

# Variable speed drives for asynchronous motors Altivar 21

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# Variable speed drives for asynchronous motors

## Altivar 21

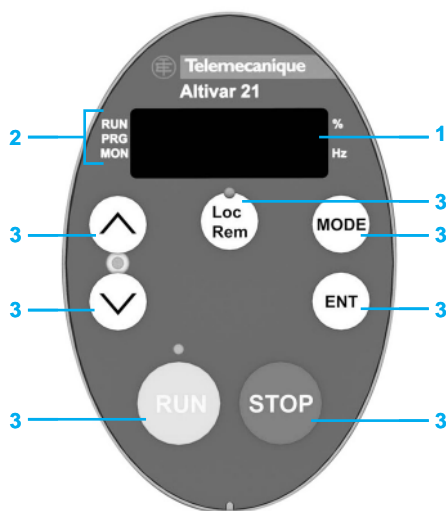
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# Variable speed drives for asynchronous motors

## Altivar 21



Integrated 7-segment display terminal

### Integrated 7-segment display terminal

The Altivar 21 drive has an integrated 7-segment display terminal.

This can be used to:

- ☐ Display status and faults
- ☐ Access and modify parameters
- ☐ Check your installation easily in local mode using the Loc/Rem key **3**.

### Description

#### 1 Display:

- ☐ Four 7-segment displays visible at 5 m
- ☐ Display of numeric values and codes
- ☐ The display flashes when a value is stored
- ☐ Unit rating of displayed value
- ☐ The display flashes to indicate a fault on the drive

#### 2 Display of drive status:

- ☐ RUN: Run command is active or speed reference present
- ☐ PRG: Drive in automatic mode
- ☐ MON: Drive in monitoring mode
- ☐ Loc: Drive in local mode

#### 3 Use of keys:

- ☐ Loc/Rem: Switching of the drive command, locally or remotely. As a "local" command, the speed reference can be modified using the  $\wedge$  and  $\vee$  keys; the LED located between these keys lights up.
- ☐  $\wedge$  and  $\vee$ : Vertical navigation in the menu, editing of values or speed reference depending on the mode selected
- ☐ MODE: Selection of one of the following modes:
  - Default display mode
  - Adjustment mode
  - Status monitoring mode
- ☐ RUN: Local motor run command; LED indicates that the RUN key is active
- ☐ STOP: Local control of motor stopping/drive fault clearing
- ☐ ENT: Saves the current value or the selected function

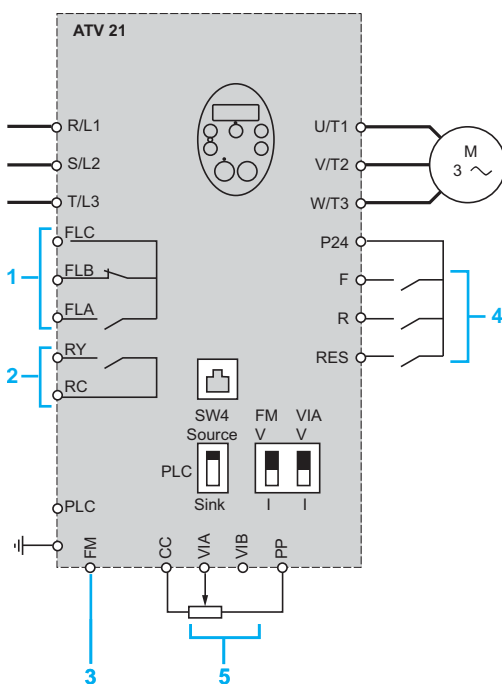
### Remote display terminal

A remote display terminal is available as an option. It can be mounted on an enclosure door and allows access to the same functions as the integrated 7-segment terminal.

It is also possible to download and store 3 configuration files using its "COPY MODE" (see page 60314/3).

# Variable speed drives for asynchronous motors

## Altivar 21



Factory-set configuration

### Simplified start-up

#### Fan and centrifugal pump

The Altivar 21 drive is factory-configured to allow a simplified start-up, without the need for any adjustment.

The following conditions must be met to be able to use this simplified start-up function:

- The drive load must be a fan or a centrifugal pump
- The motor rating must match the drive rating
- Connection must be according to the diagram opposite:
  - 1 FLA, FLB and FLC for the fault relay
  - 2 RY and RC for the low speed reached relay
  - 3 FM for the analog output
  - 4 F, R and RES for the logic inputs:
    - F for forward operation
    - R for preset speed
    - RES for fault reset
  - 5 VIA and VIB for the analog inputs:
    - VIA for the speed reference 0...10 V
    - VIB is not assigned

### Quick Menu

The Quick Menu is used to:

- Access the essential parameters of your application quickly
- Enter the motor rating plate data (nominal voltage, nominal frequency, thermal current, etc.), so that the motor parameters can be adjusted quickly, thereby benefiting from optimum motor performance
- Protect the motor by setting the drive's integrated electronic thermal overload relay

Parameters which can be accessed in the Quick Menu (AUF):

Parameter	Description
AU1	Automatic acceleration/deceleration
ACC	Acceleration
dEC	Deceleration
LL	Low speed
UL	High speed
tHr	Motor thermal current
FM	Analog output
Pt	U/F Profile
uL	Nominal motor frequency
uLu	Nominal motor voltage

# Variable speed drives for asynchronous motors

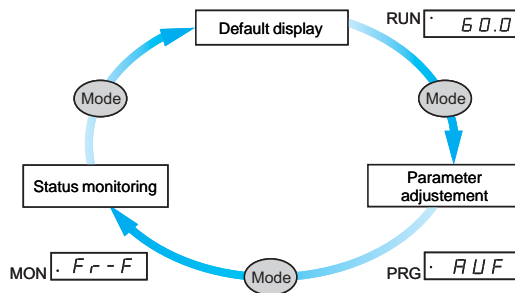
## Altivar 21

### Operating modes

The Altivar 21 drive has the following operating modes:

- Default display mode
- Parameter adjustment mode
- Status monitoring mode

It is easy to switch between these different modes simply by using the "MODE" key:



### Default display mode

This mode is automatically activated on power-up.

It is used to display a drive variable (current, speed, etc.), alarms and faults.

### Parameter adjustment mode

This mode provides a simple start-up function for the drive via direct access to the standard parameters:

- Acceleration
- Deceleration
- Macro-configuration
- Control mode
- Motor rating plate
- Etc.

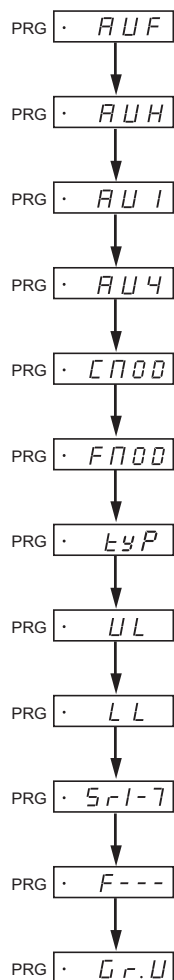
The standard parameters are identified by an alphanumeric code (ACC, dEC, etc.)

This mode also provides access to the advanced parameters required for setting up and optimizing advanced functions.

These parameters are identified by a numerical code (F100 to F900).

### Status monitoring mode

This mode is used to display all the drive variables, such as the I/O state, most recent faults, etc.



Main menus of the integrated 7-segment display terminal

### Programming

The main menus accessible from the integrated 7 segments terminal are described in the table below:

Menu type	Function
AUF	Accessing the Quick Menu
AUH	Accessing the most recently modified parameters
AU1	Selecting the ramp type (fixed or automatically adapted)
AU4	Selecting the macro-configurations
CMOD	Selecting the command channel
FMOD	Selecting the reference channel
tyP	Selecting the factory settings or the customer configuration
UL	Setting high speed
LL	Setting low speed
Sr1-7	Accessing preset speeds
F---	Accessing advanced parameters
Gr.U	Accessing parameters that are different to the factory settings

# Variable speed drives for asynchronous motors

## Altivar 21

### Maintenance, diagnostics

New functions have been added to the Altivar 21 drive to enable it to provide quick and simple maintenance, ultimately boosting productivity:

#### ■ Response to faults or alarms

It is possible to use the alarm management or drive operation configuration functions to take corrective measures before stopping the machine.

#### ■ Fault log

When a fault occurs, values such as speed, current, thermal state and timer are saved and restored in the fault log.  
The last 4 faults are stored.

#### ■ Identification of the software version

It is possible to display the relevant serial numbers and software versions, thereby helping to manage the equipment base.

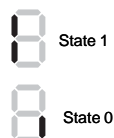
#### ■ Test functions

The Altivar 21 drive includes the following test functions:

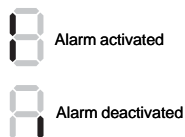
- Identifying any motor short-circuit before start-up
- Running, via the 7-segment display terminal, the remote display terminal or the PC software, automatic procedures during maintenance operations aimed at testing:
  - the motor
  - the drive power components



Example of the I/O state display



Example of alarms display



#### ■ Display of the I/O states

It is possible to display the activation or deactivation state of each input/output.

- 1 VIA: State 1
- 2 RES: State 1
- 3 R: State 0
- 4 F: State 1

#### ■ Displaying equipment maintenance alarms

Three alarms show if it is necessary to replace the drive or some of its components.

The drive automatically calculates their service lives by configuring their average annual operating temperature.

- 1 Drive: Alarm deactivated
- 2 Capacitor: Alarm deactivated
- 3 Fan: Alarm activated

### Controlling the drive via its I/O

Control signals are transmitted via cable to the I/O. Functions are assigned to logic inputs, analog inputs, etc.

A logic input can be assigned to more than one function. This means that two functions can be controlled using a single signal, thereby limiting the number of inputs required.

The Altivar 21 drive I/O can be configured independently from each other. For instance:

- A time delay can be applied when it comes to reading the logic inputs, so as to avoid any bounce-back from certain switches.
- Transforming incoming signals on the analog inputs can help the drive fully adapt to the control devices and applications:
  - Minimum and maximum values for the input signal
  - Input filtering in order to eliminate unwanted interference from the signals received
  - Magnifying glass effect through delinearizing the input signal in order to increase the precision with small amplitude signals
  - "Pedestal" and "Deadband" functions for signals in order to prevent low speed operations which can have an adverse effect on the application
- Transforming analog outputs which transfer information sent by the drive to other devices (display units, drives, PLCs, etc.):
  - voltage or current output signal
  - minimum and maximum values for the output signal
  - output signal filtering

Logic outputs can be delayed on activation and deactivation. The output state can also be configured when the signal is active.

### Functions designed specifically for pumping and ventilation applications

#### ■ Motor control profiles

##### □ Energy saving ratio

This type of command makes it possible to optimize the energy consumed based on the load applied to the machine.

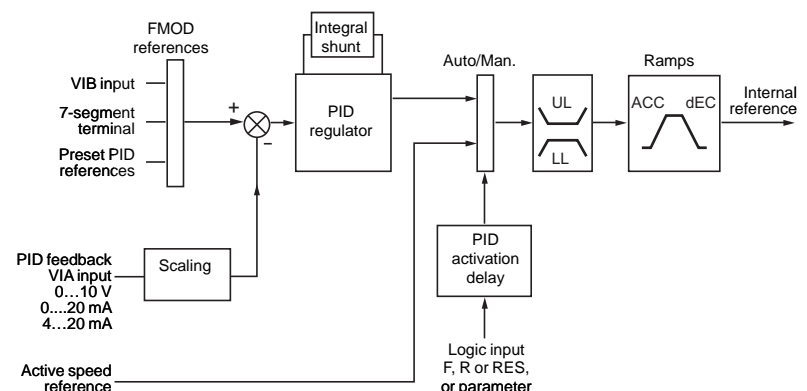
##### □ Quadratic ratio ( $Kn^2$ )

This type of command is optimized for centrifugal pumps and fans.

#### ■ PID regulator

This can be used to regulate a process with a reference and feedback given by a sensor.

Function suitable for regulation in buildings.

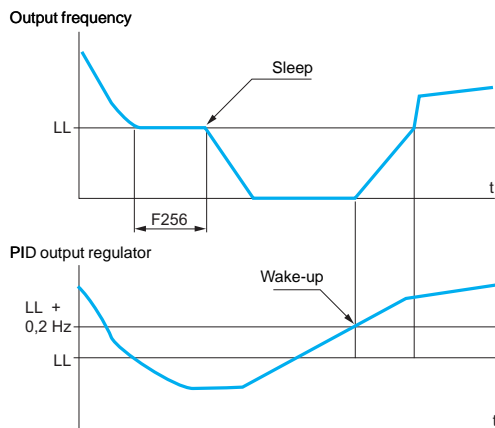


ACC: Acceleration, dEC: Deceleration, LL: Low speed, UL: High speed.

##### □ Preset PID references

2 to 7 PID references are available.





LL: Low speed

Example of the "sleep/wake-up" function in operation

## ■ PID regulator (continued)

### □ PID feedback

PID feedback can be assigned to the VIA analog input. It can also be transmitted by a communication network (network AI).

The following 4 functions can be used in combination with the PID regulator:

### □ PID feedback supervision

### □ Sleep/Wake-up

This function supplements the PID regulator, in order to avoid prolonged operation at excessively low speeds when neither useful nor desirable.

It stops the motor after a period of operation at reduced speed. This duration (parameter F256) and speed (parameter LL) can be adjusted.

It restarts the motor if the PID error or feedback exceeds an adjustable threshold (parameter LL + 0.2 Hz).

### □ Alarms

Minimum and maximum PID regulator feedback monitoring thresholds and PID regulator error monitoring threshold.

### □ Auto/Man.

This can be used to switch from speed regulation mode (Man.) to PID regulation mode (Auto). A logic input or command word bit is used for switching.

### Speed regulation mode (Man.)

The manual reference is transmitted via the terminals (analog inputs, preset speeds, etc.).

With manual switching, the speed reference changes according to the ACC and DEC ramp times.

### PID regulation mode (Auto)

In automatic mode it is possible to:

- Adapt the references and feedback to the process (transformation)
- Adjust the proportional, integral and derivative gains
- Shunt the integral
- Use the "alarm" on the logic output or display it on the 7-segment display terminal or the remote display terminal, if the threshold is exceeded (Max. feedback, Min. feedback and PID error)
- Display the PID reference, PID feedback, PID error and PID output on the display terminal and assign them to an analog output
- Apply a ramp to the PID output

The motor speed is limited to low speed (LL) and high speed (UL).

## ■ Forced operation

Combined with the function of inhibiting all faults, this function makes it possible to force the running order in a particular direction and the reference to a configured value.

# Variable speed drives for asynchronous motors

## Altivar 21

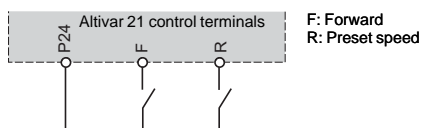
### Other application functions

#### ■ 2-wire control

This function is used to control the direction of operation by means of a stay-put contact.

It is enabled by means of 1 or 2 logic inputs (non-reversing and preset speed).

This function is suitable for all non-reversing applications, by detection of the logic input state.

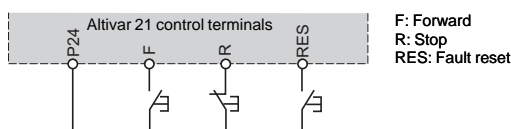


Wiring diagram for 2-wire control

#### ■ 3-wire control

This function is used to control the operating and stopping direction by means of pulsed contacts. It is enabled by means of 2 or 3 logic inputs.

This function is suitable for all non-reversing applications and stopping.

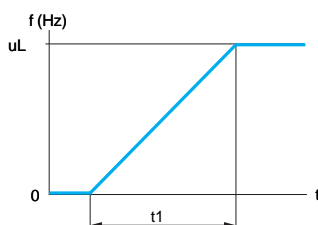


Wiring diagram for 3-wire control

#### ■ Ramps

##### □ Acceleration and deceleration ramp times

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



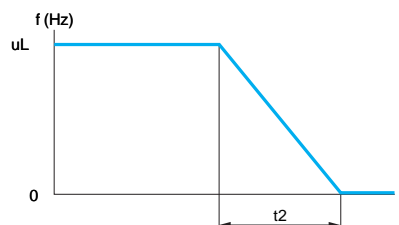
Linear acceleration ramp

uL: Nominal motor frequency

t1: Acceleration time

t2: Deceleration time

t1 and t2 can be set independently from 0.01 to 3200 s (according to one of the following ramp increments: 0.01 s, 0.1 s or 1 s);  
Factory setting: 10 s.



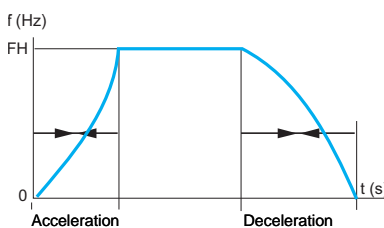
Linear deceleration ramp

##### □ Automatic adaptation of acceleration and deceleration ramps

This function can be used to adapt the acceleration and deceleration ramps automatically based on the load.

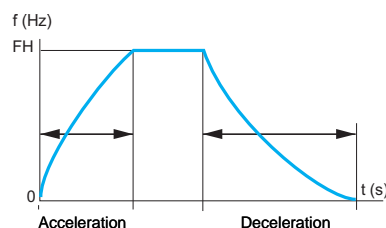
The acceleration and deceleration times are reduced for low loads and increased for high loads.

#### Low load



FH: Maximum output frequency

#### High load



FH: Maximum output frequency

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Ramps (continued)

#### □ Ramp switching

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

Ramp switching can be enabled by:

- a logic input
- a frequency threshold
- a command word bit

This function is suitable for all machines with fast steady state speed correction.

### ■ Preset speeds

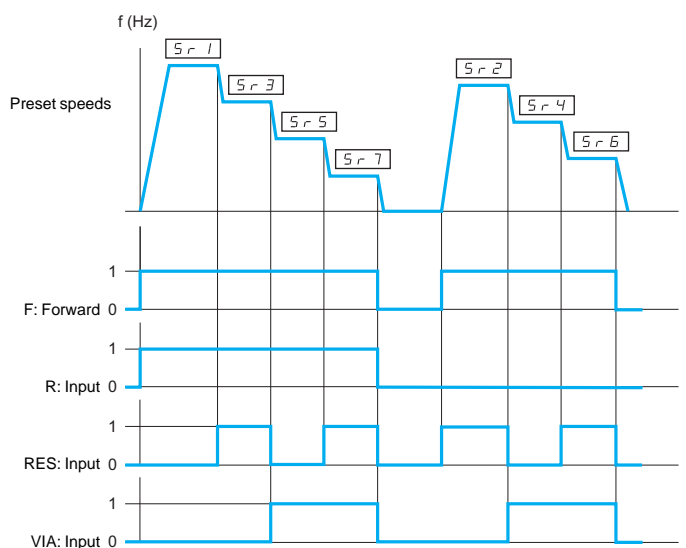
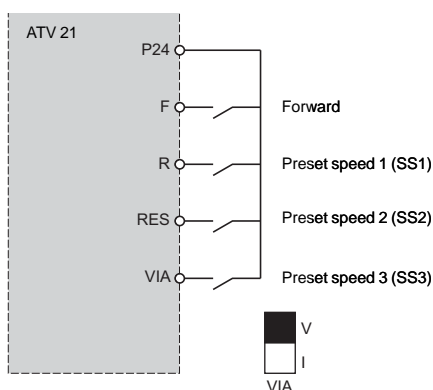
This can be used to switch preset speed references.

Choice of seven preset speeds.

Enabled by logic inputs, R and RES, and by VIA configured as a logic input.

The preset speeds are adjustable in increments of 0.1 Hz, from low speed to high speed.

This function is suitable for machines with several operating speeds.



Example of operation with 7 preset speeds

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Limiting low speed operating time

The motor is stopped automatically after a period of operation at low speed (LL) with a zero reference and a run command present.

This time can be set between 0.1 and 600 seconds (0 corresponds to an unlimited time). Factory setting 0 s. The motor restarts automatically on the ramp when the reference reappears or if the run command is interrupted and then re-established.

Function suitable for automatic Stops/Starts.

### ■ Motor control types

#### □ Sensorless flux vector control

This control type can be used with a single motor or motors connected in parallel.

#### □ 2-point vector control

The zone for operating at constant power can be optimized by defining an additional point in the control profile.

This function should be used with motors offering a two-part defluxing zone.

It can be used to limit the voltage at the motor terminals when the motor is being powered by a high line supply.

#### □ Voltage/frequency ratio

This control type is particularly suitable for special motors (high-speed motors, synchronized asynchronous motors, etc.). The ratio can be adjusted by 2 points and used to achieve output frequencies of up to 200 Hz.

#### □ Synchronous motor

This control type is exclusively reserved for controlling open loop synchronous permanent magnet motors with sinusoidal electromotive force (EMF).

### ■ Auto-tuning

Auto-tuning can be performed:

- Using a dialogue tool (integrated 7-segment display terminal, remote display terminal or PC software)
- Via a communication network

### ■ Switching frequency, noise reduction

The switching frequency setting permits a reduction in the noise generated by the motor for any application requiring a low level of noise.

The switching frequency is modulated randomly in order to avoid resonance. This function can be disabled if it causes instability.

Switching the intermediate DC voltage at high frequency is useful for supplying the motor with a current wave having little harmonic distortion.

The switching frequency is adjustable during operation to reduce the noise generated by the motor.

Value: 6 to 16 kHz

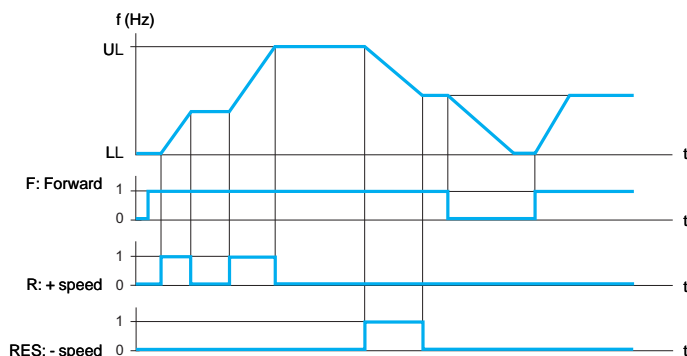
# Variable speed drives for asynchronous motors

## Altivar 21

### ■ +/- speed

Used to increase or decrease a speed reference by means of 1 or 2 logic inputs, with or without the last reference being saved (motorized potentiometer function). This function is suitable for centralized control of a machine with several sections operating in one direction.

Two logic inputs are required in addition to the operating direction for +/- speed control.



LL: Low speed, UL: High speed

### □ Reference saving

This function is associated with +/- speed control.

This can be used for reading and saving the last speed reference prior to the loss of the run command or line supply. The saved reference is applied at the next run command.

### ■ 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, provided the run command is still present:

- ☐ loss of line supply or power off
- ☐ fault reset or automatic restart
- ☐ freewheel stop

On disappearance of the event, the effective speed of the motor is detected in order to restart on a ramp at this speed and return to the speed reference. The speed detection time can reach 0.5 s.

This function is suitable for machines which exhibit low motor speed loss during a power failure (high-inertia machines such as centrifuges, etc.).

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Undervoltage management

Depending on the application, it is possible to configure the Altivar 21's response to undervoltages or power failures.

If the drive locks as a result, management of the fault relay can be configured (open or not). If the fault relay does not open an alarm is shown.

The Altivar 21 drive can also be configured to prevent the drive locking (using an alarm):

- Controlled stop according to the type of stop configured
- Deceleration based on a ramp which it automatically adapts to maintain the DC bus voltage, thereby preventing the drive from locking in fault mode
- Instant IGBT (inverter bridge) loss followed by power supplied to the motor as soon as the line voltage has reappeared. This function can be used to prevent the Altivar 21 drive being reinitialized.

### ■ Switching of 2 motor ratings

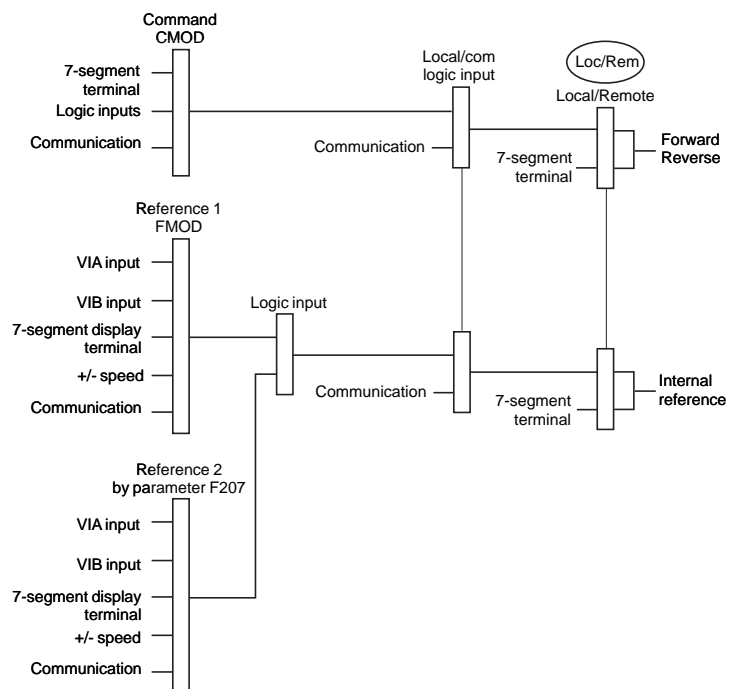
This function is used to switch two sets of 10 motor parameters:

- All or some of the motor parameters can be switched on stopping
- Some of these parameters can be switched during operation

A logic input or command word bit is used to switch the sets.

### Command and reference switching via logic input

This function is used to switch commands (terminal, logic inputs) and references (speed, PID, etc.) via a logic input.



Example of command and reference switching

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Current limit

A second current limit can be configured up to 1.1 times the drive nominal current and it can be used to limit the rise in motor temperature and the torque.

Switching between the two current limits can be enabled via:

- ☐ a logic input
- ☐ a command word bit

### ■ Stop types

#### ☐ Freewheel stop

This function stops the motor by resistive torque if the motor power supply is cut.

A freewheel stop is achieved:

- by configuring a normal stop command as a freewheel stop (on disappearance of a run command or appearance of a stop command)
- by enabling a logic input
- by activating a command word bit

#### ☐ Stop on ramp

This stops the motor according to the deceleration ramp

A stop on ramp is achieved:

- by enabling a logic input
- by activating a command word bit

#### ☐ DC injection stop

This can be used to brake high-inertia machines at low speed or maintain torque on stopping.

A DC injection stop is achieved:

- by configuring a normal stop as a DC injection stop (on disappearance of a run command or appearance of a stop command)
- by enabling a logic input
- by activating a command word bit

The DC value and the standstill braking time are adjustable.

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Motor thermal protection

Motor thermal protection is provided by the drive:

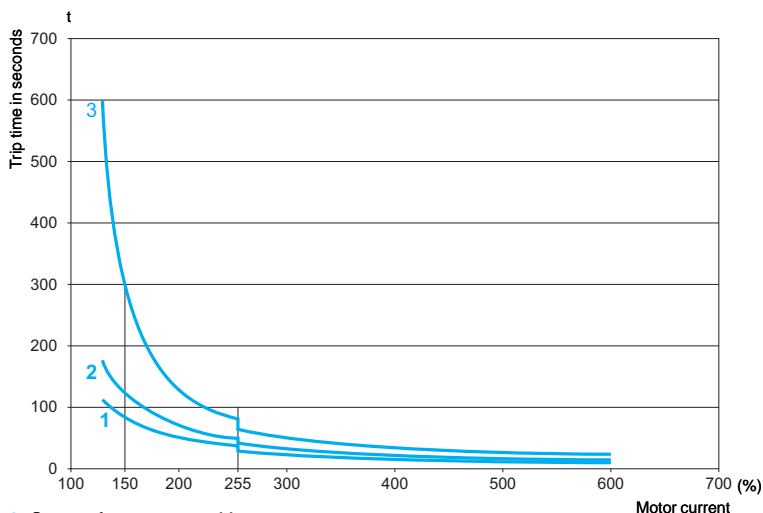
- ☐ directly, through PTC probes located in the motor windings
- ☐ indirectly, via the integrated thermal relay. Indirect thermal protection is implemented via continuous calculation of its theoretical temperature rise.

The microprocessor calculates the theoretical temperature rise of the motor based on various elements:

- ☐ the operating frequency
- ☐ the current taken by the motor
- ☐ the operating time
- ☐ the maximum ambient temperature around the motor (40°C)
- ☐ the type of motor ventilation (self-cooled or force-cooled)

Thermal protection is adjustable from 0.5 to 1.1 times the nominal current, depending on the drive type. It must be adjusted to the nominal current indicated on the motor rating plate.

**Note:** The motor thermal state memory returns to zero when the drive control part is switched off.



- 1 Output frequency: 1 Hz
- 2 Output frequency: 10 Hz
- 3 Output frequency: 30 Hz and above

#### Motor thermal protection curves

- ☐ Self-cooled motors:

The tripping curves vary with the motor frequency.

- ☐ Force-cooled motors:

Only the 30 Hz and higher tripping curve should be considered, whatever the motor frequency.



# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Drive thermal protection

The drive thermal protection is provided by a PTC probe mounted on the heatsink or integrated with the power module.

### ■ IGBT thermal protection

The drive manages the switching frequency intelligently according to the IGBT temperature.

If the drive's current rating is exceeded (e.g.: current higher than the nominal drive current for a zero stator frequency), an alarm is displayed and a timer increases for as long the alarm is present.

### ■ Machine protection

This is used to detect under- and/or overload.

### ■ Configuring the drive's fault response (fault management)

Different responses can be configured for the drive in the event of a resettable fault occurring:

- ☐ freewheel stop
- ☐ drive switches to the fallback speed
- ☐ drive maintains the speed at which it was operating when the fault occurred until the fault disappears
- ☐ stop on ramp
- ☐ DC injection stop
- ☐ no stop (alarm activated)

### List of resettable faults:

- ☐ PTC probe
- ☐ drive overheating
- ☐ motor overload if the thermal state is less than 100%
- ☐ line overvoltage
- ☐ current limit
- ☐ IGBT overheating
- ☐ communication faults (Modbus and other communication networks)

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ Resetting resettable faults

This can be used to remove the last fault using a logic input, command word bit or the STOP/RESET key on the display terminal.

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

List of resettable faults, see "Configuring the drive's fault response" page 60324/18. Line supply undervoltage and input phase loss faults are reset automatically when the line supply is restored.

Function suitable for applications where drives are difficult to access, such as when a drive is placed on a moving part.

### ■ General reset (inhibits all faults)

This function inhibits all faults, including thermal protection (forced operation), which can destroy the drive.

This function is suitable for applications where restarting is vital (smoke extraction system, machines with hardening products that need to be removed).

The function is enabled by a logic input.

Fault monitoring is active if the logic input is at state 1.

All faults are reset on a change of state  $\updownarrow$  of the logic input.

**Note:** Use of this function invalidates the guarantee.

### ■ 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 that 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, 2, 3 s, then 10 s, up to the 10<sup>th</sup> attempt.

If the drive has not restarted after the configured time, it will lock and the procedure is abandoned until it has been powered off and on again.

The faults which permit this type of restart are:

- ☐ line overvoltage
- ☐ motor thermal overload
- ☐ drive thermal overload
- ☐ DC bus overvoltage
- ☐ PTC probe
- ☐ current limit
- ☐ line voltage too low. For this fault, the function is always active, even if it is not configured.
- ☐ PI supervision,
- ☐ fault caused by Modbus or other communication networks. These faults are reset automatically as soon as the command word or frequency reference is sent to the drive.

For these types of fault, the relay configured as a fault relay remains activated if the function is configured. The speed reference and direction of operation must be maintained for this function.

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.

# Variable speed drives for asynchronous motors

## Altivar 21

### ■ PTC probe protection

The probes can be connected directly to the drive control card or to the communication cards.

The way in which a temperature fault is recorded by the drive can be configured by default or as an alarm.

### ■ IGBT testing

When enabled, this function tests every IGBT and the motor connections in order to detect a short-circuit or an open circuit. This test is run every time the drive is powered on and before each motor start.

### ■ Resetting operating time to zero

The drive operating and power-up time can be reset.

### ■ External fault

This function can lead to the drive locking if a fault occurs in the machine. This fault is flagged on the drive display unit. The fault is flagged if the signal is at 1 or at 0, according to the function configuration.

### ■ Forced local mode

Forced local mode imposes control via the logic input and prohibits all other control modes.

Switching to forced local mode may be activated via:

- ☐ a logic input
- ☐ a function key on the display terminal

The following references and commands are available for forced local mode:

- ☐ references VIA, VIB, and command via logic inputs
- ☐ reference and command via the display terminal

## Function compatibility table

### ■ Configurable I/O

The table below lists the incompatibilities between the functions and shows the priority functions.

Stop functions have priority over run commands.

The selection of functions is limited:

- by the number of drive I/O which can be reassigned
- by the incompatibility of certain functions with one another

Functions	PID regulator	Preset speeds	+/- speed	Freewheel stop	DC injection stop	Forced operation
PID regulator			⊖			→
Preset speeds			⊖			→
+/- speed	⊖	⊖				⊖
Freewheel stop					←	→
DC injection stop				↑		⊖
Forced operation	↓	↓	⊖	↓	⊖	

⊖ Incompatible functions

Compatible functions

Not applicable

### Priority functions (functions which cannot be active at the same time)

← The arrow indicates which function has priority.  
For example, the Freewheel stop function has priority over the DC injection stop function.