

# Telemecanique

*Altivar* 28 drive

*Altivar* 28 enclosed drive

March

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Merlin Gerin

Modicon

Square D

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**Schneider**  
 Electric

# Variable speed controllers for asynchronous motors

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## Altivar 28

### Presentation, functions

#### Presentation

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/packaging. 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  $\square$  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

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

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Characteristics (continued)

## Drive characteristics

<b>Output frequency range</b>	0.5 ... 400 Hz
<b>Maximum transient current</b>	150 % of nominal speed controller current, for 60 seconds (typical value)
<b>Transient overtorque</b>	150...170 % of nominal motor torque (typical value)
<b>Braking torque</b>	30 % of nominal motor torque without braking resistor (typical value). Up to 150 % with braking resistor as an option
<b>Voltage/frequency ratio</b>	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
<b>Frequency loop gain</b>	Preset in the factory. Correction possible for machines with high resistive torque or high inertia, or for machines with short cycles
<b>Slip compensation</b>	Automatic regardless of the load Elimination (or adjustment) possible
<b>Switching frequency</b>	Can be adjusted during operation from 2 to 15 kHz

## Electrical characteristics

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

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Characteristics (continued)

## Electrical characteristics (continued)

<b>Configurable logic inputs LI</b>	4 logic inputs with impedance of 3.5 k $\Omega$ , isolated + 24 V power supply (maximum 30 V), state 0 if < 5 V, state 1 if > 11 V
<b>Configurable relay output R2</b>	1 C/O contact Minimum switching capacity : 10 mA for $\text{---}$ 5 V Maximum switching capacity : on inductive load : 1.5 A for $\sim$ 250 V ( $\cos \varphi = 0.4$ ) and $\text{---}$ 30 V (L/R = 7 ms)
<b>Acceleration and deceleration ramps</b>	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
<b>Braking to standstill</b>	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
<b>Speed controller protection and safety features</b>	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
<b>Motor protection</b>	Thermal protection integrated in the speed controller by calculation of $I^2t$ Protection against loss of phase
<b>Fault relay R1</b> (fault information output)	1 N/C contact and 1 N/O contact with common point Minimum switching capacity : 10 mA for $\text{---}$ 5 V Maximum switching capacity : on inductive load : 1.5 A for $\sim$ 250 V ( $\cos \varphi = 0.4$ ) and $\text{---}$ 30 V (L/R = 7 ms)
<b>Signalling</b>	1 red LED on the front panel : - LED on = Altivar powered up Coded display via 4-character 7-segment display unit
<b>Communication</b>	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

# Variable speed controllers for asynchronous motors

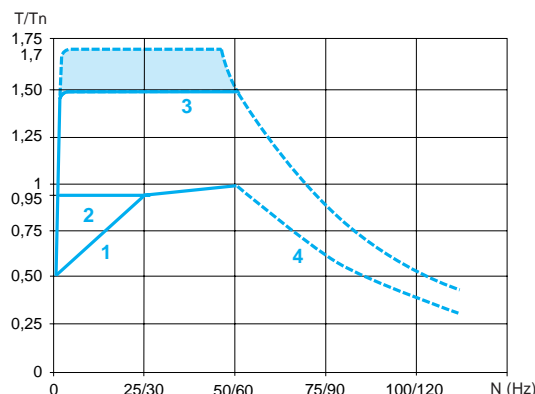
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## Characteristics, special uses

### 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

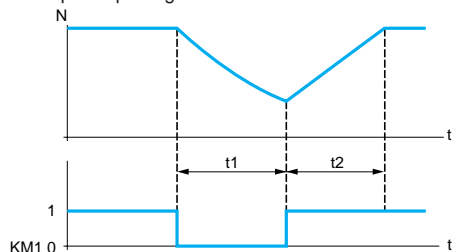
The speed controller rating must be greater than or equal to the sum of the currents of the motors to be connected to this speed controller.

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.

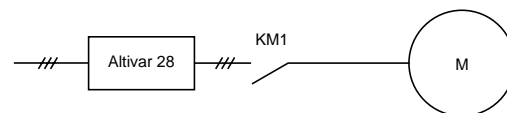
#### Switching the motor on the speed controller output

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  $\leq 250$  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

### Speed controllers with frequency range from 0.5 to 400 Hz



ATV-28HU09M2

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

#### 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)		Max. prospective line Isc kA	Altivar 28			Max. transient current (3)	Power dissipated at nominal load W	Reference	Weight kg
	at U1	at U2		Nominal current at 380 V at 500 V to 460 V A		A				
kW Hp	A	A	kA	A	A	A				
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 Isc	Altivar 28 Nominal current		Max. transient current (3)	Reference	Weight
	at U1	at U2						
kW	HP	A	A	kA	A	A		kg
0.37	0.5	7.3	6.1	1	3.3	3.6	<b>ATV-28EU09M2</b>	5.000
0.75	1	9.8	8.2	1	4.8	6	<b>ATV-28EU18M2</b>	5.000
1.5	2	16	13.5	1	7.8	10.9	<b>ATV-28EU29M2</b>	6.500
2.2	3	22.1	18.6	1	11	15	<b>ATV-28EU41M2</b>	9.500

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

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

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

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



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Dimensions

## Dimensions ATV-28H●●●●●

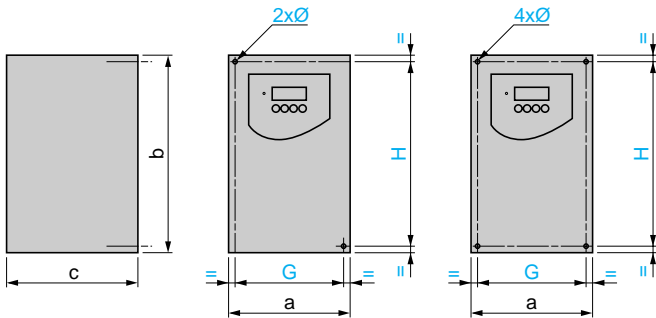
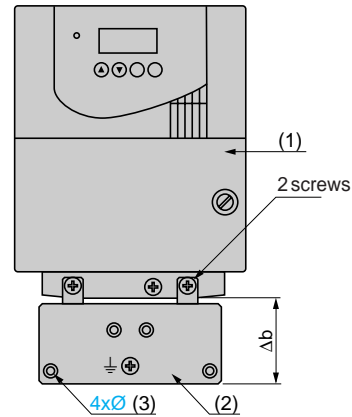


Plate for EMC mounting (supplied with the speed controller)

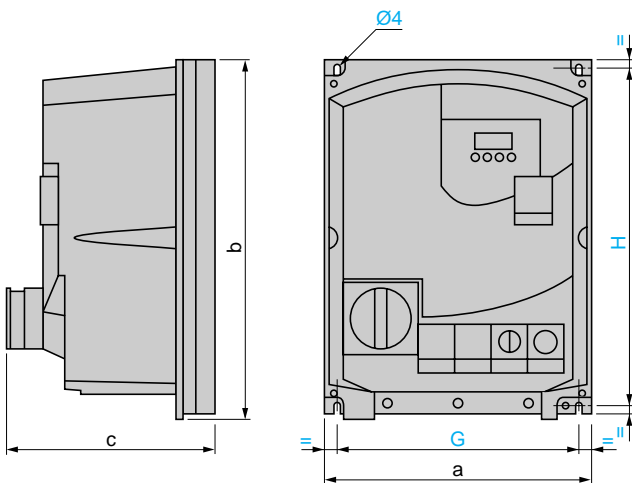


ATV-28H	a	b	c	G	H	2Ø	4Ø
U09M2, U18M2	105	130	140	93	118	5	—
U29M2, U18N4, U29N4	130	150	150	118	138	—	5
U41M2, U54M2, U72M2, U41N4, U54N4, U72N4	140	195	163	126	182	—	5
U90M2, D12M2, U90N4, D12N4	200	270	170	180	255	—	6
D16N4, D23N4	245	330	195	225	315	—	6

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

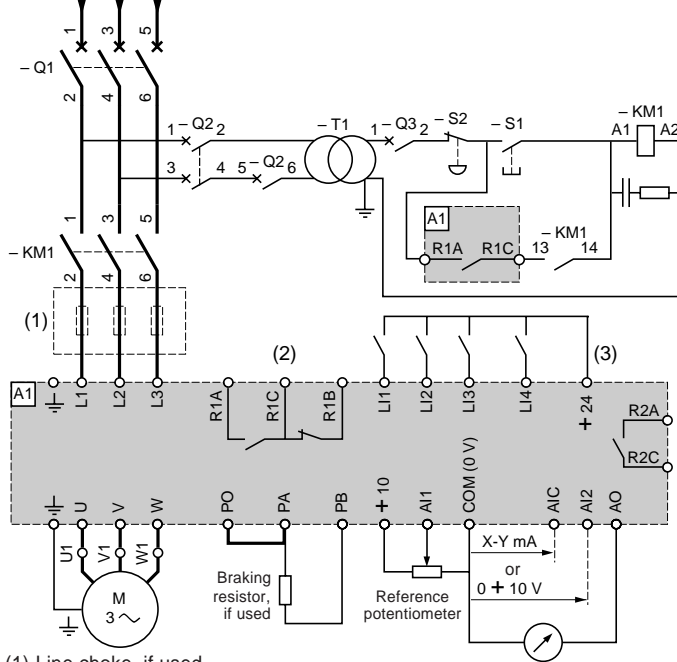
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Schemes

## Schemes

ATV-28H●●●●● (3-phase supply)



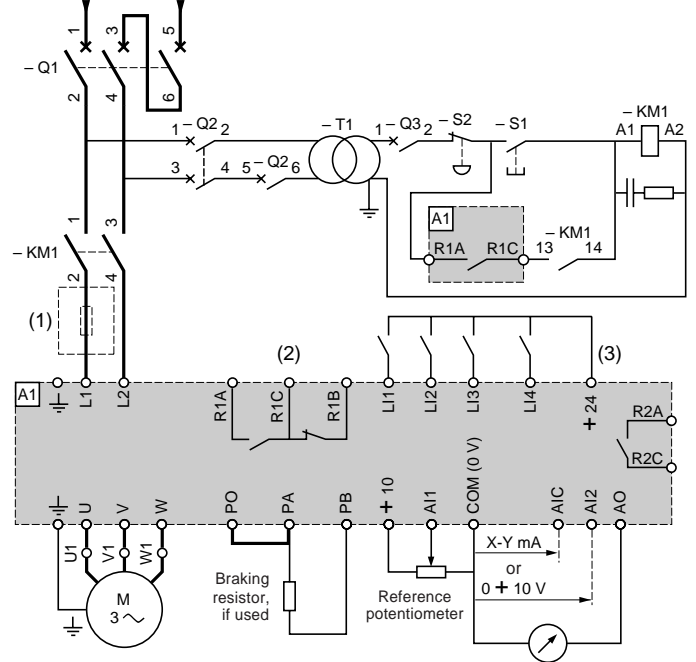
(1) Line choke, if used

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

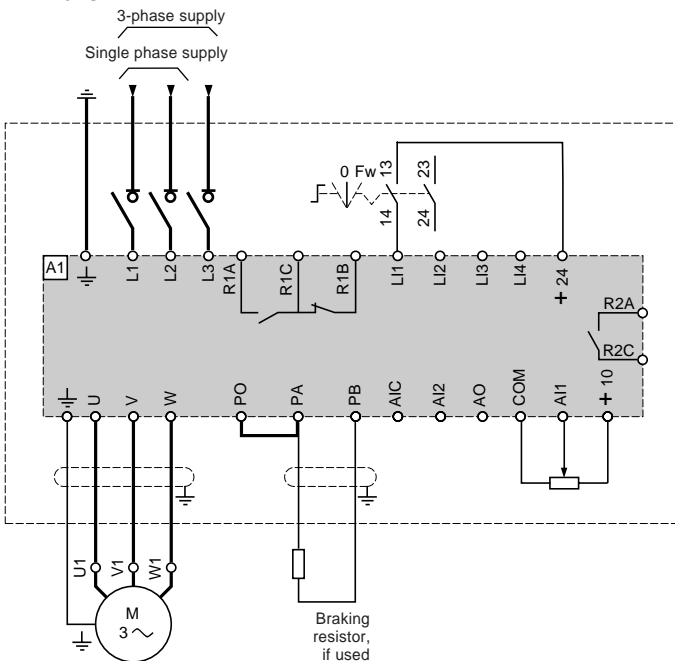
(3) Internal + 24 V. If using an external + 24 V power supply, connect the 0 V from that supply to the COM terminal (do not use the + 24 terminal on the speed controller) and connect the LI inputs common to the + 24 V of the external power supply.

**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.

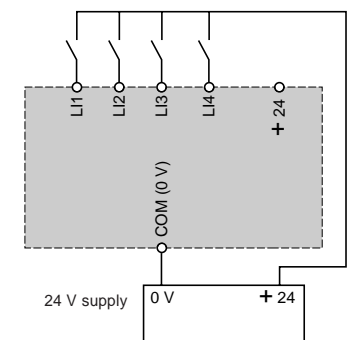
ATV-28H●●●●● (single phase supply)



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