

Telemecanique Altivar 28, *take* the plunge with *confidence*

Catalogue
February

2000



Single-phase and three-phase variable speed controller 0.37 to 15 kW, up to 500 V.

Merlin Gerin

Modicon

Square D

Telemecanique

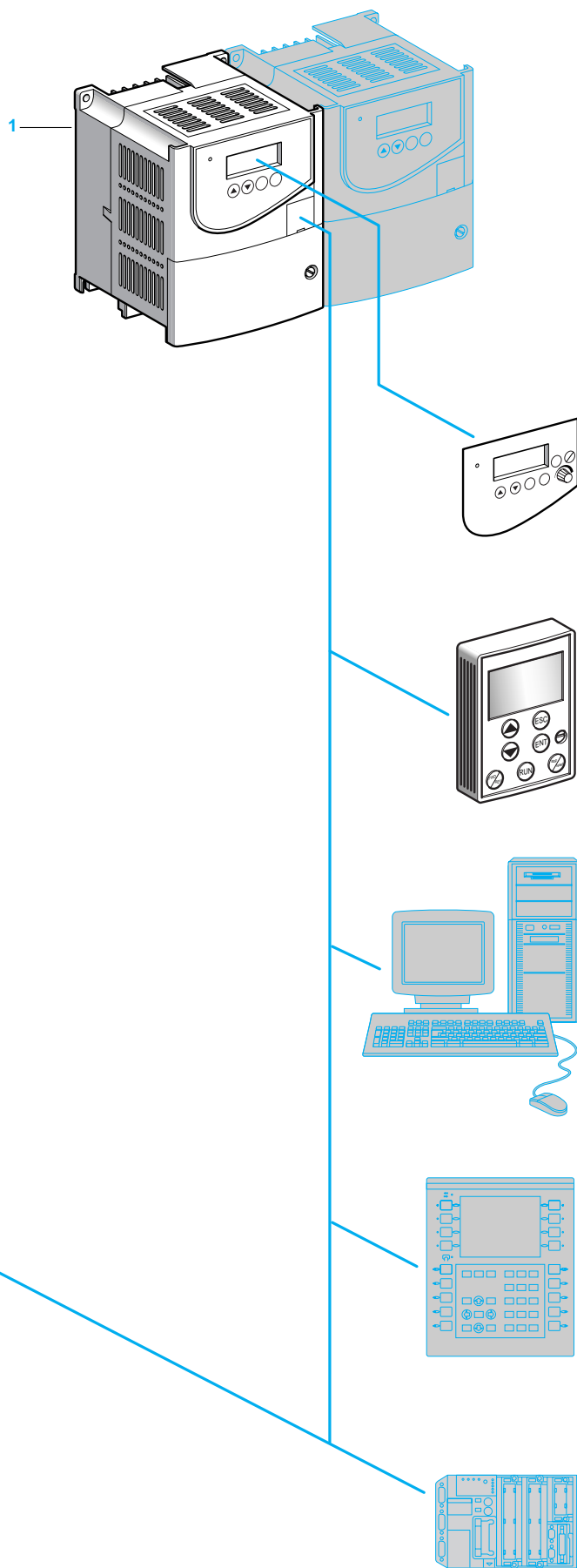
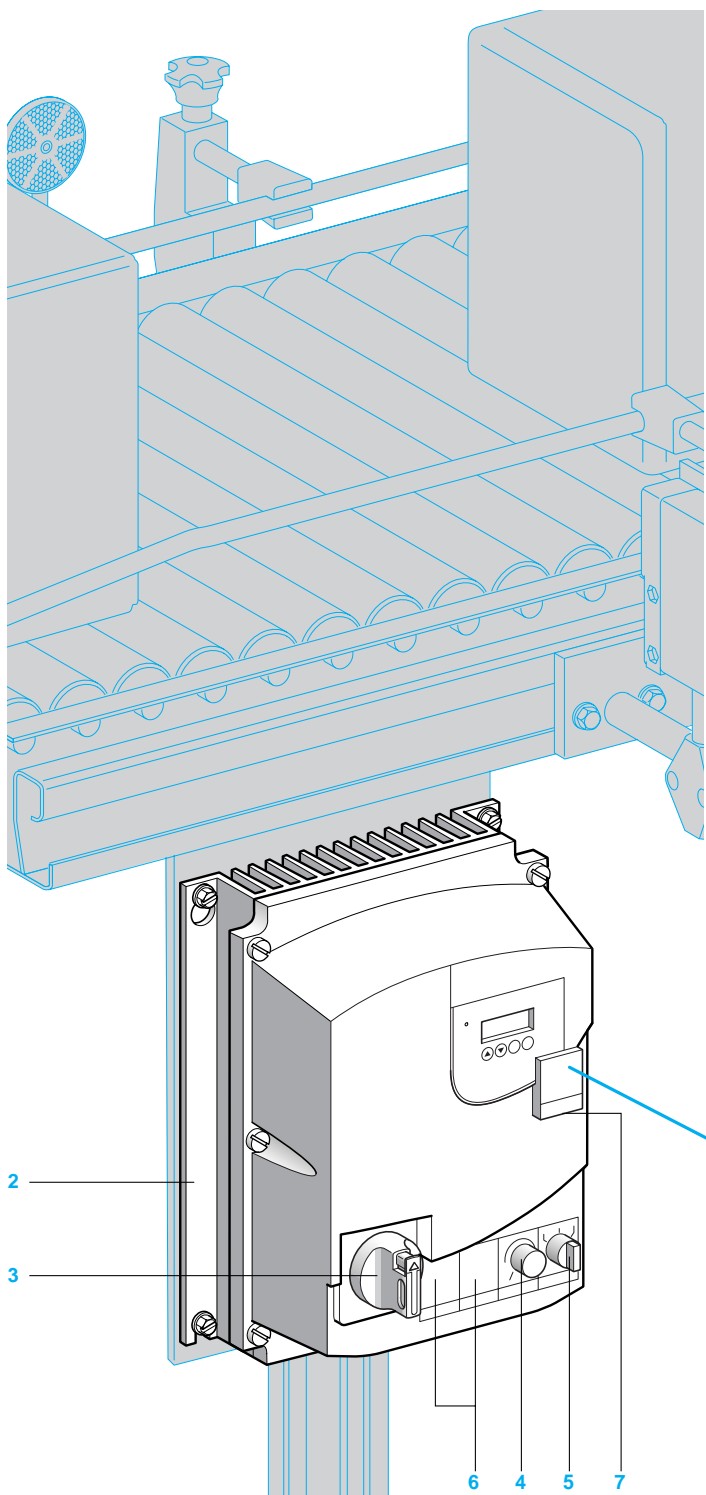
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Variable speed controllers for asynchronous motors

Altivar 28

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Presentation

Applications

A frequency inverter for 3-phase asynchronous squirrel cage motors, the Altivar 28 incorporates the latest technological developments. The Altivar 28 is robust, compact and conforms to international standards. Created from experience over several generations of speed controllers, its functions meet the requirements of the most up-to-date applications, notably : ventilation/air conditioning, pumps and compressors, horizontal material handling, packing/packageing. The increased performance in control algorithms has led to enhanced robustness, safety and ease of installation.

Factory preset values / extension of functions

The speed controller is supplied ready for use for the majority of applications. Its algorithms for flux vector control and autotuning ensure optimum operation on standard motors worldwide. Comprising an integrated adjustment terminal (4 character "7-segment" display, and 4 buttons) which can be used to customise your application by modifying the settings and extending the functions. Return to the factory preset values always remains an easy choice.

Functions

The main functions are :

- starting and speed control, dynamic braking and braking to standstill
- energy saving
- PI regulator (flow rate, pressure etc.)
- protection of motor and speed controller
- preset speeds, jog operation, 2/3-wire control
- ramp and reference switching
- automatic catching a spinning load with speed search (flying restart)
- automatic limiting of operating time at low speed
- display of speed in customer units, etc

Standard versions


- ATV-28H speed controller **1** : for normal environments, such as mounting in an enclosure. This speed controller is very compact, and several can be mounted side-by-side saving a considerable amount of space.
- ATV-28E ready-assembled speed controller **2** : This IP 55 dust and damp-proof enclosure is equipped with an ATV-28 speed controller, a Vario switch disconnecter with external padlockable control **3**, a potentiometer **4** for speed control, a 3 position selector switch **5** (Stop and 2 operating directions), two free slots **6** for any additional control or signalling units, and a cover **7** for access to the RS 485 serial link. The lower part of the enclosure can be fitted with cable glands for cable access. The display panel and adjustment and configuration buttons located on the front panel of the enclosure can be accessed directly. This enclosure, wired and ready-to-use, can be installed next to the motor.

Options

Options common to ATV-28H speed controllers and ATV-28E ready-assembled speed controllers

- Motor starter software workshop and PC connection kit :
 - preparation in the design office without the need to connect the Altivar
 - backup on floppy disk or hard disk
 - downloading to the speed controller
 - printout
- The RS 485 connection kit is a wiring kit for RS 485 multipoint serial link connection of the speed controller to PLCs and operator dialogue terminals.
- The remote display module option is presented in the form of a box with a cable fitted with a socket for connection to the speed controller serial link. This module can be mounted on the door of the wall-fixing or floor-standing enclosure and enables the speed controller to be controlled or programmed remotely.
- Braking resistors and line chokes
- Radio interference filters for long cables

Options specific to ATV-28H speed controllers

- The local control option, with its potentiometer and 2 buttons can be used to control the motor from the speed controller
- Kit for IP43 mounting in wall-fixing or floor-standing enclosure
- Plate for mounting on  rail
- Kit for UL NEMA type 1 conformity

Electromagnetic compatibility (EMC)

The speed controller has built-in filters.

The incorporation of filters in the speed controllers simplifies installation and reduces the cost of conformity for CE marking. They conform to the following standards :

EN 61800-3/IEC 1800-3, domestic and industrial environments

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Characteristics

Environment

Conformity to standards			<p>Altivar 28 speed controllers have been designed to conform to the strictest national and international standards and the recommendations for electrical industrial control devices (IEC, EN, NFC, VDE), notably :</p> <ul style="list-style-type: none">● Low Voltage EN 50178● EMC immunity :<ul style="list-style-type: none">- IEC 1000-4-2/EN 61000-4-2 level 3- IEC 1000-4-3/EN 61000-4-3 level 3- IEC 1000-4-4/EN 61000-4-4 level 4- IEC 1000-4-5/EN 61000-4-5 level 3- IEC 1800-3/EN 61800-3, environments 1 and 2● EMC, conducted and radiated emissions :<ul style="list-style-type: none">- IEC 1800-3/EN 61800-3, environments 1 public sector and 2 industrial sector under restricted distribution- EN 55011 class A (radio interference filters included)- EN 55022 class B, with additional filters
CE marking			<p>The speed controllers have been designed to comply with the European low voltage (73/23/EEC and 93/68/EEC) and EMC (89/336/EEC) directives. For this reason, Altivar 28 speed controllers are marked with the CE European Community mark.</p>
Product certification			UL and CSA
Degree of protection			<p>ATV-28H speed controllers : IP 21 and IP 41 on upper part IP 20 without blanking plate fitted on the top of the cover</p> <p>ATV-28E speed controllers (ready-assembled) : IP 55</p>
Vibration resistance conforming to IEC 68-2-6			1.5 mm peak from 3 to 13 Hz 1 gn peak from 13 to 150 Hz
Shock resistance conforming to IEC 68-2-27			15 gn for 11 ms
Maximum ambient pollution			Degree 2 conforming to IEC 664
Maximum relative humidity			93 % with no condensation or dripping water
Ambient air temperature around the device conforming to EN 50178	Storage	°C	ATV-28H and ATV-28E speed controllers (ready-assembled) : - 25...+ 65
	Operation	°C	<p>ATV-28H speed controllers :</p> <ul style="list-style-type: none">- 10...+ 40 without derating, with blanking plate- 10...+ 50 without derating, without blanking plate- 10...+ 60 with derating, without blanking plate (see mounting and installation recommendations) <p>ATV-28E speed controllers (ready-assembled) :</p> <ul style="list-style-type: none">- 10...+ 40
Maximum operating altitude		m	1000 without derating. Above 1000 m, derate the current by 1% for each additional 100 m
Operating position			Vertical

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Characteristics (continued)

Drive characteristics

Output frequency range	0.5 ... 400 Hz
Maximum transient current	150 % of nominal speed controller current, for 60 seconds (typical value)
Transient overtorque	150...170 % of nominal motor torque (typical value)
Braking torque	30 % of nominal motor torque without braking resistor (typical value). Up to 150 % with braking resistor as an option
Voltage/frequency ratio	Preset in the factory for most constant torque applications with sensorless flux vector control. Correction possible : specific ratios for pumps and fans, energy saving, constant torque U/f for special motors
Frequency loop gain	Preset in the factory. Correction possible for machines with high resistive torque or high inertia, or for machines with short cycles
Slip compensation	Automatic regardless of the load Elimination (or adjustment) possible
Switching frequency	Can be adjusted during operation from 2 to 15 kHz

Electrical characteristics

Power supply	Voltage	200 V - 15 % to 240 V + 10 % single phase 200 V - 15 % to 230 V + 10 % 3-phase 380 V - 15 % to 500 V + 10 % 3-phase
	Frequency	50/60 Hz \pm 5 %
Output voltage		Maximum voltage equal to mains voltage
Available internal supplies		1 + 10 V - 0 % + 8 % supply for the reference potentiometer (1 k Ω to 10 k Ω), maximum current 10 mA 1 + 24 V supply for control inputs, maximum current 100 mA
Configurable analogue inputs AI		1 analogue voltage input 0 + 10 V, impedance 30 k Ω : AI1 1 analogue voltage input 0 + 10 V, impedance 30 k Ω : AI2 1 analogue current input X-Y mA (X and Y programmable from 0 to 20), impedance 450 Ω : AIC AI2 and AIC cannot be used at the same time
Configurable analogue outputs AO		1 analogue current output 0-20 mA or 4-20 mA, max. load impedance 800 Ω
Frequency resolution		Display units : 0.1 Hz Analogue inputs : 0.1 Hz for 100 Hz maximum
Time constant when changing setpoint		4 ms

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Characteristics (continued)

Electrical characteristics (continued)

Configurable logic inputs LI	4 logic inputs with impedance of 3.5 k Ω , isolated + 24 V power supply (maximum 30 V), state 0 if < 5 V, state 1 if > 11 V
Configurable relay output R2	1 C/O contact Minimum switching capacity : 10 mA for \sim 5 V Maximum switching capacity : on inductive load : 1.5 A for \sim 250 V (cos ϕ = 0.4) and \sim 30 V (L/R = 7 ms)
Acceleration and deceleration ramps	Linear ramps which can be adjusted separately from 0.05 to 3,600 s Automatic adaptation of ramp times if the torque capacity is exceeded Option to cancel deceleration ramp adaptation
Braking to standstill	By d.c. injection : - by a command on an assignable logic input - automatically for a time which can be set between 0 to 25 s, or continuously, as soon as the deceleration frequency drops below 0.5 Hz
Speed controller protection and safety features	Electrical isolation between power and control circuits (inputs, outputs, supplies) Protection against short-circuits : - of the internal supplies - between output phases - between output phases and earth Thermal protection against excessive overheating and overcurrents Mains undervoltage and overvoltage safety features Overvoltage during braking safety feature
Motor protection	Thermal protection integrated in the speed controller by calculation of I^2t Protection against loss of phase
Fault relay R1 (fault information output)	1 N/C contact and 1 N/O contact with common point Minimum switching capacity : 10 mA for \sim 5 V Maximum switching capacity : on inductive load : 1.5 A for \sim 250 V (cos ϕ = 0.4) and \sim 30 V (L/R = 7 ms)
Signalling	1 red LED on the front panel : - LED on = Altivar powered up Coded display via 4-character 7-segment display unit
Communication	RS 485 multidrop serial link, simplified Modbus protocol integrated in the speed controller, with RJ45 type connector. Transmission speed 9600 or 19200 bps, no parity. Maximum number of Altivar 28 which can be connected : 8 Use : - connection of a terminal (optional) or - connection of a microprocessor card or - connection of a PC (optional) or - connection of one or more PLCs

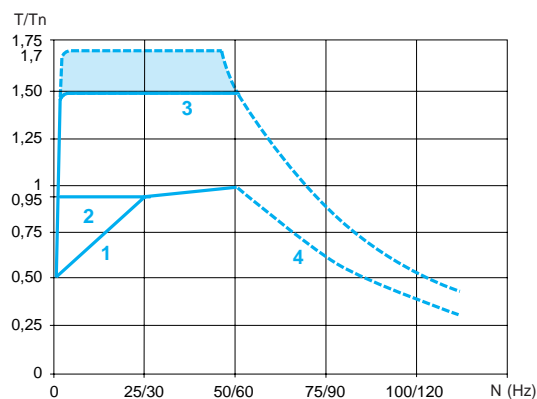
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Characteristics, special uses

Torque characteristics (typical graphs)

The graphs below define the continuous and transient overtorque available, either on a self-ventilated or force-ventilated motor. The only difference is in the ability of the motor to provide a high continuous torque at less than half the nominal speed.



- 1 Self-ventilated motor : continuous useful torque (1)
- 2 Force-ventilated motor : continuous useful torque
- 3 Transient overtorque 1.5 to 1.7 Tn
- 4 Torque in overspeed at constant power (2)

Special uses

Use with a motor with a power different to the speed controller rating

The device can supply any motor with a power less than that for which it is designed. For motor powers slightly greater than the speed controller rating, ensure that the current taken does not exceed the continuous output current of the controller.

Connecting motors in parallel

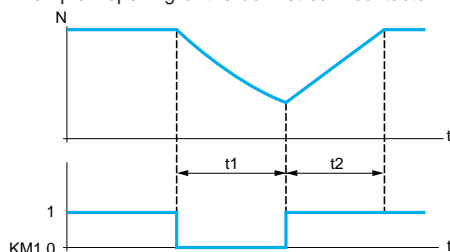
The speed controller rating must be greater than or equal to the sum of the currents of the motors to be connected to this speed controller.

In this case, external thermal protection must be provided for each motor by thermistors or thermal overload relays. If the number of motors connected in parallel is greater than or equal to 3, it is recommended that a 3-phase choke be installed between the controller and the motors.

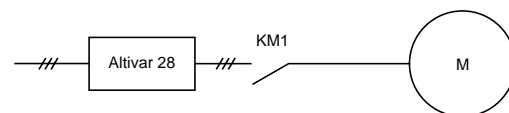
Switching the motor on the speed controller output

Switching is possible with the controller locked or unlocked. When switching on the fly (controller unlocked), the motor is controlled and accelerates smoothly to the reference speed according to the acceleration ramp. This use requires automatic catching a spinning load ("catch on the fly") to be configured and the "motor phase failure" protection to be disabled.

Example : opening of the downstream contactor



t1 : deceleration without ramp (freewheel)
t2 : acceleration with ramp



Typical applications : safety break on controller output, bypass function, switching of motors connected in parallel.

- (1) For powers ≤ 250 W, derating is less (20 % instead of 50 % at very low frequency).
 - (2) The nominal frequency of the motor and the maximum output frequency can be adjusted from 40 to 400 Hz.
- Caution:** check with the manufacturer for the mechanical overspeed capabilities of the selected motor.

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for asynchronous motors from 0.37 to 15 kW or 0.5 to 20 HP

References



ATV-28HU09M2

Speed controllers with frequency range from 0.5 to 400 Hz

Motor Power indicated on rating plate (1)	Line supply current (2) at U1 at U2	Altivar 28		Max. transient current (3)	Power dissipated at nominal load	Reference	Weight
		Max. prospective line Isc	Nominal current				
kW Hp	A A	kA	A	A	W		kg

Single-phase supply voltage : 200...240 V (4) 50/60 Hz

0.37 0.5	7.3 6.1	1	3.3	3.6	32	ATV-28HU09M2	1.800
0.75 1	9.8 8.2	1	4.8	6	45	ATV-28HU18M2	1.800
1.5 2	16 13.5	1	7.8	10.9	75	ATV-28HU29M2	2.500
2.2 3	22.1 18.6	1	11	15	107	ATV-28HU41M2	3.800

3-phase supply voltage: 200...230 V (4) 50/60 Hz

3 -	17.6 15.4	5	13.7	18.5	116	ATV-28HU54M2	3.800
4 5	21.9 19.1	5	17.5	24.6	160	ATV-28HU72M2	3.800
5.5 7.5	38 33.2	22	27.5	38	250	ATV-28HU90M2	6.100
7.5 10	43.5 36.6	22	33	49.5	343	ATV-28HD12M2	6.100

3-phase supply voltage : 380...500 V (4) 50/60 Hz

Motor Power indicated on rating plate (1)	Line supply current (2) at U1 at U2	Altivar 28		Max. transient current (3)	Power dissipated at nominal load	Reference	Weight
		Max. prospective line Isc	Nominal current at 380 V to 460 V				
kW Hp	A A	kA	A A	A	W		kg
0.75 1	3.9 3.5	5	2.3 2.1	3.5	33	ATV-28HU18N4	2.500
1.5 2	6.5 5.7	5	4.1 3.8	6.2	61	ATV-28HU29N4	2.500
2.2 3	8.4 7.5	5	5.5 5.1	8.3	81	ATV-28HU41N4	3.800
3 -	10.3 9.1	5	7.1 6.5	10.6	100	ATV-28HU54N4	3.800
4 5	13 11.8	5	9.5 8.7	14.3	131	ATV-28HU72N4	3.800
5.5 7.5	22.1 20.4	22	14.3 13.2	21.5	215	ATV-28HU90N4	6.100
7.5 10	25.8 23.7	22	17 15.6	25.5	281	ATV-28HD12N4	6.100
11 15	39.3 35.9	22	27.7 25.5	41.6	401	ATV-28HD16N4	9.600
15 20	45 40.8	22	33 30.4	49.5	543	ATV-28HD23N4	9.600

(1) These powers are given for a maximum switching frequency of 4 kHz, in continuous operation. The switching frequency can be adjusted from 2 to 15 kHz.

Above 4 kHz the nominal speed controller current should be derated and the nominal motor current should not exceed this value :

- up to 12 kHz, 10 % derating
- above 12 kHz, 20 % derating

(2) Typical value for a 4-pole motor and a maximum switching frequency of 4 kHz, without additional line choke

(3) For 60 seconds

(4) Nominal supply voltage min. U1, max. U2

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ready-assembled for asynchronous motors from 0.37 to 4 kW or 0.5 to 5 HP

References

Speed controllers with frequency range from 0.5 to 400 Hz



ATV-28EU09M2

Single-phase supply voltage 200...240 V (4) 50/60 Hz

Motor Power indicated on rating plate (1)	Line supply		Max. prospective line I _{sc}	Altivar 28		Max. transient current (3)	Reference	Weight
	at U1	at U2		Nominal current				
kW HP	A	A	kA	A		A		kg
0.37 0.5	7.3	6.1	1	3.3		3.6	ATV-28EU09M2	5.000
0.75 1	9.8	8.2	1	4.8		6	ATV-28EU18M2	5.000
1.5 2	16	13.5	1	7.8		10.9	ATV-28EU29M2	6.500
2.2 3	22.1	18.6	1	11		15	ATV-28EU41M2	9.500

3-phase supply voltage 200...230 V (4) 50/60 Hz

3	–	17.6	15.4	5	13.7	18.5	ATV-28EU54M2	9.500
4	5	21.9	19.1	5	17.5	24.6	ATV-28EU72M2	9.500

3-phase supply voltage 380...500 V (4) 50/60 Hz

Motor		Line supply			Altivar 28				
Power indicated on rating plate (1)		Line current (2) at U1	at U2	Max. prospective line I _{sc}	Nominal current at 380 V	at 500V to 460 V	Max. transient current (3)	Reference	Weight
kW	HP	A	A	kA	A	A	A		kg
0.75	1	3.9	3.5	5	2.3	2.1	3.5	ATV-28EU18N4	6.500
1.5	2	6.5	5.7	5	4.1	3.8	6.2	ATV-28EU29N4	6.500
2.2	3	8.4	7.5	5	5.5	5.1	8.3	ATV-28EU41N4	9.500
3	–	10.3	9.1	5	7.1	6.5	10.6	ATV-28EU54N4	9.500
4	5	13	11.8	5	9.5	8.7	14.3	ATV-28EU72N4	9.500

(1) These powers are given for a maximum switching frequency of 4 kHz, in continuous operation. The switching frequency can be adjusted from 2 to 15 kHz.

Above 4 kHz the nominal speed controller current should be derated and the nominal motor current should not exceed this value :

- up to 12 kHz, 10 % derating
- above 12 kHz, 20 % derating

(2) Typical value for a 4-pole motor and a maximum switching frequency of 4 kHz, without additional line choke

(3) For 60 seconds

(4) Nominal supply voltage min. U1, max. U2

Variable speed controllers for asynchronous motors

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Options : dialogue

References

Motor starter software workshop

Description	For speed controller	Reference	Weight kg
1 CD-ROM containing the installation software designed for ATV-28 and ATV-58	ATV-28 all ratings	VW3-A8104	—

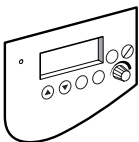
PC connection kit

Kit comprising : <ul style="list-style-type: none">- 1 connection cable, 3 m with 1 9-way SUB-D socket for the PC and 1 RJ 45 type socket for the ATV-28- 1 RJ 45 - 9-way SUB-D adaptor enabling connection to other speed controllers	ATV-28 all ratings	VW3-A8106	—

Local control option

This option can be plugged into the speed controller and used to control the motor directly from the speed controller.

Option comprising : <ul style="list-style-type: none">- reference potentiometer- 2 control buttons	ATV-28H all ratings	VW3-A28100	—



VW3-A28100

RS 485 connection kit

This kit is used for RS 485 multidrop serial link connection of the speed controller to PLCs, operator dialogue terminals, etc. It is used for configuration, adjustment, control and diagnostics of the variable speed controller. The protocol used is Modbus RTU.

Kit comprising: <ul style="list-style-type: none">1 cable with :<ul style="list-style-type: none">- 1 socket for the speed controller- 1 9-way SUB-D socket	ATV-28 all ratings	VW3-A28301	—

Remote display module

This module can be mounted on the door of a wall-fixing or floor-standing enclosure. It has the same display and programming buttons as the Altivar 28 with the addition of a switch to lock access to the menus and three buttons for controlling the speed controller.

Kit comprising : <ul style="list-style-type: none">- display module- cable fitted with 2 sockets- seal and screws for IP 65 mounting on enclosure door	ATV-28 all ratings	VW3-A28101	—




VW3-A28101

Variable speed controllers for asynchronous motors

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Options : accessories

References

Plate for mounting on rail

Description	For speed controller	Reference	Weight kg
Plate for mounting on  rail, 35 mm wide	ATV-28HU09M2 ATV-28HU18M2	VW3-A28851	0.300

Kit for IP43 mounting in wall-fixing or floor-standing enclosure

This kit enables speed controllers to be mounted inside a dust and damp proof enclosure. Removing heat via attachments enabling the ventilation system to draw cool air in at the bottom, and to expel warm air at the top. This arrangement requires holes to be drilled in the enclosure.

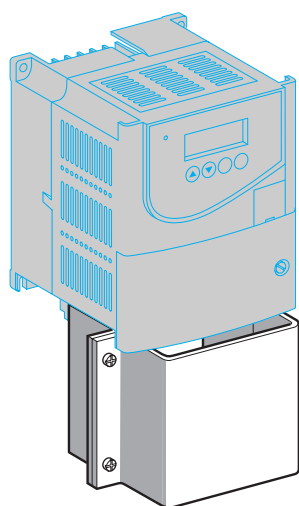
Kit comprising: - flexible ventilation ducting - protective grilles - self-adhesive drilling templates - fixing accessories	ATV-28HU09M2, HU18M2	VW3-A28801	—
	ATV-28HU29M2, HU18N4, HU29N4	VW3-A28802	—
	ATV-28HU41M2, HU54M2, HU72M2, HU41N4, HU54N4, HU72N4	VW3-A28803	—
	ATV-28HU90M2, HD12M2, HU90N4, HD12N4	VW3-A28804	—
	ATV-28HD16N4, HD23N4	VW3-A28805	—

Kit for UL NEMA type 1 conformity ⁽¹⁾

Mechanical option which fixes to the lower part of the Altivar 28	ATV-28HU09M2, HU18M2	VW3-A28811	0.600
	ATV-28HU29M2, HU18N4, HU29N4	VW3-A28812	0.700
	ATV-28HU41M2, HU54M2, HU72M2, HU41N4, HU54N4, HU72N4	VW3-A28813	0.700
	ATV-28HU90M2, HD12M2, HU90N4, HD12N4	VW3-A28814	0.800
	ATV-28HD16N4, HD23N4	VW3-A28815	1.000

Kit for substituting Altivar 18

Assembly option which enables an ATV-28 to be fitted in the place of an ATV-18 of the same rating (using the same fixing holes)	ATV-28HU09M2, HU18M2	VW3-A28821	—
	ATV-28HU29M2, HU18N4, HU29N4	VW3-A28822	—
	ATV-28HU41M2, HU54M2, HU72M2, HU41N4, HU54N4, HU72N4	VW3-A28823	—
	ATV-28HU90M2, HD12M2, HU90N4, HD12N4	VW3-A28824	—
	ATV-28HD16N4, HD23N4	VW3-A28825	—



VW3-A28811●

(1) This device enables the cables to be connected directly to the speed controller via ducting or cable gland.

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Options : braking resistors

Presentation, characteristics

Presentation

The resistor enables the Altivar 28 to operate when braking to a standstill or during slowdown braking by dissipating the braking energy.

Presentation

There are two types available:

- model in IP 30 enclosure designed for EMC conformity, protected by a temperature-controlled switch or thermal overload relay
- unprotected model IP00, for low power ratings only

Applications

High inertia machines, driving loads, fast-cycle machines.

Characteristics

References		VW3-A58702 to VW3-A58704	VW3-A58732 to VW3-A58735	VW3-A58736 and VW3-A58737
Ambient air temperature	°C	40	40	40
Degree of protection of enclosure		IP 00	IP 30	IP 30
Resistor protection		None	Via temperature-controlled switch (1)	Via temperature-controlled switch (1)
Temperature-controlled switch				
Trip temperature	°C	—	130 ± 5 %	260 ± 14 %
Max. voltage - max. current		—	~ 110 V - 0.3 A	~ 220 V - 6 A
Min. voltage - min. current		—	~ 24 V - 0.01 A	~ 24 V - 0.01 A
Maximum contact resistance	mΩ	—	150	50
Resistor load factor		The average power which can be dissipated at 40 °C by the resistor is determined for a load factor during braking which corresponds to most common applications : - 2 seconds braking with a torque of 0.6 Tn every 40 seconds - 0.8 seconds braking with a torque of 1.5 Tn every 40 seconds		
Speed controller load factor		The speed controllers' internal circuits which ensure braking using external resistors are sized for the following cycles. If these are exceeded, the speed controller locks and displays a fault. - 1.5 Tn for 60 seconds per cycle of 140 seconds - continuous Tn		

Minimum ohmic value of resistors to be connected to the ATV-28 speed controller

ATV-28● speed controller	U09M2	U18M2	U29M2 U41M2	U54M2 U72M2	U90M2 D12M2	U18N4 U29N4	U41N4 U54N4 U72N4	U90N4 D12N4	D16N4 D23N4
Minimum resistance value in ohms	65	45	30	25	10	95	70	45	25

(1) The contact should be connected in sequence (used for signalling, or for controlling the line contactor).

Variable speed controllers for asynchronous motors

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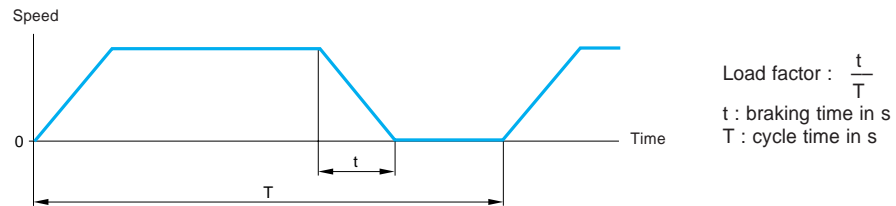
Options : braking resistors

Characteristics

Load factor

The average power which can be dissipated at 40 °C by the resistor in the unit is determined for a load factor during braking which corresponds to most current applications.

This load factor is given in the table on the previous page.

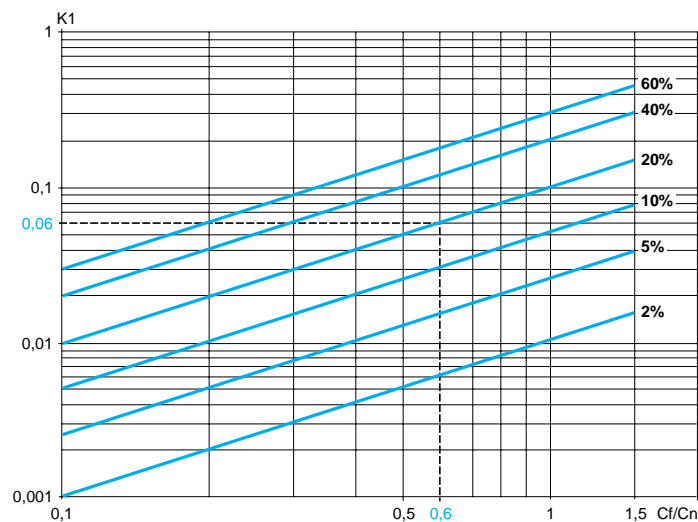


For a specific application (eg. materials handling), the nominal power of the resistor must be redefined taking into account the new load factor.

Determining the nominal power

Graph 1

Average power according to the braking torque for a load factor



Example :

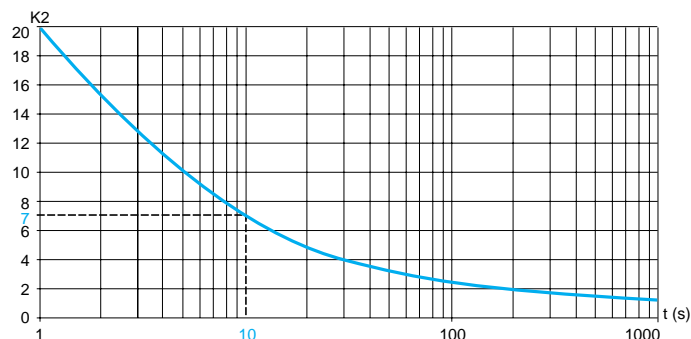
Motor power $P_m = 4 \text{ kW}$
Efficiency of motor $\eta = 0.85$
Braking torque $T_b = 0.6 T_n$
Braking time $t = 10 \text{ s}$
Cycle time $T = 50 \text{ s}$

Load factor $L_f = \frac{t}{T} = 20 \%$

From graph 1 calculate the coefficient K_1 corresponding to a braking torque of $0.6 T_n$ and a load factor of 20 %.
 $K_1 = 0.06$

Graph 2

Permissible resistor overload according to time (typical curve)



From graph 2 calculate the coefficient K_2 corresponding to a braking time of 10 seconds.
 $K_2 = 7$

The nominal power of the resistor (P_n) must be greater than :

$$P_n = P_m \times K_1 \times \eta \left(1 + \frac{1}{K_2 \times L_f} \right) = 4.10^3 \times 0.06 \times 0.85 \left(1 + \frac{1}{7 \times 0.2} \right) = 350 \text{ W}$$

Variable speed controllers for asynchronous motors

Altivar 28

Options : braking resistors

References



VW3-A58702

Unprotected braking resistors

For speed controller	Ohmic value	Average power available at 40 °C (1)	Reference	Weight
	Ω	W		kg
ATV-28●U09M2, ●U18M2, ●U29M2, ATV-28●U18N4, ●U29N4, ●U41N4	100	32	VW3-A58702	0.600
ATV-28●U41M2, ●U54M2	68	32	VW3-A58704	0.600
ATV-28●U54N4, ●U72N4	100	40	VW3-A58703	0.850

Protected braking resistors

ATV-28●U09M2, ●U18M2, ●U29M2, ATV-28●U18N4, ●U29N4, ●U41N4	100	32	VW3-A58732	2.000
ATV-28●U41M2, ●U54M2	68	32	VW3-A58733	2.000
ATV-28●U54N4, ●U72N4	100	40	VW3-A58734	2.000
ATV-28HU90N4, HD12N4	60	80	VW3-A58735	3.400
ATV-28●U72M2, ATV-28HD16N4, HD23N4	28	200	VW3-A58736	5.100
ATV-28HU90M2, HD12M2	14	400	VW3-A58737	6.100

(1) Power which can be dissipated by the resistor at the maximum temperature of 115 °C, corresponding to a maximum temperature rise of 75 °C in an environment of 40 °C.

Variable speed controllers for asynchronous motors

Altivar 28

Options : line chokes

Presentation, characteristics, references

Presentation

These chokes provide improved protection against overvoltages on the line supply and to reduce harmonic distortion of the current produced by the speed controller.

The recommended chokes limit the line current.

They have been designed to comply with standard EN 50178 (VDE 0160 level 1 high-energy overvoltages on the line supply).

The choke values are defined for a voltage drop of between 3 and 5 % of the nominal line supply voltage. A higher value may cause a loss of torque.

The use of line chokes is particularly recommended in the following cases :

- Line supply with significant disturbance from other equipment (interference, overvoltages)
- Line supply with a voltage imbalance between phases > 1.8 % of the nominal voltage
- Speed controller supplied by a line with very low impedance (close to transformers which are more than 10 times more powerful than the speed controller rating)

The prospective short-circuit current at the speed controller connection point should not exceed the maximum value given in the reference table. The use of chokes enables the following line supplies to be connected :

Isc max. 22 kA for 200/240 V ; Isc max. 65 kA for 380/500 V

- Installation of a large number of frequency inverters on the same line
- Reduction of overload in cos ϕ power factor correction capacitors, if the installation has a power factor correction installed

Characteristics

Conforming to standards	EN 50178 (VDE 0160 level 1 high-energy overvoltages on the line supply)						
Voltage drop	Between 3 and 5 % of the nominal line supply voltage. A higher value may cause a loss of torque						
Type of choke	VZ1-L 004M010	VZ1-L 007UM50	VZ1-L 018UM20	VW3- A66501	VW3- A66502	VW3- A66503	VW3- A66504
Degree of protection	Choke	IP 00	IP 00	IP 00	P 00	IP 00	IP 00
	Terminals	IP 20	IP 20	IP 20	IP 20	IP 20	IP 10
Value of inductance (mH)	10	5	2	10	4	2	1
Nominal current (A)	4	7	18	4	10	16	30
Losses (W)	17	20	30	45	65	75	90

References

Altivar 28 Single phase or 3-phase	Line current				Choke Reference	Weight kg
	without choke		with choke			
	at min. U	at max. U	at min. U	at max. U		
	A	A	A	A		

Single-phase supply voltage : 200...240 V (1) 50/60 Hz

ATV-28●U09M2	7.3	6.1	4.2	3.9	VZ1-L004M010	0.630
ATV-28●U18M2	9.8	8.2	7.4	6.1	VZ1-L007UM50	0.880
ATV-28●U29M2	16	13.5	12.5	11	VZ1-L018UM20	1.990
ATV-28●U41M2	22.1	18.6	17	15.1	VZ1-L018UM20	1.990

3-phase supply voltage : 200...240 V (1) 50/60 Hz

ATV-28●U54M2	17.6	15.4	10.2	9.4	VW3-A66503	3.500
ATV-28●U72M2	21.9	19.1	14.4	12.7	VW3-A66504	6.000
ATV-28HU90M2	38	33.2	21	18.6	VW3-A66504	6.000
ATV-28HD12M2	43.5	36.6	24.3	22	VW3-A66504	6.000

3-phase supply voltage : 380...500 V (1) 50/60 Hz

ATV-28●U18N4	3.9	3.5	1.9	1.8	VW3-A66501	1.500
ATV-28●U29N4	6.5	5.7	3.2	3	VW3-A66501	1.500
ATV-28●U41N4	8.4	7.5	4.6	4.4	VW3-A66502	3.000
ATV-28●U54N4	10.3	9.1	5.9	5.5	VW3-A66502	3.000
ATV-28●U72N4	13	11.8	7.3	7	VW3-A66502	3.000
ATV-28HU90N4	22.1	20.4	11.5	11	VW3-A66503	3.500
ATV-28HD12N4	25.8	23.7	13.4	12.7	VW3-A66503	3.500
ATV-28HD16N4	39.3	35.9	22.2	21.4	VW3-A66504	6.000
ATV-28HD23N4	45	40.8	25.2	24.7	VW3-A66504	6.000

(1) Nominal line supply voltage : min. U ...max. U.



VW3-A6650●

Variable speed controllers for asynchronous motors

Altivar 28

Options : additional radio interference suppression input filters

Presentation, characteristics

Presentation

Function

The Altivar 28 incorporates radio interference suppression input filters to comply with the EMC "products" standards IEC 1800-3 and EN 61800-3. Compliance with these standards meets the requirements of the European directive on EMC.

The additional filters meet the strictest requirements : they are designed to reduce conducted emissions on the line supply to below the limits of standards EN 55011 class A (1) or EN 55022 class B.

These additional filters are mounted behind the ATV-28H speed controllers. The filters have tapped holes for mounting the speed controller in front.

Use according to the type of supply

These additional filters can only be used on TN type (connected to neutral) and TT type (neutral to earth) supplies. Standard IEC 1800-3, appendix D2.1, states that, for type IT (impedance earthed or isolated neutral) supplies, the filters may prevent the earth leakage detectors from working reliably.

In addition, the effectiveness of the additional filters on this type of supply depends on the type of impedance between neutral and earth and is therefore not recommended.

In the case of a machine which must be installed on an IT supply, the solution is to insert an isolation transformer and operate the machine locally on a TN or TT supply.

Characteristics

Conforming to standards			EN 133200
Degree of protection			IP 21 and IP 41 on the upper part
Maximum relative humidity			93 % with no condensation or dripping water conforming to IEC 68-2-3
Ambient air temperature around the device	Operation	°C	-10... + 60
	Storage	°C	- 25... + 70
Maximum operating altitude	Without derating	m	1000 (above this, derate the current by 1 % for each additional 100 m)
Vibration resistance	Conforming to IEC 68-2-6		0.5 mm peak from 2 to 9 Hz 0.5 gn peak from 9 to 200 Hz
Shock resistance	Conforming to IEC 68-2-27		15 gn for 11 ms
Maximum nominal voltage	50/60 Hz single phase	V	240 + 10 %
	50/60 Hz 3-phase	V	500 + 10 %

(1) If the cable exceeds 5 m.

Variable speed controllers for asynchronous motors

Altivar 28

Options : additional radio interference suppression input filters

References

For speed controller Reference	Filter		In (2)	If (3)	Loss (4)	Reference	Weight
	Maximum length of shielded cable						
	EN 55011 class A (1)	EN 55022 class B (1)					
	m	m	A	mA	W		kg
Single-phase supply voltage : 200...240 V - 50/60 Hz							
ATV-28●U09M2, ●U18M2	50	20	10	100	8	VW3-A28401	1.500
ATV-28●U29M2	50	20	16	150	7.5	VW3-A28402	1.800
ATV-28●U41M2	50	20	25	80	10	VW3-A28404	1.900
3-phase supply voltage : 200...230 V - 50/60 Hz							
ATV-28●U54M2, ●U72M2	50	20	22	350	12	VW3-A28405	2.700
ATV-28●U90M2, ●D12M2	50	20	45	400	20	VW3-A28406	4.300
3-phase supply voltage : 380...500 V - 50/60 Hz							
ATV-28●U18N4, ●U29N4	50	20	16	150	2.5	VW3-A28403	2.000
ATV-28●U41N4, ●U54N4, ●U72N4	50	20	22	350	12	VW3-A28405	2.700
ATV-28●U90N4, ●D12N4	50	20	45	400	20	VW3-A28406	4.300
ATV-28●D16N4, ●D23N4	50	20	45	400	20	VW3-A28407	5.600

(1) The filter selection tables give the maximum length for the shielded cables which connect the motors to the speed controllers, for a switching frequency of 2 to 15 kHz. These limits are given for information only as they depend on the interference capacity of the motors and cables used. For motors connected in parallel, the total of the lengths must be taken into account.

(2) In : Nominal current of the filter

(3) Maximum earth leakage current at 50 Hz

(4) Heat dissipation

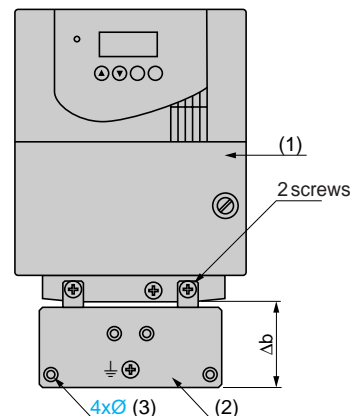
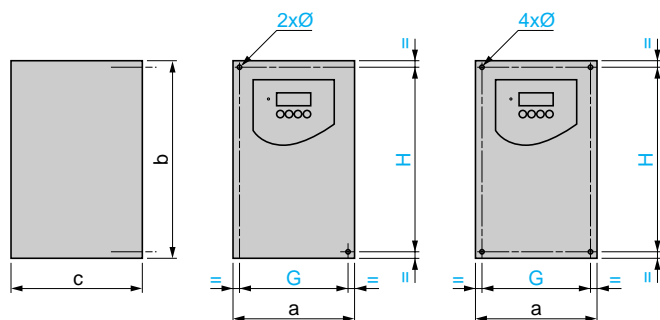
Variable speed controllers for asynchronous motors

Altivar 28

Dimensions

Dimensions
ATV-28H●●●●●

Plate for EMC mounting (supplied with the speed controller)

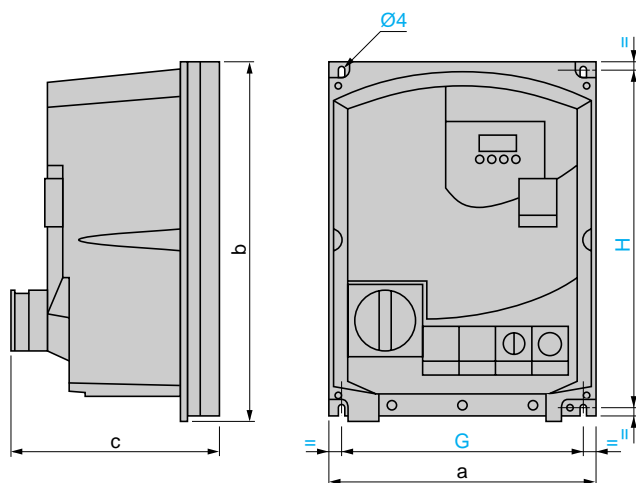


ATV-28H	a	b	c	G	H	2Ø	4Ø
U09M2, U18M2	105	130	140	93	118	5	—
U29M2, U18N4, U29N4	130	150	150	118	138	—	5
U41M2, U54M2, U72M2, U41N4, U54N4, U72N4	140	195	163	126	182	—	5
U90M2, D12M2, U90N4, D12N4	200	270	170	180	255	—	6
D16N4, D23N4	245	330	195	225	315	—	6

ATV-28H	Δb	Ø (3)
U09M2, U18M2, U29M2, U41M2, U54M2, U72M2, U18N4, U29N4, U41N4, U54N4, U72N4	48	4
U90M2, D12M2, U90N4, D12N4, D16N4, D23N4	79	4

(1) Speed controller
(2) Plate
(3) M4 tapped holes for fixing EMC clamps

ATV-28EU●●●● (ready-assembled)



ATV-28E	a	b	c	G	H	Ø
U09M2, U18M2	219	297	177	202	280	5.5
U29M2, U18N4, U29N4	219	297	201	202	280	5.5
U41M2, U54M2, U72M2, U41N4, U54N4, U72N4	230	347	222	212	320	5.5

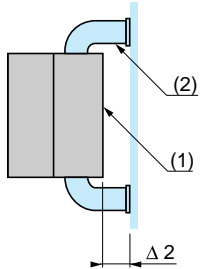
Variable speed controllers for asynchronous motors

Altivar 28

Dimensions (continued)

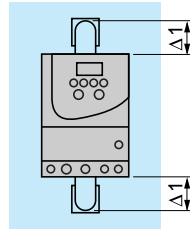
Kit for IP43 mounting in wall-fixing or floor-standing enclosure
VW3-A28801 to A28804

Common side view



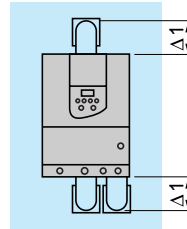
(1) Speed controller
(2) Kit **VW3-A2880**

VW3-A28805

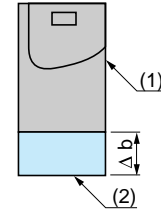


VW3-	Δ 2	Δ 1
A28801	80	200
A28802	80	200
A28803	90	250
A28804	110	300
A28805	110	300

VW3-A28805



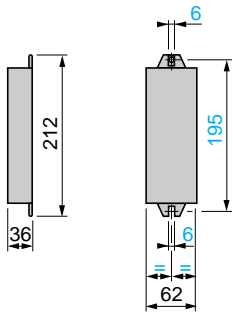
Kit for UL NEMA type 1 conformity
VW3-A2881



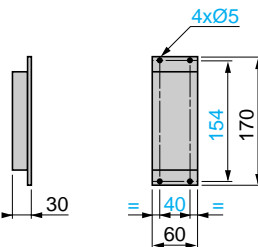
VW3-	Δ b
A28811 to A28813	68
A28814 and A28815	96

(1) Speed controller
(2) Kit **VW3-A2881**

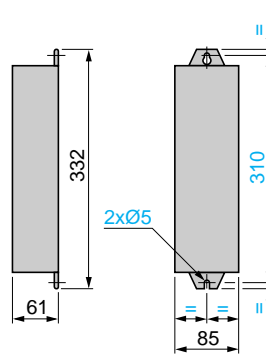
Unprotected braking resistors
VW3-A58703
2-wire output, 0.5 m



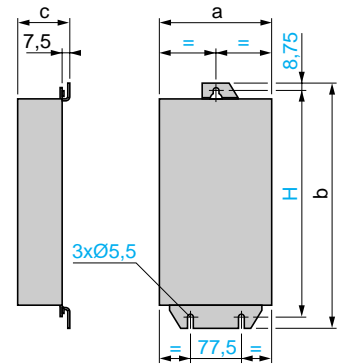
VW3-A58702 and A58704
2-wire output, 0.5 m



Protected braking resistors
VW3-A58732 to A58734

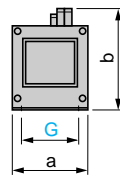
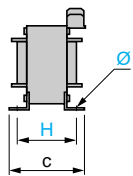


VW3-A58735 to A58737



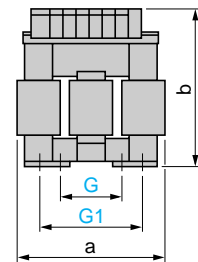
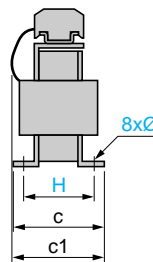
VW3-	a	b	c	H
A58735	163	340	61	320
A58736, A58737	156	434	167	415

Single-phase chokes
VZ1-L.....



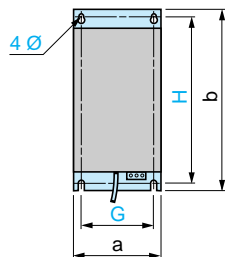
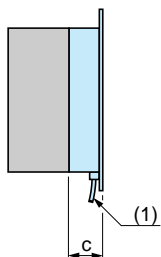
	a	b	c	G	H	Ø
VZ1-L004M010	60	100	80	50	44	4 x 9
VZ1-L007UM50	60	100	95	50	60	4 x 9
VZ1-L018UM20	85	120	105	70	70	5 x 11

3-phase chokes
VW3-A66501 to A66504



VW3-	a	b	c	c1	G	G1	H	Ø
A66501	100	135	55	60	40	60	42	6 x 9
A66502	130	155	85	90	60	80.5	62	6 x 12
A66503	130	155	85	90	60	80.5	62	6 x 12
A66504	155	170	115	135	75	107	90	6 x 12

Radio interference suppression filters (EMC)
VW3-A28401 to A28407



VW3-	a	b	c	G	H	Ø
A28401	105	185	50	85	170	4
A28402	130	205	60	110	190	4
A28403	130	205	60	110	190	4
A28404	140	250	60	140	230	4
A28405	140	250	60	140	230	4
A28406	200	355	60	160	330	5
A28407	245	425	60	205	360	5

(1) Cable for connection to speed controller.

Variable speed controllers for asynchronous motors

Altivar 28

Mounting and installation recommendations

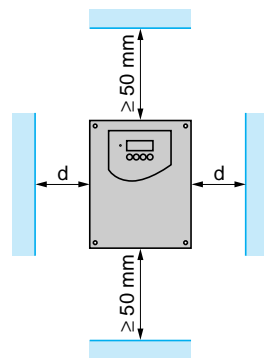
Depending on the conditions in which the speed controller is to be used, setup will require certain installation precautions as well as the appropriate accessories.

Mounting recommendations for ATV-28H speed controllers

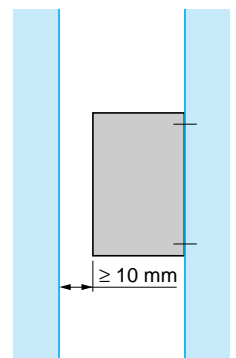
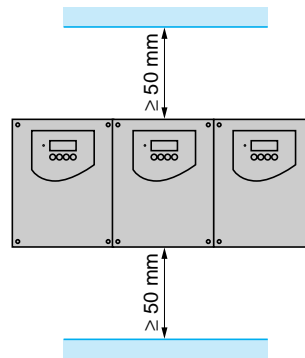
Install the unit vertically, at $\pm 10^\circ$.

- Do not place close to heating elements.
- Leave sufficient free space to ensure that the air required for cooling purposes can circulate from the bottom to the top of the unit.

Single speed controllers



Speed controllers mounted side by side



From - 10 °C to + 40 °C

- $d \geq 50 \text{ mm}$

No special precautions.

- $d = 0 \text{ mm}$ (speed controllers mounted side by side)

Remove the protective cover from the top of the speed controller, as shown below (the degree of protection becomes IP 20).

From + 40 °C to + 50 °C

- $d \geq 50 \text{ mm}$

Remove the protective cover from the top of the speed controller, as shown below (the degree of protection becomes IP 20). If the cover is left on, derate the nominal speed controller current by 2.2 % for every °C above 40 °C.

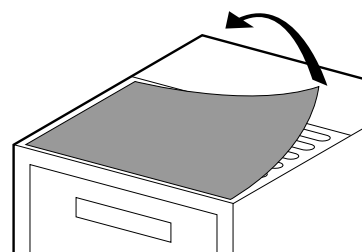
- $d = 0 \text{ mm}$

Remove the protective cover from the top of the speed controller, as shown below (the degree of protection becomes IP 20) and derate the nominal speed controller current by 2.2 % for every °C above 40 °C.

From + 50 °C to + 60 °C

- $d \geq 50 \text{ mm}$

Remove the protective cover from the top of the speed controller, as shown below (the degree of protection becomes IP 20) and derate the nominal speed controller current by 3 % for every °C above 50 °C.



Variable speed controllers for asynchronous motors

Altivar 28

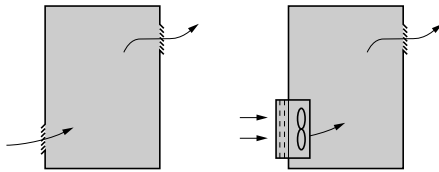
Mounting and installation recommendations (continued)

Special precautions for mounting ATV-28H speed controllers in enclosures

Follow the mounting recommendations on the facing page.

In order to ensure that air circulates freely in the speed controller :

- Provide ventilation grilles.
- Ensure there is sufficient ventilation, otherwise install forced ventilation with a filter. The vents and/or the fans which may be fitted should provide an air flow at least as good as that of the speed controller fans (see below).
- Use special IP 54 filters.
- Remove the cover from the upper part of the speed controller.



Fan air flow according to speed controller rating

Speed controller	Flow
ATV-28H	m³/min
U09M2, U18M2, U29M2, U18N4, U29N4	0.25
U41M2, U54M2, U72M2, U41N4, U54N4, U72N4	0.65
U90M2, D12M2, U90N4, D12N4, D16N4, D23N4	1.5

Dust and damp proof metal wall-fixing or floor-standing enclosure (degree of protection IP 54)

It is necessary to mount the speed controller in a dust and damp proof enclosure in certain environmental conditions : dust, corrosive gas, high humidity with the risk of condensation and dripping water, splashing liquids, etc.

This arrangement enables the speed controller to be used in an enclosure where the maximum internal temperature can reach 50 °C.

Calculating the dimensions of the enclosure

Maximum thermal resistance Rth (°C/W)

$$R_{th} = \frac{\theta - \theta_e}{P}$$

θ = maximum temperature in the enclosure in °C
 θ_e = maximum external temperature in °C
 P = total power dissipated in the enclosure in W

Power dissipated by the speed controller : see page 8.

Add the power dissipated by the other components of the device.

Effective exchange surface area of the enclosure S (m²)

(sides + top + front panel, in the case of a wall-mounted unit)

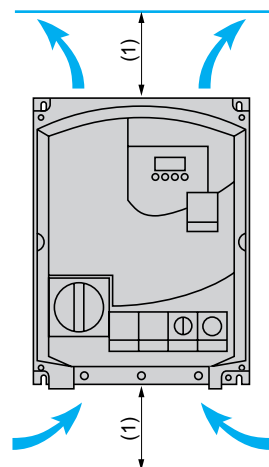
$$S = \frac{K}{R_{th}}$$

K = thermal resistance on the enclosure surface area

For metal enclosure : $K = 0.12$ with internal fan, $K = 0.15$ without fan.

Warning : Do not use insulated enclosures, because of their low conductivity.

Mounting recommendations for ready-assembled ATV-28E speed controllers



Install the unit vertically, at $\pm 10^\circ$.

Do not place it close to heating elements.

Leave sufficient free space to ensure that the air required for cooling purposes can circulate from the bottom to the top of the unit.

(1) ≥ 100 mm

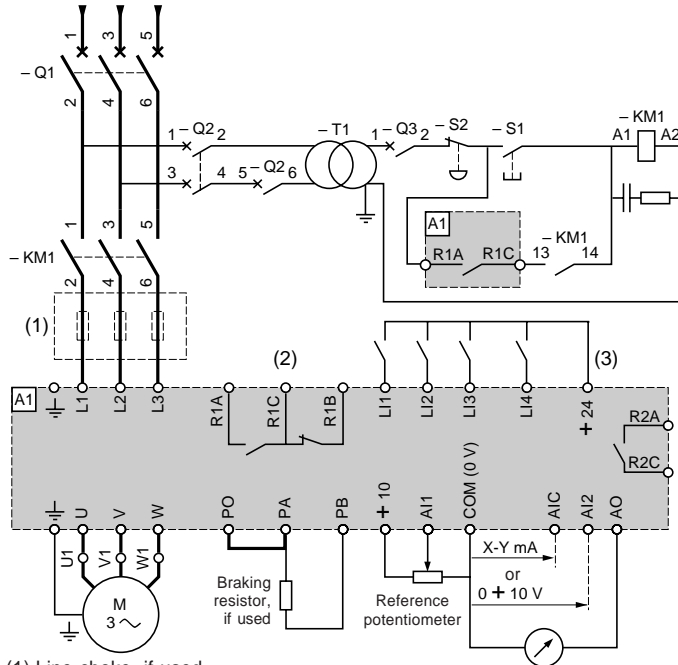
Variable speed controllers for asynchronous motors

Altivar 28

Schemes

Schemes

ATV-28H●●●●● (3-phase supply)



(1) Line choke, if used

(2) Fault relay contacts for remote indication of the speed controller status

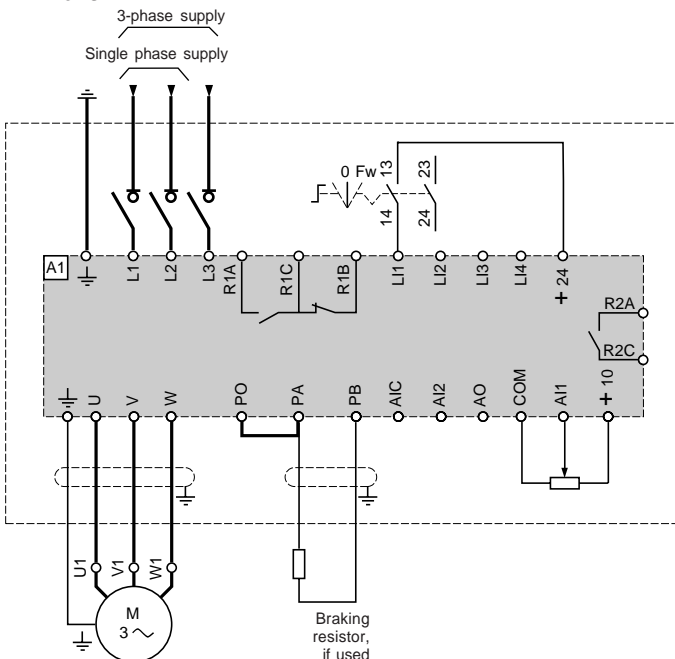
(3) Internal + 24 V. If using an external + 24 V power supply, connect the 0 V from that supply to the COM terminal (do not use the + 24 terminal on the speed controller) and connect the LI inputs common to the + 24 V of the external power supply.

Note :

- All terminals are located on the lower part of the speed controller.

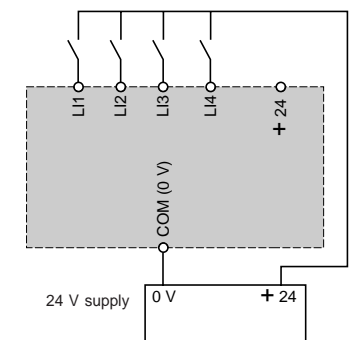
- All inductive circuits near the speed controller or coupled to the same circuit, such as relays, contactors, solenoid valves, fluorescent lighting etc. should be fitted with interference suppressors.

ATV-28EU●●●●●



Other connections

External 24 V supply



Components to connect (for complete references, please consult our specialist catalogue)

Reference	Description
Q1	GV2-L or Compact NS (see following pages)
KM1	LC1-D●● + LA4-DA2U (see following pages)
S1, S2	XB2-B or XA2-B pushbuttons
T1	100 VA transformer, 220 V secondary
Q2	GV2-L rated at twice the nominal primary current of T1
Q3	GB2-CB05

Variable speed controllers for asynchronous motors

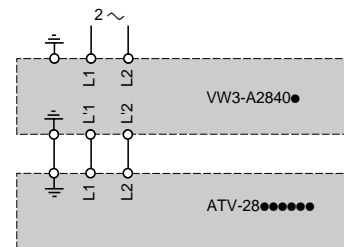
Altivar 28
Electromagnetic compatibility

Schemes, principle, installation diagram

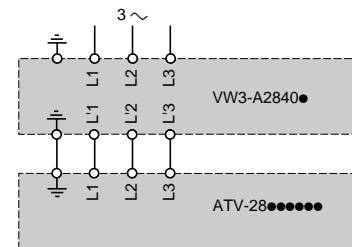
Schemes

Additional input filters, VW3-A2840 radio interference filters

Single phase supply



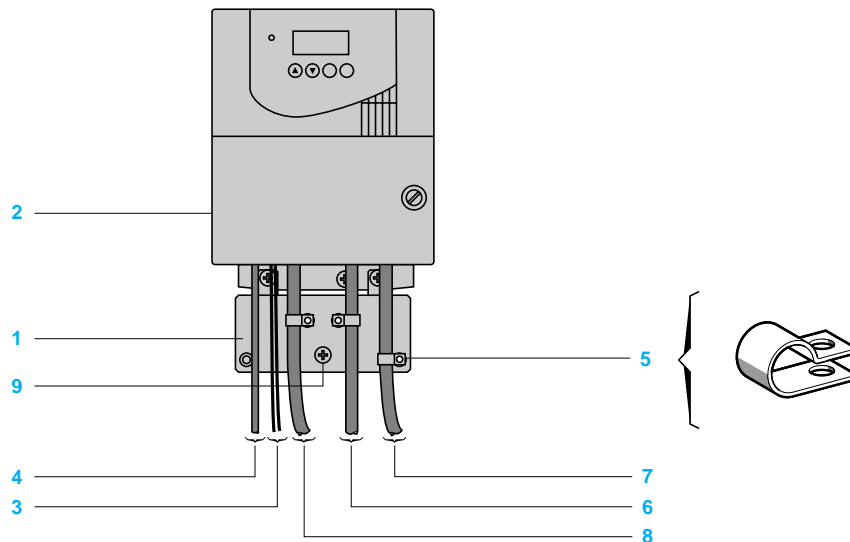
3-phase supply



Principle

- Earth connections between speed controller, motor and cable shielding must have "high frequency" equipotentiality.
- Use shielded cables with shielding connected to earth for a complete 360° at both ends of the motor cable, braking resistor (if used) and control-command cables. Conduit or metal ducting can be used for part of the shielding, provided that there is no break in continuity.
- Ensure maximum separation between the power supply cable (line supply) and the motor cable.

Installation diagram



1 Sheet steel plate (supplied) to be fitted to the speed controller (earthed casing).

2 Altivar 28.

3 Non-shielded power supply wires or cables.

4 Non-shielded wires for the output of the fault relay contacts.

5 Attachment and connection to earth of the shielding of cables 6, 7 and 8 as close as possible to the speed controller :
- Strip the shielding
- Use cable clamps of an appropriate size to clamp the shielding to the mounting plate 1 tight enough to ensure good contact.

- Types of clamp : stainless steel

6 Shielded cable for connecting the motor, shielding connected to earth at both ends. This shielding must be unbroken, and if there are intermediate terminals, they must be in EMC shielded metal boxes.

7 Shielded cable for connecting the control/command. For applications which require a large number of conductors, small cross-sections must be used (0.5 mm²).

The shielding must be connected to earth at both ends. This shielding must be unbroken, and if there are intermediate terminals, they must be in EMC shielded metal boxes.

8 Shielded cable for connecting the braking resistor, if used. The shielding must be connected to earth at both ends. This shielding must be unbroken, and if there are intermediate terminals, they must be in EMC shielded metal boxes.

9 Earth screw for the motor cable on low power drives, as the screw on the heatsink is inaccessible.

Note :

1 Although there is a high frequency equipotential earth connection between the speed controller, the motor and the cable shielding, it is still necessary to connect the PE protective conductors (green-yellow) to the appropriate terminals on each of the devices.

2 If an additional input filter is used, it is mounted behind the speed controller and connected directly to the line supply by an unshielded cable. Connection 3 is then made using the filter cable.

Variable speed controllers for asynchronous motors

Altivar 28 Motor starters

Combinations for customer assembly

Applications

The combinations offered below provide a complete motor starter, comprising a circuit-breaker, a contactor and an Altivar 28 variable speed controller.

The circuit-breaker provides protection against accidental short-circuits, isolation and visual indication.
The contactor controls and manages any safety applications, as well as isolation of the motor at standstill.
The electronics within the Altivar 28 speed controller protect against short-circuits between phases and between phase and earth, ensuring service continuity, as well as thermal protection of the motor.

Single phase (200 to 240 V) or 3-phase (200 to 230 V) supply voltage

For 0.37 to 7.5 kW or 0.5 to 10 HP motors

Circuit-breaker

NS80HMA : product marketed under the Merlin Gerin brand

Contactor components

LC1-K06 and LC1-K09 : 3-pole + 1 "N/O" auxiliary contact

LC1-D12 to LC1-D32 : 3-pole + 1 "N/O" auxiliary contact

LC1 D40 : 3-pole + 1 "N/O" auxiliary contact, + 1 "N/C" auxiliary contact

Standard power for 4-pole 3-phase motors 50/60 Hz 230 V (1)		Circuit-breaker Reference	Rating	Max. prospective line lsc	Contactor Basic reference to be completed with the voltage reference (2)	Speed controller Reference
kW	HP		A	kA		
0.37	0.5	GV2-L14	10	1	LC1-K0610●●	ATV-28HU09M2
0.75	1	GV2-L14	10	1	LC1-K0610●●	ATV-28HU18M2
1.5	2	GV2-L20	18	1	LC1-K0610●●	ATV-28HU29M2
2.2	3	GV2-L22	25	1	LC1-D12●●●●	ATV-28HU41M2
3	–	GV2-L20	18	5	LC1-D09●●●●	ATV-28HU54M2
4	5	GV2-L22	25	5	LC1-D12●●●●	ATV-28HU72M2
5.5	7.5	NS80HMA50	50	22	LC1-D32●●●●	ATV-28HU90M2
7.5	10	NS80HMA50	50	22	LC1-D32●●●●	ATV-28HD12M2

(1) The values expressed in HP conform to the NEC (National Electrical Code).

(2) Normal control circuit voltages
a.c. control circuit

	Volts ~	24	48	110	220	230	240
LC1-D	50 Hz	B5	E5	F5	M5	P5	U5
	60 Hz	B6	E6	F6	M6	–	U6
	50/60 Hz	B7	E7	F7	M7	P7	U7
LC1-K	Volts ~	24	48	110	220/ 230	230	230/ 240
	50/60 Hz	B7	E7	F7	M7	P7	U7

For other voltages between 24 and 660 V, or d.c. control circuits, please consult your Regional Sales Office.



GV2-L
+
LC1-K
+
ATV-28

Variable speed controllers for asynchronous motors

Altivar 28 Motor starters

Combinations for customer assembly (continued)

3-phase supply voltage (380 to 415 V)

For 0.75 to 15 kW or 1 to 20 HP motors

Circuit-breaker

NS80HMA : product marketed under the Merlin Gerin brand

Contactor components

LC1-K06 and LC1-K09 : 3-pole + 1 "N/O" auxiliary contact

LC1-D18 to LC1-D32 : 3-pole + 1 "N/O" auxiliary contact

Standard power for 4-pole 3-phase motors 50/60 Hz 230 V (1)		Circuit-breaker		Max. prospective line Isc	Contactor Basic reference to be completed with the voltage reference (2)	Speed controller Reference
kW	HP	Reference	Rating			
			A	kA		
0.75	1	GV2-L08	4	5	LC1-K0610●●	ATV-28HU18N4
1.5	2	GV2-L10	6.3	5	LC1-K0610●●	ATV-28HU29N4
2.2	3	GV2-L14	10	5	LC1-K0610●●	ATV-28HU41N4
3	–	GV2-L14	10	5	LC1-K0610●●	ATV-28HU54N4
4	5	GV2-L16	14	5	LC1-K0610●●	ATV-28HU72N4
5.5	7.5	GV2-L22	25	22	LC1-D09●●●●	ATV-28HU90N4
7.5	10	NS80HMA50	50	22	LC1-D18●●●●	ATV-28HD12N4
11	15	NS80HMA50	50	22	LC1-D32●●●●	ATV-28HD16N4
15	20	NS80HMA50	50	22	LC1-D32●●●●	ATV-28HD23N4

(1) The values expressed in HP conform to NEC (National Electrical Code).

(2) Normal control circuit voltages

a.c. control circuit

	Volts ~	24	48	110	220	230	240
LC1-D	50 Hz	B5	E5	F5	M5	P5	U5
	60 Hz	B6	E6	F6	M6	–	U6
	50/60 Hz	B7	E7	F7	M7	P7	U7
LC1-K	Volts ~	24	48	110	220/230	230	230/240
	50/60 Hz	B7	E7	F7	M7	P7	U7

For other voltages between 24 and 660 V, or d.c. control circuits, please consult your Regional Sales Office.



GV2-L
+
LC1-K
+
ATV-28

Variable speed controllers for asynchronous motors

Altivar 28

Combination of functions and applications

Applications

Pumps and compressors

Centrifugal pumps, dosing pumps
Screw compressors



Fans

Driers, drying ovens, tunnels, extractor hoods
Air conditioning



"Drive" functions

Maximum frequency 400 HZ

Voltage/frequency ratio U/f (1) :

- variable torque
- sensorless flux vector control
- energy saving

Switching frequency

Automatic d.c.

injection on stopping

Dynamic, resistance
braking

Autotuning

Skip frequency

Noise reduction (random freq.)

Undervoltage operation (- 40%)

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4 to 15 kHz

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Application and control system functions

Automatic adaption of the
deceleration ramp

Automatic catching a spinning load
(flying restart)

Automatic restart

Controlled stop on loss of line supply

Limitation of the operating time
at low speed

Analogue inputs

- Summing

- PI regulator

Logic inputs

- 2 operating directions

- d.c. injection

- Fast stop

- Freewheel stop

- Step by step (JOG)

- Preset speeds

- Ramp switching

- Reference switching

Relay outputs

- Speed reference reached

- Frequency threshold reached

- Current threshold reached

- Motor thermal threshold reached

- Analogue output (torque, speed,
current, power)

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(1) Voltage/frequency ratio U/f : the 4th quadrant (constant torque) is used for motors connected in parallel and special motors (eg : high resistance cage motors).

Horizontal material handlingContinuous, belt,
screw, and chain
conveyorsCycle conveyors
Transfer tables
Manipulation arms

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Packaging/PackingBanding machines
Bagging machines
Labelling machinesPalletisers
Depalletisers

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4 kHz	4 kHz
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Special machinesTimber machines
Textile machinesMixers
Kneaders

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4...15 kHz	4 kHz
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Variable speed controllers for asynchronous motors

Altivar 28 Functions

Description

Summary of functions

Function configuration and settings

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Analogue output AO	page 39

Configurable I/O

Compatibility of configurable I/O functions	page 40
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Variable speed controllers for asynchronous motors

Altivar 28

Function configuration and settings

Description

Speed controller factory settings

The controller is supplied **ready-to-use for most applications**, with the following functions and settings :

- line supply : 50 Hz
 - motor voltage : 230 V (ATV28●●●●M2) or 400 V (ATV28●●●●N4)
 - ramps : 3 seconds
 - low speed : 0 Hz, high speed : 50 Hz
 - motor thermal current = nominal speed controller current
 - d.c. injection braking to a zero = 0.7 nominal speed controller current, for 0.5 seconds
 - constant torque operation, with sensorless flux vector control
 - logic inputs :
 - 2 directions of rotation (LI1, LI2), 2-wire control
 - 4 preset speeds (LI3, LI4) : 0 Hz, 10 Hz, 15 Hz, 50 Hz
 - analogue inputs :
 - AI1 speed reference 0 + 10 V
 - AI2 (0 + 10 V) or AIC (0, 20 mA) summing AI1
 - relay R2 : speed reference reached
 - analogue output AO : motor frequency
 - automatic limiting of deceleration ramp in the event of overbraking
 - switching frequency 4 kHz
 - random switching frequency
-

Local control option

This option consists of a reference potentiometer and provides access to 2 additional buttons on the speed controller :

- RUN button : controls the starting of the motor. The direction of operation is determined by a parameter in the settings menu

- STOP/RESET button : controls the stopping of the motor and the clearing (resetting) of any faults.

The reference given by the reference potentiometer is summed with analog input AI1.

Installing this option requires a special factory setting of certain I/O :

- LI1 = no : not reassignable
 - LI2 to LI4 : 8 preset speeds, reassignable
-

User settings and extension of functions

The display unit and buttons can be used to modify the settings and extend the functions described in the following pages. It is very easy to return to the factory settings.

Motor starter software workshop

Function :

The PC dialogue option is used to establish an RS 232 C standard link between the Altivar and a PC.

The software contained on the CD-ROM offers the following advantages :

- clear display of messages in several languages
 - preparation in the design office without the need to connect the Altivar to the PC
 - backup of configurations and settings on floppy disk or hard disk, as well as downloading to the speed controller
 - print option
 - retrieval of backup files from the Altivar 18 for transfer to Altivar 28
-

Variable speed controllers for asynchronous motors

Altivar 28

Function configuration and settings

Description (continued)

Operating speed range

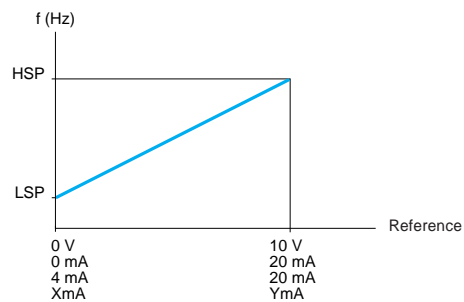
Function :

The 2 frequency limits HSP (high speed) and LSP (low speed) define the speed range authorised by the machine in actual operating conditions.

Applications :

All applications. Ensure that the HSP setting is suitable for the motor.

Settings :



LSP : 0 to HSP, factory setting 0
HSP : LSP to 400 Hz, factory setting 50

Acceleration and deceleration ramps

The linear acceleration and deceleration ramps can be adjusted separately from 0.05 to 3600 seconds. Factory setting : 3 seconds.

Ramp switching

Function :

Switching of two acceleration and deceleration ramp times, which can be adjusted separately. Validation : by one logic input to be reassigned, or one adjustable frequency threshold.

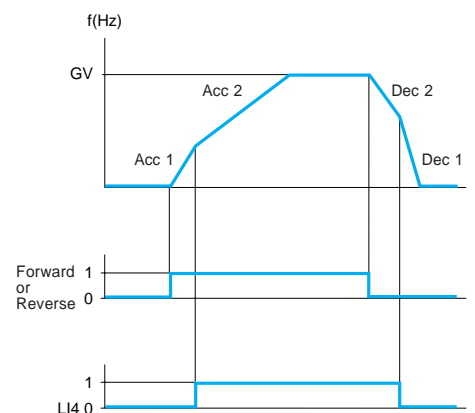
Applications :

Material handling with smooth starting and approach.
Machines with fast steady state speed correction.

Settings :

Acceleration and deceleration.

Example of switching using input LI4



Acceleration 1 and deceleration 1 :
- settings 0.05 to 3600 s
- preset at 3 s

Acceleration 2 and deceleration 2 :
- settings 0.05 to 3600 s
- preset at 5 s

Variable speed controllers for asynchronous motors

Altivar 28

Function configuration and settings

Description (continued)

Automatic adaptation of the deceleration ramp

Function :

Automatic adaptation of the deceleration ramp time, if the initial setting is too short given the inertia of the load. This function avoids possible locking of the speed controller in the event of an **overbraking** fault.

Applications :

All applications not requiring precise stopping and not using braking resistors.

Setting :

Yes or No. Factory setting : yes.

Automatic adaptation must be disabled if the machine has position control with stopping on a ramp and a braking resistor installed.

Voltage/frequency ratio for the motor power supply

Function :

Calculation of the voltage/frequency ratio limit values, according to the characteristics of line supply, the motor and the application.

Applications :

All constant torque or variable torque applications with or without overspeed.

Adjustment points :

The base frequency bFr corresponding to the line supply must be set beforehand (factory setting : 50 Hz).

- FrS : nominal motor frequency (in Hz)
- UnS : nominal motor voltage (in V)
- tFr : maximum frequency of speed controller output (in Hz)

Settings :

UnS :

- **ATV-28●●●●M2** controllers : 200-230-240, factory setting 230
 - **ATV-28●●●●N4** controllers : 380-400-460-500, factory setting 400 if bFr = 50, or 460 if bFr = 60
- FrS : 40 to 400, factory setting = bFr
tFr : 40 to 400, factory setting = 1.2 bFr

Note : The factory setting 60 Hz of tFr can be maintained even with a 50 Hz line supply and motor because it simply concerns an HSP safety limit.

Type of voltage/frequency ratio

Function :

Adaptation of voltage/frequency ratio to the application to optimise performance.

Applications :

- Constant torque applications (machines with average load operating at low speed) with motors connected in parallel or special motors (eg : high resistance cage motors) : ratio **L**
- Variable torque applications (pumps, fans) : ratio **P**
- Heavily loaded machines operating at low speed, fast cycle machines, with flux vector control (sensorless) : ratio **n**
- Energy-saving, for machine with slow variations in torque and speed : ratio **nLd**. Voltage is automatically reduced to the minimum according to the required torque.

Adjustment points :

UFR : correction of the voltage/frequency ratio by modifying the IR compensation

Settings :

- Ratio **L**, **n**, **nLd**, or **P**, factory setting **n**
- UFR : 0 to 100, factory setting 20
 - From 20 to 0 : decrease in torque available at low speed
 - From 20 to 100 : increase in torque available at low speed

Autotuning (for "flux vector control" **n** or "energy-saving" **nLd** voltage/frequency ratios)

The autotuning function is performed on stopping, by request using the integrated adjustment terminal. The speed controller automatically measures the motor parameters and changes the corresponding speed controller parameters.

Applications :

When torque or damping performance is inadequate, or when a higher level of performance is required.

Variable speed controllers for asynchronous motors

Altivar 28 Function configuration and settings

Description (continued)

Switching frequency, noise reduction

Function :

High frequency switching of the intermediate d.c. voltage can be used to supply the motor with a current wave of low harmonic distortion. The switching frequency can be adjusted during operation to reduce the noise generated by the motor.

Value : 2 to 15 kHz, factory setting 4 kHz

Switching frequency modulation is random to avoid resonance phenomena. This function can be inhibited if it causes instability.

Applications :

All applications which require a low level of motor noise.

Power adaptation :

The speed controller output current should be derated if the frequency is above 4 kHz (factory setting) :

- from 4 kHz to 12 kHz : derating of 10 %
- from 12 kHz to 15 kHz : derating of 20 %

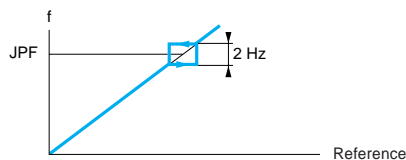
Skip frequencies

Function :

Prevention of a critical speed causing mechanical resonance. It is possible to inhibit extended motor operation in one adjustable frequency range with a width of 2 Hz.

Applications :

Pumps, fans.



Factory setting : JPF = 0 (inactive)

Controlled stop on loss of line supply

Function :

Control of motor stopping on loss of line supply, following a ramp which is self-adapting as a function of the restored kinetic energy.

Applications :

Material handling, machines with high inertia, continuous production processing machines.

Factory setting : inactive

Automatic catching a spinning load with speed search ("catch on the fly")

Function :

Restarting the motor with a speed surge following a short power break. On restart, the speed controller searches for the effective speed of the motor in order to restart on a ramp and return to the reference speed. The speed search time can reach 3.2 s depending on the initial difference.

This function requires the speed reference and the direction of operation to be maintained on restart.

Factory setting : inactive

Applications :

Machines where motor speed does not drop rapidly during a power break (high inertia machines).

Variable speed controllers for asynchronous motors

Altivar 28

Function configuration and settings

Description (continued)

Automatic restart

Function :

Automatic restart after locking of the speed controller on a fault, if the other operating conditions allow and the fault has disappeared.

This restart is made by a series of automatic attempts performed at increasing intervals :

1 second, 5 seconds, 10 seconds then 1 minute and so on.

If the speed controller has not restarted after 6 minutes, it will lock and the procedure is abandoned until it is switched off and then on again.

Factory setting : inactive

The faults which allow this restart are either that the line voltage is too low or the following have occurred :

- overbraking
- line overvoltage
- motor thermal overload
- speed controller thermal overload
- line voltage too low
- mains phase loss
- motor phase loss
- serial link fault

If any of these faults occur, the controller fault relay remains energised if the function is configured.

This function requires the speed reference and the operating direction to be maintained.

Applications :

Machines or installations operating continuously without monitoring, which, when restarted, pose no danger to either equipment or personnel (pumps, fans, etc).

Limitation of the operating time at low speed (LSP)

Function :

The motor is automatically stopped at the end of a period of operation at low speed (LSP) where the speed reference is less than LSP and the run signal is present.

This time can be adjusted from 0.1 to 25.5 seconds.

The setting 0 makes the function inactive (no shutdown)

Restart occurs automatically on a ramp when the reference reappears or on a break and re-establishment of the run signal.

Applications : Automatic start/stop of pressure regulated pumps.

Factory setting : Inactive

Fault relay, unlocking

The fault relay is energised when the speed controller is powered up and there is no fault present. It consists of a C/O contact with common point.

The speed controller is unlocked after a fault :

- by powering down until the red lamp extinguishes then powering the speed controller up again
- automatically in the cases described in the "automatic restart" function

Variable speed controllers for asynchronous motors

Altivar 28

Function configuration and settings

Description

Thermal protection of motor

Function :

Indirect protection of the motor by continuous calculation of I^2t .

This function provides thermal protection of the motor in the following cases :

- ambient temperature around the motor $\leq 40\text{ }^{\circ}\text{C}$
- extended operation between 30 Hz and 50/60 Hz with self-ventilated motor
- above 30 Hz, when the decrease in motor ventilation is taken into account in the calculation
- maintaining power to the speed controller. The thermal state memory is cleared when the speed controller is switched off.

I_{th} : 0.5 to 1.15 times the permanent output current of the speed controller, factory set at 1.0 times.

Set to the nominal current indicated on the motor rating plate.

To disable thermal protection : increase the adjustment value to the maximum.

In the case of motors connected in parallel on the same speed controller, each motor starter must be fitted with a thermal overload relay, in order to compensate for any risk of unequal distribution of loads.

Thermal protection of speed controller

Function :

- Indirect protection of the speed controller by current limit.

This function provides thermal protection of the speed controller under normal ambient temperature conditions.

Typical tripping levels :

- motor current = 185 % of the nominal speed controller current : 2 seconds
- motor current = maximum speed controller transient current : 60 seconds

- Protection via thermistor fitted on the heatsink.
-

Operation on line supply at - 40 %

Function :

Reduces the trip threshold of the "undervoltage" fault to operate on a line supply with voltage drops of 40 %.

Warning: It is essential to use a line choke.

The speed controller performance is reduced when operated at undervoltage.

Variable speed controllers for asynchronous motors

Altivar 28 Logic input application functions

Description (continued)

Forward/reverse operation

Function :

Reverse operation can be disabled for applications with a single direction of motor rotation.
Example : fans

2-wire control

Function :

Run (forward or reverse) and stop are controlled by the same logic input for which state 1 (run) or 0 (stop) is taken into account.

To take account of machine safety requirements, the restart mode after loss of supply can be configured.

3-wire control

Function :

Run (forward or reverse) and stop are controlled by 2 different logic inputs.
LI1 is always assigned to the stop function. Stop occurs on opening (state 0).

The pulse on the run input is memorized until the stop input is opened.

On power-up or after a manual or automatic fault reset, the motor can only be powered once the "forward", "reverse" and "injection stop" commands have been reset.

Ramp switching : 1st ramp : ACC, DEC; 2nd ramp : AC2, DE2

Function :

This can be activated in 2 ways :
- by activating a logic input LIx
- by detecting an adjustable frequency threshold

If a logic input is assigned to the function, ramp switching can only be performed by this input.

Step by step operation (JOG)

Function :

Low speed pulse operation. Minimum time between 2 pulses : 0.5 seconds.

Applications :

- Machines with insertion of product in manual operation.
- Gradual advancing of the mechanism during a maintenance operation.

If the JOG contact is closed then the operating direction contact activated, the ramp is 0.1 s whatever the ACC, dEC, AC2 and dE2 settings. If the operating direction contact is closed then the JOG contact activated, the configured ramps are used.

Parameter which can be accessed in the adjust menu :

- JOG speed

Variable speed controllers for asynchronous motors

Altivar 28 Logic input application functions

Description (continued)

Preset speeds

Function :

Switching preset speed references.

Applications :

Material handling and machines with 2 or 4 operating speeds.

Assignments :

2, 4 or 8 speeds can be preset, requiring 1, 2 or 3 logic inputs respectively.

- 2 speeds

Llx = 0 1st speed = LSP + reference
Llx = 1 2nd speed = HSP

- 4 speeds

Llx = 0 and Lly = 0 1st speed = LSP or reference if it is present
Llx = 1 and Lly = 0 2nd speed (adjustable from LSP to HSP)
Llx = 0 and Lly = 1 3rd speed (adjustable from LSP to HSP)
Llx = 1 and Lly = 1 4th speed = HSP

- 8 speeds

Llx = 0, Lly = 0 and Llz = 0 1st speed = LSP or reference if it is present
Llx = 1, Lly = 0 and Llz = 0 2nd speed (adjustable from LSP to HSP)
Llx = 0, Lly = 1 and Llz = 0 3rd speed (adjustable from LSP to HSP)
Llx = 1, Lly = 1 and Llz = 0 4th speed (adjustable from LSP to HSP)
Llx = 0, Lly = 0 and Llz = 1 5th speed (adjustable from LSP to HSP)
Llx = 1, Lly = 0 and Llz = 1 6th speed (adjustable from LSP to HSP)
Llx = 0, Lly = 1 and Llz = 1 7th speed (adjustable from LSP to HSP)
Llx = 1, Lly = 1 and Llz = 1 8th speed = HSP

Factory settings : 4 speeds

1st speed : LSP = 0 + analogue reference

2nd speed : 10 Hz

3rd speed : 15 Hz

4th speed : HSP = 50 Hz

To unassign the logic inputs, the following order must be observed : PS8 (Llz), then PS4 (Lly), then PS2 (Llx).

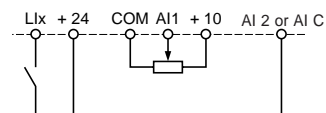
Note : The "preset speeds" function is not compatible with the PI function.

Reference switching

Function :

Two references are switched (AI1 reference and AI2 or AIC reference) by a command on a logic input.

This function automatically assigns AI2 or AIC to speed reference 2.

Connection diagram :

Contact open, reference = AI2 or AIC
Contact closed, reference = AI1

If AI2 or AIC is assigned to the PI function, operation combines both functions, see page 38.

Variable speed controllers for asynchronous motors

Altivar 28 Logic input application functions

Description (continued)

Freewheel stop

Function :

Stops the motor using the resistive torque only. The motor power supply is cut. Freewheel stop occurs when the logic input opens (state 0).

d.c. injection stop

Functions :

Both the following operating modes may be used individually or together on the same speed controller :

- d.c. injection braking, automatic on stopping (frequency < 0.5 Hz)
 - current on stopping can be set from 0.25 times the motor thermal current I_{th} to 1 times the speed controller permanent current. Factory setting 0.7 times the speed controller current.
 - braking time on stopping : 0 to 25 seconds or continuous.
- d.c. injection braking activated by logic command, LI2, LI3 or LI4 :
 - braking when LI is activated
 - fixed braking current : nominal speed controller current for 5 seconds then 0.5 motor I_{th}.

Applications :

- Low speed braking of high inertia fans.
- Maintaining a standstill torque (0.2 to 0.4 T_n) for fans located in an air flow.

Factory setting : automatic on stopping only, 0.5 seconds.

Note : Injection braking is disabled if the fast stop function is in progress.

Fast stop

Validation : 1 logic input LI2, LI3 or LI4. Fast stop when the logic input opens (state 0).

Function :

Braked stop with the deceleration ramp time divided by 4 but at the minimum accepted by the speed controller-motor assembly without locking on an **overbraking** fault (time increased if the braking capability is exceeded).

Applications :

Conveyors with electrical emergency stop braking (optimization of the braking time according to the load).

Note : On a fast stop, automatic injection braking or braking on a logic input is disabled.

Fault reset

Function :

Clears the memorized fault and resets the speed controller if the cause of the fault has disappeared, except in the case of the following faults : OCF (overcurrent), SCF (motor short-circuit), EFF and InF (internal faults) which require the controller to be switched off.

The fault is cleared when the logic input changes from 0 to 1.

Forced local mode when using the serial link (option)

Function :

Changes from line control mode (serial link) to local mode (control via the terminals).

Variable speed controllers for asynchronous motors

Altivar 28 Analogue input application functions

Description

Speed reference

Function :

2 factory set summing inputs.

- 1 speed reference input + 10 V (AI1)
- 1 additional analogue input used
 - either with voltage 0 + 10 V (AI2)
 - or with current X-Y mA (AIC), X and Y can be configured from 0 to 20 mA

Applications :

Machines where the speed is controlled by an external parameter.

PI regulator

The reference is the input AI1 or an internal reference (rPI) which can be adjusted via the Altivar 28 keypad. AI2 or AIC can be assigned to feedback.

Function :

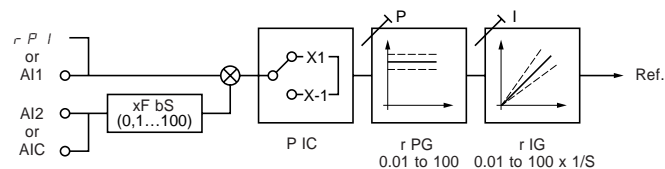
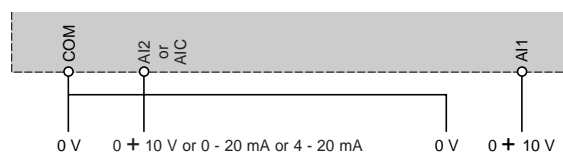
Simple regulation of flow rate or pressure with a sensor sending a feedback signal adapted to the speed controller.

Applications :

Pumping and ventilation

Adjustable parameters :

- regulator proportional gain (rPG)
- regulator integral gain (rIG)
- PI feedback multiplication coefficient (FbS) : adjusts the maximum feedback value so that it corresponds to the maximum value of the PI regulator reference
- reversal of correction direction (PIC) : if PIC = no, the speed of the motor increases when the error is positive, if PIC = yes, the speed of the motor decreases when the error is positive.

**Connection diagram :**

Feedback by flow rate or pressure sensor

Speed reference controlled by flow rate or pressure

Note : The PI function is not compatible with the “preset speeds” and “step by step” (JOG) functions.

“Manual-Automatic” operation with PI

Function :

This function combines the PI regulator and reference switching by a logic input. The speed reference is given by AI1 or by the PI function, depending on the state of the logic input.

Warning : If a logic input is assigned to “reference switching” (see page 36), only input AI3 can be used for PI.

Variable speed controllers for asynchronous motors

Altivar 28

Relay and analogue output application functions

Description

R2 relay

Frequency threshold reached :

The relay contact is closed if the motor frequency is greater than or equal to the frequency threshold set by Ftd in the adjust menu.

Speed reference reached :

The relay contact is closed if the motor frequency is greater than or equal to the speed reference value.

Current threshold reached :

The relay contact is closed if the motor current is greater than or equal to the current threshold set by Ctd in the adjust menu.

Thermal state reached :

The relay contact is closed if the motor thermal state is greater than or equal to the thermal state threshold set by ttd in the adjust menu.

Analogue output AO

Function :

Analogue output AO is a current output, which can be configured for 0-20 mA or 4-20 mA.

Motor current :

Supplies the image of the motor rms current.
20 mA corresponds to twice the nominal motor thermal current Ith.

Motor frequency :

Supplies the motor frequency calculated by the speed controller.
20 mA corresponds to the maximum frequency (parameter tFr).

Motor torque :

Supplies the image of the motor torque as an absolute value.
20 mA corresponds to twice the nominal motor torque (typical value).

Power :

Supplies the image of the power supplied to the motor by the speed controller.
20 mA corresponds to twice the nominal speed controller power.

Variable speed controllers for asynchronous motors

Altivar 28
Configurable I/O

Description

Compatibility of configurable I/O functions

Only functions which may be incompatible with other functions are listed in this table.

- Stop functions have priority over run commands.
- Speed references via logic command have priority over analogue setpoints.

The choice of functions is limited :

- by the number of speed controller inputs and outputs to be reassigned
- by the incompatibility of certain functions with others

Function	d.c. injection braking	Summing input	PI regulator	Reference switching	Freewheel stop	Fast stop	Jog operation	Preset speeds
d.c. injection braking					↑			
Summing input			⊖	⊖				
PI regulator		⊖					⊖	⊖
Reference switching		⊖						⊖
Freewheel stop	←					←		
Fast stop					↑			
Jog operation			⊖					←
Preset speeds			⊖	⊖			↑	

- ⊖ Incompatible functions
- Compatible functions
- Not applicable

Priority functions (functions which cannot be active simultaneously) :

- ← The direction of the arrow indicates which function has priority.
- ↑

Example : The "Freewheel stop" has priority over the "d.c. injection braking" function.

Variable speed controllers for asynchronous motors

Altivar 28
Configurable I/O

Description (continued)

Summary of configurable I/O assignments

Speed controller I/O		R2 relay	Analogue input AI2/AIC	3 logic inputs LI2-LI3-LI4	Analogue output AO
Possible assignment	Reverse operation				
	Alternate ramp switching				
	Step by step (JOG)				
	Preset speeds				
	Reference switching				
	Freewheel stop				
	Injection stop				
	Fast stop				
	Forced local mode				
	Fault reset				
	Summing reference				
	PI regulator				
	2nd speed reference				
	Frequency threshold reached				
	Frequency reference reached				
	Current threshold reached				
	Thermal threshold reached				
	Motor current				
	Motor frequency				
	Power delivered				
	Motor torque				



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