

**87-900-818-01**

January 1991



## **Instruction Manual**

### **Turbo-V200 controller**

**Model 969-9422**

**Model 969-9522**

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# SAFETY SUMMARY

Operators and service personnel must be aware of all hazards associated with this equipment. They must know how to recognize hazardous and potentially hazardous conditions, and know how to avoid them. The consequences of unskilled, improper, or careless operation of the equipment can be serious. This product must only be operated and maintained by trained personnel. Every operator or service person must read and thoroughly understand operation/maintenance manuals and any additional information provided by Varian. All warnings and cautions should be read carefully and strictly observed. Address any safety, operation, and/or maintenance questions to your nearest Varian office.

The following format is used in this manual to call attention to hazards:

## WARNING

**Warnings are used when failure to observe instructions or precautions could result in injury or death.**

## CAUTION

**Cautions are used when failure to observe instructions could result in damage to equipment, whether Varian-supplied or other associated equipment.**

## NOTE

*Information to aid the operator in obtaining the best performance from the equipment.*

## 1-1 General

The Turbo-V200 Controller is a solid-state frequency converter with self-diagnostic and protection features.

It incorporates all the facilities required for the automatic operation of the Turbo-V200 pump series. Remote start/stop, pump status signals, forepump start/stop, interlock control capability (for pressure switch, water flow switch, etc.), are provided via auxiliary connectors.

LED displays located on the front panel indicate the operating condition of the Turbo-V pump.

Fig. 1-1 is a picture of the Turbo-V200 controller.

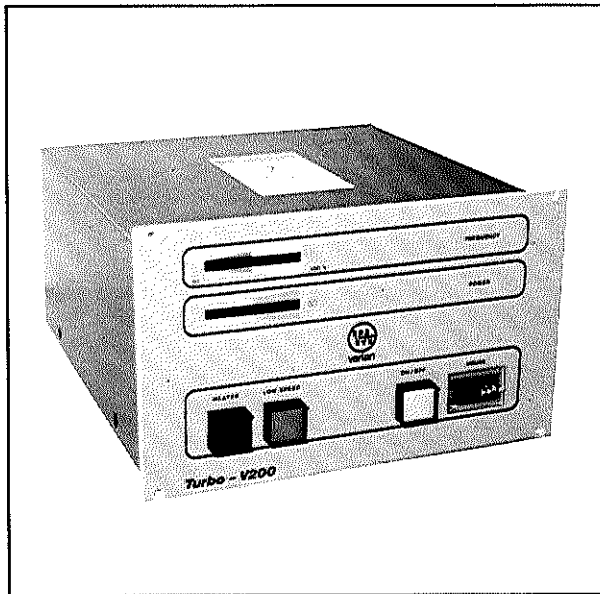


Figure 1-1 - Turbo-V controller

## 1-2 Turbo-V200 controller description

The controller is available in two versions which differ in the factory-set input voltage:

- model 969-9422 (220 Vac, 50-60 Hz)
- model 969-9522 (120 Vac, 50-60 Hz)

The controller is a solid-state frequency converter with control circuitry for automatic operation of the Turbo-V pump.

The frequency converter section consists mainly of four printed circuit boards, power board, interconnection board, control board, and display board; each is designed for easy replacement. The power board converts the single phase (50-60 Hz) AC mains supply into a DC voltage and then to a three-phase, low voltage, medium frequency output which is required to power the Turbo-V pump. The interconnection board contains the line voltage selector, the power supply, and the optoisolated interconnection circuits. The control board maintains a controlled acceleration of the pump by a gradual increase of frequency until the pump achieves its rated rotational speed. This frequency ramp ensures optimum acceleration with minimal losses and slip in the motor.

The control board can correctly sequence the forepump, fan, vent device, and water cooling system components for automatic operation, and can accept inputs from external vacuum switches and the forepump contactor.

The display board drives the power and frequency bar graph.

The Turbo-V200 controller front panel controls are shown in Fig. 1-2 while the controller rear panel is shown in Fig. 1-3.

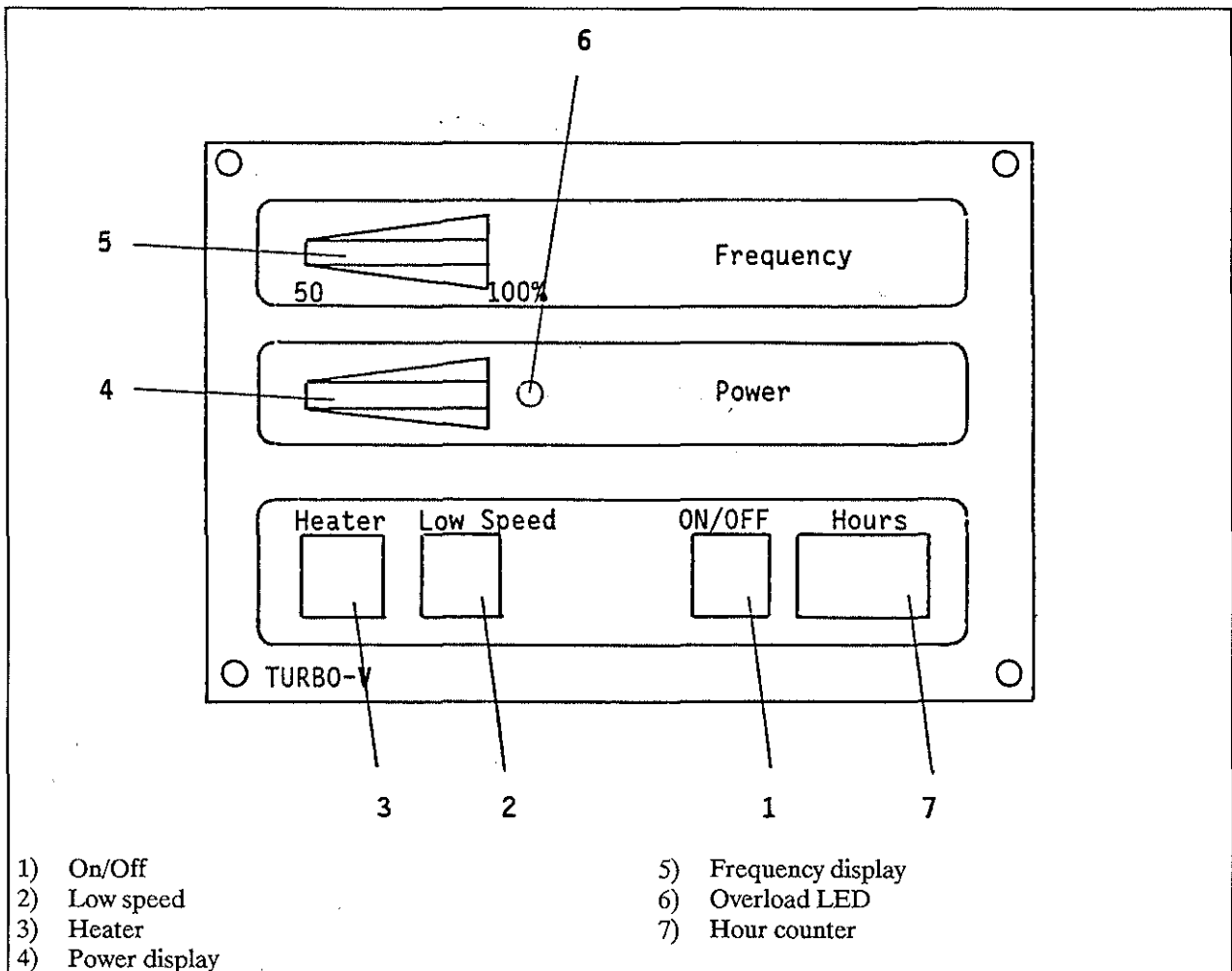


Figure 1-2 - Controller front panel

### 1 - On/Off

When engaged, this switch starts the Turbo-V pump after a few seconds delay. Disengaging the switch again, removes power from the pump and will stop it (regardless of the rotational speed).

The On/Off switch is also used to reset the pump/controller from a failure condition.

### 2 - Low speed

When this switch is engaged, the pump runs at about 70% of its normal speed.

### 3 - Heater

When this switch is engaged, an output voltage (same value as the mains) is present at the power interconnecting socket (J21) to power the heater band when the pump is in operation.

### 4 - Power display

The display shows the power drawn by the pump.

It consists of twelve LED's; the first LED will come on at about 30 W and the last LED is on when the power reaches about 170 W.

### 5 - Frequency display

The display consists of 12 LED's and indicates the output frequency of the controller. The first LED is on when the frequency output reaches 50% of the nominal value (425 Hz) and the last LED is barely visible at about 95% of the nominal frequency (800 Hz).

**6 - Overload LED**

This LED indicates that the pump has been stopped because:

- the pump has been operated at an excessive pressure, or the power level exceeds 220 W for more than 20 seconds;
- the temperature of the pump exceeds 60°C;
- the temperature of the transformer is above 90°C;
- the temperature of the power PCB heat sink is above 60°C;
- during the start-up time, the power level exceeds 700 W during the first 45 seconds and 350 W during the other 135 seconds.

**7 - Hour counter**

This meter shows the accumulated Turbo-V pump operation time and is independent of the mains frequency.

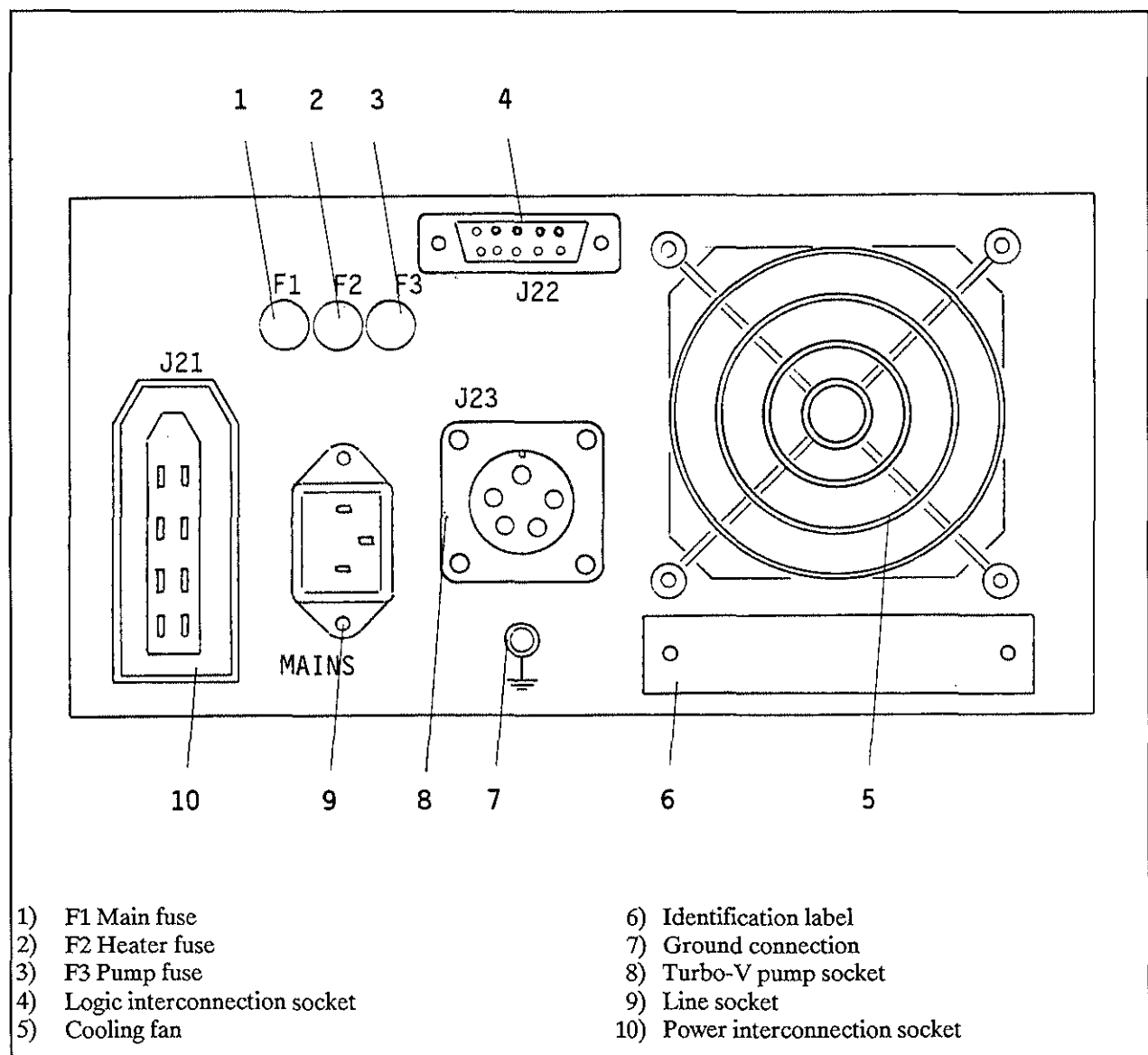


Figure 1-3 - Controller rear panel

1-2.1 Turbo-V controller specifications

Input	Voltage Frequency Power	100-200-220-240 Vac $\pm 10\%$ - 1 phase 47 to 63 Hz 850 VA maximum
Output	Voltage Frequency Power	54 Vac $\pm 3\%$ - 3 phases 850 Hz $\pm 2\%$ 700 W maximum
Operating temperature		0° to 40°C
Storage temperature		-20° to +70°C
Fuse F1 (mains) F2 (heater) F3 (pump)		T 8 A (slow blow) for 100-120 Vac T 5 A (slow blow) for 220-240 Vac T 5 A (slow blow) disregarding the mains T 16 A (slow blow)
Optoisolator input (remote start, remote low speed)		minimum ON            4 Vdc, 1.6 mA maximum                16 Vdc, 9 mA reverse voltage         3 Vdc insulation voltage      150 V
Optoisolator output (normal speed)		Optomos device contact able to carry 60 mA at 36 Vac or 48 Vdc
Auxiliary output connectors		power socket (ref. sect. II) logic socket (ref. sect. II)
Interconnecting cables	mains cable pump cable	(3 wire, 3 meters long) (5 wire, 5 meters long)
Weight		6.1 Kg (13.5 lbs)

1-2.2 Controller outline

The outline dimensions for the Turbo-V controller are shown in Fig. 1-4.

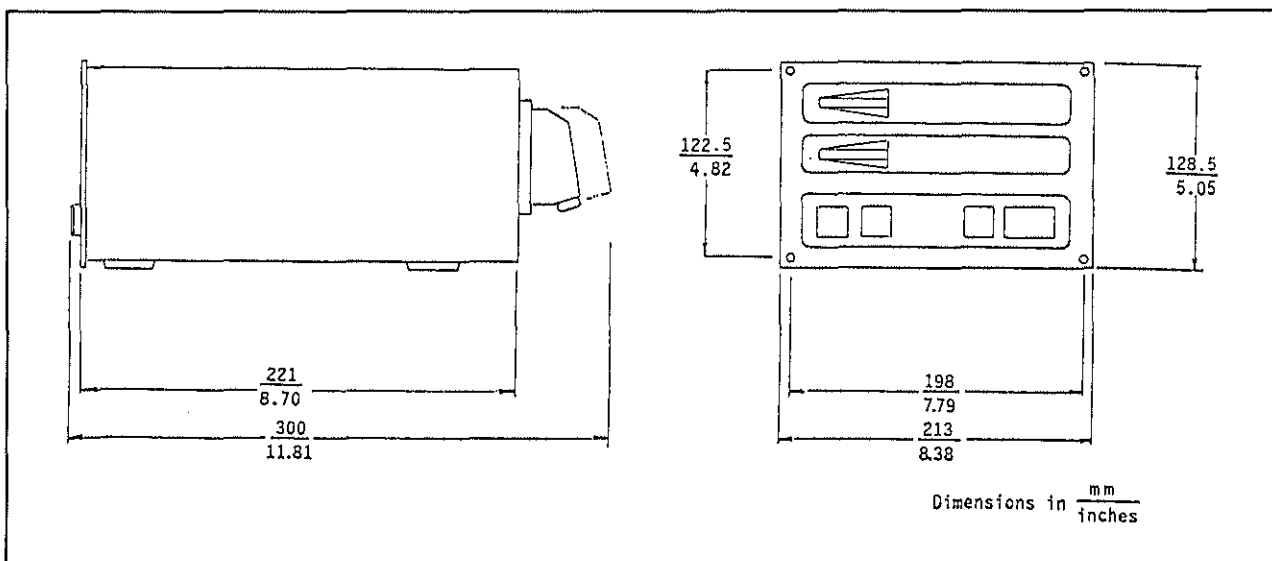


Figure 1-4 - Controller outline



## 2-1 Turbo-V200 controller set-up

Inspect the controller for any shipping damage.

The Turbo-V200 controller model 969-9422 is factory-set for 220 Vac operation and the model 969-9522 is factory-set for 120 Vac operation.

Both controller models are set up for use with a grease-lubricated pump 969-9024, 969-9025, or 969-9026.

### NOTE

*To operate the Turbo-V200 model 969-9021, 969-9022, 969-9023, 969-9027, 969-9028 (oil pumps), remove the jumper on control PCB as directed at point b) below (see also fig. 4-1, item 10).*

This jumper determines the parameters that will be set up for the associated pumps.

### WARNING

**High voltage developed in the controller can cause severe injury or death. Before servicing the unit, turn off front panel switch and disconnect input power cable.**

### NOTE

*The Turbo-V controller can be used as a bench unit or as a rack module, but must be positioned so that free air can flow through the holes.*

### NOTE

*The Turbo-V controller is equipped with a 3 wire power cord and plug (internationally approved) for user's safety.*

*Use this power cord and plug in conjunction with a properly grounded power socket to avoid electrical shock.*

### a) Mains change over

If a change in line voltage operation is desired, proceed as follows:

- disconnect the power card and remove the Turbo-V controller cover

- check line voltage selector setting on main PCB
- remove line voltage selector cord and select operating voltage 110/120/220/240 Vac than insert board into slot
- check for correct mains Fuse F1 value (see paragraph 1-2.1)
- install cover and connect the power cord.

### b) Grease/oil pump operation change over

- disconnect the power cord and remove the Turbo-V controller cover
- on control PCB, right back side (fig. 4-1), simply lift the jumper up and out of its socket
- install cover and connect the power cord.

### 2-1.1 Power interconnections

The controller is provided with a power connector plug P21. Ensure that the main circuit breaker is off, then remove the plug and wire the pins (maximum wire size 18 AWG) as indicated below to obtain the desired capability (Fig. 2-1).

**Pin 1a:**  
Ground

**Pin 1b-3a / 3b-3a / 2b-2a:**

Output of 120 Vac (independent of line voltage) 0.4 A total for vent device, fore-pump relay coil, Turbo-V fan. Voltage is present after ON/OFF push button is pressed (with the proper links on P22) and will remain present until an overload or power is removed from the turbopump.

**Pin 4b - 4a:**

Output mains voltage 3 A max for heater band. Voltage is present only when the turbo-pump is running and the HEATER push button is pressed.

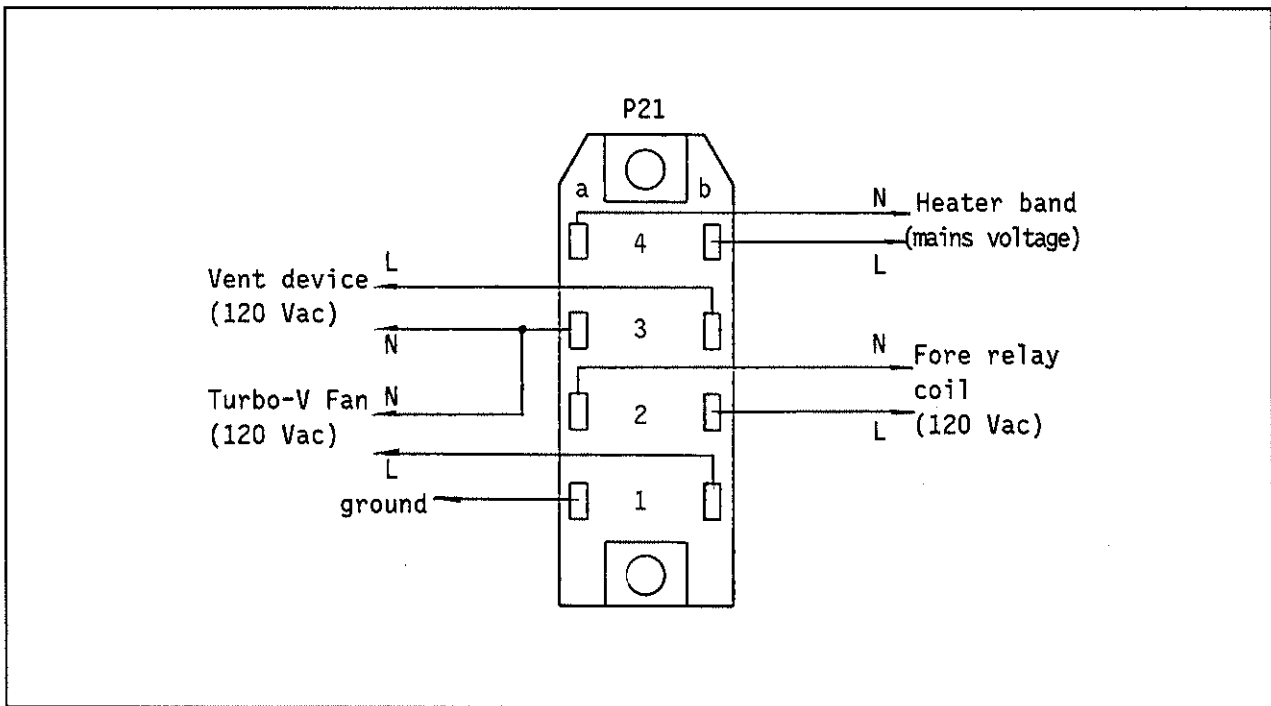


Figure 2-1 - Power socket output signals

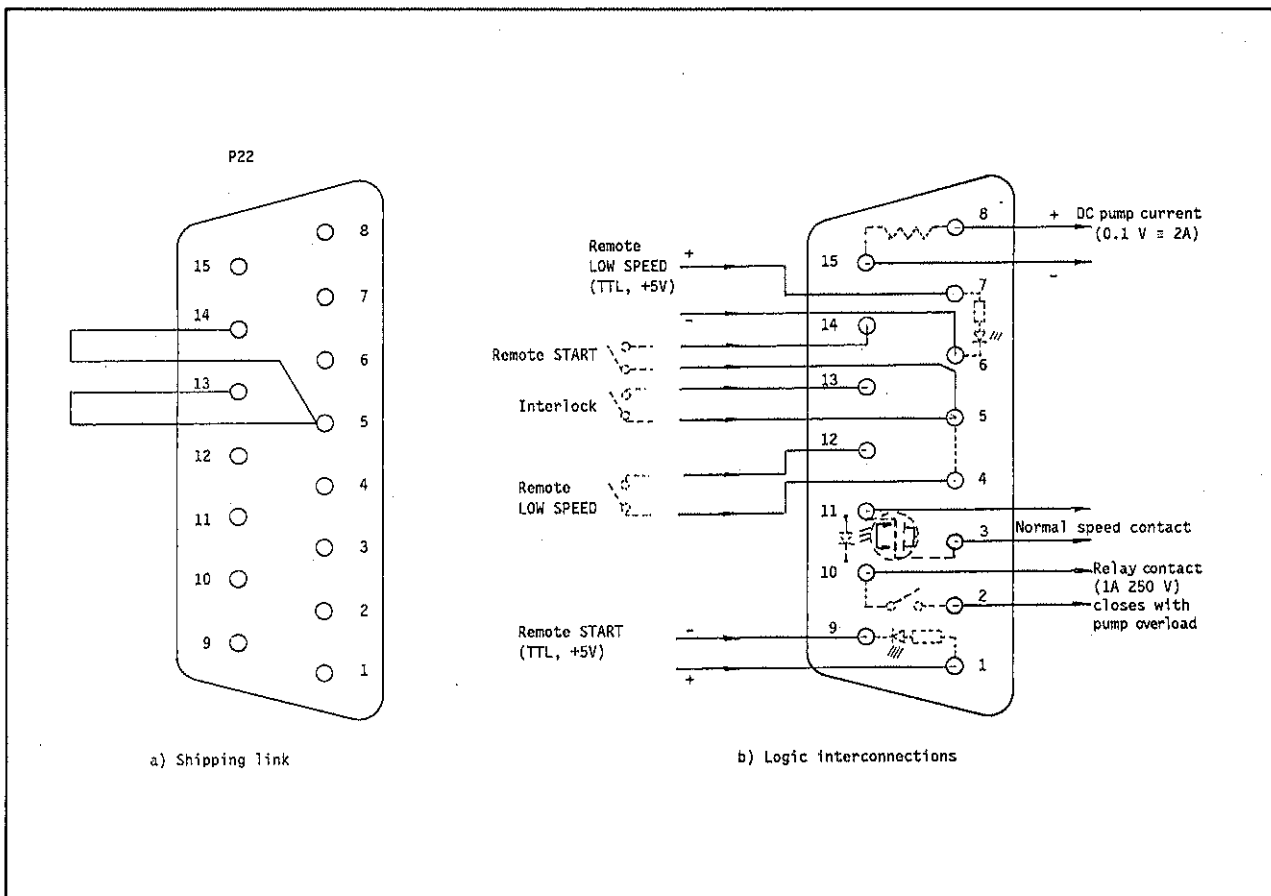


Figure 2-2 - Logic connector configuration

### 2-1.2 Logic Interconnections

All logic controls inputs and outputs are accessible at logic connector J22. Ensure that the power is off, then remove the provided mating connector P22 and make the connections with 26 AWG (or smaller) wire to the pins as indicated below to obtain the desired capability (see Fig. 2-2).

#### a) Input to the Turbo-V Controller

**NOTE**

*Even if the remote Start is used, the ON/OFF switch must be pressed (ON).*

#### Pin 1-9:

Remote START optically isolated from the internal circuit, requires a permanent logic level of 5 Vdc (1 mA minimum) and is TTL compatible.

When this signal is present, the turbopump starts; when the signal is removed, the turbopump is stopped.

#### Pin 14-5:

Remote START requires a permanently closed contact.

When the contact closes, the turbopump starts, and stops when the contact opens.

**NOTE**

*Pin 14-5 must be shorted to allow the Turbo-V pump to start if a remote contact is not used.*

#### Pin 7-6:

Remote LOW-SPEED is optically isolated from the internal circuit, requires a permanent logic level of 5 Vdc (1 mA minimum), and is TTL compatible.

When this signal is present, the turbopump runs at low speed; when it is not present, the turbopump runs at high speed.

#### Pin 12-4:

Remote LOW SPEED requires a permanently closed contact.

When the contact closes, the turbopump runs at low speed and runs up at high speed when the contact opens.

**NOTE**

*With the Low Speed front panel switch set to ON, the remote switch is inoperative and vice-versa.*

#### Pin 13-5:

INTERLOCK (e.g. vacuum pressure switch, water flow switch, feedback from the fore-pump relay) requires a permanently closed contact.

This signal can be used to delay the starting of the turbopump, and when the contact is open, the turbopump stops.

**NOTE**

*Pin 13-5 must be shorted to allow the Turbo-V pump to start if a vacuum pressure switch or an external contact is not connected.*

#### b) Output from the Turbo-V Controller

#### Pin 11-3:

Remote NORMAL speed indication optically isolated output. When the pump is not in normal speed (either High or Low speed) the controller output is an open contact. The optomos device will close (contact carries 60mA at 36 Vac or 48 Vdc) when Normal speed is reached.

#### Pin 15-8:

Analog output of DC pump current draw. 0.1 V proportional to 2 A.

#### Pin 2-10:

Fault contact.

This contact (which carries 1 A, 250 V max) is open when the turbopump is running and closes when the pump is turned off for a pump/controller malfunction condition only.

A typical Turbo-V controller interconnection diagram is shown in Fig. 2-3.

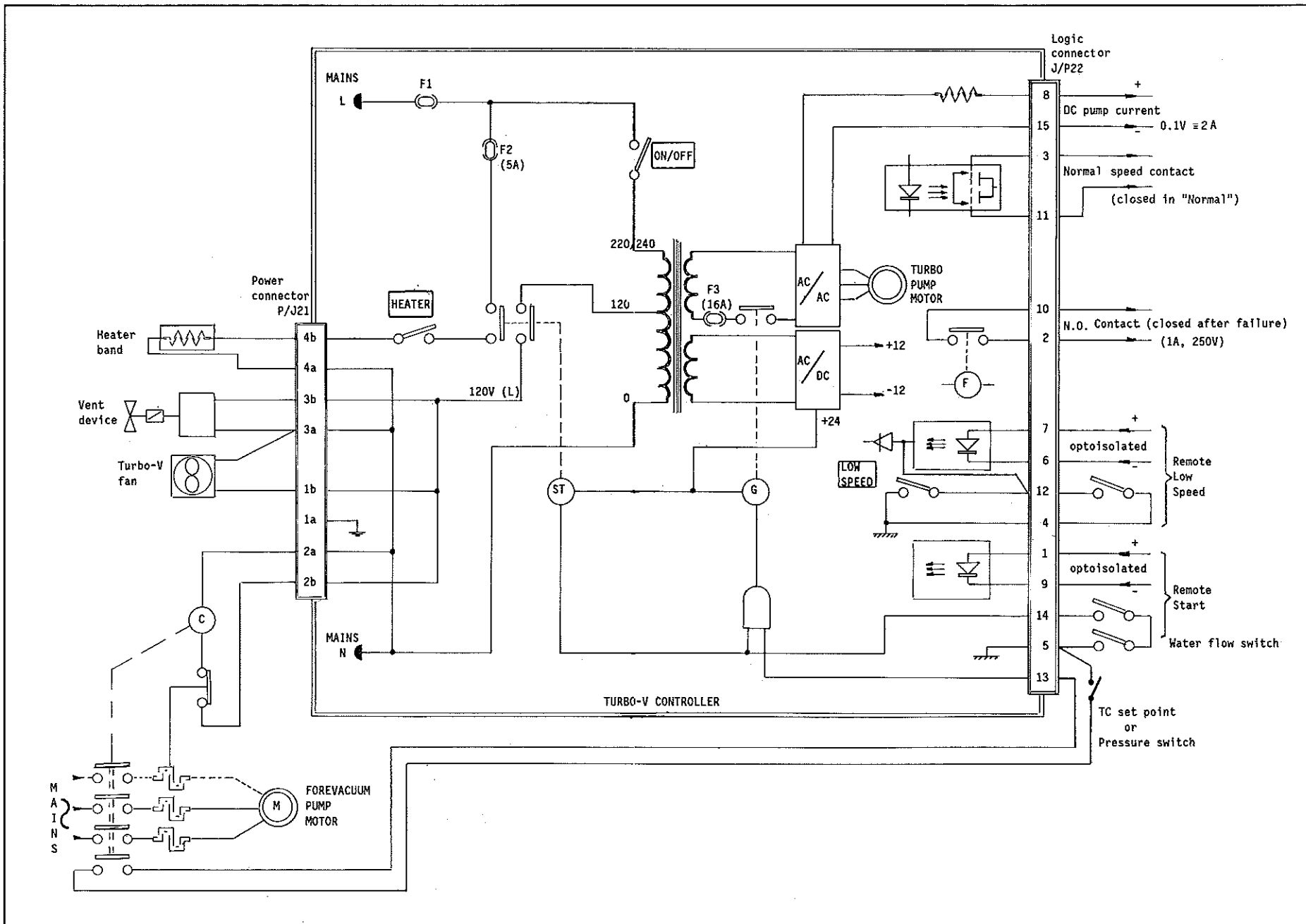


Figure 2-3 - Turbo-V controller interconnections



### 2-1.3 Turbo-V pump connection

#### WARNING

Before connecting the Turbo-V pump to the controller, ensure correct grounding between pump and controller.

A five-meter long cable is provided to connect the controller to the pump. The output connector is shown in Fig. 2-4 and has the following pin configuration:

**Pin A-E:**

Input from pump thermistor

**Pin B-C-D:**

54 Vac, 3 phase output to pump motor stator.

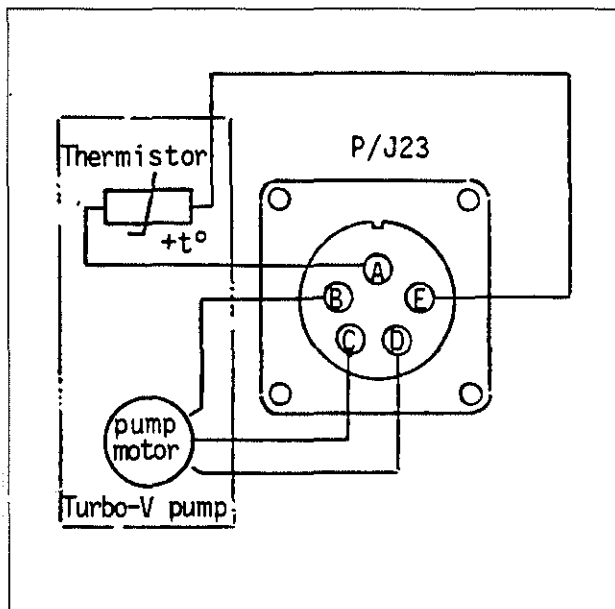


Figure 2-4 - Turbo-V pump connector

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### 3-1 General

Make all vacuum manifold and electrical connections and refer to Turbo-V Instruction Manual prior to operating the Turbo-V controller.

**WARNING**

To avoid injury to personnel and damage to the equipment, make sure the pump is steady (if supported by its rubber feet), or attach the pump to the bench using the threaded holes where the rubber feet are installed.

**NOTE**

*The forepump and the Turbo-V pump can be switched on at the same time if a pressure less than 1 mbar is obtained in the chamber within the Turbo-V pump start-up time.  
If the vacuum chamber is larger, it must be roughed down before starting the Turbo-V pump.*

**NOTE**

*The logic plug must be left in position including the shipping links if no external interconnections are made for the controller to operate.*

### 3-2 Operating procedure

To operate the Turbo-V pump and controller either remotely or from the front panel, proceed as follows:

#### 3-2.1 Start up

- a) Plug the controller power cable into a suitable power source.
- b) If the forepump and vent device are not operated by the controller, close the vent valve and switch on the forepump.

**NOTE**

*Even if the remote Start is used, the ON/OFF switch must be pressed (ON).*

- c) Press the ON/OFF button or use the remote START signal: the FREQUENCY LED's and the POWER LED's will light, and the power output will be at the maximum level. The frequency display will go to the minimum values (about 60% of nominal frequency if the pump is completely stopped) or to a higher value proportional to the rotational speed of the pump.

The pump will accelerate to its rated rotational speed and the frequency display will light up to 100%. When this speed is reached, about half of the power LED's will remain lighted to indicate that the normal condition has been reached.

If the system has a vacuum leak and/or the pump draws too much power but below the overload threshold, the power LED's will continue to stay fully or partially lit.

#### 3-2.2 Operating

- a) When the gas load at the turbopump inlet flange increases, the power drawn by the turbopump increases to maintain the rotational speed. This will occur either in normal operation or with the Low Speed switch engaged. In normal speed, when the gas load becomes higher, the control frequency starts to decrease automatically. The Turbo-V pump is slowed down proportionally to the gas load at least until it reaches about 70% of the nominal speed. Subsequently, the power drawn by the turbopump increases to the overload threshold. At this point, the turbopump and the interconnected accessories are stopped.
- b) The pump can be stopped at any rotational speed and can be restarted at any rotational speed from either the front panel buttons or the remote connections. The controller automatically synchronizes the output to the rotational speed of the pump and then accelerates up to the nominal speed.

### 3-2.3 Overload

- a) For the following conditions the OVERLOAD LED will light shutting down the output power to the turbopump, the forepump, and the fan (if connected):
- 1) a short circuit occurs on the pump motor stator,
  - 2) the pump is overheated (above 60°C),
  - 3) the power drawn by the pump exceeds 220 W for more than 20 seconds,
  - 4) the controller (transformer, power device) is overheated, or
  - 5) during the start-up time the power level exceeds 700 W during the first 45 seconds and 350 W during other 135 seconds.
- b) Once the fault that caused an overload condition is corrected, press the ON/OFF button twice to restart.

### 3-2.4 Shut down

- a) Press the ON/OFF button or remove the remote signal; power is removed and the pump will begin to slow down. If the forepump is interfaced to the controller, it will automatically be switched off. If the recommended Turbo-V vent device or vent valve is used, after the preset delay time the Turbo-V pump will be vented.

#### CAUTION

When the Turbo-V pump is shut down for any reason, the pump must be vented from the high vacuum side or from the vent port with dry and inert gas to prevent back-streaming from the forepump line into the Turbo-V pump.

- b) The Turbo-V pump can be shut down at any rotational speed by pressing the ON/OFF button.

#### NOTE

*It is recommended to operate the vent device and the forepump automatically by the controller in order to ensure correct sequences.*

- c) Turn off the cooling water supply to avoid vapor condensation in the pump.

### 3-2.5 Low speed operation

When a low base pressure or maximum pumping speed are not required, this mode of operation reduces bearing wear with a subsequent increase of pump life.

#### NOTE

*With the Low Speed front panel switch set to ON, the remote switch is inoperative and vice-versa.*

This feature becomes active 3 minutes after start. To operate in this low speed mode, engage the Low Speed switch either before starting the pump or after it is operating. The Turbo-V pump will run at about 70% of its normal speed and achieve a base pressure somewhat higher than the standard specifications.

About half of the frequency LED's will remain lit to indicate the low speed operation. If the gas load becomes higher, the power drawn by the turbopump increases to the overload threshold. At this point, the turbopump and the interconnected accessories are stopped.

### 3-2.6 Power failure

In the event of a power failure (momentary or long term), the Turbo-V controller will stop the turbopump and all the interconnected pumps/devices. The Turbo-V vent device, if used, will vent the turbopump only if the power failure is longer than the preset delay time.

When power is restored, the Turbo-V controller automatically restarts the interconnected devices and the turbopump in the proper sequence.

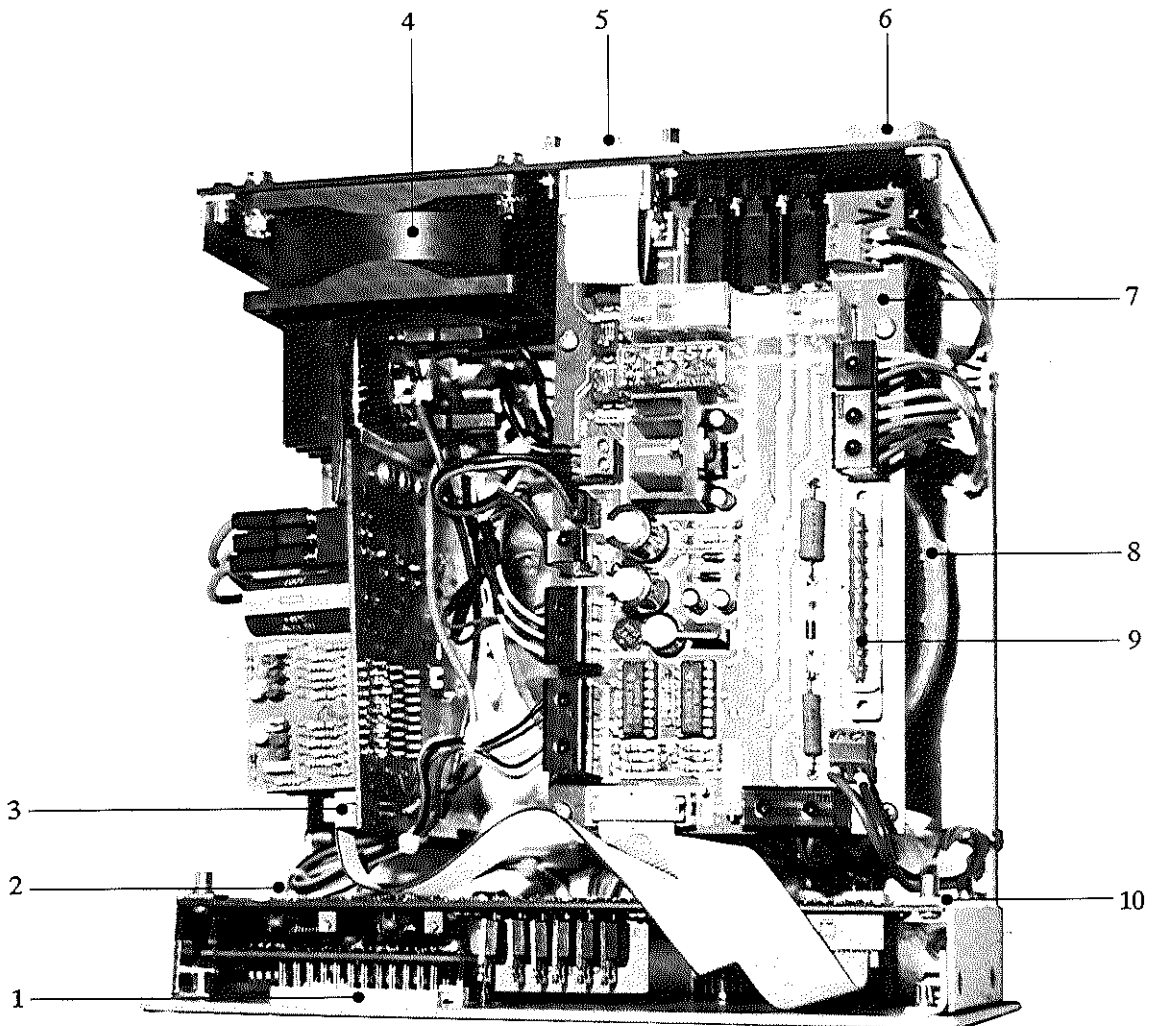


**4-1 General**

Replacement controllers are available on advance exchange basis through Varian Service.

**WARNING**

**High voltage in the controller can cause severe injury or death. Service must be performed by authorized personnel only.**



- 1) LED displays PCB
- 2) Control PCB
- 3) Power PCB
- 4) Fan
- 5) Logic socket

- 6) Power socket
- 7) Interconnection PCB
- 8) Power transformer
- 9) Voltage selector card
- 10) Oil/grease jumper

*Figure 4-1 - Controller (top view)*

## 4-2 Controller replacement parts

Description	Part Number
Power PCB assy	03.660437
Control PCB assy	03.660438-02
Interconnection PCB assy (set to 220 V)	03.660439-02
Interconnection PCB assy (set to 120 V)	03.660439-01
Display PCB assy	03.660440
Pushbutton ON/OFF	03.660435-01
Pushbutton LOW SPEED	03.660435-02
Pushbutton HEATER	03.660435-03
Lamp 28 V (Low speed, On/Off)	03.660435-55
Lamp 60 V (Heater)	03.660435-56
Hour counter	03.660405-52
Fan 24 Vdc	03.660405-51
Panel connector J23 pump	03.660405-53
Mating connector P23	03.660432-51
Panel connector J22 logic (with flat cable)	03.660433-03
Mating connector P22	03.660421
Panel connector J21 power	03.660436-01
Mating connector P21	03.660436-02
Interconnecting cable controller/pump	03.660432