% | NO | NO |
| Phase failure | | NO | YES (CR 62) |
| + and - 15V supply | + et - 13 à 17V | YES | YES (CR 59) |
| Convertor over temperature | | YES | YES (CR 58) |
| Overspeed detector | 1,2 N max | YES | YES (CR 57) |

## 2. INSTALLATION - CONNECTIONS

### 2. 1 - Dimensions - Fixing details - terminal block layout (see fig.2 page 6)

### 2. 2 - Installation precautions

The flow of cooling air is from bottom to top.

VTU stacks should not therefore be placed in the top of cabinets where hot air can accumulate. A hot air outlet should be fitted to the top of the cabinet.

A space of at least 10 cm should be left above and bellow the VTU.

If the VTU is fan cooled, a space of approx. 10 cm should also be left on either side.

### 2. 3 - Terminal connections

#### 2.3.1 - Power terminal block

AL1- AL2- AL3 : mains connections terminals (located at the top of the controller). There is no need to take account of phase rotation.

FL1- FL2 : power supply terminals to field power convertor. (normally connected to terminals AL2 and AL3 (ensure that mains voltage is the correct value for the motor field, see fig.21).

A1 - A2 : Motor armature terminals (located at the base of the controller).

F1 - F2 : Motor field terminals.

#### 2.3.2 - Control terminal block (ref. J1)

It is located on the CPR 1215 customisation board and includes 32 terminals numbered 1 to 32, from left to right.

1 - 2 - 3 : zero speed relay (optional)

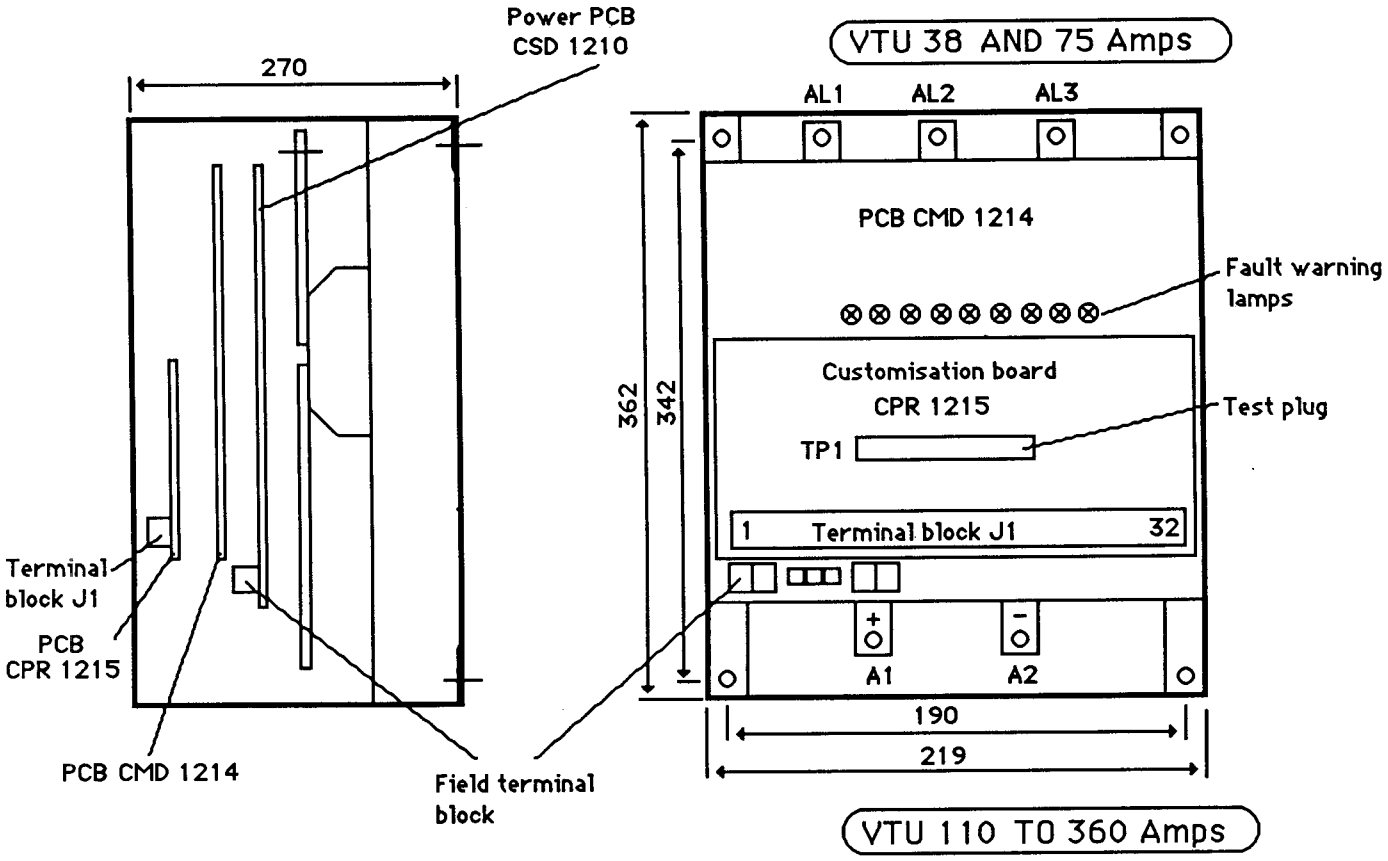
4 - 5 - 6 : general fault relay (4 = normally open, 5 = common, 6 = normally closed).

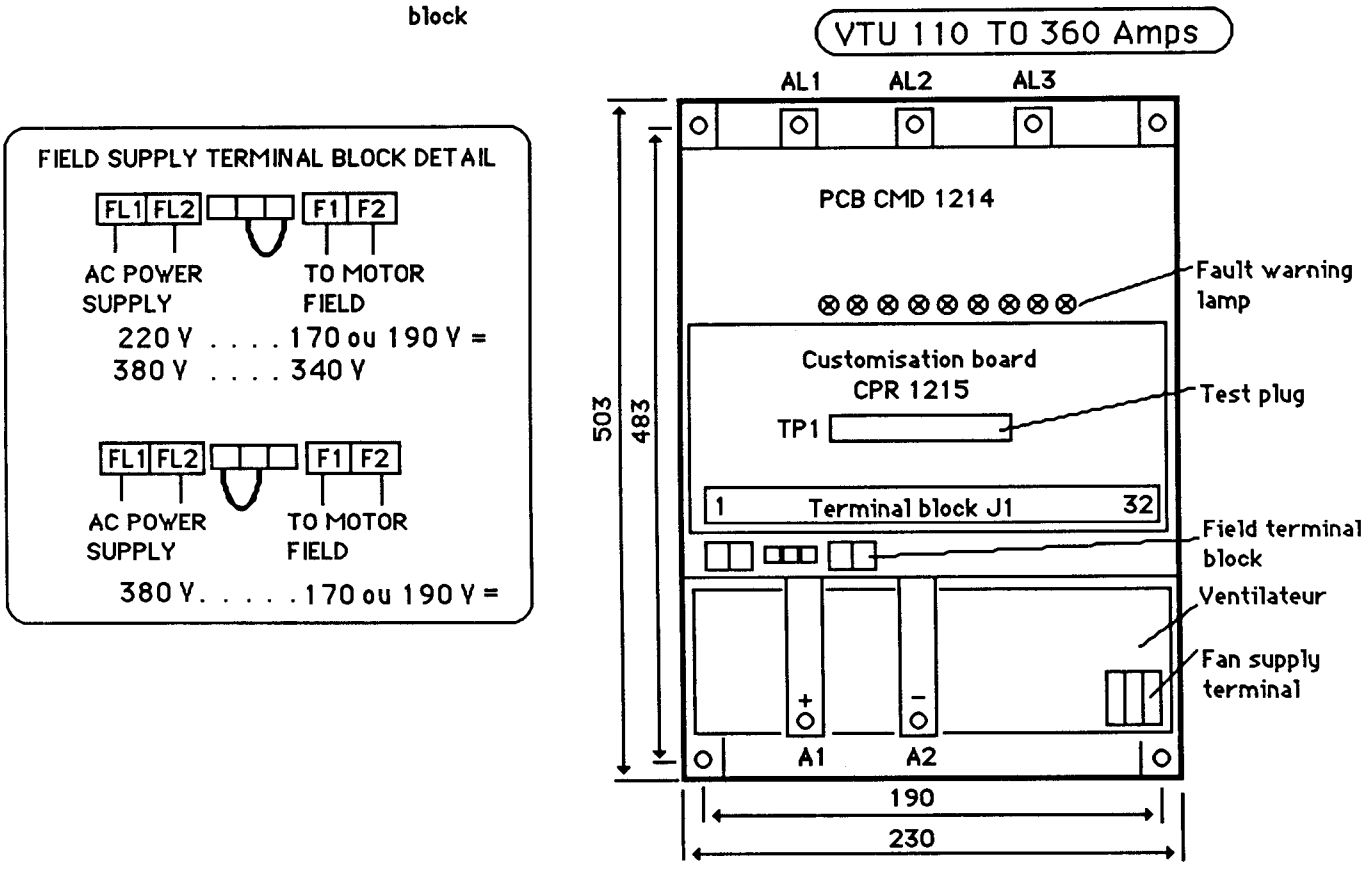
7 - 8 : supplementary current input (terminal 8, 0V or common).

9 - 10 : armature voltage (terminal 9 + ive) for speed control without tachogenerator).

11 : back E.M.F output for field weakening option.

## Dimensions - Fixing details -Terminal block layout




FIELD SUPPLY TERMINAL BLOCK DETAIL




AC POWER SUPPLY — TO MOTOR FIELD

220 V . . . . 170 ou 190 V =
380 V . . . . 340 V




AC POWER SUPPLY — TO MOTOR FIELD

380 V. . . . . 170 ou 190 V =

12-13-14 : Field weakening option
15-16 : Current reference output (terminal 15 common)
17-18 : Tachogenerator return (terminal 17 +ive)
19-20 : Supplementary speed input (terminal 19 common)
21-22 : Controller clamp (terminals closed circuit = controller unclamped).
23-24 : General fault reset via momentary contact between these terminals.
25 : Speed demand input (with reference to terminal 27)
26-27 : Fixed +10V supply to speed demand potentiometer (terminal 27 common)
Terminals 28 to 32 are only used with special options.
28-29 : Insulated current input (0 to 16 mA, 0 to 20 mA, or 4 to 20 mA).
30-31-32 : Insulated speed demand input.

Terminal connection sizes :
- Power terminal : bars with 0 8 mm for 8 mm eye connector.
- Control terminals : direct connection of stripped wire up to 2,5 mm2.
- Field terminals : 0 4 mm screw terminal for 4 mm fork connector.

## 2.4 - Typical connection diagram (see fig.3 page 7)

### 2.4.1 - Power fuses

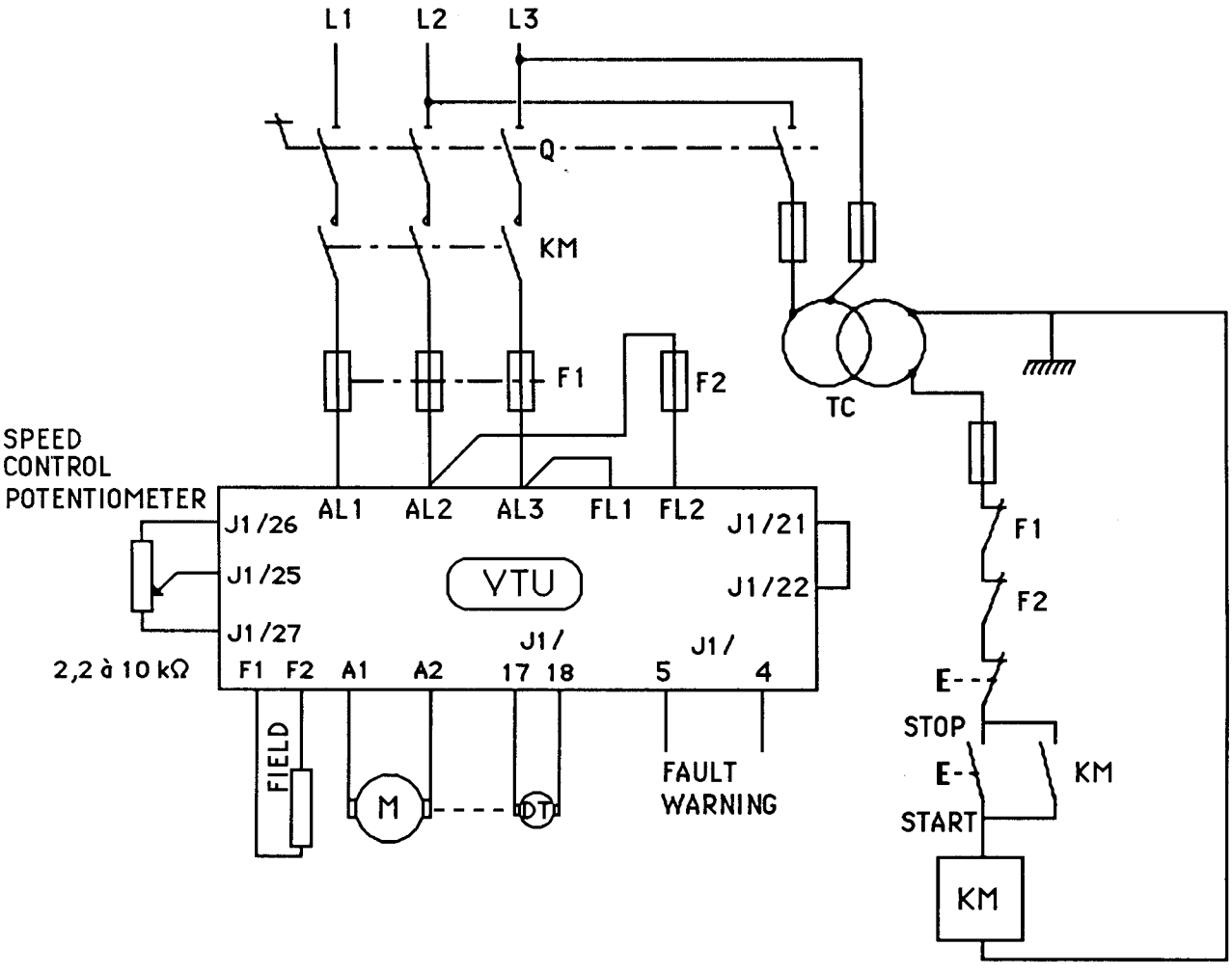
For general use, three fuses of the high speed semi-conductor protection type should be used on the three phase input AL1, AL2, AL3.

Fuse rating

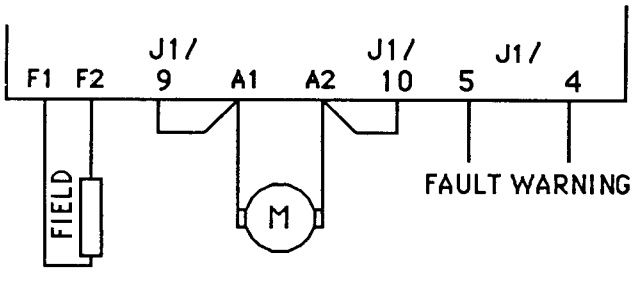
| Nominal current of controller | 38 | 75 | 110 | 170 | 260 | 360 |
|---|---|---|---|---|---|---|
| Fuse rating | 40 | 100 | 125 | 200 | 315 | 500 |

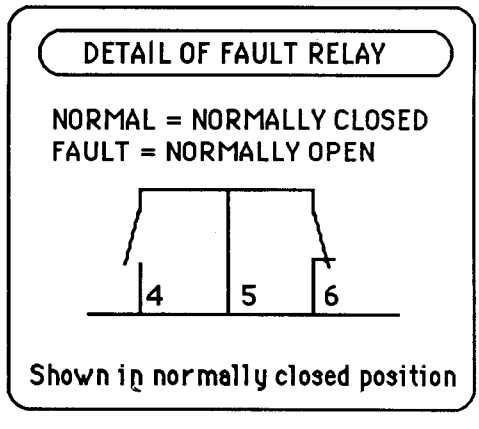
**WARNING** : A fourth fuse of the same rating should be fitted to one of the motor armature connections (A1 or A2) in cases where motor is being used as a regenerative brake.

## Typical connection diagram




VTU WITH MOTOR NOT FITTED WITH TACHOGENERATOR



### 2.4.2 - Field circuit fuses

A mains type fuse should be fitted in series with terminal FL1 or FL2. A rating of 10A is suitable for most standard applications.

## 3 - PRE-START UP CHECKS

### 3. 1 - Power supply

Check that the supply voltage corresponds to the value indicated on the identification plate of the VTU (see table 1 page 2).

Set the 3 voltage selection switches (S1, S2, S3) situated on the power board (CSD 1210).

These should be in the same position, S1, S2, S3 are fitted to the rear side of board CSD 1210.

S1, S2, S3 should be in the upper position for low supply voltage, and the lower position for high supply voltage.

### 3.2 - Supply voltage frequency

Set the switches on the masterboard CMD 1214 to the position corresponding to the power supply frequency (50 or 60 Hz).

All the switches (SA1 to SA4) should be in the same position.

### 3.3 - Operation with tachogenerator

The tachogenerator should be connected to terminals J1/17 (+ive) and J1/18 (-ive) on the customisation board (CPR 1215).

If the polarity is incorrect, the motor will accelerate to a speed slightly above its rated speed. It is therefore sensible to check polarity. To do this, turn the motor by hand in a clockwise direction when facing the end of the shaft (this is the correct direction if the polarity of the armature and of the field is correct).

For this direction of rotation, the tachogenerator polarity should be :

+ive on terminal J1/17

-ive on terminal J1/18

Using jumper SA4 on the customisation board CPR 1215, select the position corresponding to the voltage delivered by the tachogenerator at the maximum speed of the motor :

- Position 1 : voltage between 20 and 60V
- Position 2 : voltage between 50 and 130V
- Position 3 : voltage between 100 and 300V

Position 4 is used for operation without tachogenerator, i.e using the motor armature voltage to control the speed (see para.3.4).

### 3.4 Operation without tachogenerator

Connect the armature voltage to terminals 9 and 10 of terminal block J1 by linking terminal A1 to J1/9 and A2 to J1/10.

In this case, the galvanic isolation between the power and control circuits is not total, but it is at high impedance, which enables the VTU to operate correctly however the speed reference is connected.

Place jumper SA4 (customisation board CPR 1215) in position 4.

### 3. 5 - Position check on other selector switches

These are fitted to CPR 1215 board :

S1 (speed reference selection) should be in position 1, except when the VTU is fitted with "insulated reference" option.

S2 (secondary ramp on/off) should be in position 2 for secondary ramp "ON".

S3 (di/dt selection) should be in position 1.

S5/1, S5/2 (separation of speed loop from power loop) should be in position "ON" i.e : towards the right.

S5/3 (field weakening option selection) should be in position "ON", i.e : towards the right when the VTU is not fitted with the field weakening option.

S6/1 (isolation of thyristor control circuit from rest of control circuit) should be in position "ON", i.e : towards the right.

S6/2 (isolation of linearisation loop from control circuit) should be in position "ON", i.e : towards the right.

### 3.6 - Field circuit connection check

Refer to table 1 and FiG.3.

As a safety measure, use a DC voltmeter to measure the voltage between terminals F1 and F2 as soon as the motor is switched on and check that the measured value is the same as the value mentioned on the identification plate.

## 4 - STARTING UP AND ADJUSTMENTS

### 4. 1 - Adjustment of the current limit

This adjustment should be carried out by allowing current to flow when the motor is stopped. This is because the VTU tolerates a transient overload of 1,5 times the rated current for 10s.

If the overload persists, beyond this time, the VTU locks out (see para.1.1). This measurement is not therefore easy.

The real current limit value will be 1,5 times the rated motor value.

This setting can be carried out approx. using potentiometer R 110 :

- if R 110 is fully clockwise, the motor current limit is at the rated value of the controller (see table 1 page 2).
- if R 110 is fully anticlockwise, the current limit is equivalent to half the rated value of the controller.
- if R 110 is in mid-position, the motor current limit is equivalent to 0,75 times the rated value of the controller.

The motor current is limited to a value proportionnal to the angular position of R 110, between one half and the total rated value of the controller.

More precise adjustment is possible using another method :

- Connect a voltmeter between testpoints TP1/11 and TP1/8 located on the test connector TP1 (on board CPR 1215).

The CTC 1282 test board provides easier access to the test points.

- Disconnect one of the armature connections (A1 or A2).
- Switch off the power to the VTU, select a speed reference signal greater than 1V.
- Read the voltage at TP1/11. This voltage of approx. 10V is equivalent to the rated current value of the controller.
- Connect the voltmeter between testpoints TP1/10 and TP1/10 a voltage equal to :

$$\text{Voltage at TP1/11} \times \frac{\text{rated motor current}}{\text{rated controller current}}$$

### 4.2 - Tachogenerator polarity checks (see para.3.3)

### 4.3 - Maximum speed adjustment

Refer to para 3.3 for rating selection via jumper SA4 (board CPR 1215).

Fine adjustment is carried out using potentiometer R 107 on board CPR 1215.

### 4.4 - Acceleration/deceleration ramp adjustment

The secondary ramp is selected via switch SA2 (CPR 1215) which should be in position 2 to switch the ramp on.

Potentiometer R 105 adjusts the deceleration ramp (increase in time by turning potentiometer clockwise).

Potentiometer R 106 adjusts the acceleration ramp (increase in time by turning potentiometer clockwise).

The minimum time is 0,5s and the maximum time is 15s with the standard value for capacitor C3 (2,2 F). By increasing the value of C3, the ramp time can be increased in proportion.

### 4.5 - Speed loop response adjustment

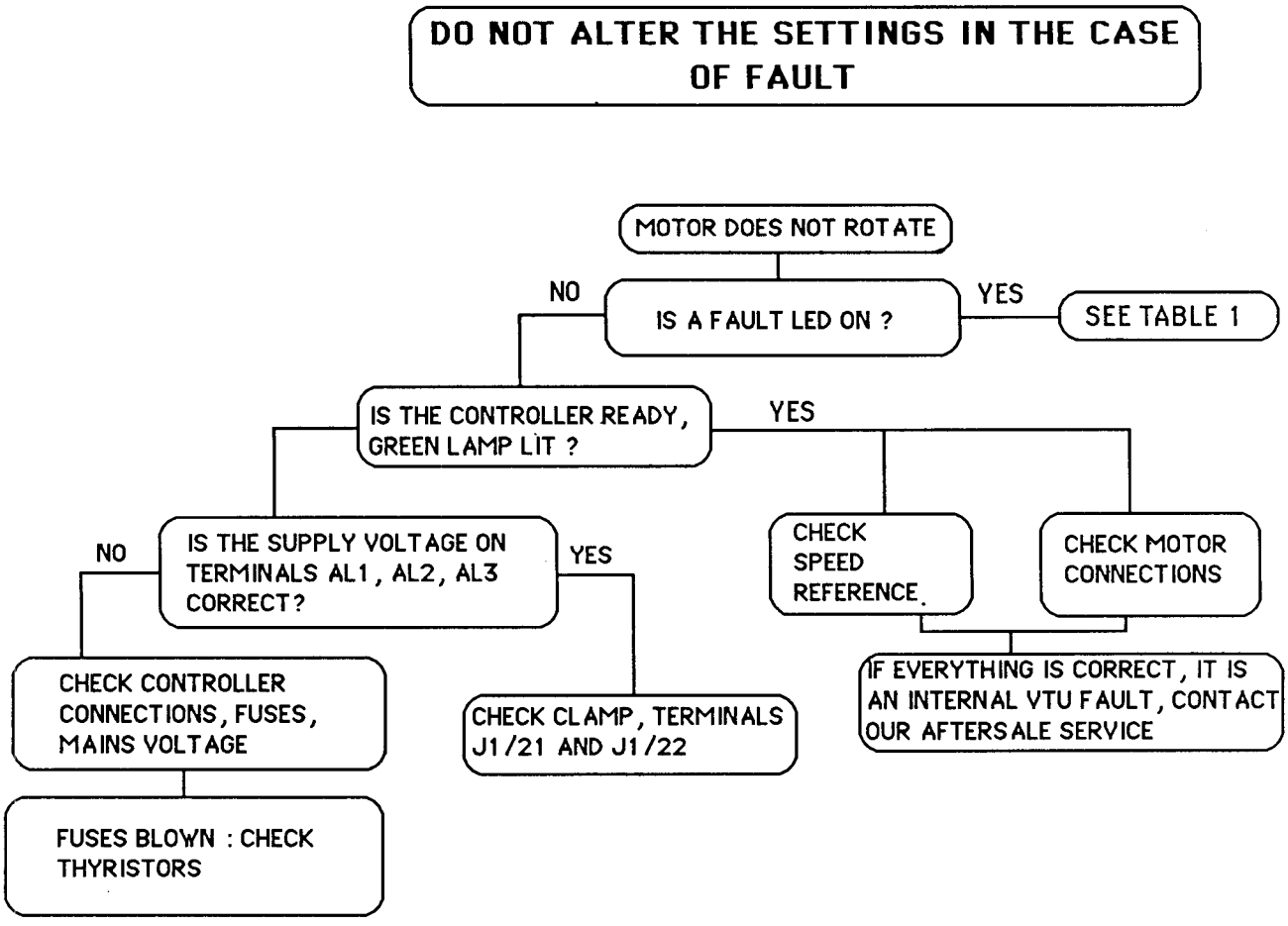
This adjustment is normally carried out with the ramps set to minimum (see para. 4.4).

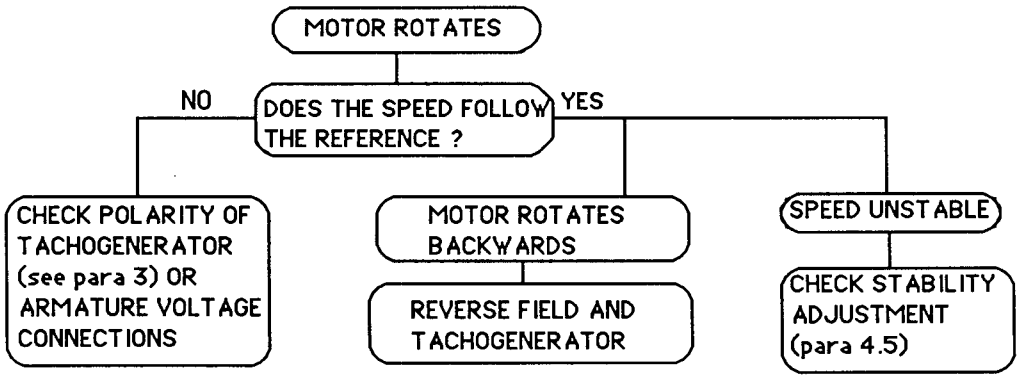
Set the speed control to a figure equivalent to approx. half the nominal value.

Observe the tachogenerator signal. It should attain the reference value as quickly as possible without excessive overshoot.

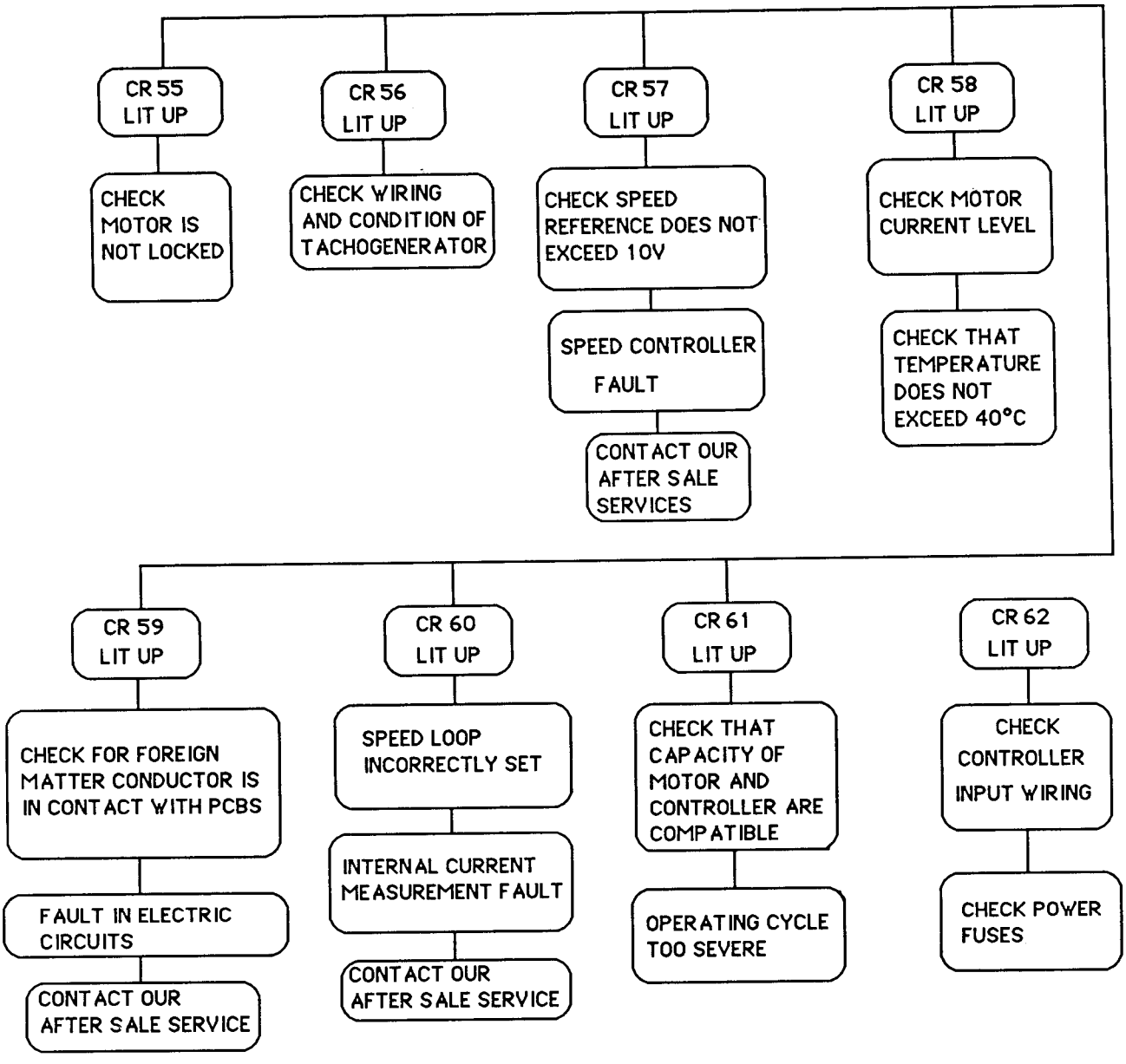
Adjustment is via potentiometer R 109 (CPR 1215). It may be necessary to increase the value of capacitor C6 (standard value 0,47 F).

## 5 - FAULT FINDING



# FAULT CONDITION TABLE - LED STATUS

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