

Variable speed drives for asynchronous motors Altivar 11

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Variable speed drives for asynchronous motors

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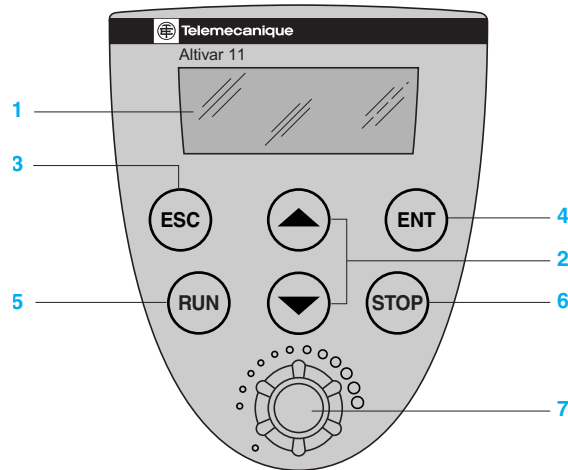
Drive factory setting

To facilitate installation of the drive, the functions have been programmed to be suitable for the most common applications.

Drive functions and I/O:

- 2-wire control on transition:
 - Logic input LI1: Forward
 - Logic input LI2: Reverse
- Preset speeds:
 - Logic input LI3: Preset speeds
 - Logic input LI4: Preset speeds
- Analog input AI1: 0-5 V speed reference
- Analog/logic output DO: Motor frequency (analog)
- Deceleration ramp adaptation
- Automatic DC injection for 0.5 s to standstill

Functions of the display and keys



- 1 Information is displayed in the form of codes or values in three 7-segment displays
- 2 Buttons for scrolling through the menus or modifying values
- 3 "ESC": Button for exiting the menus (no confirmation)
- 4 "ENT": Validation button for entering a menu or confirming the new value selected

Only on the Asia and pump ranges:

- 5 "RUN": Local control of motor operation
- 6 "STOP": Local control of motor stopping
- 7 Speed reference potentiometer

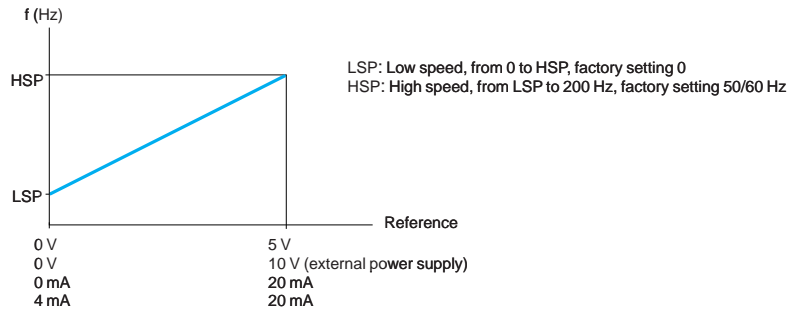
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Application functions

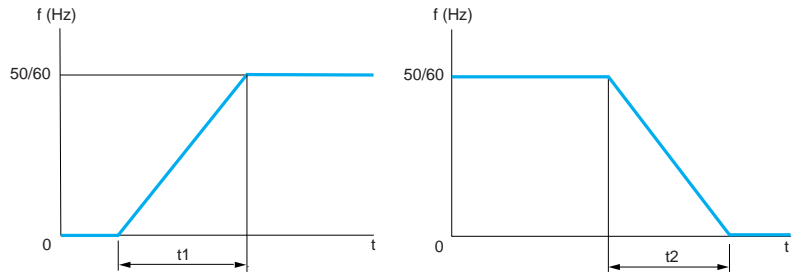
■ Operating speed range

Used to determine the 2 frequency limits which define the speed range permitted by the machine under actual operating conditions.



■ Acceleration and deceleration ramp times

This function is used to define acceleration and deceleration ramp times according to the application and the machine dynamics.



Linear acceleration ramp
Adjustment of t_1 : 0 to 99.9 s,
factory setting 3 s.

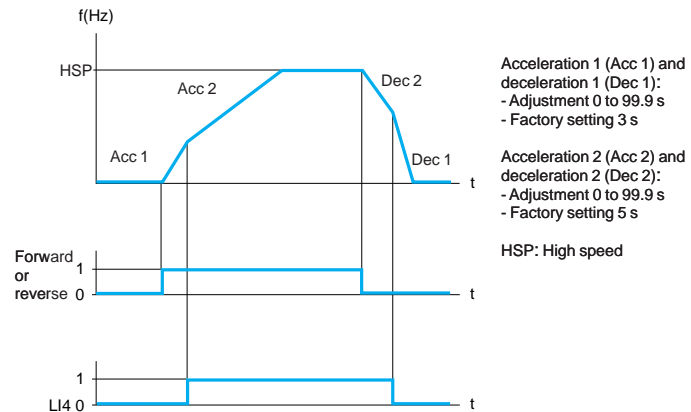
Linear deceleration ramp
Adjustment of t_2 : 0 to 99.9 s,
factory setting 3 s.

■ Second ramp

This function is used to switch two acceleration and deceleration ramp times, which can be adjusted separately.

Enabled by means of 1 reassignable logic input.

It is suitable for machines with fast continuous speed correction and high speed lathes with acceleration and deceleration limiting above certain speeds.



Example of switching using logic input LI4

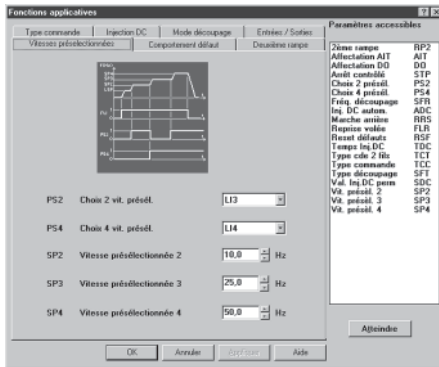
■ Deceleration ramp adaptation

This function is used to automatically increase the deceleration time if the initial setting is too low when the load inertia is taken into account. It prevents the drive locking if there is an "overvoltage on deceleration" fault.

If this function is disabled, an appropriate braking unit and resistor can be used.

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Adjusting the preset speeds using the PowerSuite software workshop for PC

■ Preset speeds

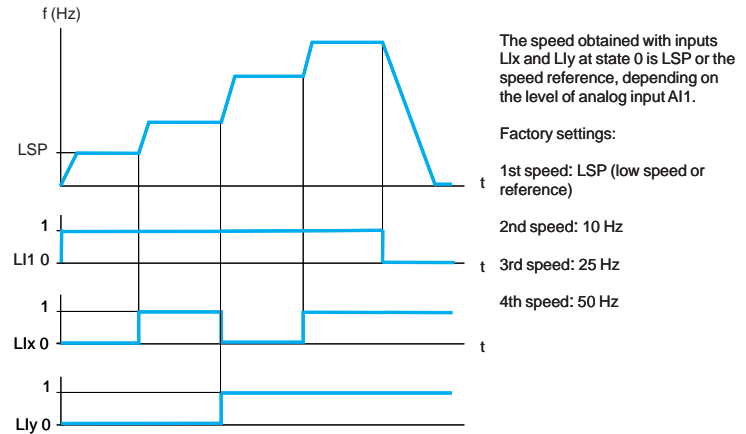
This is used to switch preset speed references.

Choice of two or four preset speeds.

It is enabled by means of 1 or 2 logic inputs.

The preset speeds are adjustable in increments of 0.1 Hz from 0 Hz to 200 Hz.

They take priority over the reference given by the analog input, or for the Asia range, on the drive's potentiometer.



The speed obtained with inputs L1x and L1y at state 0 is LSP or the speed reference, depending on the level of analog input AI1.

Factory settings:

- 1st speed: LSP (low speed or reference)
- 2nd speed: 10 Hz
- 3rd speed: 25 Hz
- 4th speed: 50 Hz

Example of operation with 4 preset speeds

■ Limiting low speed operating time

The motor is stopped automatically after a period of operation at low speed (LSP). This time can be set between 0.1 and 999 seconds (0 corresponds to an unlimited time).

The motor restarts if the frequency reference is greater than the low speed threshold (LSP) and if a run command is still present.

Function suitable for automatic Stops/Starts.

■ PI regulator

Used for simple control of a flow rate or a pressure with a sensor which supplies a feedback signal adapted to the drive.

This function is suitable for pumping and ventilation applications.

□ PI reference:

- Internal reference representing 0.1 to 100% of the maximum frequency reference (HSP).
- Regulation reference selected from all the possible types of regulation reference.
- 2 or 4 preset PI references adjustable from 0.1 to 100% of the maximum frequency (HSP). These require the use of 1 or 2 logic inputs respectively.
- Manual reference given by the potentiometer on the front panel (only on the Asia range).

□ PI feedback

- Analog input AI1

□ Auto/Man.

- Logic input LI for switching operation to speed reference (Man) or PI regulation (Auto).

During operation in automatic mode, it is possible to adapt the process feedback, to correct inverse PI and to adjust the proportional and integral gains.

The motor speed is limited to between LSP and HSP.

■ Three additional high speeds

These three additional high speeds are defined by HS2, HS3 and HS4.

Used to select 2 or 4 high speeds (HSP/HS2 or HSP/HS2/HS3/HS4).

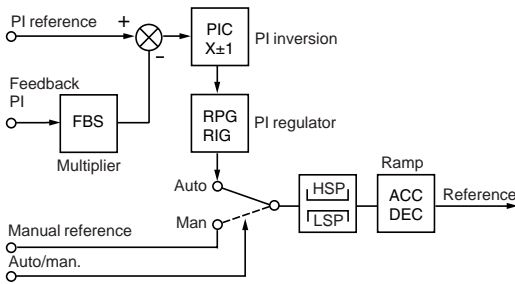
Enabling 2 or 4 high speeds requires the use of 1 or 2 logic inputs respectively.

■ 2nd current limit

A second current limit can be configured between 0.5 and 1.5 times the nominal drive current.

Used to limit the torque and the temperature rise of the motor.

The switch between the two current limits is enabled via a logic input.



- ACC: Acceleration
- DEC: Deceleration
- FBS: PI feedback multiplication coefficient
- HSP: High speed
- PIC: Reversal of the direction of correction of the PI regulator
- LSP: Low speed
- RIG: PI regulator integral gain
- RPG: PI regulator proportional gain

PI regulator

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■ Configuration of analog input AI1

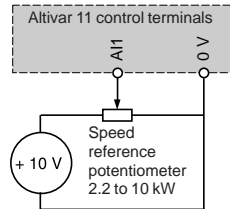
This is used to modify the characteristics, for either voltage or current, of analog input AI1.

Factory setting: 0-5 V (internal power supply only)

Other possible values via external power supplies: 0-10 V, 0-20 mA, 4-20 mA

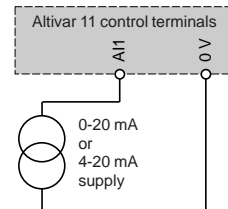
Analog voltage input

Use with external 10 V



Analog current input

0-20 mA or 4-20 mA use



■ Analog or logic output DO

Output DO can be programmed to be a logic output or an analog output. It enables remote signalling of the following information as required:

- Frequency threshold reached (logic output)
- Reference reached (logic output)
- Current threshold reached (logic output)
- Current in the motor (analog output)
- Motor frequency (analog output)

Diagram with internal power supply

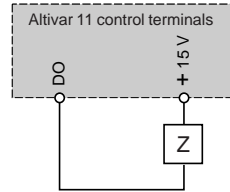
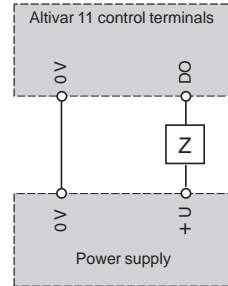


Diagram with external power supply



If DO is a logic output, Z is a relay or low level input.

If DO is an analog output, Z can be a galvanometer, for example.

For a galvanometer with resistance R, the maximum voltage supplied will be:

$$U \times \frac{R(\Omega)}{R(\Omega) + 1000(\Omega)}$$

■ Direction of operation: forward/reverse

In 2-wire control, forward operation cannot be reassigned to any logic input other than LI1.

In 3-wire control, stopping cannot be reassigned to any logic input other than LI1, and forward operation cannot be reassigned to any logic input other than LI2.

Reverse operation can be disabled for applications with a single direction of motor rotation, by not assigning any logic input to reverse operation.

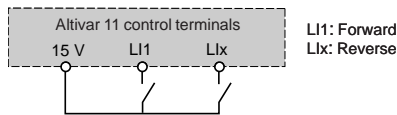
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■ 2-wire control

This function is used to control the direction of operation by means of a stay-put contact.
Run (forward or reverse) and stop commands are controlled by the same logic input.
It is enabled by means of 1 or 2 logic inputs (one or two directions).
This function is suitable for all non-reversing and reversing applications.

3 operating modes are possible:

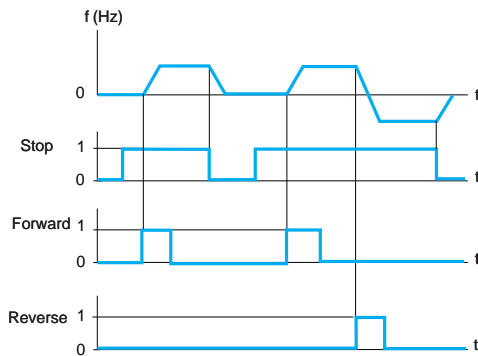
- Detection of the state of the logic inputs
- Detection of a change in state of the logic inputs
- Detection of the state of the logic inputs with forward operation always having priority over reverse



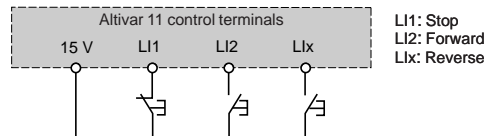
Wiring diagram for 2-wire control

■ 3-wire control

This function is used to control the operating direction and stopping by means of pulsed contacts.
Run (forward or reverse) and stop commands are controlled by 2 different logic inputs.
It is enabled by means of 2 or 3 logic inputs (non-reversing or reversing).
This function is suitable for all non-reversing and reversing applications.



Example of operation with 3-wire control



Wiring diagram for 3-wire control

■ Automatic DC injection

This function enables DC injection to standstill, which is adjustable from 0 to 1.2 times the value of the drive nominal current (preset at 0.7 In), as soon as operation is no longer controlled and the motor speed is zero:

- either for a period of time, which is adjustable from 0.1 to 30 s, (preset 0.5 s),
- or continuously.

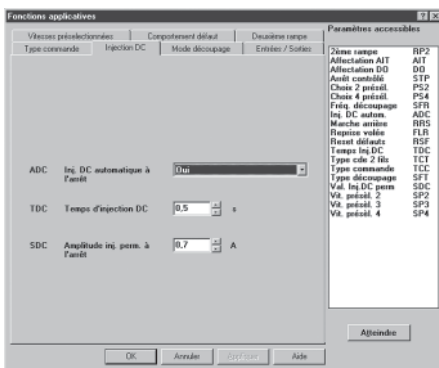
Factory setting: Function active with DC injection for 0.5 s.
In 3-wire control, DC injection is only active if logic output LI1 is active (stop).

■ Switching frequency, noise reduction

Switching the intermediate DC voltage at high frequency is useful for supplying the motor with a current wave having little harmonic distortion.
There are 3 switching frequency ranges:

- Random switching frequency around 2 or 4 kHz (avoids resonance)
- Fixed low frequency that can be set at 2 or 4 kHz
- Fixed high frequency that can be set at 8, 12 or 16 kHz

Factory setting: Low frequency set at 4 kHz.
This function is suitable for all applications which require low motor noise.



Adjusting the "DC injection" function using the PowerSuite software workshop for PC

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■ Fault relay, unlocking

The fault relay is energized when the drive is powered up and is not faulty. It opens in the event of a fault or when the drive is powered down.

The drive can be unlocked after a fault in one of the following ways:

- By powering down the drive until the display disappears completely, then powering back up
- By activating the logic input associated with the “fault reset” function, if the function is enabled
- By enabling the “automatic restart” function

■ Fault reset

This is used to clear the stored fault and restart the drive if the cause of the fault has disappeared.

The fault is cleared by a transition of the logic input LI which is assigned to this function.

Factory setting: Function inactive.

The restart conditions after a reset are the same as those of a normal power-up.

The following faults can be reset: drive thermal overload, motor thermal overload, line supply overvoltage, overvoltage on deceleration, overspeed, input phase loss (1), line supply undervoltage (2).

■ Automatic restart

This function enables the drive to be restarted automatically after it has locked in fault mode, provided the relevant fault has disappeared and the other operating conditions permit a restart.

This restart is performed by a series of automatic attempts separated by increasingly longer waiting periods of: 1 s, 5 s, 10 s, then 1 min for the following periods.

If the drive has not restarted after 6 minutes, it locks and the procedure is abandoned until the drive is powered down and back up again.

Factory setting: Function inactive

A restart is authorized with the following faults: drive thermal overload, motor thermal overload, line supply overvoltage, overvoltage on deceleration, input phase loss (1), line supply undervoltage (2).

If the function is enabled, the drive’s safety relay remains activated until one of these faults appears.

This function requires the speed reference and the direction of operation to be maintained, and is only compatible with 2-wire level control.

This function is suitable for machines or installations which are in continuous operation or are not monitored, and where a restart will not endanger equipment or personnel in any way.

■ Automatic catching of a spinning load with speed detection (“catch on the fly”)

This function is used to restart the motor smoothly after one of the following events:

- Loss of line supply or power off
- Fault reset or automatic restart
- Freewheel stop triggered by a fault

On restarting, the effective speed of the motor is detected in order to restart on the ramp at this speed and return to the reference speed. The speed detection time can be up to 1 s depending on the initial deviation.

Factory setting: Function inactive

This function requires the activation of 2-wire level control and is not compatible with the continuous DC injection braking function.

This function is suitable for machines for which the loss of motor speed is negligible during the power failure (machines with high inertia).

(1) The “line supply phase loss” fault is only accessible on drives with a three-phase power supply, if monitoring of the fault has been enabled (factory setting: enabled).

(2) The drive will restart as soon as the undervoltage fault disappears, regardless of whether the function is active.

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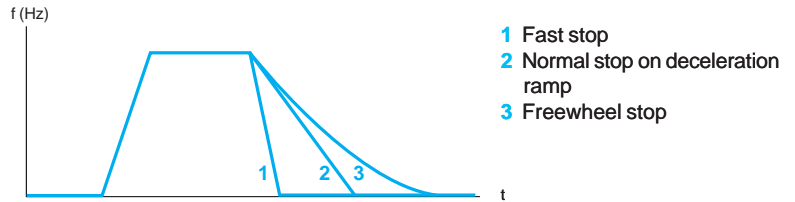
■ Controlled stop on loss of line supply

This is used to define the drive stopping modes on a "loss of line supply" fault.

Three stopping modes are available for selection:

- Freewheel stop: The drive locks and the motor stops in accordance with the inertia and the resistive torque
- Normal stop: Stop with valid deceleration ramp time (deceleration 1 or 2).
- Fast stop: The stopping time depends on the inertia and the braking capability of the drive.

Factory setting: Freewheel stop



■ Freewheel stop

This function enables freewheel stopping of the motor by resistive torque. The motor power supply is cut. Stop when the assigned logic input is not connected (state 0, contact open).

■ Drive thermal protection

Direct protection by thermistor, integrated in the drive's power module. This protects the components, even in the event of poor ventilation or excessive ambient temperature.

When the fault is detected, it locks the drive.

■ Motor thermal protection

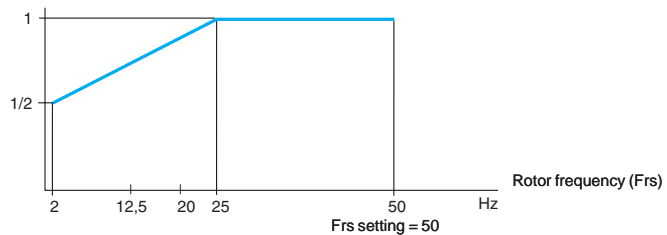
The theoretical temperature rise of the motor is continuously calculated to provide thermal protection.

The drive is locked on a fault if this temperature rise exceeds 118% of the nominal temperature rise.

This function is suitable for applications with self-cooled motors and thermal derating based on the rotor frequency.

Note: The thermal state of the motor is not stored when the drive is powered down.

K coefficient to be applied to the preset I_{th}
(actual $I_{th} = K \times$ preset I_{th})



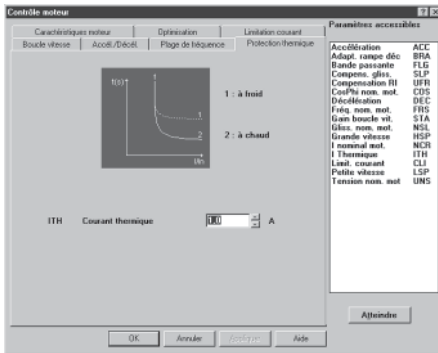
■ Monitoring

The display shows the state of the drive or, if selected, one of the following values:

- Frequency reference
- Output frequency applied to the motor
- Motor current
- Line voltage
- Motor thermal state
- Drive thermal state

■ Parameter protection by confidential code

This function enables the drive configuration to be protected using an access code.



Adjusting the thermal protection using the PowerSuite software workshop for PC

Incompatible functions

The choice of the last function configured is enabled, whatever the configuration of the previous functions.

Application functions can be assigned to the same logic input, in which case one logic input enables a number of functions (for example: direction of operation and second ramp).

A check must be carried out to ensure that the functions are compatible.

■ **Direction of operation and 2-wire control:** Forward operation can only be assigned to LI1.

■ **Direction of operation and 3-wire control:** Forward operation can only be assigned to LI2.

■ **Automatic restart:** This function requires the configuration of 2-wire level control. Changing the configuration of the type of control disables automatic restart.

■ **Automatic catching a spinning load with speed detection:**

- Requires the configuration of 2-wire level control. Changing the configuration of the type of control disables automatic catching a spinning load.
- Is not compatible with continuous DC injection braking to a standstill. Configuring this function disables automatic catching a spinning load.

Functions specific to the Asia range ATV 11●U●●●●A

■ **Local control**

The keypad on the Asia range has two additional keys (RUN and STOP) and a potentiometer (speed reference).

- The keys and the potentiometer are active if local control is enabled.
- The logic and analog inputs are inactive if local control is enabled.
- **Reverse:** If local control is active, the reverse function is not visible.

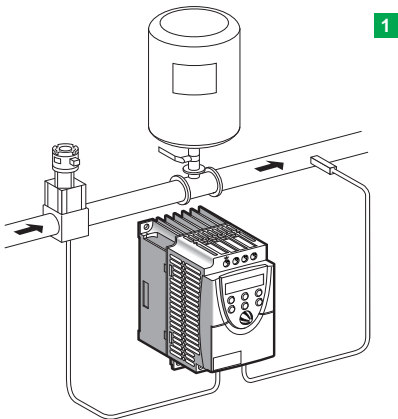
Factory setting: Function active

■ **Logic inputs**

It is possible to choose the active level of the logic input.
 Positive logic: The inputs are active if the signal is ≥ 11 V.
 Negative logic: The inputs are active if the signal is ≤ 5 V.
 Factory setting: Positive logic

Variable speed drives for asynchronous motors

Altivar 11 pump range



Single variable mode

1

Functions specific to the pump range ATV 11●U●●M2E347

The main objective here is to control a complete pumping installation using a single drive, **ATV 11●U●●M2E347**, by ensuring constant pressure in the system whatever the flow rate.

The Altivar 11 pump range has 11 supplementary functions designed for water pumping applications:

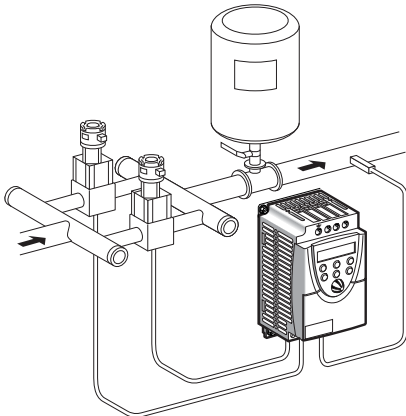
- Control in single variable mode
- Control in single variable mode with auxiliary pump
- Underload
- Overload
- Sleep
- Wake-up
- PI feedback supervision
- No-load operation detection
- Quick start
- Automatic restart on underload and overload faults
- PI reference adjustment range for the end user

■ Control in single variable mode

The system is operated using a single variable speed pump (1).

A PI regulator controls the variable speed pump.

A pressure sensor provides the “PI feedback” information required for system feedback.



Single variable mode with auxiliary pump

2

■ Control in single variable mode with auxiliary pump

The system is operated using a fixed speed pump, called the auxiliary pump, and a variable speed pump, which is unable to provide the full flow range required on its own (2).

The auxiliary pump’s starting and stopping are controlled by the DO logic output according to the PI regulator output (variable pump frequency reference) with a hysteresis effect as shown in the diagram below (3).

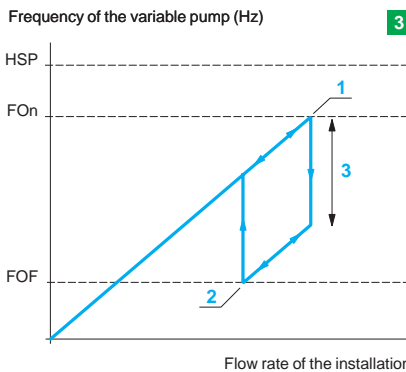
Auxiliary pump starting (4)

If the variable pump control frequency exceeds the threshold (FO_n) for longer than a time period (t_{ON}), the auxiliary pump is put into operation 1. The variable pump reference decreases linearly until it reaches the threshold (FOF).

In order to reduce the effect of overpressure caused by the starting of the auxiliary pump, the deceleration time of the variable pump (r_{ON}) must be set to the time that the auxiliary pump takes to reach its nominal speed.

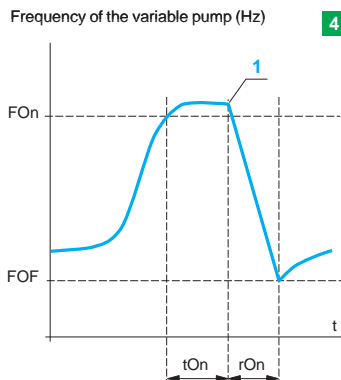
Auxiliary pump stopping (5)

Conversely if the variable pump control frequency falls below the threshold (FOF) for a period (t_{OF}), the auxiliary pump is stopped 2 and the variable pump reference increases linearly until it reaches the threshold (FO_n). The acceleration time (r_{OF}) is set to the stopping time of the auxiliary pump in order to minimize the effect of underpressure.



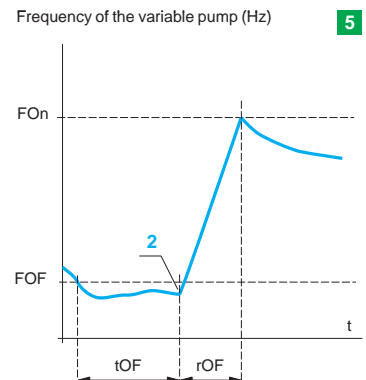
Single variable mode with auxiliary pump: hysteresis

3



Auxiliary pump start

4



Auxiliary pump stop

5

- 1 Auxiliary pump starting
 - 2 Auxiliary pump stopping
 - 3 Frequency range corresponding to the auxiliary pump flow rate
- FO_n: Starting frequency of the auxiliary pump
FOF: Stopping frequency of the auxiliary pump

Variable speed drives for asynchronous motors

Altivar 11 pump range

■ Underload

This function stops the motor when it is underloaded. The function is active in steady state.

If the current is below an underload threshold for an adjustable period of time, the drive locks in an underload fault.

The current threshold can be set to between 20% and 100% of the nominal motor current value.

An hysteresis of 10% is applied to this threshold to conform the end of the underload state. The time delay is adjustable up to 100 s. When this parameter is at 0, the function is disabled.

■ Overload

This function stops the motor when it is overloaded. The function is active in steady state.

If the motor current is greater than an overload threshold for an adjustable time period, the drive locks in an overload fault.

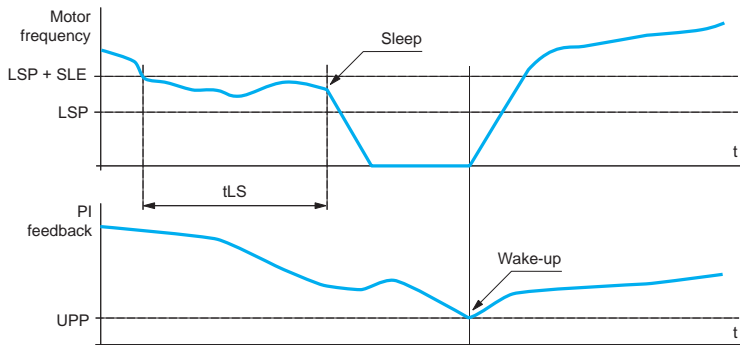
The overload threshold can be set to between 70% and 150% of the nominal motor current.

An hysteresis of 10% is applied to this threshold to confirm the end of the overload state. The time delay is adjustable up to 100 s. When this parameter is at 0, the function is disabled.

■ Sleep/Wake-up

Allows the variable pump to come to a complete stop when the flow rate is considered too low, below an adjustable "sleep threshold" (LSP+SLE) and time delay (tLS).

When the system is in "sleep" state, if the PI feedback value, showing the pressure downstream of the pump, falls below a "wake up" threshold (UPP), the variable pump is restarted.



Sleep/Wake-up functions

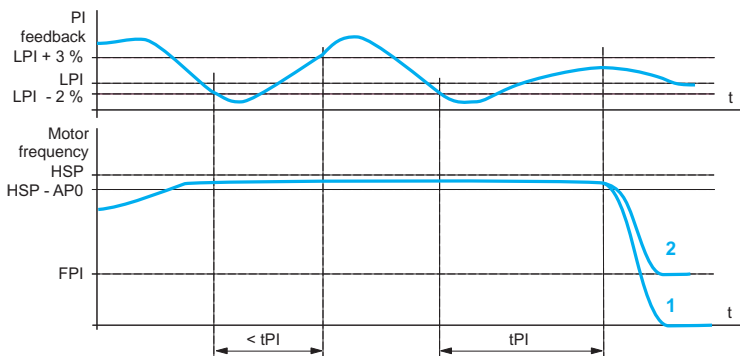
LSP: Low speed
 SLE: Sleep threshold offset
 UPP: Wake-up threshold
 tLS: Sleep threshold operating time

■ PI feedback supervision

Once the variable pump is running at maximum speed and at the same time the PI feedback is lower than the supervision threshold (LPI) at the end of a time delay (tPI), the drive switches to fallback mode. There are two possible scenarios (see graphs below):

- The drive performs a freewheel stop and displays a specific fault code **1**
- Configurable fixed speed operation with display of a specific fault code **2**

The drive reverts to regulation mode when the PI feedback returns to the supervision threshold (LPI).



PI feedback supervision

In single variable mode with auxiliary pump, this function is active when both pumps are operating.

LPI: PI feedback supervision threshold
 HSP: High speed
 FPI: Fallback speed
 APO: Maximum speed detection hysteresis
 tPI: PI feedback supervision function time delay

Variable speed drives for asynchronous motors

Altivar 11 pump range

■ No-load operation detection

This function is used in applications where zero flow cannot be detected by the sleep function alone. It is active when the auxiliary pump is stopped and the variable pump motor frequency reference is below a configured threshold.

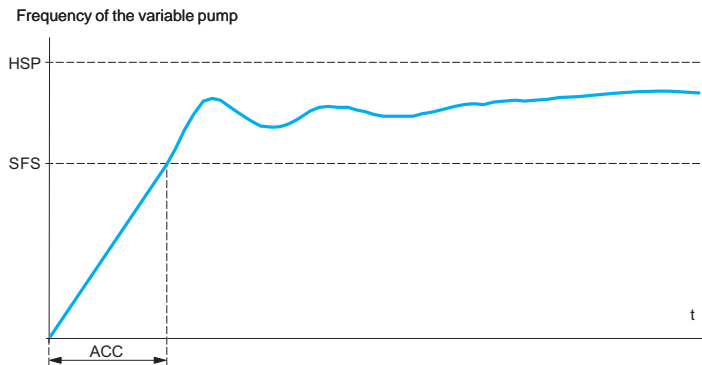
It consists of periodically forcing the motor frequency reference to a low value:

- If the request is still present, it results in an increase in the PI error and the drive reverts to regulation in line with the previous reference.
- If the request is no longer present (zero flow), the PI error will not change, which is characteristic of no-load operation. The variable pump motor is stopped.

■ Quick start

The quick start function aims to overcome the problems associated with the high regulation gains that are necessary at start-up but inappropriate for regulation. The drive accelerates linearly on a ramp (ACC) until its speed reaches the configured quick start threshold (SFS).

Once it reaches this threshold (SFS), PI regulation begins.



HSP: High speed
SFS: Quick start threshold
ACC: Acceleration ramp time

Quick start

■ Automatic restart on underload and overload faults

Generally, the user can set a parameter to activate an automatic restart on a fault, if the cause(s) of the fault no longer exist(s).

In the case of underload and overload faults, an adjustable period of 1 s to 6 min 16 s can be used to delay the restart.

■ PI reference adjustment range for the end user

This function allows the end user to set the PI regulator reference to increase or reduce the rate of flow.

Adjustment by the user is either by modifying the PI regulator reference parameter, or by manual control of the potentiometer, accessible on the drive's front panel.

The installer has access to two PI reference limit parameters, which can be used to define a user's range of action.

■ Local control

The keypad on the pump range has two additional keys (RUN and STOP) and a potentiometer (speed reference).

The keys and the potentiometer are active if local control is enabled.