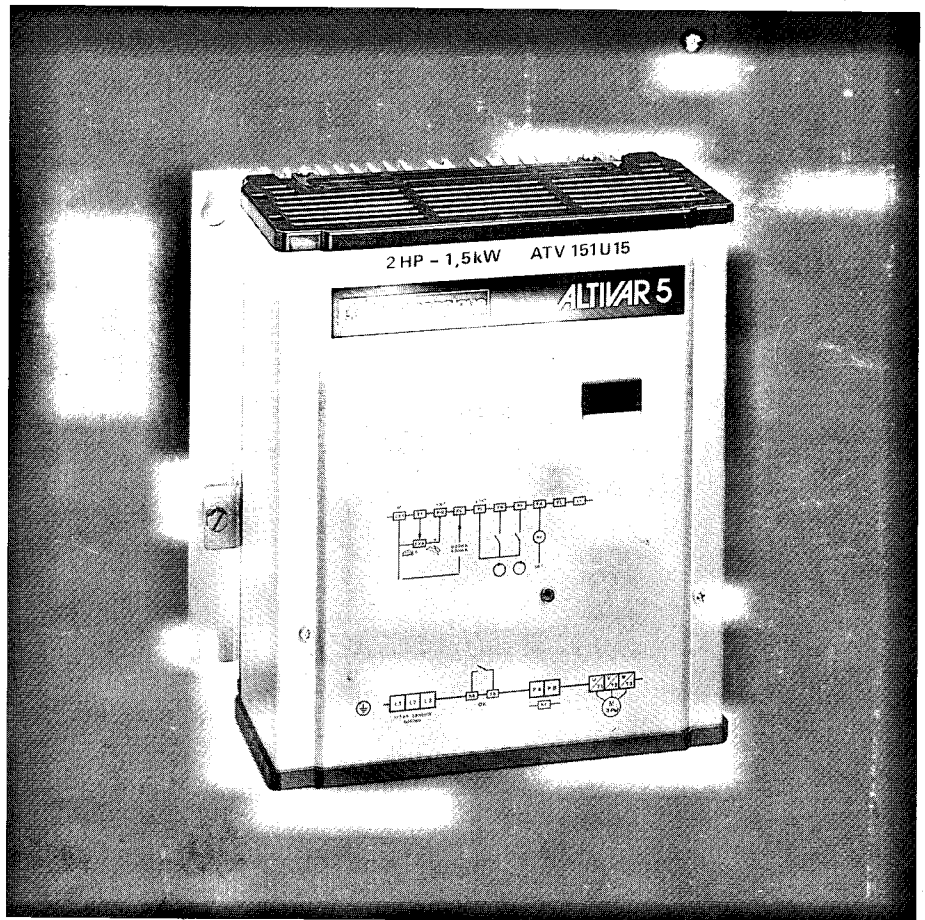


ALTIVAR[®] 5 series 15 1

variable speed controllers
for asynchronous motors

user's manual



from 0,75 to 2,2 kW

mains supply { 220/240 V single / three phase : ATV151...
380/415 V three phase : ATV-151...Q



WARNING

When the speed controller power supply is switched on, the power units, as well as a certain number of control components are connected to the mains supply; contact with these parts is extremely dangerous.

After disconnecting the ALTIVAR from the mains voltage, wait 5 minutes before carrying out any operation inside the controller. This period corresponds to the time constant for the discharge of the capacitors. The PA and PB terminals are also connected to the potential of the capacitors.

During operation, the motor can be stopped by cancelling the run command or the speed reference, while the speed controller remains energized. If untimely restarting needs to be prevented for personnel safety reasons, this electronic interlock is inadequate. Provision must be made for the disconnection of the power circuit.

NOTE

The speed controller includes safety devices which, in the event of a fault, can trigger the stopping of the controller, and hence the motor. The motor itself can also be subject to stoppage by mechanical jamming. Finally, voltage fluctuations and power supply failures in particular, can also cause the motor to stop.

The disappearance of the fault causing the stoppage can initiate a restart involving a hazard for certain types of machines or installations, especially those which must conform to specific safety regulations.

It is important that in such cases the user should take appropriate steps to prevent such restarting possibilities. For example, by the use of an underspeed detector, causing the disconnection of the speed controller power supply in the event of a non-programmed motor stoppage.

As a general rule, the speed controller power supply must always be switched off before carrying out any operation on either the electrical or the mechanical parts of the installation or the machine.

Contents

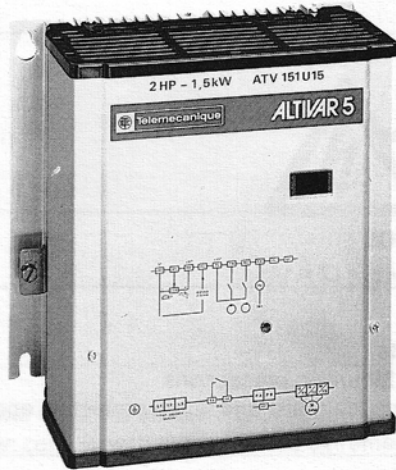
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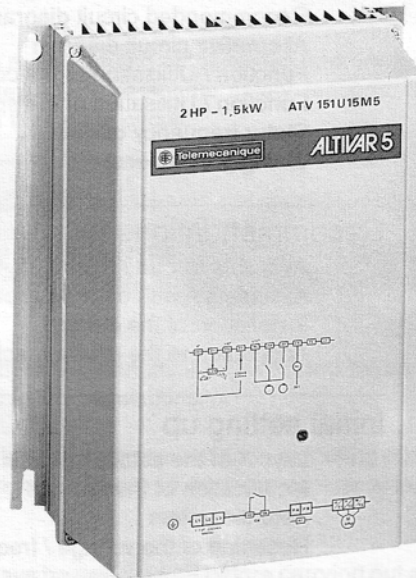
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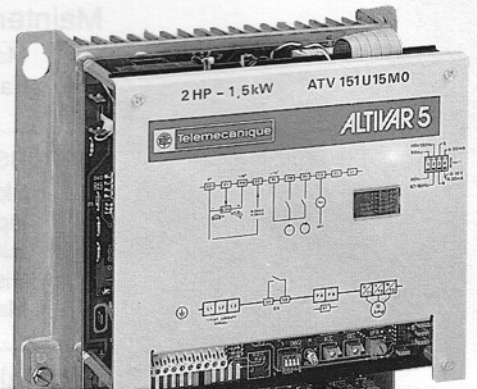
IP20 ATV-151... Q



IP54 ATV-151... M5/Q5

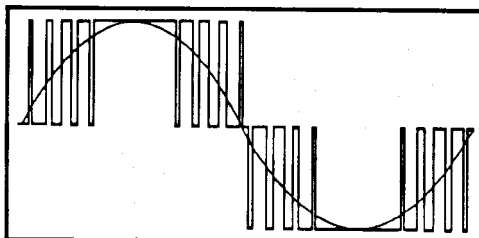


IP00 ATV-151...M0/Q0

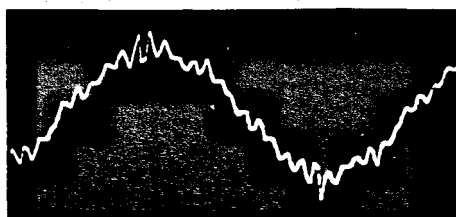


General

- The ALTIVAR ATV-15 1 is a frequency inverter operating on the principle of synthesizing a sine wave by pulse width modulation (PWM).



- The resulting waveform of the current is very close to a sine wave.



When associated with a standard three phase asynchronous squirrel cage motor,
the ALTIVAR ATV-15 1 provides a simple and reliable motor-speed controller combination.

- In order to obtain the best possible results from the ALTIVAR ATV-15 1, read this manual carefully and apply all the relevant information and recommendations given.

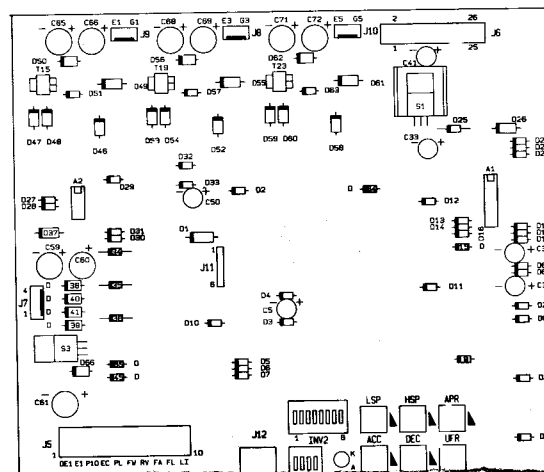
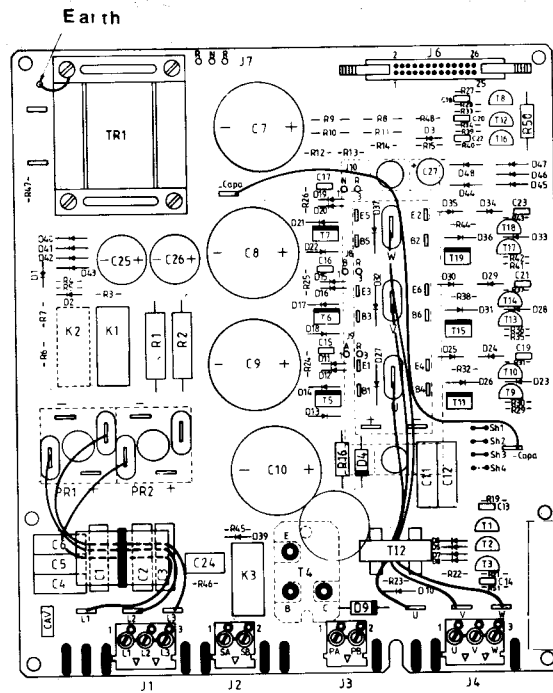
Preliminary checks

Remove the ALTIVAR ATV-15 1 from its packing, and check that it shows no signs of having been damaged during transport.

Make sure that the speed controller label conforms to the delivery note corresponding to the purchase order.

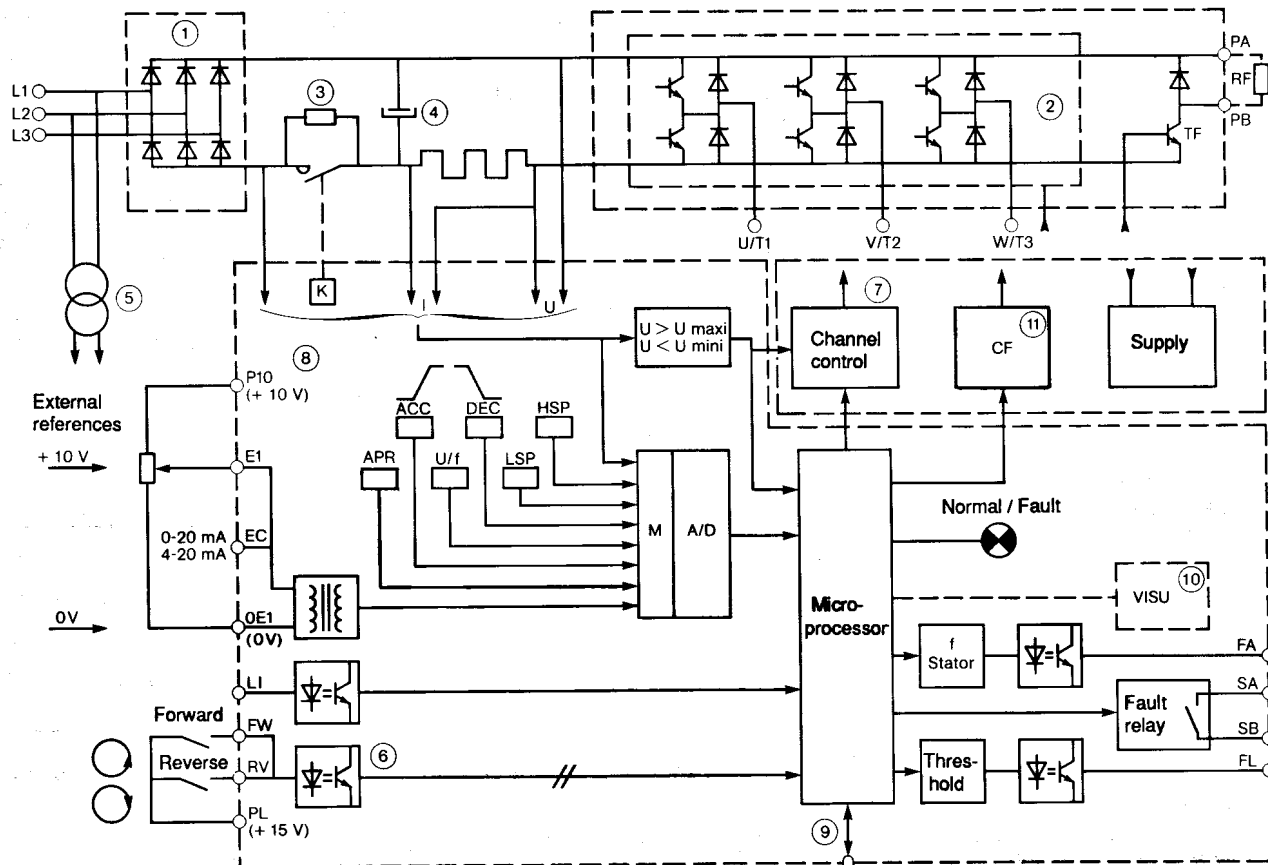
DESIGN AND OPERATION

Technology



Design and operation

Functional block diagram



Description of functions

- ① Rectifier
- ② Inverter bridge
- ③ Charge current limiting device
- ④ Filter capacitor
- ⑤ Control circuit transformer
- ⑥ Isolated inputs
- ⑦ Transistor control power board
- ⑧ Microprocessor control board
- ⑨ Initial setting up unit connector
- ⑩ Optional display unit
- ⑪ Slowdown braking control

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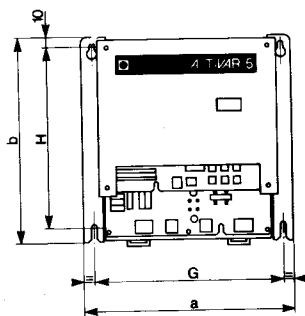
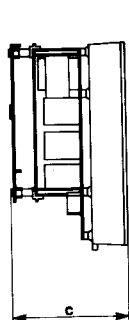
Technical characteristics

Reference ATV-151 220 V single or three phase mains supply	IP00	-	ATV-151U15M0		ATV-151U22M0	
	IP20	-	ATV-151U15		ATV-151U22	
	IP54	-	ATV-151U15M5		ATV-151U22M5	
Reference ATV-151 380 V three phase mains supply	IP00	ATV151075 Q0	ATV-151U15Q0		ATV-151U22Q0	
	IP20	ATV151075 Q	ATV-151U15Q		ATV-151U22Q	
	IP54	ATV151075 Q5	ATV-151U15Q5		ATV-151U22Q5	
Motor power (kW)		0,75	1,5		2,2	
Motor power (HP)		1	2		3	
Supply voltage		from 220 V - 15 % to 240 V + 6 % from 380 V - 15 % to 415 V + 6 %				
Mains frequency		50 / 60 Hz				
Line current (A)	Supply	three	single	three	single	three
	ATV-151...	-	14	10	18	14
	ATV-151...Q	3,3	-	6	-	9
Output voltage		Maximum value equal to mains voltage				
Frequency range		1 to 67 / 80 Hz or 1 to 110 / 132 Hz				
Rated current (A)	ATV-151...	-	6,8		9,6	
Transient current (A)	ATV-151...	-	8,6		12,1	
Rated current (A)	ATV-151...Q	2,2	4		6	
Transient current (A)	ATV-151...Q	3	5,2		7,4	
Total dissipated power at rated load (W)		75	95		115	
Torque / overtorque		(see p. 16)				
Speed references		0-10 V, 0-20 mA, 4-20 mA				
Low speed / high speed limits		adjustable (see p. 22)				
Acceleration/deceleration ramps		independently adjustable by potentiometer from 2 to 300 s or from 0,1 to 5 s optional selection by switch (see p. 22)				
Reversing		control inputs (see p. 14)				
Braking to standstill		by automatic d.c. injection for 0,5 s if the frequency becomes \leq 1 Hz (see p. 37)				
Slowdown braking		by incorporated chopper - resistance (see p. 25)				
Speed controller protection		against short-circuits between output phases and earth, between output phases against permanent overloads against mains over / under voltages				
Operating temperature		0° C to 40° C				
Storage temperature		- 25° C to + 70° C				
Humidity		90° maximum without condensation or dripping water				
Altitude		1000 m without derating (derating by 3 % for each additional 1000 m)				
Degree of protection		IP00 - IP20 - IP54				

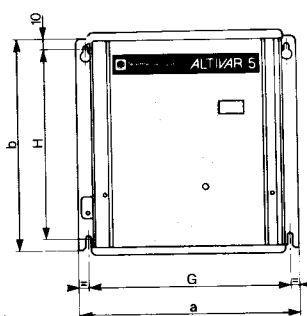
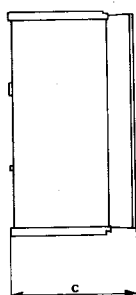
Note : the speed controllers with dust and damp protecting enclosure IP54 (ATV-151...M5 / Q5) can be fitted with a control box, reference VY1-A15106, which authorises local control.

Installation

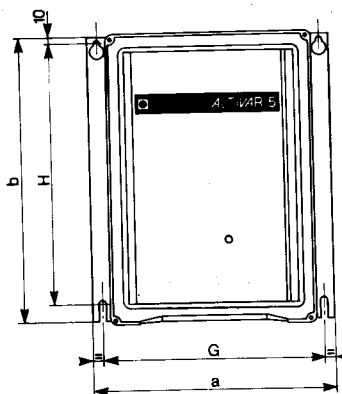
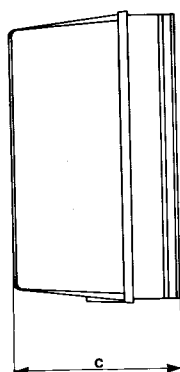
Dimensions and weights



ATV-151...M0/Q0
IP00



ATV-151...Q
IP20



ATV-151...M5/Q5
IP54

Reference	a mm	b mm	c mm	G mm	H mm	Weight kg
ATV-151U15M0	260	260	147	235	230	5,10
ATV-151U22M0	260	260	147	235	230	5,10
ATV-151075Q0	260	260	147	235	230	
ATV-151U15Q0	260	260	147	235	230	
ATV-151U22Q0	260	260	147	235	230	
ATV-151U15	260	266	150	235	230	5,60
ATV-151U22	260	266	150	235	230	5,60
ATV-151075Q	260	266	150	235	230	
ATV-151U15Q	260	266	150	235	230	
ATV-151U22Q	260	266	150	235	230	
ATV-151U15M5	296	360	200	271	320	12
ATV-151U22M5	296	360	200	271	320	12
ATV-151075Q5	296	360	200	271	320	
ATV-151U15Q5	296	360	200	271	320	
ATV-151U22Q5	296	360	200	271	320	

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Installation

Climatic environment

Temperature, humidity, altitude, degree of protection : see technical characteristics, page 6.
 Pollution : protect the controller against the adverse effects of dust, corrosive gases, splashing liquid,...
 If the environmental conditions require, use the IP54 controllers (ATV-151...M5 / Q5) or mount the IP00 or IP20 controllers in dust and damp protecting metal enclosures, see below.

Mounting precautions

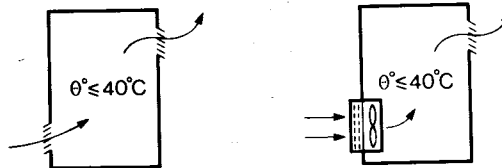
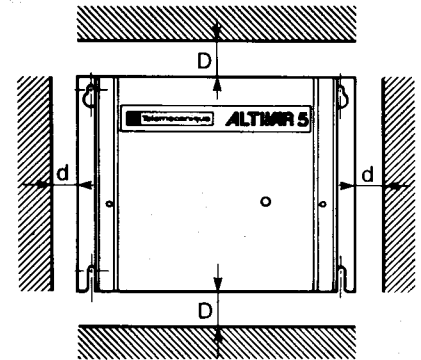
- Mount the controller vertically.
- Do not locate near heat radiating elements.

Mounting of IP00 and IP20 controllers in general purpose metal enclosure

Degree of protection IP23.

In order to ensure adequate air flow inside the controller :

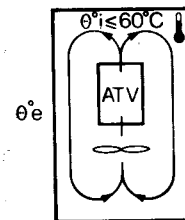
- leave sufficient space around the unit :
 - $d \geq 50$ mm
 - $D \geq 100$ mm,
- provide ventilation louvres,
- verify that the ventilation is sufficient, if not fit a cooling fan with filters.



Mounting of IP00 and IP20 controllers in dust and damp protecting metal enclosure

Degree of protection IP54

- Provide a ventilating fan to circulate the air inside the enclosure and prevent hot spots in the controller :
 - flow rate : $44 \text{ dm}^3/\text{s}$,
 - mount the cooling fan **below** the controller at a distance of ≤ 50 mm.
 This arrangement enables the controller to be used in enclosures where the maximum internal temperature is 60°C .



Fit a temperature sensor to ensure protection of the controller above 60°C .

- Calculation of the enclosure size :

- Maximum thermal resistance R_{th} ($^\circ\text{C}/\text{W}$)

$$R_{th} = \frac{60 - \theta^e}{P} \quad \theta^e = \text{maximum external temperature in } ^\circ\text{C}.$$

P = total power dissipated inside the enclosure in W.

Power dissipated in the controllers at rated load : see technical characteristics (p. 6).

- Useful exchange surface of the enclosure S (m^2)
 (sides + top + front for a wall mounted enclosure)

$$S = \frac{K}{R_{th}} \quad K = \text{thermal resistance of the enclosure per square metre (} K = 0,12 \text{ for type DE1-HB metal enclosures).}$$

Insulated enclosures are not recommended owing to their poor thermal conduction.

Installation

● Calculation example :

ATV-151075Q (0,75 kW) mounted in a dust and damp protecting enclosure with forced ventilation.
Maximum external temperature : 30°C.

- Power dissipated inside the enclosure : 75 W.
- Maximum thermal resistance :

$$R_{th} = \frac{60 - 30}{75} = 0,4^{\circ}\text{C/W}$$

Minimum effective heat exchange surface area :

$$S = \frac{0,12}{0,4} = 0,3 \text{ m}^2$$

Effective exchange surface area of a type DE1-HB422 wall mounted enclosure :

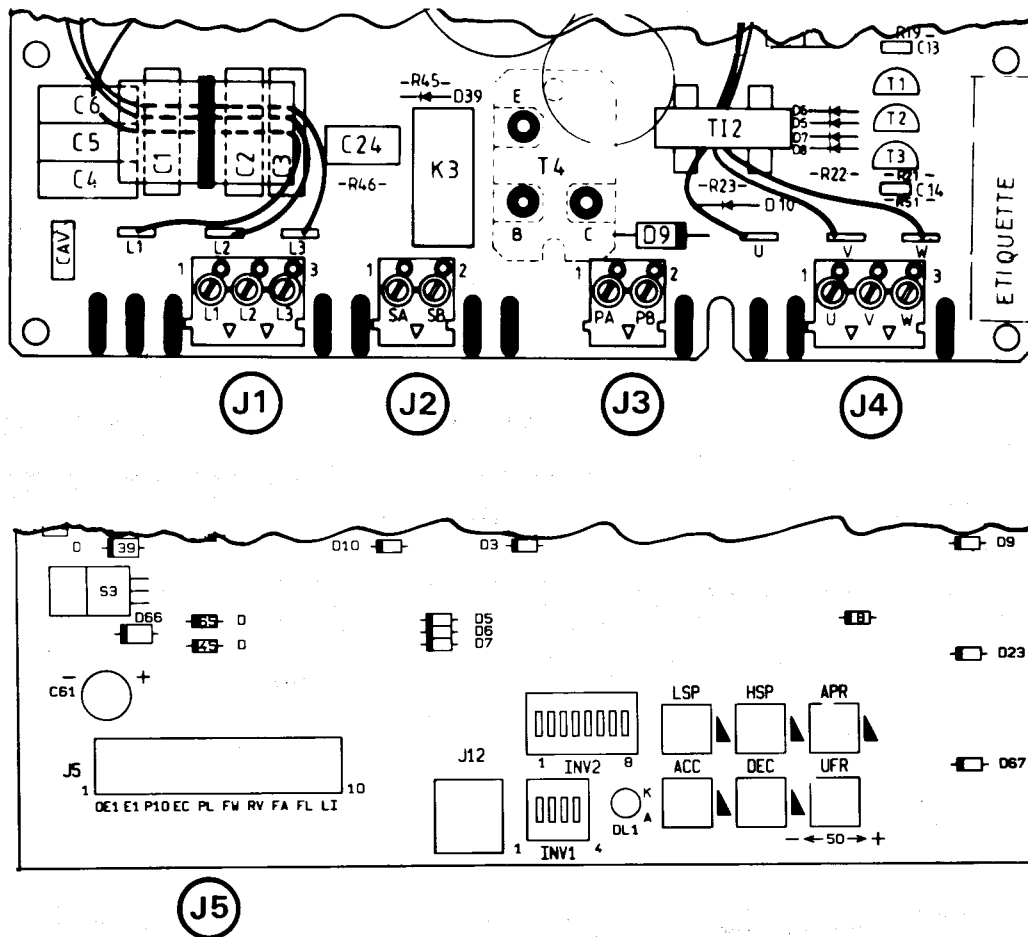
- height : 500 mm,
- width : 300 mm,
- depth : 200 mm.

$$S = (0,5 \times 0,3) + (0,2 \times 0,3) + 2 (0,5 \times 0,2) = 0,41 \text{ m}^2$$

In accordance with the basic assumptions, this enclosure is suitable.

Connections

Terminals



Des.	Item	Function	Characteristics	
			ATV-151...	ATV-151...Q
J1	L1	Power supply	220 V - 15 % single or 240 V + 6 % three phase 50/60 Hz	380 V - 15 % three phase 415 V + 6 % 50/60 Hz
	L2			
	L3			
J4	U/T1	Connections to the motor	220/240 V at 50/60 Hz	380/415 V at 50/60 Hz
	V/T2			
	W/T3			
J3	PA	Braking resistance connection	Minimum ohmic value (see page 26)	
	PB			
J5	0E1	Speed reference input common	0V	
	E1	Speed reference input voltage	0-10 V, $Z_e = 33 \text{ k}\Omega$	
	P10	Output voltage	+ 10 V, $I_S = 10 \text{ mA}$	
	EC	Speed reference input current	0-20 mA, 4-20 mA, $Z_e = 100 \Omega$	
	PL	Control input supply	+ 15 V, $I_S = 30 \text{ mA}$	
	FW	Forward signal input	15-24V, $Z_e = 1,5 \text{ k}\Omega$	
	RV	Reverse signal input		
	FA	Frequency signal output	2,5 V to 50 Hz, $I_S = 1\text{mA}$, $R_S > 10 \text{ k}\Omega$	
	FL	Threshold output	Open collector, recommended relay 24 V - 0,5 W	
LI	Assignable input	15 - 24 V, $Z_e = 1,5 \text{ k}\Omega$		
J2	SA	Fault relay output	Voltage free contact 220/240 V - 50/60 Hz - 2 A	- closes when supply is switched on - opens on fault
	SB			

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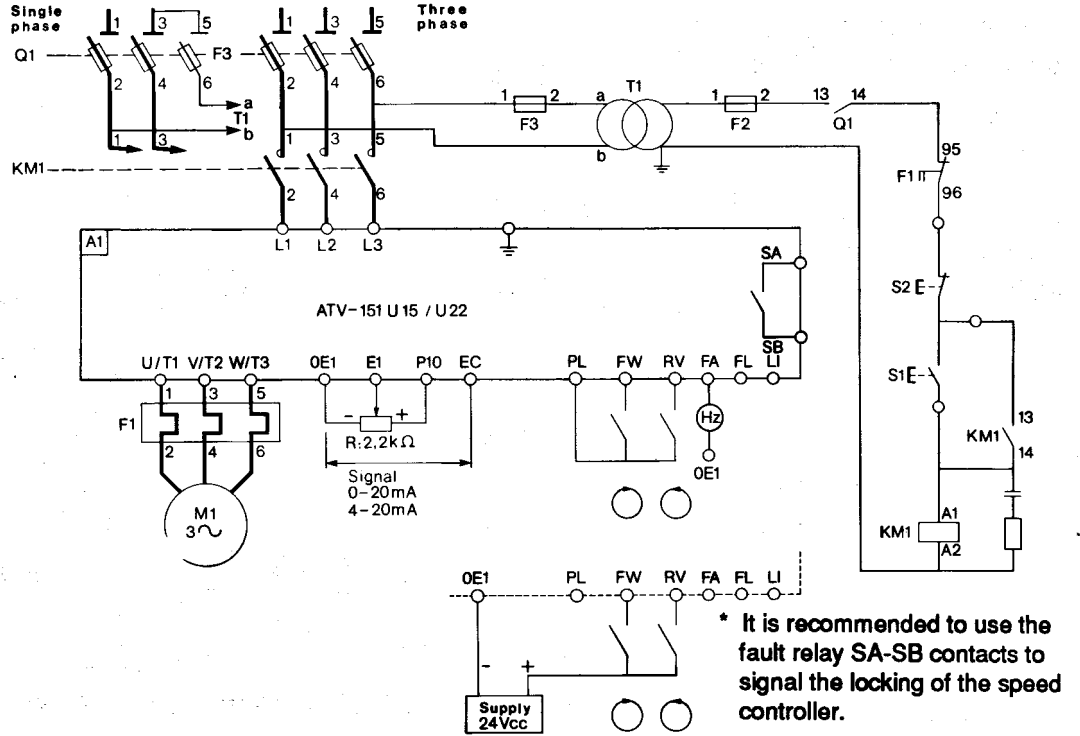
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Connections

2 directions

220/240 V single / three phase supply 50/60 Hz

Recommended circuit diagram



For single phase, connect to L1, L2.

Nomenclature of equipment required

Item	Description	Reference	Reference
M1	Motor	1,5 kW	2,2 kW
A1	Altivar	ATV-151U15	ATV-151U22
Q1	Isolator + 2/3 fuses + 1 fuse (F3 - see below)	LS1-D2531A65 DF2-CN16/12	LS1-D2531A65 DF2-CN20/16
KM1	Contactor	LC1-D123.A65	LC1-D123.A65
	Suppressor	LA9-D09980	LA9-D09980
F1	Thermal overload relay + separate mounting plate	LR1-D09312A65 LA7-D0964A65	LR1-D09314A65 LA7-D0964A65
T1	Transformer	63 VA	63 VA
R	Potentiometer	SZ1-RV1202	SZ1-RV1202
S1-S2	Push-buttons	XB2-B...	XB2-B...
F2	Fuse	DF2-CN02	DF2-CN02
F3	Fuse	DF2-CA02	DF2-CA02
	Fuse carrier	DF6-AB10	DF6-AB10

* The overload relay must be set to the motor full load current value. For continuous duty below 25Hz this protection is inadequate for a self-ventilated motor.
(Use PTC thermistor probes associated with an LT2-S thermistor protection relay).

Cabling

Terminals	For Altivar	Recommended cable size	AWG
PL-FW-RV-FA-FL-LI-SA-SB	all ratings	mm ² 1	18

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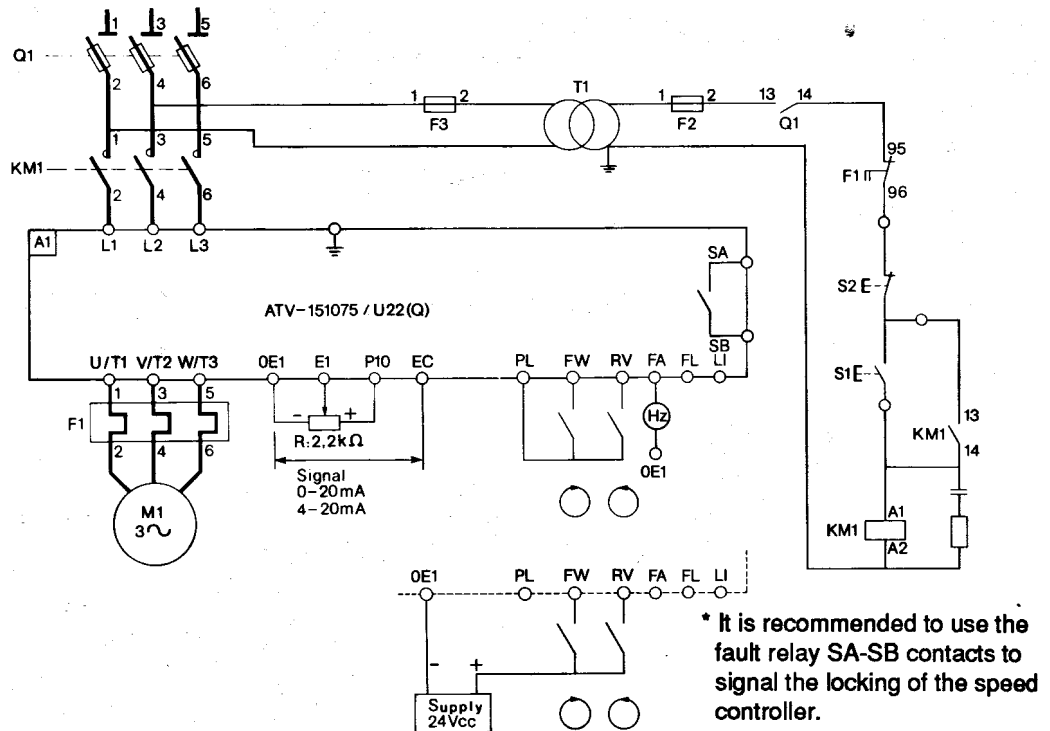
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Connections

2 directions

380/415 V three phase supply 50/60 Hz

Recommended circuit diagram



Nomenclature of equipment required

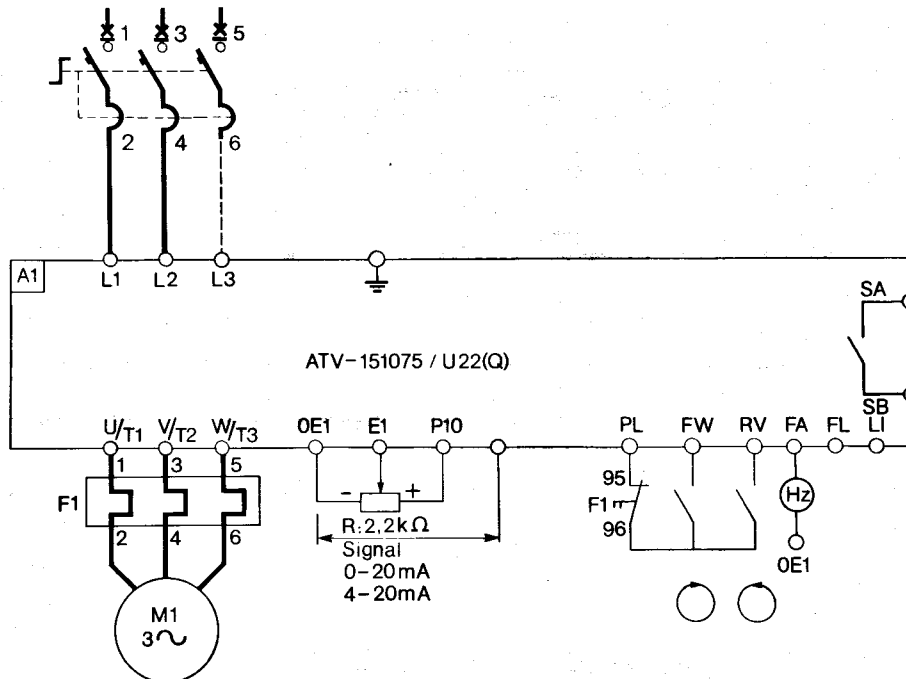
Item	Description	Reference	Reference	Reference
M1	Motor	0,75 kW	1,5 kW	2,2 kW
A1	Altivar	ATV-151075Q	ATV-151U15Q	ATV-151U22Q
Q1	Isolator + 3 fuses	LS1-D2531A65 DF2-CN04	LS1-D2531A65 DF2-CN06	LS1-D2531A65 DF2-CN10
KM1	Contactar	LC1-D093.A65	LC1-D093.A65	LC1-D093.A65
	Suppressor	LA9-D09980	LA9-D09980	LA9-D09980
F1	Thermal overload relay * + separate mounting plate	LR1-D09307A65 LA7-D0964A65	LR1-D0938A65 LA7-D0964A65	LR1-D09310A65 LA7-D0964A65
T1	Transformer	63 VA	63 VA	63 VA
R	Potentiometer	SZ1-RV1202	SZ1-RV1202	SZ1-RV1202
S1-S2	Push-buttons	XB2-B...	XB2-B...	XB2-B...
F2	Fuse	DF2-CN02	DF2-CN02	DF2-CN02
F3	Fuse	DF2-CA02	DF2-CA02	DF2-CA02
	Fuse carrier	DF6-AB10	DF6-AB10	DF6-AB10
* The overload relay must be set to the motor full load current value. For continuous duty below 25Hz this protection is inadequate for a self-ventilated motor. (Use PTC thermistor probes associated with an LT2-S thermistor protection relay).				

Cabling

Terminals	For Altivar	Recommended cable size mm ²	AWG
PL-FW-RV-FA-FL-LI-SA-SB	all ratings	1	18
OE1-E1-P10-EC	all ratings	1 (twisted cable)	18
L1-L2-L3-U/T1-V/T2-W/T3	ATV-151075Q, U15Q	1,5	16
	ATV-15U22Q	2,5	14

Connections

Alternative circuit diagram



* For single phase, connect to L1, L2.

A1	ALTIVAR ATV-151...	075	U15	U22
Q1	Isolator 220 V single phase	-	GK2 - CF21	GK2 - CF22
	Circuit breaker 220 V three phase	-	GK2 - CF16	GK2 - CF21
	Optimal 25 380 V three phase	GK2 - CF10	GK2 - CF12	GK2 - CF16
Other components, see pages 11, 12.				

- It is recommended to use the fault relay contact (terminals SA-SB) to signal the locking of the speed controller.

This solution is not recommended if the isolator or circuit breaker is operated frequently.

CAUTION : Avoid any on-load switching between the speed controller output and the motor. If, to meet essential operating requirements, a contactor must be fitted between the controller and the motor, a special sequence must be provided (see p. 18).



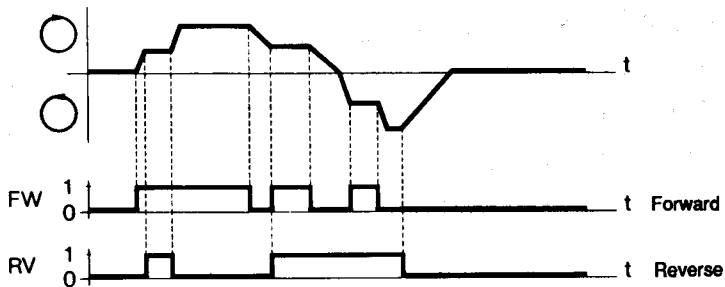
Direct thermal protection using probes embedded in the motor windings must be provided for operation in severe ambient conditions :

- high ambient temperature ($\theta \geq 40^\circ\text{C}$),
- possible clogging of cooling fins,
- insufficient ventilation (self-ventilating motor operating at full load at low speed).

Connections

Function of the control inputs

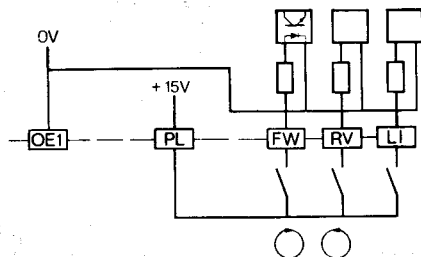
● Direction of rotation



- The direction control selected first takes priority over the other.
- Ramp deceleration.
- If FW and RV are in state 1, development of the acceleration or deceleration ramp is blocked.

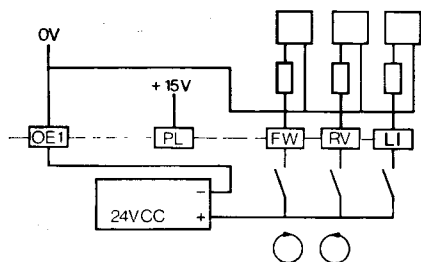
Utilisation of the control inputs

● Operation on internal supply



- The control inputs :
- are isolated from the mains,
 - have a common point with the speed reference input.

● Operation on external supply



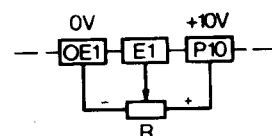
- The control inputs :
- are isolated from the mains,
 - the (-) of the supply is connected to the 0V of the control.

Function of the speed reference inputs

- The reference fixes the speed of the rotating field in the motor. The real speed remains dependent on the acceleration and deceleration ramps and on the torque capabilities of the motor / speed controller combination.
- The resulting reference is the algebraic sum of the different references applied simultaneously, within the limits of the selected frequency range.
- The speed range is linked to the low speed / high speed threshold adjustments, see page 22.
- The speed reference inputs are isolated from the mains.
- The 10 V internal supply (terminals OE1-P10) is protected against short-circuits.

Utilisation of the speed reference inputs

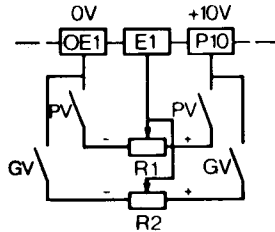
● Example 1 : manual reference selection



Input impedance : 33 k Ω
 $2 \text{ k}\Omega \leq R \leq 10 \text{ k}\Omega$

Connections

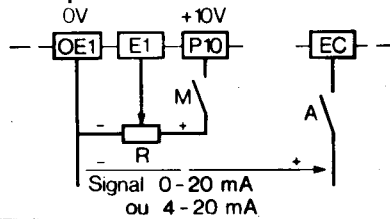
● Example 2 : selection of two manual references



LS : low speed
HS : high speed

Input impedance : 33 kΩ

● Example 3 : automatic reference from 0-20 mA or 4-20 mA sensor



A : automatic operation
M : manual operation

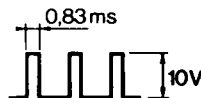
Selection 0-20 mA / 4-20 mA by INV1
(see p. 21).

Input impedance : 100 Ω

Stator frequency display

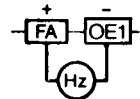
● **Function :** remote display of speed image. Speed indication is only approximate; it does not take motor slip into account.

● **Signal :**



● **Connection :**

- moving scale magneto-electric voltmeter
average voltage : $U = 6,6 \text{ V}$ for 132 Hz
 $U = 2,5 \text{ V}$ for 50 Hz
 $I_s = 1 \text{ mA}$
- digital frequency meter :
 $f_s = f/6$ f_s : stator frequency
 f : signal frequency

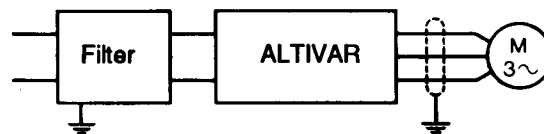


Wiring precautions

● Power circuit

The frequency inverter emits high frequency electromagnetic waves of low intensity. These cause interference signals which may affect the operation of audio-frequency equipment.

This interference can be reduced by screening the motor cables, using a good earth connection, and by installing suppression filters on the supply side of the controller. See page 30.

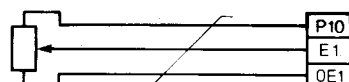


● Control circuit

Although the control inputs are protected and filtered, it is recommended to reduce interference to a minimum by separating control circuits from power circuits.

● Speed reference circuits

These circuits must be protected against interference signals. The use of twisted cable is recommended, with a pitch of 25 to 50 mm.



Recommendations for use

of the motor-speed controller combination

Available torque

● **Continuous duty** : derating of the motor is due to two factors.

- Although the motor current waveform is very close to a sine wave, motor heating is slightly greater than that caused when the motor is directly connected to the mains supply. The resulting reduction in torque is of the order of 5%, which is lower than the tolerance limits for motor manufacture.

- For self-ventilated motors, the ventilation necessary for cooling is linked to the motor speed. This results in motor derating, which occurs at approximately half of the rated speed.

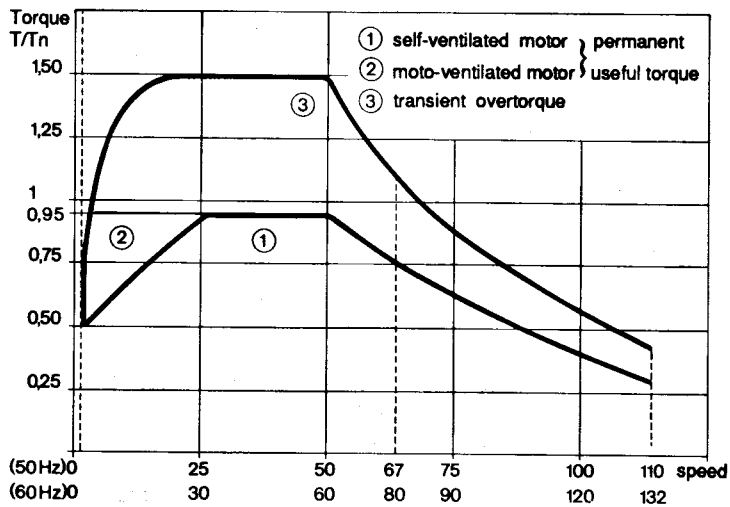
● **Transient operation periods**

Overtorque possibilities are linked to the maximum transient current which the controller can provide and to the repetition of the overloads.

● **Overspeed operation ($f \geq 50/60$ Hz)**

As the voltage can no longer change with frequency, the result is reduced induction in the motor, causing a loss of torque.

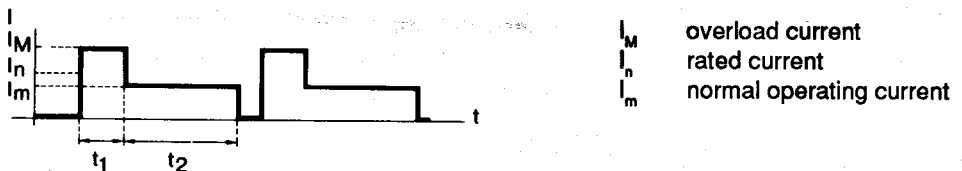
The motor manufacturer can advise whether the motor is suitable for overspeed operation.



Intermittent duty

The rate of starting and braking is limited by the value of the overloads, their duration, as well as the load during normal running and the motor cooling possibilities.

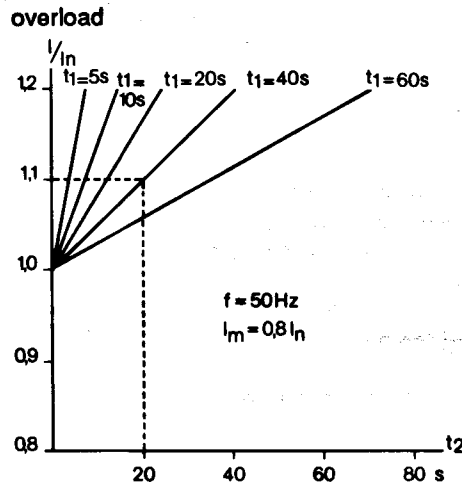
On intermittent duty, the current which causes the motor and speed controller to overheat appears as follows :



Recommendations for use

of the motor-speed controller combination

The following curves can be used to determine the ratio between the overload duration and the operating time at 0,8 of the rated current at rated speed.



Example : following an overload of $1,1 I_n$ for 40 seconds, it would require 20 seconds at $0,8 I_n$ to return to the previous thermal state.

If the normal running speed is lower than the rated speed, time t_2 will be longer.

Association with different motors

ALTIVAR speed controllers are designed to drive motors with the corresponding power rating. They can, however, be used with motors having different power ratings, providing that certain precautions are observed.

● Motor power \leq rated power of the controller

This combination is possible.

As compensation is not at the optimum level, this can lead to a reduction in continuous torque at low speed. Adjust the U/f ratio if necessary.

● Motor power \geq rated power of the controller

Magetising current peaks limit this combination to the motor power immediately above the controller rating.

Again, compensation is not at the optimum level and the U/f ratio should be adjusted if necessary. The motor current must remain lower than or equal to the speed controller rated current.

● Motors in parallel

Speed controller selection :

$$\text{Controller } I_n \geq I_{n1} + I_{n2} + \dots + I_{nx}$$

Each motor should be protected by a thermal overload relay.

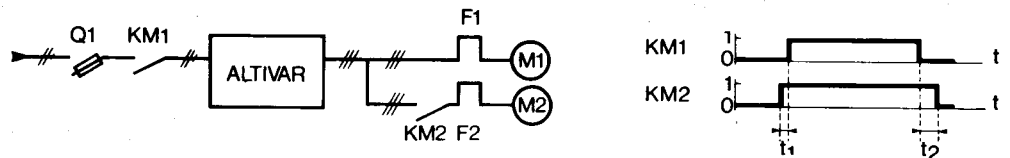
Compensation is not at the optimum level. Adjust the U/f ratio if necessary.

If the motors have different power ratings, the U/f ratio adjustment can only be a compromise.

Recommendations for use

of the motor-speed controller combination

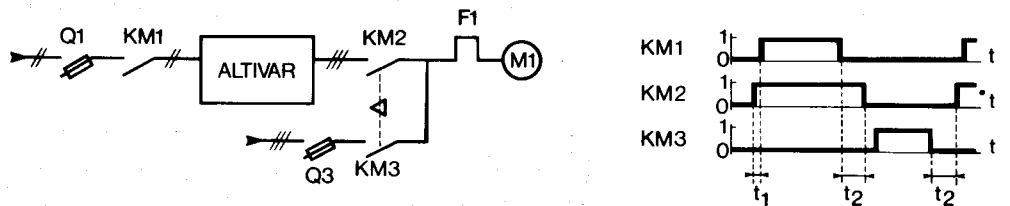
● Additional motor connected downstream of the speed controller



- Comply with the sequence shown : $t_1 = 20 \text{ ms}$,
 $t_2 = 0,5 \text{ s}$ (demagnetisation of the motor).

- If the power of the motor to be connected is low with respect to the rating of the speed controller and it produces an acceptable overload (maximum current \leq controller transient current), connection on the run is possible.

● Direct coupling of the motor to the mains : "BY-PASS"



- Comply with the sequence shown : $t_1 = 20 \text{ ms}$,
 $t_2 = 0,5 \text{ s}$ (demagnetisation of the motor).

● Use of a brake motor

- Electric brake

Make sure that the brake winding is brought out to terminals.

The brake should be separately supplied at its rated voltage and switched simultaneously with the motor.

- Tapered rotor motor

The brake is released by the magnetic field of the motor.

Experience shows that this type of motor can be used with a frequency inverter.

The brake is released at a frequency $\geq 5 \text{ Hz}$.

● Use of a synchronised asynchronous motor

- Operation is possible.

Recommendations for use

of the motor-speed controller combination

Installation of the motor

Mount and couple the motor with care so as to eliminate vibrations and resonance.

Adaptation to the driven machine

The motor-speed controller combination must be adequately rated to :

- overcome the load torque of the driven machine over the whole speed range used,
- supply the transient overtorque needed for the required accelerations, see available torque p. 16.

If braking is required for rapid deceleration, investigate the following possibilities :

- slowdown braking (see p. 25),
- d.c. injection braking (see p. 37).

Precautions to be taken according to the type of machine load :

- constant torque load (conveyors) :
ensure that the starting torque is compatible with the available overtorque,
- constant power load (winders) :
check the speed range;
the torque is highest at low speed, check the torque capability at the lowest speed, provide forced ventilation if necessary,
- transient driving load / high inertia :
examine the braking possibilities.

Adaptation to the mains supply

If a 220 V or 380 V supply is not available, the controller can be supplied via a transformer or autotransformer rated as follows :

	single phase	three phase
ATV-151U15	3 kVA	4 kVA
ATV-151U22	4 kVA	5,5 kVA
ATV-151075Q		2,2 kVA
ATV-151015Q		4 kVA
ATV-151U22Q		5,5 kVA

Initial setting up

* The ALTIVAR ATV-151 is factory preset to meet most common utilisation requirements. The preset values are marked below with an asterisk *.

Check that they are compatible with your requirements.

If so, after checking the connections (see recommended circuit diagrams pages 11 and 12 or the alternative diagram on p. 13), the speed controller can be switched on.

If not, readjust the settings.

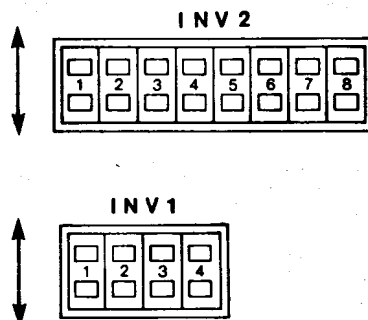
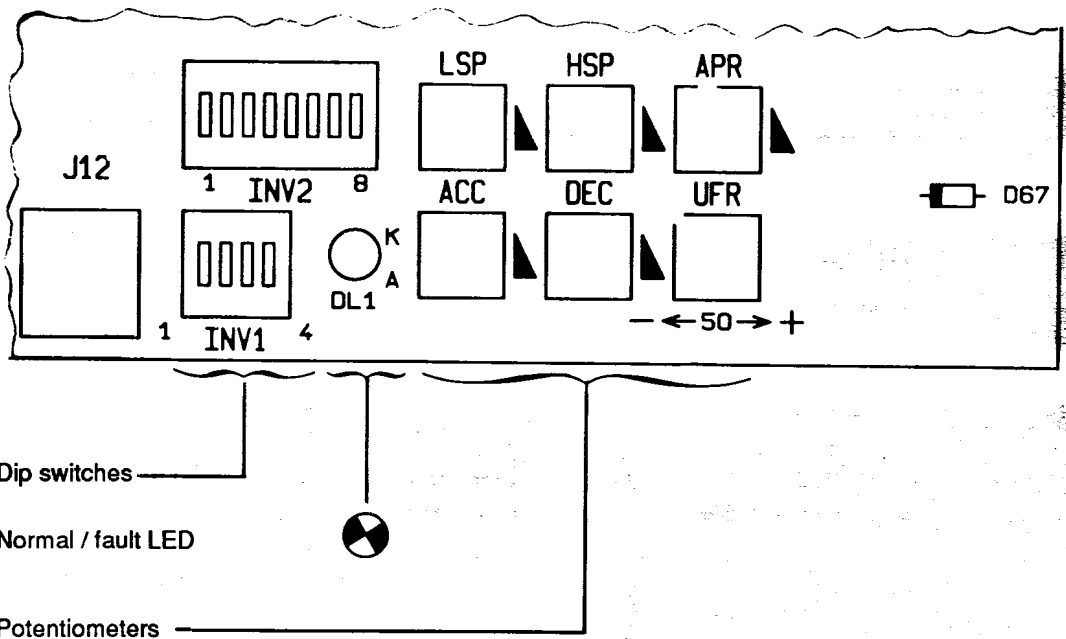
The setting controls are grouped on the front side of the control board and are accessible after removing the front cover (versions IP20 and IP54).

Before removing the front cover, switch off the speed controller.

CAUTION : do not touch the components.



Layout of the setting controls



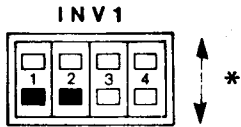
Detailed drawing of the switches

Initial setting up

Modification of the settings

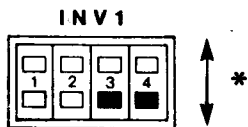
The links and switches must only be modified when the power is switched off.

● Output frequency selection using switches 1 and 2 of INV1



INV-1 Rated motor current (FRS)	INV-1 Motor maximum frequency (FR)	Voltage / frequency ratio
50Hz * 	67 Hz * 	U (V) 220/240V 380/415V
	110 Hz 	U (V) 220/240V 380/415V
60Hz 	80 Hz * 	U (V) 220/240V 380/415V
	132 Hz 	U (V) 220/240V 380/415V

● Selection of type of speed reference using switch 4 of INV1



INV1 4		
* 	0-10 V	0-20 mA
	-	4-20 mA

● Selection of type of operation with switch 3 of INV1

INV1 3	
* 	Normal operation with automatic adaptation of the voltage / frequency ratio - N -
	Special operation without automatic adaptation - S -

Initial setting up

Potentiometers

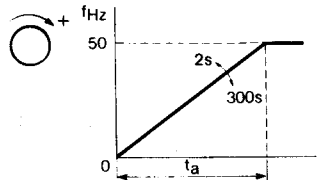
- The potentiometers are factory preset *.

Should the settings need to be modified, the initial setting up unit (option VW3-A15208) enables display of the adjusted values (see p. 31).

- Functions

Acceleration

ACC

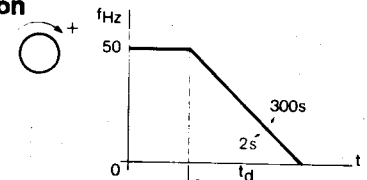


* Preset value : 2 s

- Other possible choice of ramp time : 0,1 to 5 s (see page 34).

Deceleration

DEC



* Preset value : 2 s

Low speed - High speed

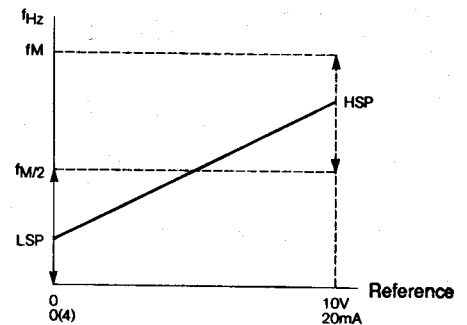
LSP

HSP

fM = maximum frequency selected

When the low speed is at minimum, the controller stays locked for a reference lower than 1 Hz.

* Preset values **LSP** * at minimum
HSP * 50 Hz

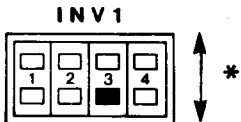


Voltage / frequency ratio

UFR

* Factory preset to the value 50%, suitable for most applications.

Resetting of the voltage/frequency ratio

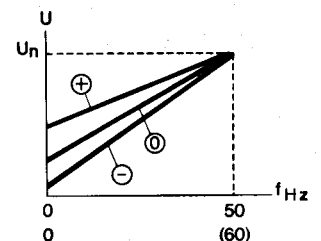


- Selector switch 3 of INV1 in the bottom position "N" *

- Applications requiring high torque at low speed.

If the torque is inadequate, turn the UFR potentiometer from 50 % towards (+) until correct operation is obtained.

- For utilisation on a machine with low load at low speed (centrifugal pumps, fans...) turn the UFR potentiometer towards the (-) position.

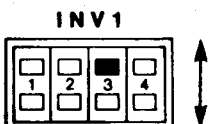


- Selector switch 3 of INV1 in the top position "S"

- Special case of machines with fast transient cycles.

For this type of application, the standard auto-adaptation of the voltage / frequency ratio cannot be used.

The increase of torque, by turning the UFR potentiometer in the (+) direction, must be carried out making sure that the current, at low speed, does not cause excessive temperature-rise of the motor (see page 16), or an overcurrent trip of the controller.



Maintenance

Maintenance



Before carrying out any operation inside the controller, switch off the supply circuits and make sure that the capacitors are fully discharged (about 5 minutes after switching off).

CAUTION : the d.c. voltage across the PA and PB terminals can reach 750V (380V) or 400V (220V) on load.

- The ALTIVAR ATV-15 1 does not require preventive maintenance, nevertheless the following operations are recommended at regular intervals :
 - check the condition and tightness of the connections,
 - make sure that the temperature around the controller remains at an acceptable level,
 - remove the dust from the controller if necessary.
- Should anything unusual occur when putting the controller into service or during operation, make sure that all the recommendations relating to the environment and to mounting and connecting the controller have been complied with.

Maintenance assistance facilities

The LED located on the front panel of the speed controller can indicate several states :

- | | | | |
|----------------|--|----------------|--|
| - illuminated | | → ALTIVAR "ON" | • ready to operate
• operating normally |
| - extinguished | | → no voltage | • ALTIVAR "OFF" |
| - flashing | | → fault | • see table page 24 |

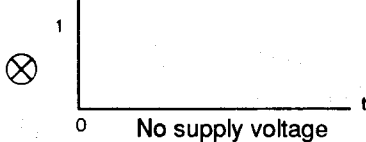
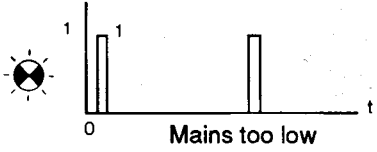
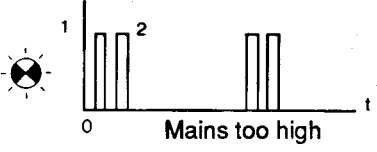

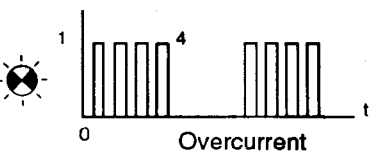
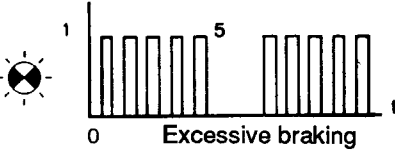
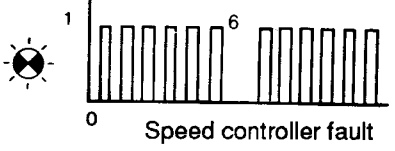
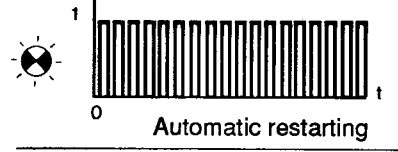
● Fault storage

The first detected fault is displayed and stored if the supply voltage remains "ON". The fault relay drops out.

● Erasure of stored fault

- Switch off the power supply to the controller.
- Determine the cause of the fault before resetting.
- Switch the supply back on; this will cause the fault memory to erase.

Maintenance

Fault signal signification	Probable cause	Trouble-shooting procedure
 <p>No supply voltage</p>	<ul style="list-style-type: none"> - no voltage - internal controller fault 	<ul style="list-style-type: none"> → check the voltage across L1-L2-L3 terminals → check the incoming fuses
 <p>Mains too low</p>	<ul style="list-style-type: none"> - temporary mains failure - mains voltage too low $U \leq 185 \text{ V}$ or 320 V (Q) - temporary voltage drop ($t \geq 100 \text{ ms}$) 	<ul style="list-style-type: none"> → check the supply voltage → reset
 <p>Mains too high</p>	<ul style="list-style-type: none"> - mains voltage too high $U \geq 255 \text{ V}$ or 440 V (Q) (when switching on the controller) 	<ul style="list-style-type: none"> → check the supply voltage → reset
 <p>Speed controller overload</p>	<ul style="list-style-type: none"> - thermal trip owing to prolonged overload 	<ul style="list-style-type: none"> → check the motor load
 <p>Overcurrent</p>	<ul style="list-style-type: none"> - short-circuit at speed controller output 	<ul style="list-style-type: none"> → switch off - check the cabling - check the motor
 <p>Excessive braking</p>	<ul style="list-style-type: none"> - capacitor overvoltage, owing to a too sudden deceleration, a driving load or abnormal transient increase of the mains voltage 	<ul style="list-style-type: none"> → increase deceleration time - add braking option if required → reset
 <p>Speed controller fault</p>	<ul style="list-style-type: none"> - internal power control fault 	<ul style="list-style-type: none"> → check the speed controller
 <p>Automatic restarting</p>	<ul style="list-style-type: none"> - the speed controller is locked owing to a transient external fault 	<ul style="list-style-type: none"> → if the fault continues after 3 restarts, permanent locking occurs → if the fault disappears, the motor restarts and the flashing stops

Options

Slowdown braking

● Operating principle

When the frequency produced by the controller decreases rapidly, the motor behaves like an asynchronous generator and produces a braking torque.

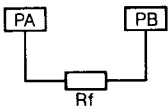
The motor feeds energy back to the controller. This energy depends on the rate of deceleration, the inertia of the moving mass and the resistive torque.

As the controller cannot feed this energy back into the supply, this causes an increase in the voltage of the filter capacitors, which limits the braking effect.

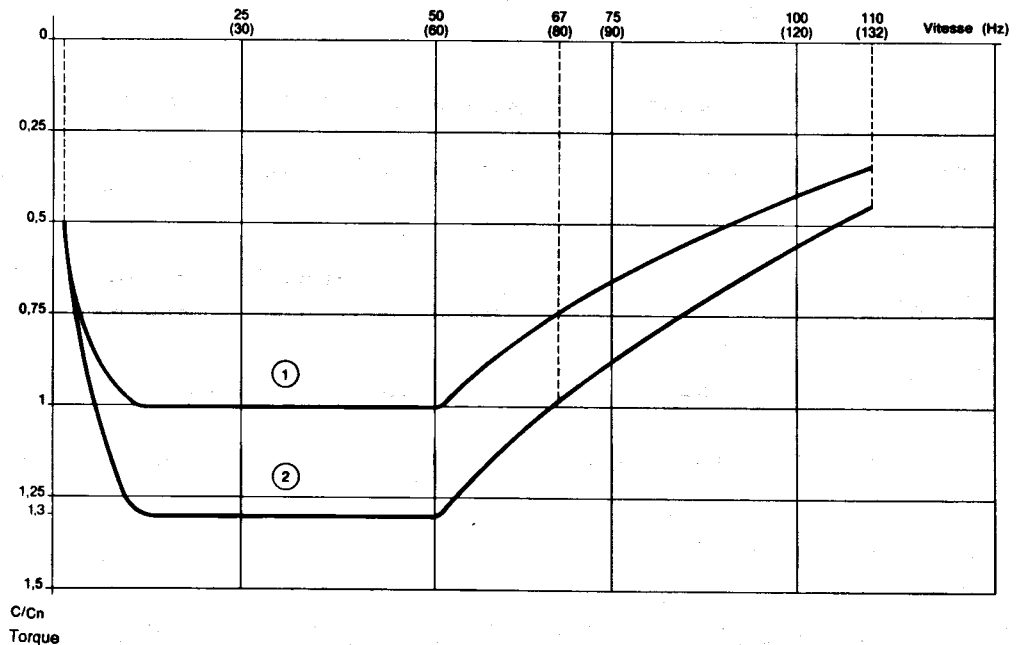
One part of the braking energy is dissipated as losses in the motor, the corresponding braking torque is between 0,5 and 0,8 of the rated motor torque.

If higher braking power is required, provide a way of dissipating part of the braking energy into an external resistance which can be fitted between the PA and PB terminals of the speed controller. (Resistance VY1-ADR ... optional).

Permanent braking power authorised by the speed controller : 1 kW (whatever the speed controller rating).



● Available braking torque



① Permanent braking torque (driving load)

② Maximum transient braking torque

When frequency is < 10 Hz, braking torque decreases rapidly.

Options

Slowdown braking

● Calculation of braking power

- High inertia machine, non driving load

$$\text{Braking torque on deceleration : } T_f = J \frac{\Delta\omega}{\Delta t} \text{ in Nm}$$

J : total moment of inertia referred to the motor shaft in kgm²,

$\Delta\omega$: angular speed difference in rad/s,

Δt : deceleration time in seconds.

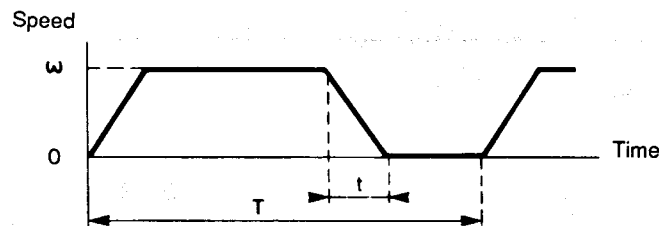
Instantaneous braking power : $P_f = T_f \omega$ in W.

Average braking power during deceleration : $P_{fd} = 0,5 T_f \Delta\omega$ in W.

$$\text{Average braking power during one cycle : } P_{fm} = P_{fd} \frac{t}{T} \text{ in W.}$$

t : braking time in s,

T : cycle time in s.



- Driving load, indefinite continuous operation

Braking is permanent : $P_f = P_{fm} = T_f \omega$ in W,

T_f : braking torque in Nm,

ω : speed in rad/s.

CAUTION : whatever the application, the required instantaneous braking power must be $\leq 1,3$ speed controller rated power.

● Determination of the braking resistance

The braking resistance is characterised by its ohmic value and power dissipation capacity.

Ohmic value of the resistance

Reference ATV-151... 220/240 V		U15	U22
Minimum resistance value (Ω)		39	
Reference ATV-151...Q 380/415 V	075Q	U15Q	U22Q
Minimum resistance value (Ω)		68	
Recommended cable size (mm ²)		2,5	

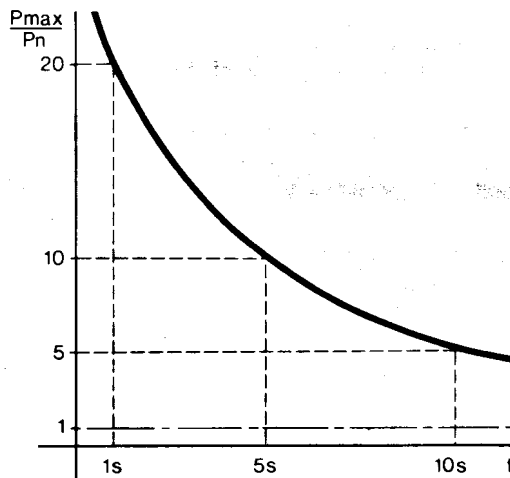
Options

Slowdown braking

Resistance power :

- rated P_n : this is the power dissipated by the resistance during continuous duty, it must be higher than the average braking power P_{fm} ,
- maximum P_{max} : this is the power dissipated during a short period of time on intermittent duty; it must be higher than the braking power P_f .

Possibilities of resistance overload according to braking time t .



For a resistance of rated power P_n , a maximum power P_{max} equal to $20 P_n$ can be accepted if the braking lasts 1 second, or $5 P_n$ if braking lasts 10 seconds.

● Standardised resistances (most widely used utilisation conditions)

Reference ATV-151... 220/240 V	U15, U22	—
Reference ATV-151...Q 380/415 V	—	075Q, U15Q, U22Q
Standardised resistance (Ω)	68	100
Rated power (W)	72	72
Dimensions (mm) H x W x D*	153 x 20 x 60	153 x 20 x 60
Reference VY1-AD	R068W072	R100W072

* Dimensions of the resistance with fixing brackets.

Options

Slowdown braking

Resistance calculation example

Consider a motor having the following characteristics :

- power : 2,2 kW - 220 V,
- rated speed : 1450 rpm,
- moment of inertia : 0,006 kgm²,

driving a machine whose :

- inertia is 10 times that of the motor,
- resistive torque is 1/10 of the rated torque of the motor.

Stopping required in 2 seconds from the rated speed, at a rate of 4 cycles per minute.

$$\text{Rated angular speed} : \omega_n = \frac{2\pi N}{60} = \frac{2\pi \cdot 1450}{60} = 152 \text{ rad/s}$$

$$\text{Rated motor torque} : T_n = \frac{P_n}{\omega_n} = \frac{2200}{152} = 14,4 \text{ Nm}$$

$$\text{Resistive torque} : T_r = \frac{14,4}{10} = 1,44 \text{ Nm}$$

$$\text{Total inertia} : J = 0,006 + 10 \times 0,006 = 0,066 \text{ kgm}^2$$

$$\text{Braking torque} : T = J \frac{\Delta\omega}{\Delta t} = 0,066 \times \frac{152}{2} = 5,02 \text{ Nm}$$

$$\text{Motor braking torque} : T_f = T - T_r = 5,02 - 1,44 = 3,58 \text{ Nm}$$

$$\text{Instantaneous braking power} : P_f = T_f \omega = 3,58 \times 152 = 544 \text{ W}$$

$$\text{Average braking power during deceleration} : P_{fd} = 0,5 T_f \Delta\omega = 0,5 \times 3,58 \times 152 = 272 \text{ W}$$

$$\text{Cycle time} : T = \frac{60}{4} = 15 \text{ s}$$

$$\text{Average braking power during one cycle} : P_{fm} = P_{fd} \frac{t}{T} = 272 \times \frac{2}{15} = 36 \text{ W}$$

Standardised resistance VY1- ADR068W072 :

- rated power : $P_n = 72 \text{ W}$,

- maximum power admissible during 2 s (see curve on page 27) :
 $P_{max} = 15 \times 72 = 1080 \text{ W}$.

$$\left. \begin{array}{l} P_n \geq P_{fm} = 36 \text{ W} \\ P_{max} \geq P_f = 544 \text{ W} \dots \end{array} \right\} \text{the resistance is suitable.}$$

Options

Slowdown braking

Initial setting up



● Resistance Installation safety precautions

In order to avoid all accidental contact with the braking resistance (maximum voltage 750V (380V) or 400V (220V) between the terminals and a temperature which can reach 350°C during operation), fitting of a protective cover is recommended.

Ensure a minimum space around the resistance (distance indicated in the operating notice n° 359577) and provide openings in the enclosure to ensure the air circulation necessary to remove the heat dissipated.

● Initial setting up

The initial setting up of the slowdown braking option needs no adjustment.

After checking the connections, and modifying the speed controller settings if necessary, the equipment can be switched on.

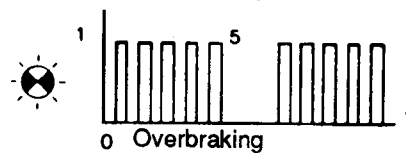
If uncertain about determination of the braking power, proceed as follows :

- preset a deceleration ramp time longer than the required braking time,
- start the motor and carry out successive braking operations, gradually reducing the ramp time until the final adjustment is reached, making sure that braking cycles are identical to those for actual use.

If the resistance overheats, the braking resistance should be replaced by one with a higher power rating.

Maintenance

In the event of overbraking, the controller can display the following code :



Capacitor overvoltage owing to overbraking or a driving load.

Increase the deceleration time.

Options

Input filters for reduction of radio interference

Input filters for reduction of radio interference
(220/240 V or 380/415 V mains supply)

● Function

The input filters are intended to reduce mains interference which can be caused by an ALTIVAR and which affect receivers (radio, television, interphone,...),

● Characteristics

These filters enable the speed controllers to conform to international standards (CISPR, VDE 0875 - 1/11/84), with regard to radio-electrical interference in conduction mode.

● Installation-Connections

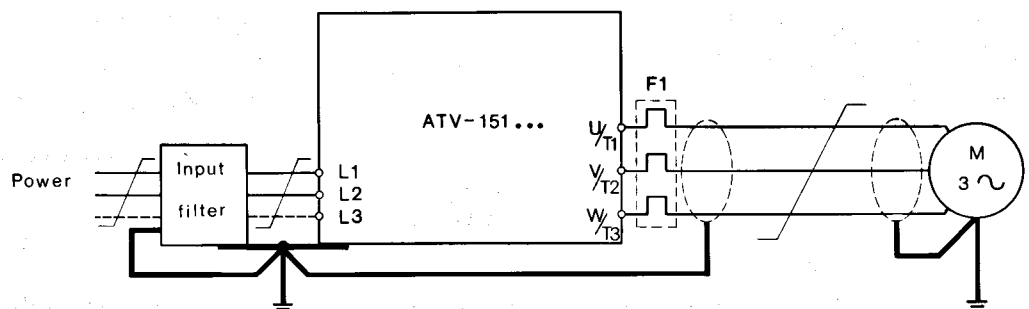
- Mount the filter near the speed controller (distance ≤ 15 cm).
- Link the filter and speed controller earth terminals and connect them to the earth. The links must be as short as possible with low impedance and the earth of very high quality.
- To limit radiation effect, twist the conductors at the filter input and output, and use screened and twisted cables for all connections to the speed controller (motor, reference, controls,...), screening connected to earth.

● Observations

- In order to limit the ALTIVAR-motor connection cable radiation, install the speed controller as near to the motor as possible.
- Separate the power circuits from the control circuits.

● References-Dimensions

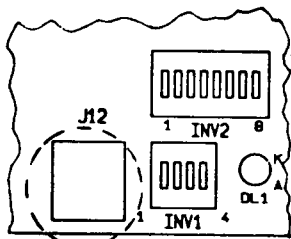
Mains supply	ALTIVAR Reference	Filter Reference	Size (mm) W x H x D	Weight (kg)
220/240 V single phase	ATV-151U15 ATV-151U22	VY1-A251U2202	125 x 125 x 65	1,050
220/240 V three phase	ATV-151U15 ATV-151U22	VY1-A451U5502	250 x 150 x 65	2
380/415 V three phase	ATV-151075Q ATV-151U15Q	VY1-A451U1502	150 x 125 x 65	1,500
	ATV-151U22Q	VY1-A451U5502	250 x 150 x 65	2



Options

VW3-A15208 initial setting up unit

Initial setting up unit



● Function

If the settings require adjustment, the initial setting up unit enables :

- display of the adjustment values,
- indication of the type of fault should abnormal operation occur.

● Connections

By J12 connector on the control board.

Connections to be made only when the speed controller is switched off.



● Dialogue

By liquid crystal display with 2 lines of 16 characters.

When the controller is switched on, display of :

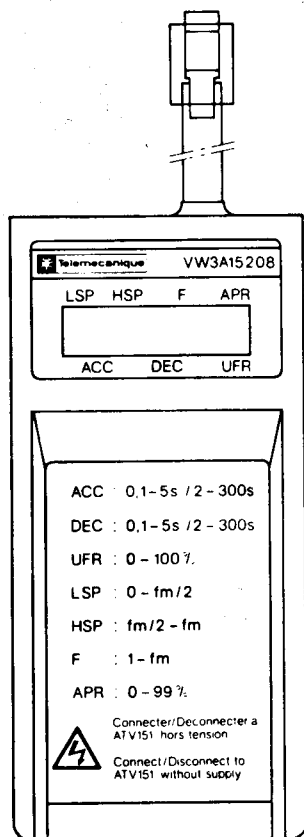
- power rating of the motor usually associated,
- mains supply voltage required,
- microprocessor software number.

LSP	HSP	F	APR
ATV 1		V1.0	
2,2 kW		220-240 V	
ACC	DEC	UFR	

● Assistance with initial setting up

Display of the parameters adjusted by potentiometers.

LSP	HSP	F	APR
I	50	50Hz	29%
2s	2s	50%	
ACC	DEC	UFR	



- ACC : Ramp time : acceleration, deceleration (in s)
- DEC : Ramp time : acceleration, deceleration (in s)
- LSP : Low speed, high speed frequency limits (in Hz)
- HSP : Low speed, high speed frequency limits (in Hz)
- UFR : Correction of the voltage / frequency ratio (in % from 0 to 100 %)
- F : Stator frequency reference (in Hz)
- APR : Affectable potentiometer

● Assistance with maintenance

Display of fault codes.

LSP	HSP	F	APR
		USF	
		Under Voltage	
ACC	DEC	UFR	

- OSF : Overvoltage
- OLF : Motor overload
- USF : Undervoltage
- DRF : Speed controller fault
- OCF : Overcurrent
- ARS : Automatic restarting
- OBF : Overbraking
- PHF : Phase failure (380V product only)

NOTE : in the event of an emergency stop, the deceleration time, divided by 4, is shown as a flashing display.

● Dimensions, weight

H x W x D = 185 x 90 x 35 (mm)

Weight : 0,550 kg

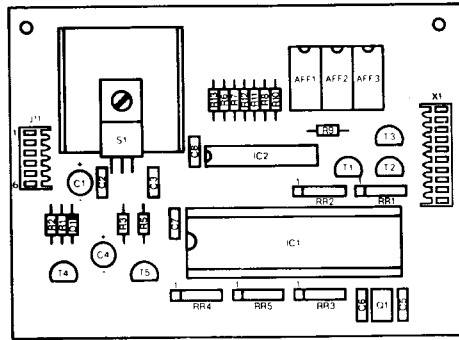
Options

VW3-A15207 display module

VY1-A15106 manual control station

Display module

This is a circuit board which can be incorporated in the speed controller, enabling :
 - stator frequency reference reading,
 - fault code display, in the event of abnormal operation.

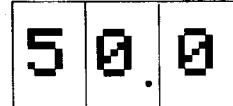


Dimensions : H x W = 112 x 81 (mm)

Weight : 0,150 kg

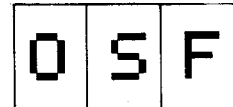
● **Operating assistance**

Display of parameters used when operating.
 F : Stator frequency reference (in Hz)



● **Assistance with maintenance**

Display of fault codes.



OSF : Overvoltage

OLF : Motor overload

USF : Undervoltage

DRF : Speed controller fault

OCF : Overcurrent

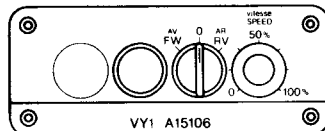
ARS : Automatic restarting

OBF : Overbraking

PHF : Phase failure (380V product only)

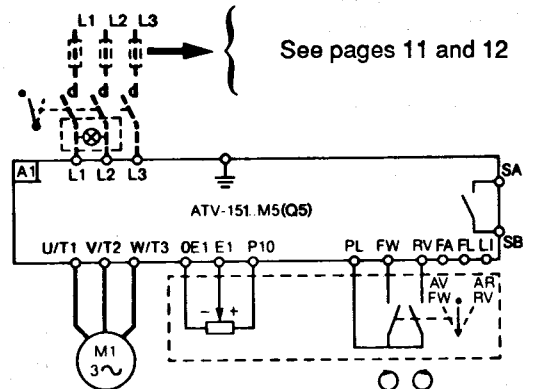
Manual control station

The manual control station is designed exclusively for the IP54 version ALTIVAR 15 1.
 It comprises : 1 operating direction selector switch,
 1 ON indicator light,
 1 speed reference potentiometer.



Dimensions :
 H x W x D = 96 x 162 x 92 (mm)

Weight : 0,250 kg

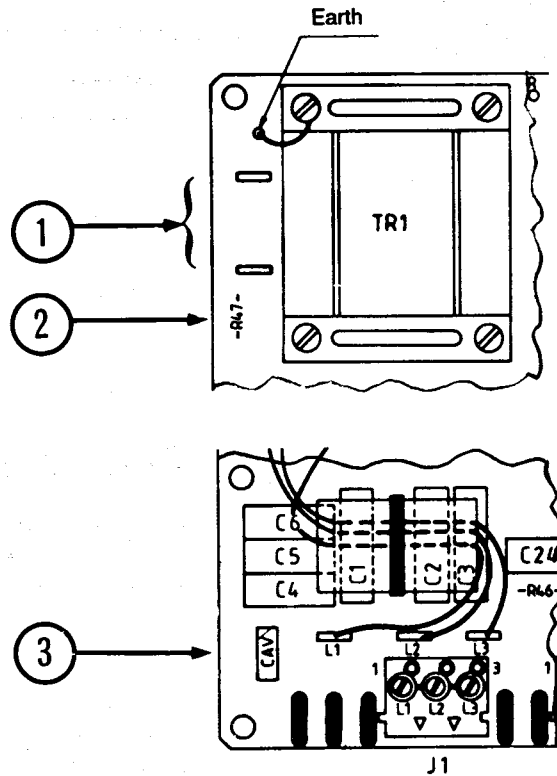


See pages 11 and 12

Special applications


Separate control supply

This enables the control to be supplied independently from the power.
(For example, to memorise of fault codes, in the event of a power supply failure).

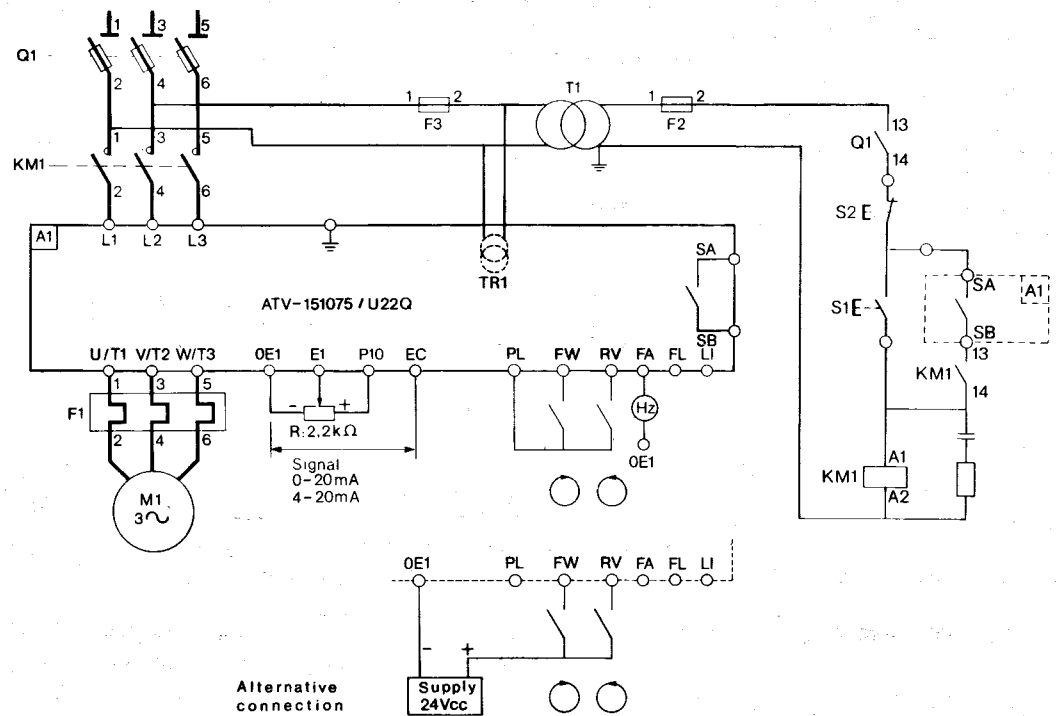


Modification to be carried out on the power board :

- 1 - connect the control voltage using the two Faston tags located next to the TR1 transformer
- 2 - disconnect the resistance R47
- 3 - open the link CAV

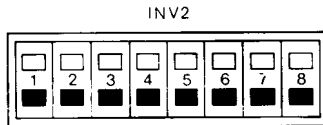
CAUTION : 
carry out the connection with the controller switched off. It is essential to wait for at least 5 minutes before changing the internal connections (the time taken for the filter capacitors to discharge).

Recommended circuit diagram



Special applications

Possibilities provided by the INV2 dip switches

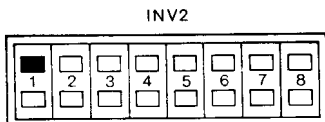


▲ The product is supplied with the switches in the lower position.

INV2 selection								Operations carried out
1	2	3	4	5	6	7	8	
•	•	•	•	•	•	•	•	Factory settings (p.38)
•								Ramp times 0,1 to 5 s (p.34)
	•							Automatic restarting (p.34)
		•	•					Current limitation (p.35)
			•	•				Braking to standstill with d.c. injection (p.37)
			•	•	•			Speed reference (assignable) (p.36)
				•	•			Freewheel stopping (p.36)
				•	•			Emergency stop (p.37)
				•	•			Braking to standstill with d.c. injection (p.36)
					•	•		Low speed detection (p.38)
					•	•		Braking to standstill suppression (p.38)
					•	•		Speed difference detection (p.38)
					•	•		Current level 1,1 In detection (p.38)



Other ramp times



Selected using switch 1 of INV2.

Switch 1 in upper position : ramp time = 0,1 to 5 s
in lower position : ramp time = 2 to 300 s

Automatic restarting

Some installations require automatic restarting of the speed controller after locking on fault, followed by the disappearance of the causes for the stop (for example : ventilating fans operating at night, without supervision). In this case, the supply must be maintained. Use the circuit diagram on page 13 with isolator-circuit breaker.

To select automatic restarting, put switch 2 of INV2 into the upper position. Faults concerned : USF, OSF, OBF and DRF.



These measures can only be taken with machines or installations involving no danger on automatic restarting for either the personnel or the equipment (see appropriate safety regulations).

Operation :

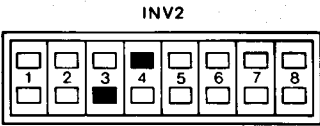
- In the event of a fault (USF, OSF, OBF, DRF) the speed controller locks for 12 seconds, the corresponding code being displayed, then restarts automatically if the fault has disappeared and the other operating conditions allow it.
- If the fault persists, the controller locks definitively and the safety relay opens.
- A maximum of three successive faults can be processed within a 5 minute period.

Special applications

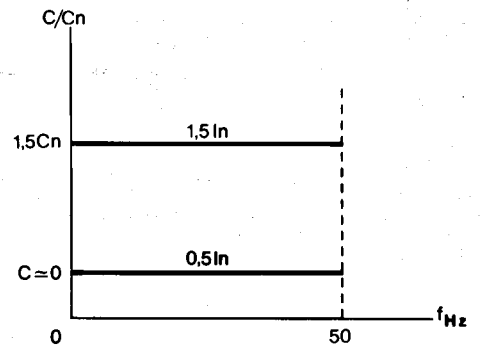
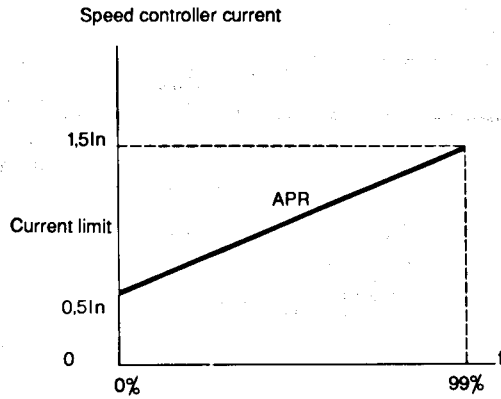
Current limitation via potentiometer APR

Selected using switches 3 and 4 of INV2.

In order to limit the maximum torque, adjust the APR potentiometer between 0,5 and 1,5 motor In.



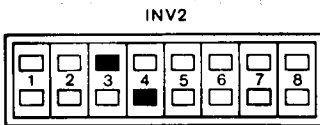
Display 0 to 99 %



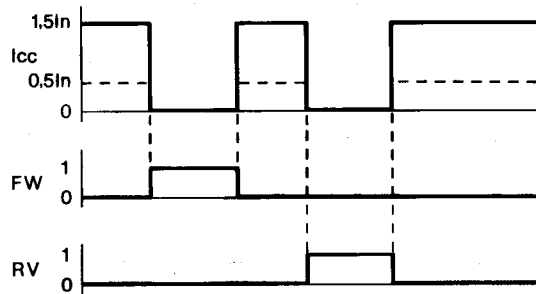
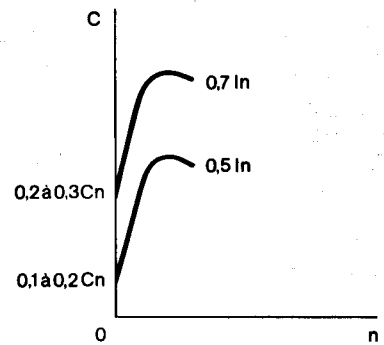
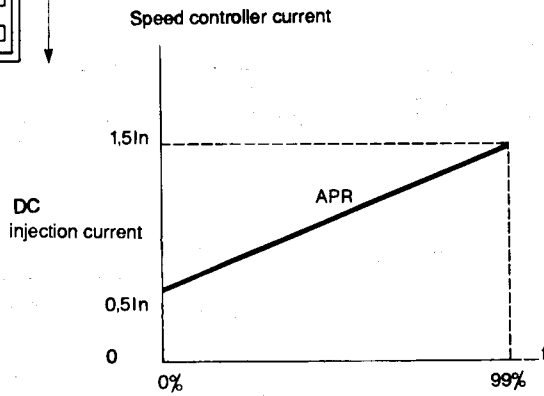
Maintaining torque at standstill (torque depending on the motor remanence and the d.c. injected)

Selected using switches 3 and 4 of INV2.

Adjust the current using the APR potentiometer.



Display 0 to 99 %

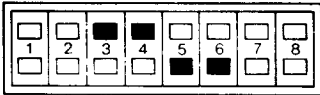


- Braking current adjustable between 0,5 and 1,5 speed controller In, via the APR potentiometer.

NOTA : above 0,7 motor In ensure motor protection against overheating (thermistor probe).

Special applications

INV2



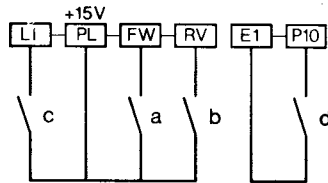
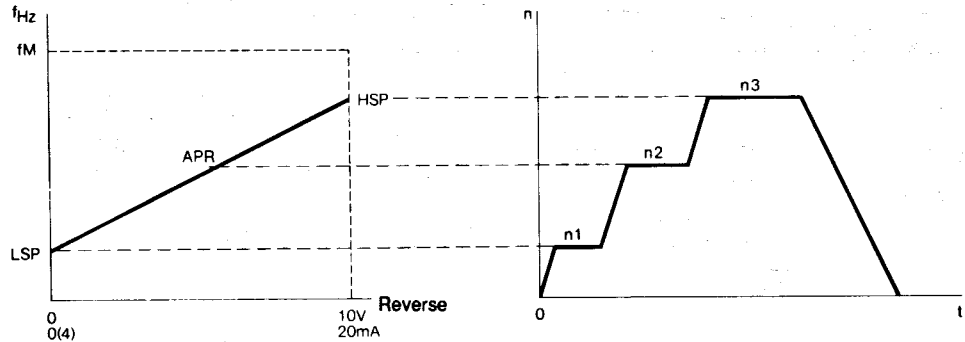
Speed reference via potentiometer APR

By signal to terminal LI and selection using switches 3, 4, 5 and 6 of INV2.

Example : selection of 3 speeds by external control.



Display 0 to 99 %



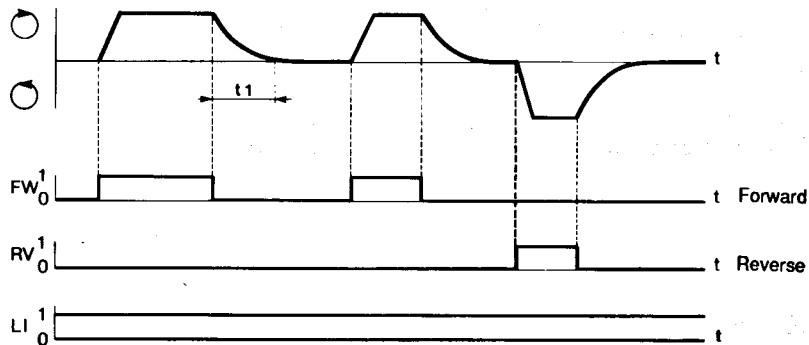
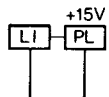
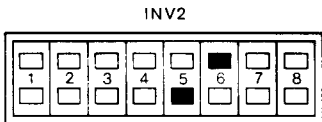
Forward : $n1 = a$
 $n2 = a \cdot c$
 $n3 = a \cdot d$

Reverse : $n1 = b$
 $n2 = b \cdot c$
 $n3 = b \cdot d$

In this configuration, if $LI = FW = RV = 0$,
 deceleration time on the ramp is divided by 4.
 See emergency stop function on p. 37.

Freewheel stopping on machine Inertia

By signal to terminal LI and selection using switches 5 and 6 of INV2.



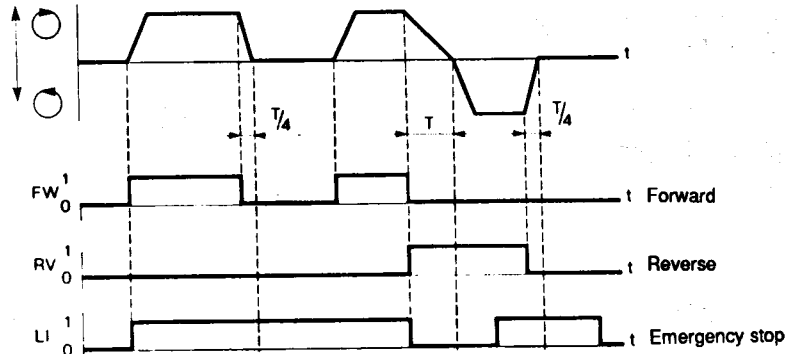
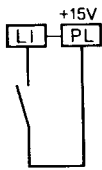
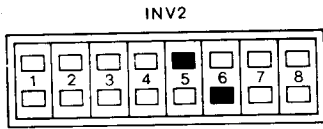
- Deceleration without ramp speed controller locked.

$t1$ depends on the speed, the machine inertia and the resistive torque.

Special applications

Emergency stop

By signal to terminal LI and selection using switches 5 and 6 of INV2.



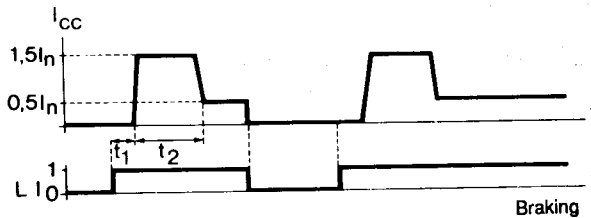
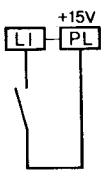
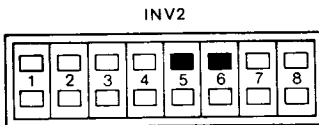
- Deceleration on the ramp divided by 4, will be at a minimum of 0,1s (where the motor-speed controller combination allows this).

NOTE : the emergency stop function can also be obtained when the APR potentiometer is preselected for a third internal speed reference (switches 3 and 4 in upper position, see page 36), in the following conditions :

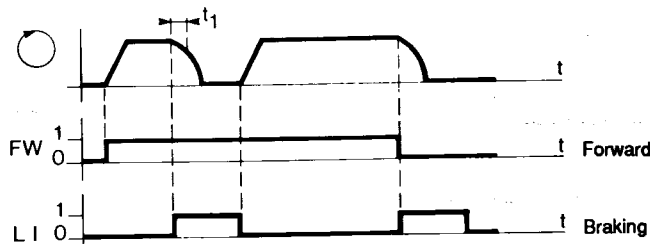
switches 5 and 6 in the lower position, signal LI = FW = RW = 0.

Braking to standstill using d.c. injection

By signal to terminal LI and selection using switches 5 and 6 of INV2.

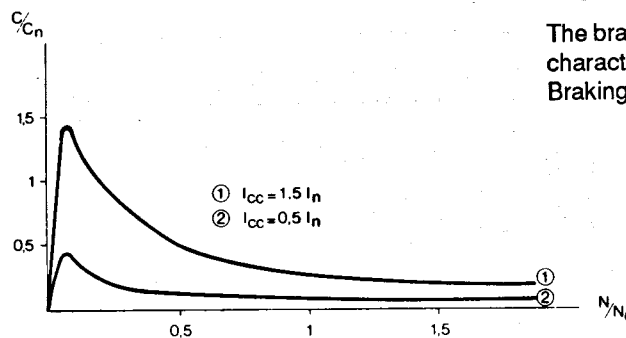


- t1 dead time - waiting for demagnetisation of the motor, t1 depends on motor speed and power (between 0 and 1,5 seconds), t2 = 3 seconds.



- Braking control has priority over direction control.

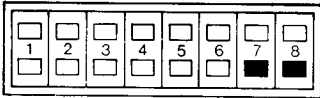
Typical braking curves



The braking torque curves are linked to the motor characteristics. Braking torque is in the region of 0 at zero speed.

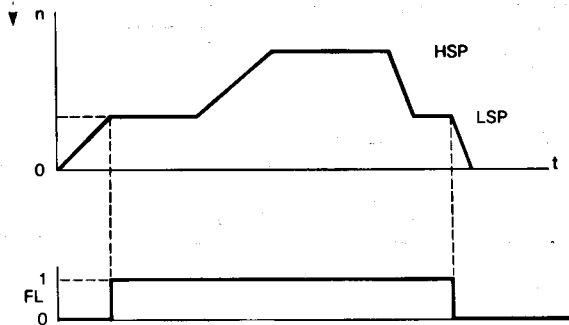
Special applications

INV2

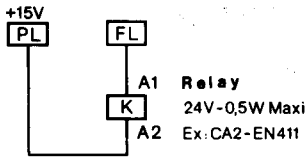


Detection of low speed level (LSP)

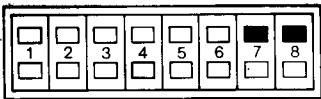
▲ Controls the motor mechanical brake when the low speed threshold is reached.



FL = 1 if $U \geq ULSP$



INV2

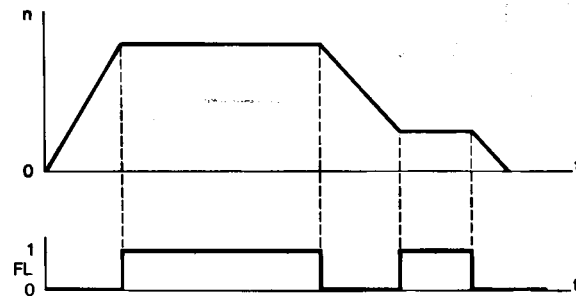


Braking to standstill suppression

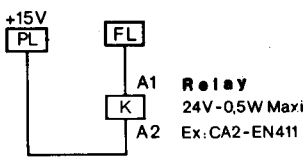
Suppression of braking to standstill via automatic d.c. injection for 0,5 s when frequency becomes < 1 Hz.

Set speed attained detection

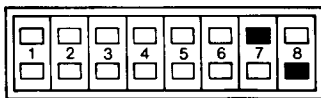
Causes the relay to close when the set speed is reached.



FL = 1 if Δf between the reference frequency and the stator frequency at the output of the speed controller is < 2 Hz

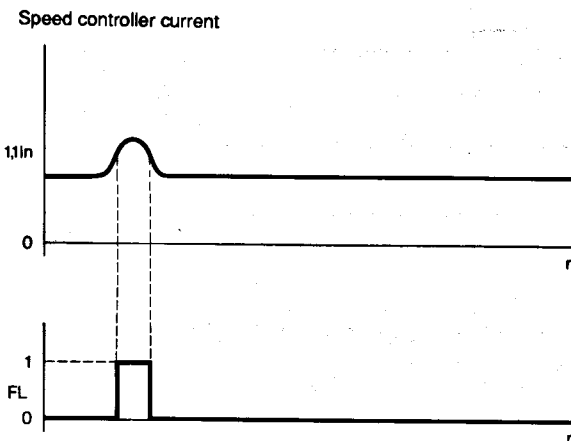


INV2

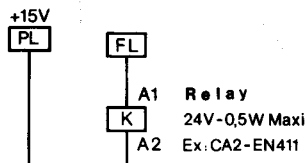


Detection of level 1,1 speed controller In

Enables speed controller operation on instantaneous overload to be indicated.



FL = 1
if $I \geq 1,1$ speed controller I_n



Notes
