AccurET Modular 300 Position Controllers

Hardware Manual

Version L

ETEL

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Table of contents

Record of revisions:

Document revisions		
Version	**Date**	**Main modifications**
Ver A	10.01.11	First version
Ver B	29.03.12	Updated version - UL certification completed
Ver C	12.09.13	Updated version - Minor changes
Ver D	08.05.14	Updated version - Minor changes
Ver E	08.12.14	Updated version - Dual encoder feedback connection (refer to §3.2.5) - Technical details added
Ver F	06.07.16	Updated version: - Low voltage directive 2006/95EC replaced by 2014/35/EU and EMC Directive 2004/108EC replaced by 2014/30/EU - Minor changes
Ver G	19.10.17	Updated version: - Safe Torque Off (STO) function added (refer to §3.6)
Ver H	20.11.18	Updated version: - Inductance calculation (refer to §2.3.1) - Include new product codification for EtherCAT variant (refer to §2.5.1)
Ver I	17.05.19	Updated version: - Minor modification concerning Hall effect sensor (refer to §3.3.1)
Ver J	26.11.19	Updated version: - I/O commutation times updated (refer to §3.3.1 & §3.3.2) - Minor changes
Ver K	18.09.20	Updated version: - Additional information (refer to §1.2.5, §1.2.6 and §1.2.7) - Power supply information updated (refer to §2.2.2) - Ordering information updated (refer to §2.5) - Relay updated (refer to §3.6)
Ver L	14.09.21	Updated version: - Minor changes

Documentation concerning the AccurET Modular 300:

- **Hardware Manual** — **Specifications & electrical interfaces**
- Operation & Software Manual — AccurET setup, use & programming manual
- Service Manual — Maintenance of the fuse
- Functional Safety User's Manual — Functional Safety implementation

The AccurET Modular 300 position controllers as well as their corresponding power supply have been successfully tested and evaluated to meet the UL 508C for US market.

This standard describes the fulfillment by design of minimum requirements for electrically operated power conversion equipment which is intended to eliminate the risk of fire, electrical shock, or injury to persons being caused by such equipment.

1. Introduction

This document concerns a two axes position controller of ETEL's AccurET family: the AccurET Modular 300 (EA-P2M-300-xxxxxA) also called 'controller' in this document as well as its corresponding power supply 300 (EA-S0M-300-xx/xxA) also called ’power supply’ in this document.
The purpose of this manual is to give details regarding the specifications, installation, interfacing and hardware items. All details for proper connections are provided herein. Detailed information concerning the programming of the controller is provided in the corresponding **'Operation & Software Manual'**.

Remark: The updates between two successive versions are highlighted with a modification stroke in the margin of the manual.

1.1 Safety

The user must have read and understood this documentation before carrying out any operation on an AccurET Modular controller and its corresponding power supply. Please contact ETEL or authorized distributors in case of missing information or doubt regarding the installation procedures, safety or any other issue.

	**ETEL SA disclaims all responsibility to possible industrial accidents and material damages if the procedures & safety instructions described in this manual are not followed (including the ones given in the manuals listed page 5).**

- Never use the controller and the power supply for purposes other than those described in this manual.
- A competent and trained technician must install and operate the controller and the power supply, in accordance with all specific regulations of the respective country concerning both safety and EMC aspects.
- Troubleshooting and servicing are permitted only by ETEL's technicians and agreed distributors.
- The customer must provide at all times the appropriate protections against electrical direct contact and moving parts of the connected system. Operating the controller will make the motor move.
- The safety symbols placed on the controller or written in the manuals (page 5) must be respected.
- If the controller and the power supply are integrated into a machine, the manufacturer of this machine must establish that it fulfills the 2014/30/EU directive on EMC before operating the controller.

	**Signals a danger of electrical shock to the operator. Can be fatal for a person.**
	**Signals a danger for the controller and the power supply. Can be destructive for the material. A danger for the operator can result from this.**
	**Indicates electrostatic discharges (ESD), dangerous for the controller and the power supply. The components must be handled in an ESD protected environment.**

Remark: The controller associated to its motor connector complies with the 2014/30/EU directive on EMC and the 2014/35/EU low voltage directive.

1.2 Presentation

1.2.1 Working principle

AccurET position controllers are supplied in a modular format dedicated to multi-axis applications where a single power supply unit is able to power many AccurET units to minimize the space required for the Electronics. Their modular cooling unit as well as their versatile design allow several configurations. These controllers include on a single board, the control circuits, the power bridge and all the necessary interfaces for the communication, the encoders and the inputs/outputs for two motors.

1.2.2 Applications

The AccurET modular 300 can drive two, single-phase, two-phase or/and three-phase motors. This controller can drive brushless motors, DC motors, steppers, etc. They must also be fitted with analog incremental 1 Vpp encoders, or absolute encoders (EnDat 2.1 and EnDat 2.2) or TTL encoders. Digital Hall effect sensors can also be connected to the controller. It is also possible to drive stepper motors in open loop (no need for encoders in this case).

1.2.3 General operating conditions

	**- The AccurET controller is an open type device and must be installed in an enclosure providing electrical, mechanical and fire protection as well as controlled environment such as temperature, humidity, and pollution degree 2,…(refer to UL 508C and EN 61800-5-1 standards for more information).** **- Never switch the unit ON outside of the enclosure.** **- The controllers and their corresponding power supply must be connected to an electrical network of overvoltage category III (refer to EN 61800-5-1 and UL 508C standards for more information) and are suitable for use on a circuit capable of delivering not more than 5000 Arms, symmetrical amperes.** **- All control voltages or all connections (except Mains) must fulfill requirements for Limited Voltage Circuits/ Isolated Secondary Circuits.** **- The controllers must have its control input (X100) connected to a power supply with SELV outputs (Isolated secondary output).** **- The control input 0 VDC is internally connected to the Protective Earth (PE).**
	**- The AccurET modular 300 are designed to operate in a non-aggressive and clean environment, within a humidity range of 10 % and 85 %, an altitude < 2000 m (6562 ft), and a temperature range between +10 °C (50 °F) and +40 °C (104 °F).** **- The AccurET modular 300 are intended for use in the second environment(1).** **- The AccurET modular 300 are not designed or intended for use in the on-line control of air traffic, aircraft navigation and communications as well as critical components in life support systems or in the design, construction, explosive atmosphere, operation and maintenance of any nuclear facility.** **- ETEL recommends limiting the vibration level of AccurET controllers by not mounting them on highly dynamic moving parts.**

(1): Definition of Second Environment in product standard EN 61800-3 (2004): Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes (industrial areas and technical areas of any building fed from a dedicated transformer are examples of second environment locations).

1.2.4 Transport and storage conditions

	**- During the transport and the storage, the controller and the corresponding power supply must remain inside their original packaging which complies with the ESD standard.**
	**- The transport conditions must respect the class 2K3 of the IEC 60721-3-2 standard (temperature between -25 °C (-13 °F) and +70 °C (+158 °F), and humidity < 95 % without condensation).** **- The storage conditions must respect the class 1K2 of the IEC 60721-3-1 standard (temperature between +5 °C (+41 °F) and +45 °C (+113 °F), and humidity between 5 and 85 % without condensation).**

1.2.5 Unpacking, packing and handling

When removed from the original packaging, the controller shall be manipulated with ESD protective equipment. The housing of the controller protects the inner components, but discharges might occur when touching the connectors, which are in direct contact with the electronic components.
If the controller must be transferred or shipped (including returns to ETEL for service and repair), it must be packed in the original package.
Before unpacking the controller, the unit shall be placed in the room at working environmental conditions (in accordance with the requirements stated in §1.2.3) during at least 2 hours. This is to avoid damages due to condensation. If the controller is transferred in the operating room within a complete system, the acclimation time shall be adapted to the thermal inertia of the complete system.

1.2.6 Installation and initial operation

- Mechanical mounting: refer to §2.4.
- Electric Interface: refer to §3.
- Operating and software: refer to “Operation & Software Manual”.

The AccurET modular 300 is intended to move axes, and this can lead to some risks at the machine level:

Warning	
	**Faulty machine performance** Collision with persons, property damage to machine - Inappropriate use may cause considerable damage to persons or property. ETEL does not accept any responsibility for direct or indirect damage caused to persons or property through improper use or incorrect operation of the machine. - Before switch-on, close the electrical cabinet - Commissioning is to be performed only by qualified personnel - Remember that kinetic energy is stored in the movable parts of a machine and that it may continue to move without braking if the servo drives suddenly fail. - During initial switch-on after installation, maintain a safe a distance from the inverters or power stages and drives. If malfunctions occur, switch off the power supply of the system, and contact qualified personnel.

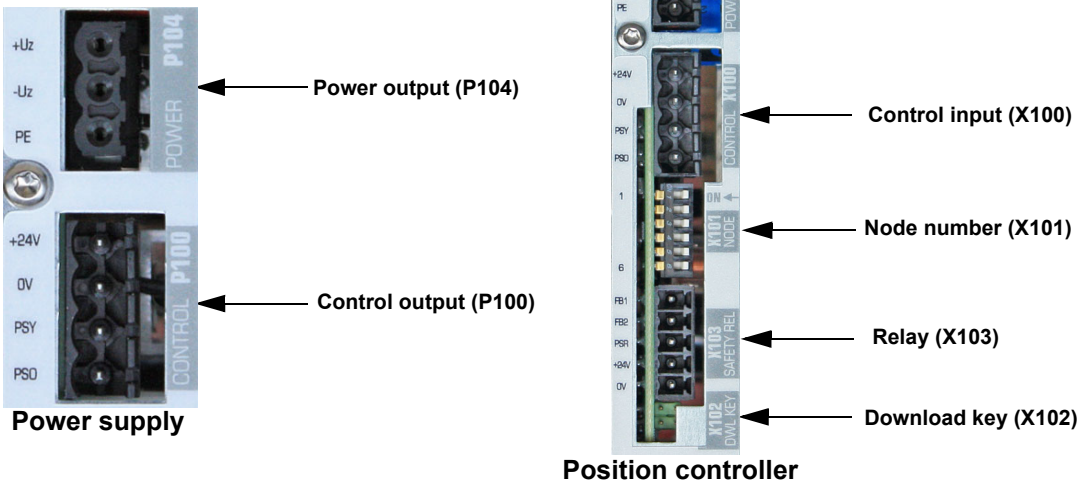
Notice	
	Prior to the following tests, the machine or system must be disconnected from the power supply and tested for zero voltage! - The continuity of the protective conductor circuit is to be inspected (10 A testing current is recommended), EN 60204-1. - Check the protective conductor contact resistance according to EN 60204-1, EN 61800-5-1 or a nationally valid standard. - Conduct a visual inspection on the security of all connections, in particular of the protective conductor connections. - For the correct grounding of protective conductor of the controller, please refer to §3.10. - Ensure that no flammable objects are near the vent openings.

1.2.7 Maintenance operations

No maintenance operation is required. No replacement of safety-related components is necessary during the lifetime of the product.

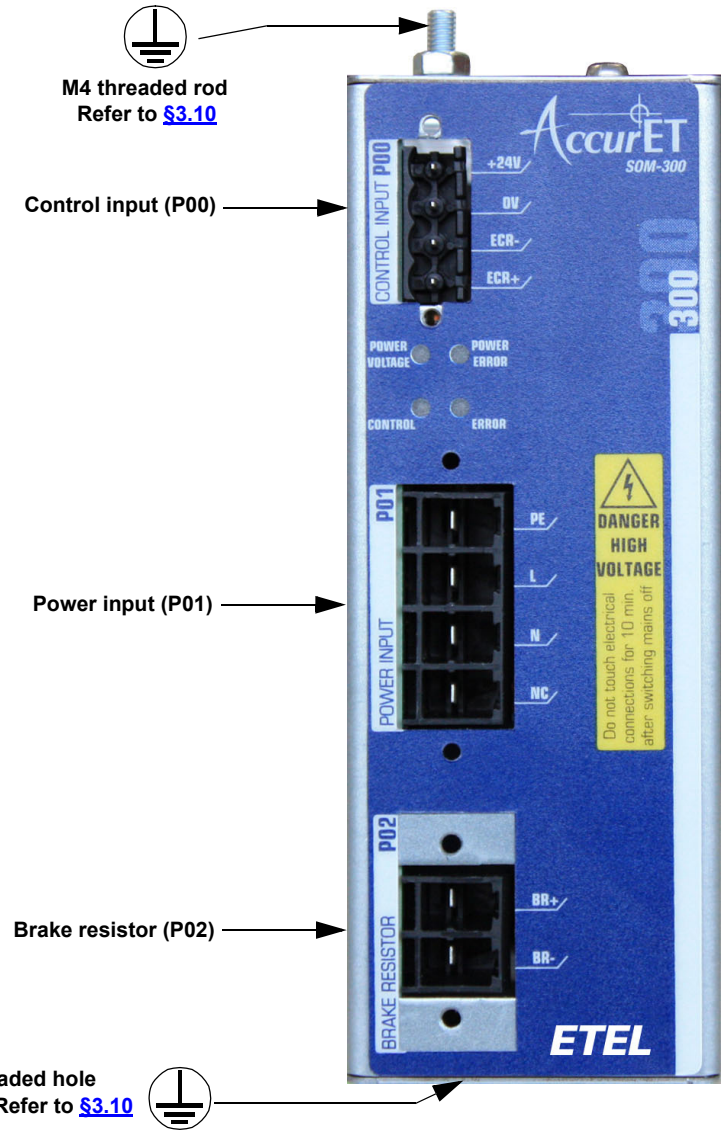
1.3 Connection diagram

1.3.1 Top view



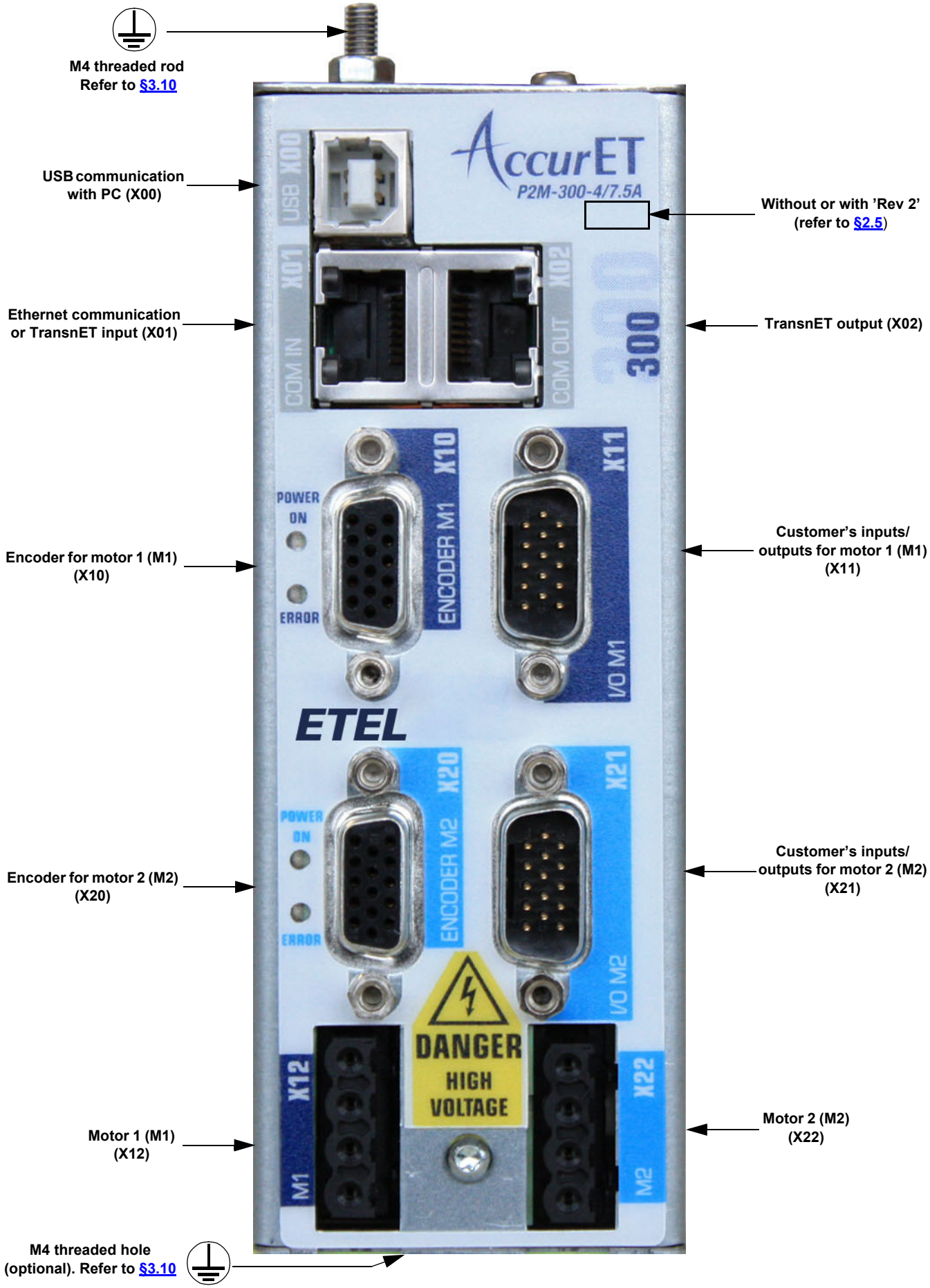
1.3.2 Front view

- **Power supply**



Remark: Refer to §3. for more information.

- **Position controller**



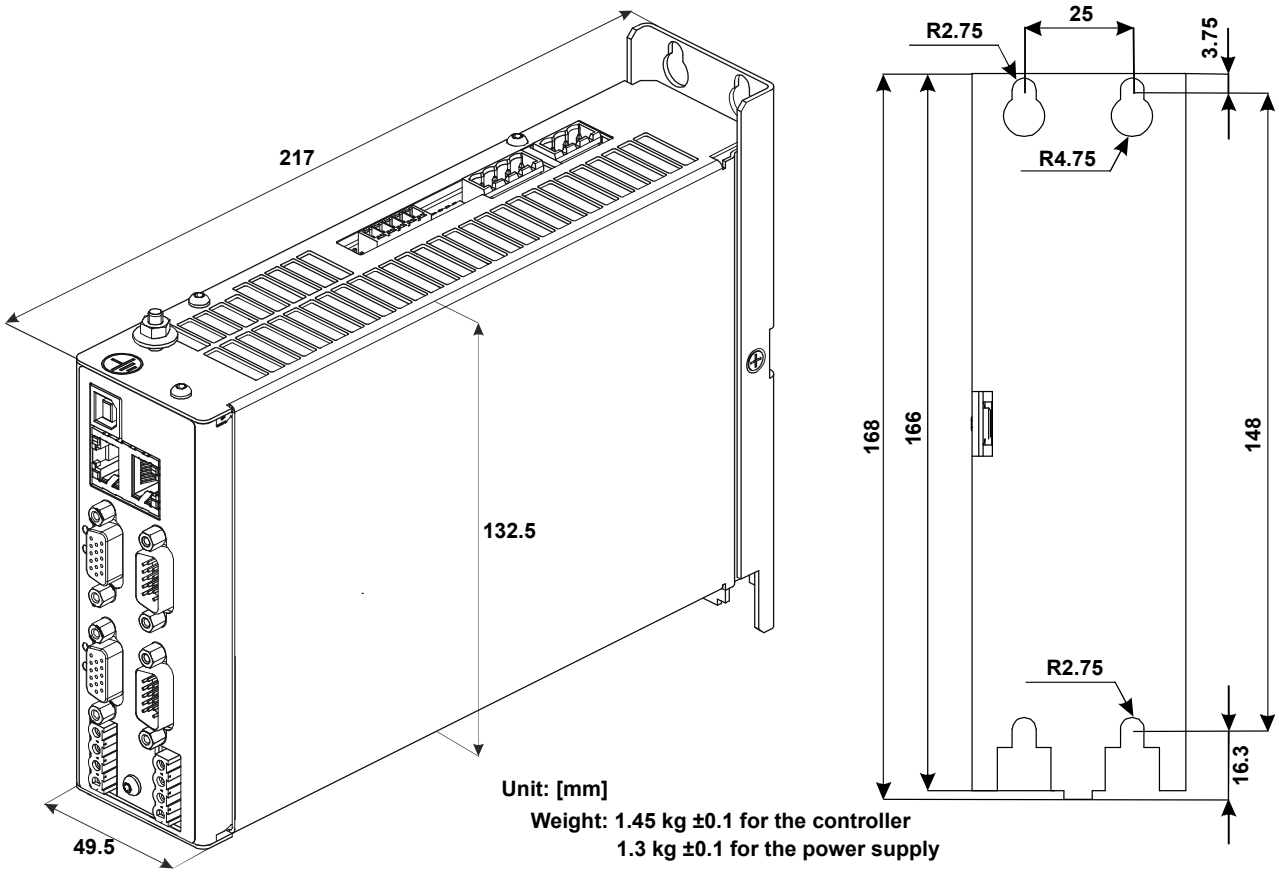
Remark: Refer to §3. for more information. A wider version also exists to accommodate an optional board.

2. Models characteristics

Depending on the possibility to have or not an optional board, there are two different widths for the controller AccurET 300 (50mm and 75mm). The power supply 300 has the same dimensions as the 50mm width controller.

2.1 Outline and dimensions

2.1.1 Controller without optional board slot



Unit: [mm]

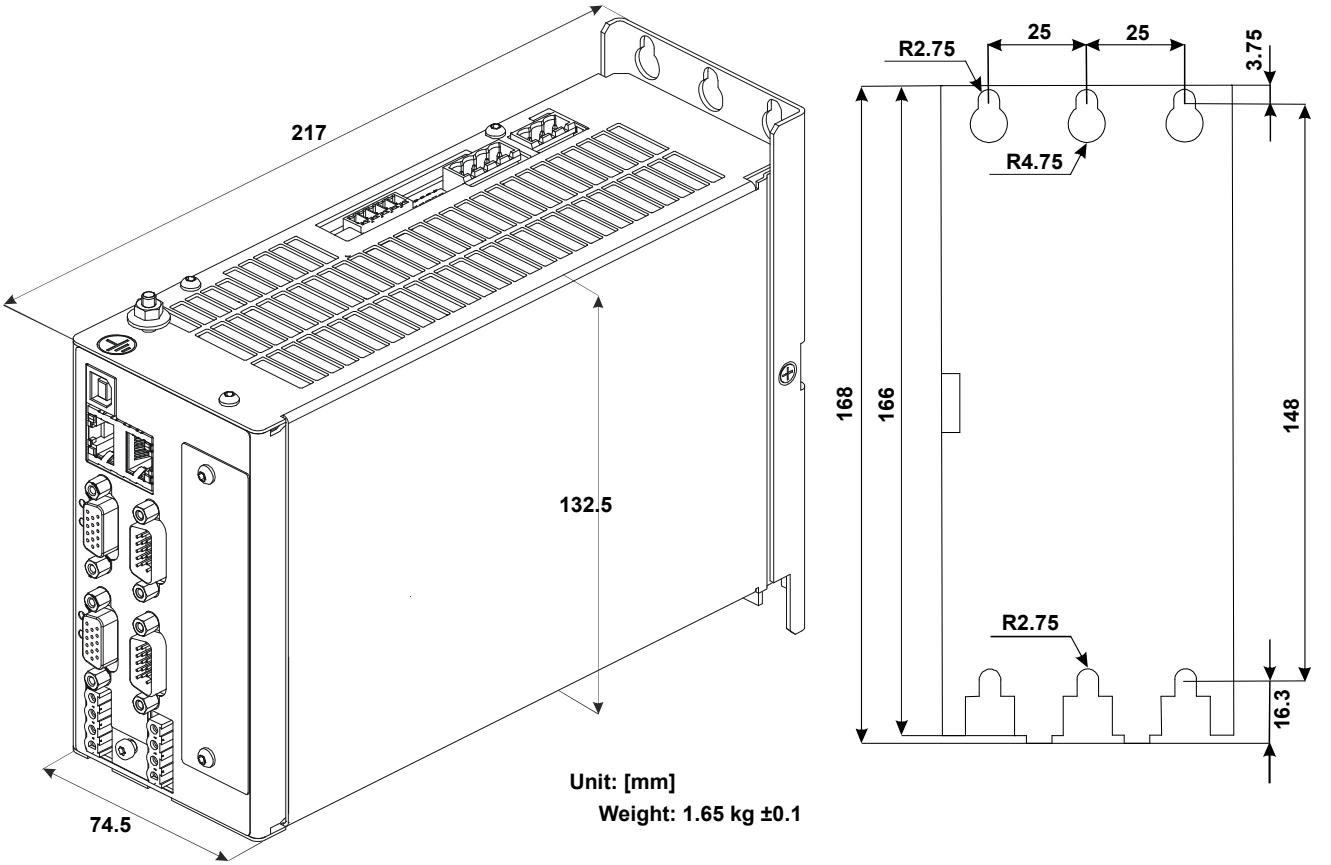
Weight: 1.45 kg ±0.1 for the controller
1.3 kg ±0.1 for the power supply

Remark: If the user needs the ETEL cooling system, the center-to-center distance between the screws at the top of the controller and the bottom screws used to fix the mounting bar is 169 mm (refer to §2.4).

It is recommended to leave 100mm above and under the controller to guarantee an air flow (the fan power depends on the user application). **Caution: some magnetic components such as the fans** (not those present in ETEL's cooling unit) **may perturb the current measurement of the controller if they are too close**. If this problem occurs, use another type of fan or increase the distance between **the fan and the controller while ensuring the following minimum air flow**: 65.4m^3/h for a 50mm width and 76.4m^3/h for a 75mm width.

The ventilation must be activated as soon as the control and/or power input is switched on.

2.1.2 Controller with optional board slot



Remark: If the user needs the ETEL cooling system, the center-to-center distance between the screws at the top of the controller and the bottom screws used to fix the mounting bar is 169 mm (refer to §2.4).

It is recommended to leave 100mm above and below the controller to guarantee an air flow (the fan power depends on the user application). **Caution: some magnetic components such as the fans** (not those present in ETEL's cooling unit) **may perturb the current measurement of the controller if they are too close**. If this problem occurs, use another type of fan or increase the distance between **the fan and the controller while ensuring the following minimum air flow**: 65.4 m^3/h for a 50 mm width and 76.4 m^3/h for a 75 mm width.

The ventilation must be activated as soon as the control and/or power input is switched on.

2.1.3 Weight

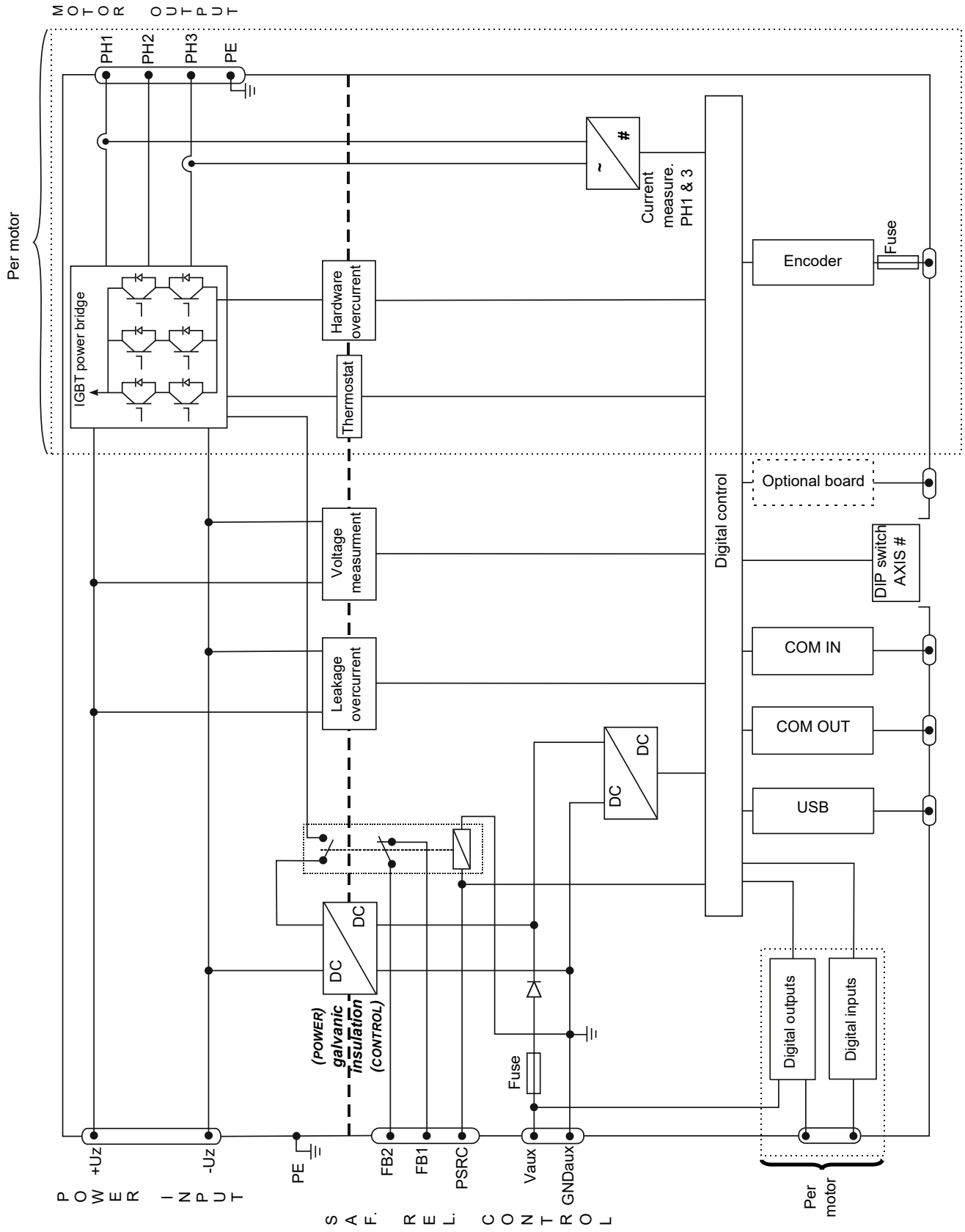
The weight and the correspondence between the controller/power supply's width and the AccurET type can be found in the following table:

	AccurET 300		Power 300
Characteristics	Any current without optional board slot	Any current with optional board slot	-
Width	50 mm	75 mm	50 mm
Weight	1.45 kg ±0.1	1.65 kg ±0.1	1.4 kg ±0.1

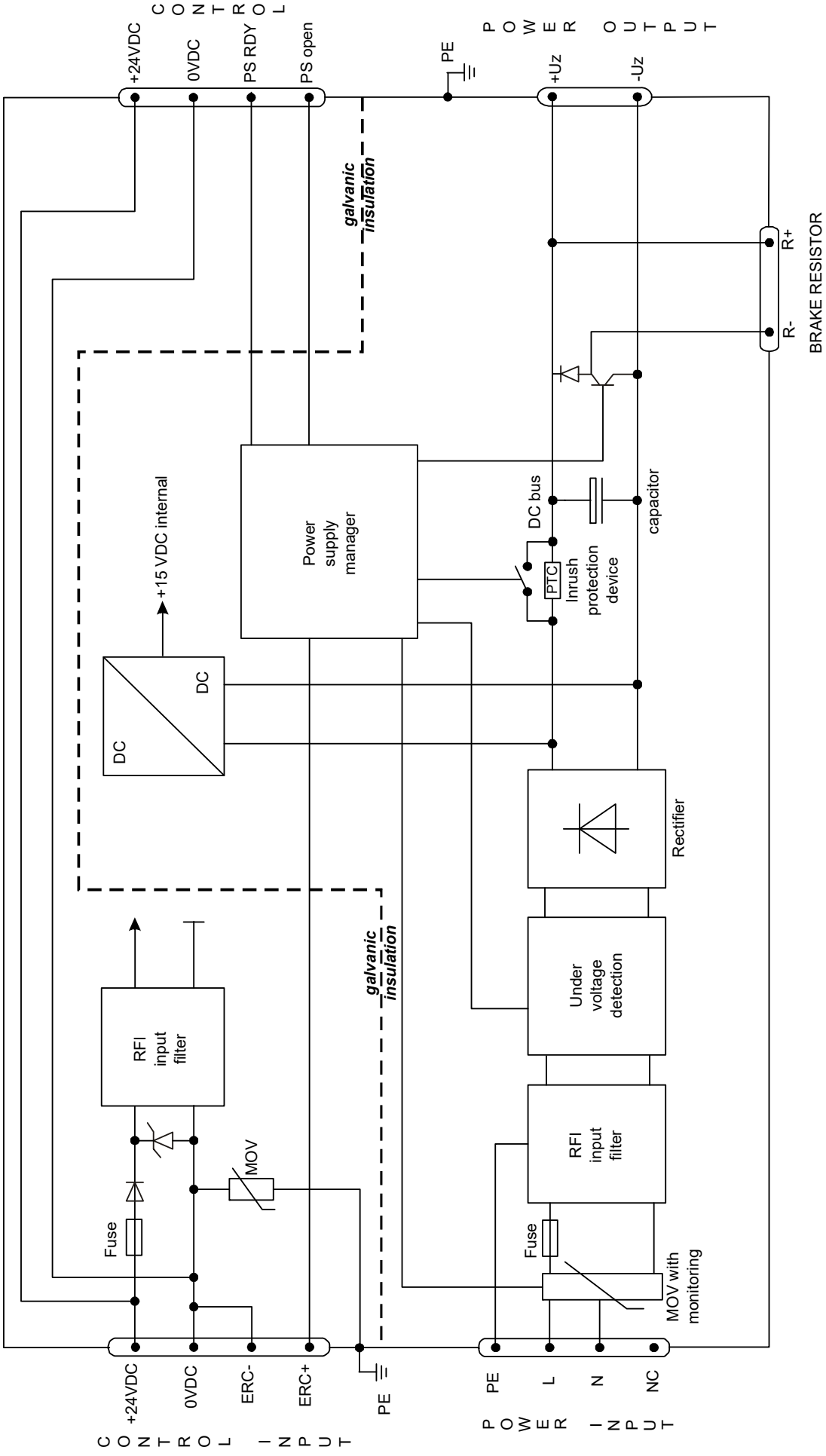
2.2 Block schematics

2.2.1 Position controller

The power part and the control part of the controller are galvanically separated. The inputs and outputs are insulated from the control part.



2.2.2 Power supply



2.3 Ratings

2.3.1 Position controllers

All the specifications are given for an ambient temperature ranging from +10 °C (50 °F) to +40 °C (104 °F) and with the ETEL bottom to top air flow cooling system (with a top to bottom air flow, the performances are 25 % lower). If this cooling system is not used, a **minimum air flow** of 65.4 m^3/h for a 50 mm width controller and 76.4 m^3/h for a 75 mm width controller is required. Contact your ETEL representative if the ambient temperature is not included in the above-mentioned range.

EA-P2M-300 POWER FEATURES				
Characteristics			**EA-P2M-300-4/7.5A**	**EA-P2M-300-07/15A**
Output to the motor (per axis)		Bus voltage	Max. 340 VDC	
		Current range on product label (refer to §2.5)	4/7.5 A	07/15 A
		Measurable current - full range	12.5 A	25 A
	Motor ripple at 40 kHz (PWM at 20 kHz)	**Three-phase** motor Max. full load current	5.65 A (4 Arms)	7.07 A (5 Arms)
		Three-phase motor Max. overload current	10.6 A (7.5 Arms) (1 s)	21.21 A (15 Arms) (0.3 s)
	Motor ripple at 20 kHz (PWM at 10 kHz)	**Three-phase** motor Max. full load current	5.65 A (4 Arms)	9.9 A (7 Arms)
		Three-phase motor Max. overload current	10.6 A (7.5 Arms) (2 s)	21.21 A (15 Arms) (1 s)
	Motor ripple at 40 kHz (PWM at 20 kHz)	**Two-phase** motor Max. full load current	4.52 A (3.2 Arms)	4.52 A (3.2 Arms)
		Two-phase motor Max. overload current	10.6 A (7.5 Arms) (1 s)	21.21 A (15 Arms) (0.15 s)
	Motor ripple at 20 kHz (PWM at 10 kHz)	**Two-phase** motor Max. full load current	5.65 A (4 Arms)	6.36 A (4.5 Arms)
		Two-phase motor Max. overload current	10.6 A (7.5 Arms) (2 s)	21.21 A (15 Arms) (0.5 s)
	Motor ripple at 40 kHz (PWM at 20 kHz)	**One-phase** motor Max. full load current	5.65 A (4 Arms)	7.07 A (5 Arms)
		One-phase motor Max. overload current	10.6 A (7.5 Arms) (1 s)	21.21 A (15 Arms) (0.1 s)
	Motor ripple at 20 kHz (PWM at 10 kHz)	**One-phase** motor Max. full load current	5.65 A (4 Arms)	9.9 A (7 Arms)
		One-phase motor Max. overload current	10.6 A (7.5 Arms) (2 s)	21.21 A (15 Arms) (0.3 s)
Power input (X104 connector)		DC voltage	48 - 340 VDC	
		Max. continuous input current	8 Arms	
		Max. peak input current	Not limited at controller level. Refer to power supply.	
		DC bus capacitors	94 µF	
Control input (X100 connector)		DC voltage	24 VDC (±10%)	
		Max. current at 24 VDC	Typ. 1.3 A(1) / Max. 2.5 A	
		DC bus capacitors	2200 µF	

(1): The current can change depending on the type(s) of encoder(s), the type of optional board as well as the number of inputs/outputs used. A current equal to about twice the above-mentioned typical value can be necessary to switch on the controller (because of the inrush pulse).
With two-phase motor, the current in 'motor phase 1- / 2-' is equal to (√2 x motor phase 1+) or (√2 x motor phase 2+). Be careful to use the suitable cable diameter.

Remark: Be careful to select an external 24 VDC power supply which delivers a correct voltage ramp up during switch on without rebound or oscillation.
The values of current in the table above are given for a two or three-phase sinusoidal current. If a DC current is requested (motor at standstill, or very low speed), these values can be divided by a factor up to √2.

When the current ripple in the motor becomes too important, it could limit the performance of the control loops or even overheat the motor. To avoid this, the inductance of the motor must comply with the following formula:

$$\frac{L1 \cdot I_p \cdot \sqrt{2}}{\alpha} \geq \frac{V_{PWR}}{f_{PWM}}$$

Where:
- L1: inductance of the motor [mH] (terminal to terminal)
- I_p: peak current of the motor [Arms]
- V_{pwr}: DC bus voltage of the position controller [V]
- f_{PWM}: controller PWM frequency [kHz]
- α: constant, depending on use cases:
  - α = 2 when $f_e \leq 100$ Hz
  - α = 4 when $f_e > 100$ Hz
  - f_e: electrical frequency of motor phases [Hz]

For a rotary motor, it is defined as:

$$f_e = \frac{n}{60} \cdot p$$

n: speed of the rotary motor [rpm]
p: number of pair of poles (2p is the number of poles)

For a linear motor, it is defined as:

$$f_e = \frac{v}{2T_p}$$

v: speed of the motor [mm/s]
$2T_p$: magnetic period [mm]

Remark: In case the formula is not complying, the user could add external inductance on each phase of the motor.

Example using an ETEL ironless linear motor (ILF03-030):

2Tp = 32 mm
L1 = 3.22 mH
R = 5.0 Ω
I_p = 7.11 Arms
v = 1000 mm/s
f_{PWM} = 20 kHz
V_{pwr} = 300 V

Electrical frequency:

$$f_e = \frac{1000}{32} = 31.25Hz$$

Constant α = 2 (as $f_e \leq 100$ Hz)

Verification that the inductance of the motor is big enough:

$$\frac{3.22 \cdot 7.11 \cdot \sqrt{2}}{2} \geq \frac{300}{20} \quad \Rightarrow \quad 16.2 \geq 15 \quad \Rightarrow \quad \text{There is no risk}$$

EA-P2M-300 CONTROL FEATURES		
General	Motion profile and command management sampling time	400 µs
	Digital current loop sampling time	50 µs
	Position loop sampling time	50 µs
	Motion profiles	Trapezoidal / S-curve / sine / look-up table /.../ interpolated (UltimET)
	Processor	SHARC Digital Signal Processor, 40 bits floating point
	Power relay	Relay disabling the output power bridge
Standard interfaces	USB 2.0 (for setting only)	Full speed (12 Mbps)
	TransnET Ethernet	1 Gbps 10 / 100 MHz
Position encoders interfaces	Analog 1Vpp	Max. 500kHz in. / Up to 2'048 (x4) interpolation factor
	EnDat 2.1 and 2.2 (absolute encoder)	RS485
	Encoder limit switch (EHO/L1 & ELS/L2 signals)	TTL signal
	Digital (TTL high speed)(*)	Max. 10MHz input frequency
User's inputs / outputs	Digital input	4 per motor
	Fast digital input	6 (common to both motor)
	Digital output	2 per motor
	Fast digital output	4 (common to both motor)
	Analog input	0
	Analog output	0
Software / programmability	ComET commissioning software	For software compatibility, refer to the ComET manual
	EDI (DLL files for C and C++)	For software compatibility, refer to the EDI manual
	Firmware update	USB and TransnET

(*): the period frequency (2.5 MHz) is one fourth of the counter frequency (10 MHz).

2.3.2 Power supply

All the specifications are given for an ambient temperature ranging from +10 °C (50 °F) to +40 °C (104 °F) and with the ETEL bottom to top air flow cooling system (with a top to bottom air flow, the performances are 25 % lower). If this cooling system is not used, a **minimum air flow** of 65.4 m^3/h for a 50 mm width controller and 76.4 m^3/h for a 75 mm width controller is required. Contact your ETEL representative if the ambient temperature is not included in the above-mentioned range.

POWER FEATURES		
Characteristics		**S0M-300-40/80A values**
Power output (P104 connector)	DC voltage	100 - 340 VDC
	Max. continuous current	Limited by max. AC input current 10(1) Arms
	Max. pulse current	40 A
	Efficiency	Around 95 %
Control output (P100 connector)	DC voltage	24 VDC ±10 %
	Max. continuous current (coming from external 24VDC power supply)	10 A(2)

POWER FEATURES		
Characteristics		**S0M-300-40/80A values**
Power input (P01 connector)	AC operating voltage range (single phase)	100 - 240 VAC (50 / 60 Hz)
	Inrush threshold voltage	71 VAC
	Max. AC current	10 A (at 100 - 240 VAC)
	Max. inrush current	15 Apeak at 240 VAC
	Max. continuous power	2.4 KW
	Power factor correction	No
Control input (P00 connector)	DC voltage	24 VDC (± 10%)
	Max. current	10 A
External braking resistor (P02 connector)	Internal value (voltage limitation device)	No
	External resistor (depends on customer application)	>39 Ω
	Max. continuous current (3)	10 A
Weight	-	1.3 kg ±0.1

(1): can be reached only with forced cooling (external fan necessary)
(2): depending on the type of encoder, the type of optional board as well as the number of inputs/outputs used, one controller can consume differently from another. On average, 5 controllers can be used with a single power supply.
(3): the current is fixed by the value of the external resistor (>39 Ω)

Remark: N/A means «Not Applicable».

DESIGN & FEATURES		
Characteristics	**Power input**	**Control input**
Separated supply	No specific power up sequence is required, however, ETEL recommends not to supply “power input” (P01 connector) if the “control input” (P00 connector) is not supplied. Advantage: if the power input is turned off for safety reasons, the control input may remain on and the reading of the monitoring registers is kept.	
Input filters	Filter reduces EMI (Electromagnetic Interferences)	Yes
Fuse	Protects the power output against short-circuits	Yes
Inrush current limiters	Measurement, relay and limitation PTC resistor, with feedback to the controller. Input AC voltage threshold for Inrush relay closed: 71VAC. Input AC voltage threshold for Inrush relay opened 50VAC. Inrush current < 15 A(*)	-
DC bus capacitors	984 µF	47 µF
Undervoltage detection	If Vin<50 VAC (red LED power error is ON)	In the controller
Voltage limitation / braking	If Vpwr > 370 VDC, braking ON (no feedback to the controller)	N/A
Output overvoltage detection	Error on controller if > 400 VDC	36 V (protection by zener)
Input overvoltage protection	MOV with monitoring of the status	MOV

(*): Repeated Input AC voltage drop might lead to unusual PTC heating and thus slow down subsequent DC Bus voltage rise (i.e. capacitors charging).

2.4 Mounting

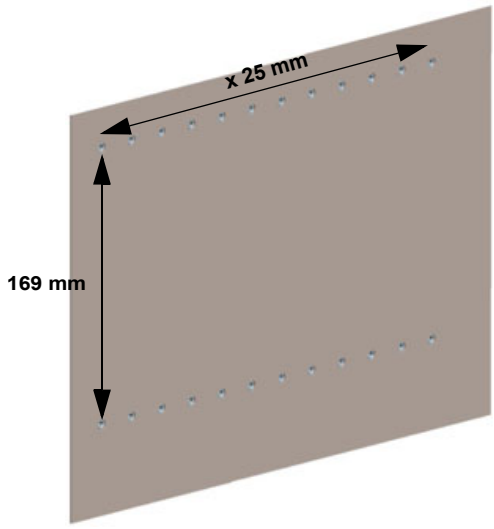
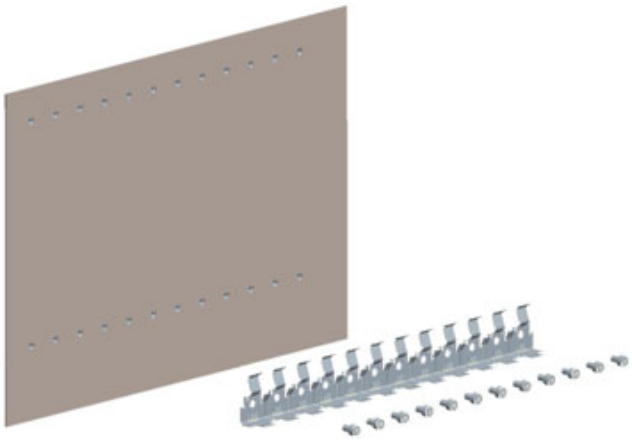
⚠	**The controller and the power supply have the following electrical safety degree: IP 20 (according to EN 60529 standard).** **The AccurET controller and power supply must be installed in an enclosure providing electrical, mechanical and fire protection as well as adapted environment such as temperature, humidity, pollution degree 2,…(refer to UL 508C and EN 61800-5-1 standards for more information).**

2.4.1 Hardware mounting

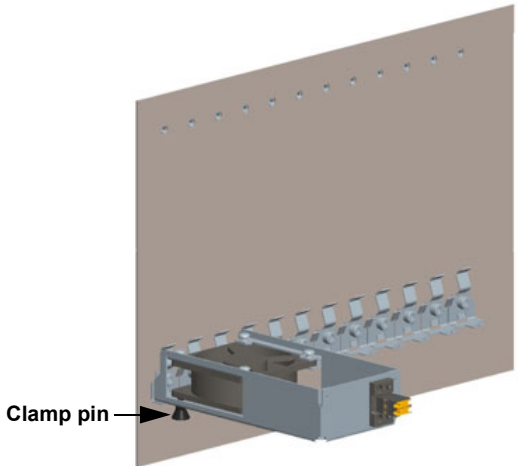
The controller and its corresponding power supply should be protected against any splashes of liquid and any contacts with smoke and dust. It must be installed inside a closed cabinet and mounted as mentioned below. The ground must be connected prior to any other connections (refer to §3.10 for more information). Fresh air is necessary to cool the controller inside the cabinet. It is recommended to leave 100 mm above and below the controller to guarantee an air flow (the fan power depends on the user application). **Caution: some magnetic components such as the fans** (not those present in ETEL's cooling unit) **may perturb the current measurement of the controller if they are too close**. If this problem occurs, use another type of fan or increase the distance between **the fan and the controller while ensuring the following minimum air flow**: 65.4 m^3/h for a 50 mm width and 76.4 m^3/h for a 75 mm width.

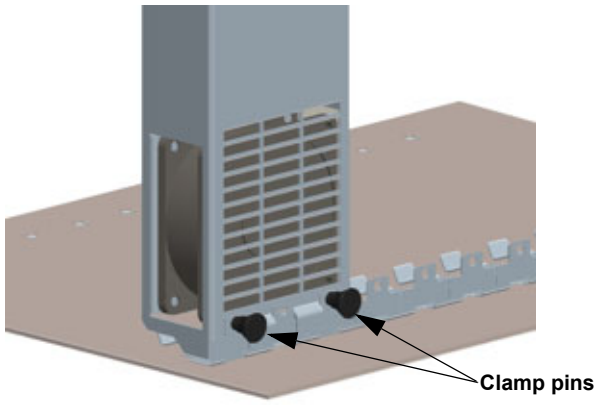
There are three different ways to fasten the controller:

- The ETEL cooling system is required. In that case, the procedure described hereafter must be followed.
- The user does not need the ETEL cooling system as well as the mounting bar. In that case, only 4 screws are needed to fasten it. Refer to §2.1 to have the dimensions.
- The user does not need the ETEL cooling system but wants to use the mounting bar. In that case, the step 1 and 2 of the procedure mentioned below must be followed (refer also to §2.1 to have the dimensions).

Step 1	Step 2
	
The drilling must be realized. The center-to-center distance between the screws at the top of the controller and the bottom screws used to fix the mounting bar is 169 mm. The pitch between each screw belonging to the same row is 25 mm.	Fasten the mounting bar with M5 screws

Step 3

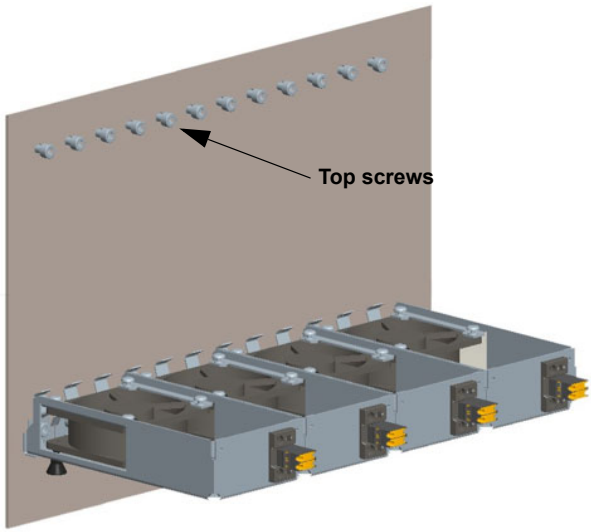




Bottom view

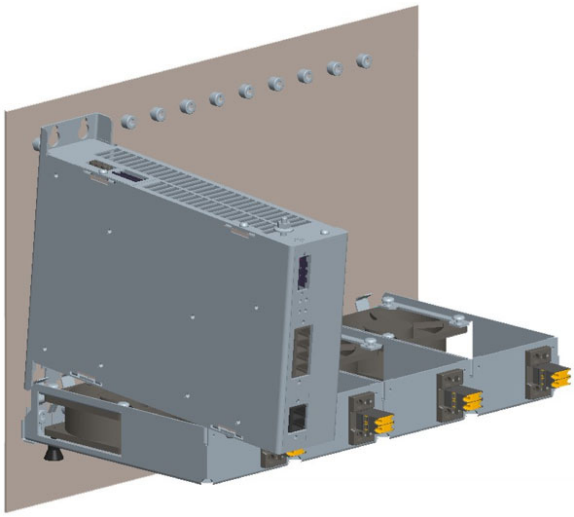
Put the fans in position and fix them with the black clamp pins (2 per fan)

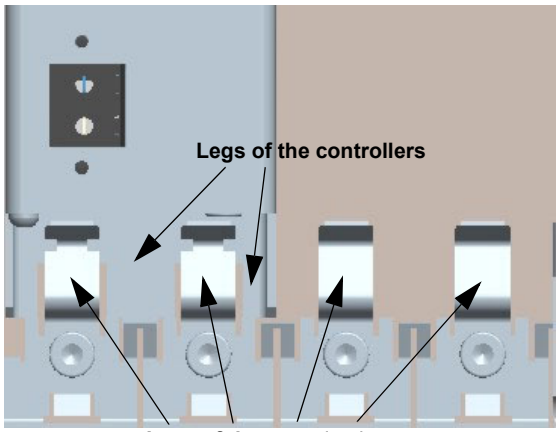
Step 4



Screw, at half way, the top screws

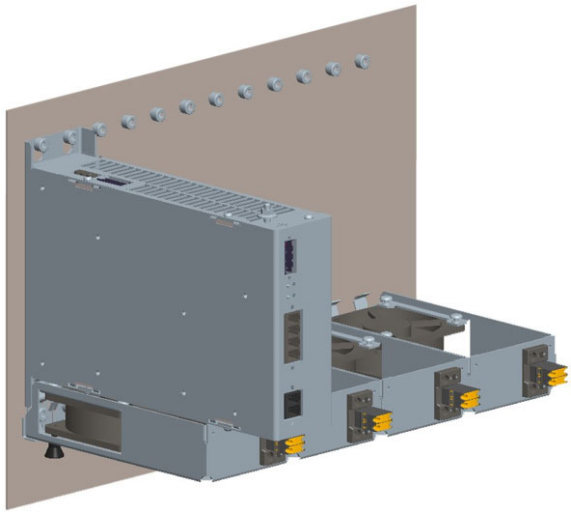
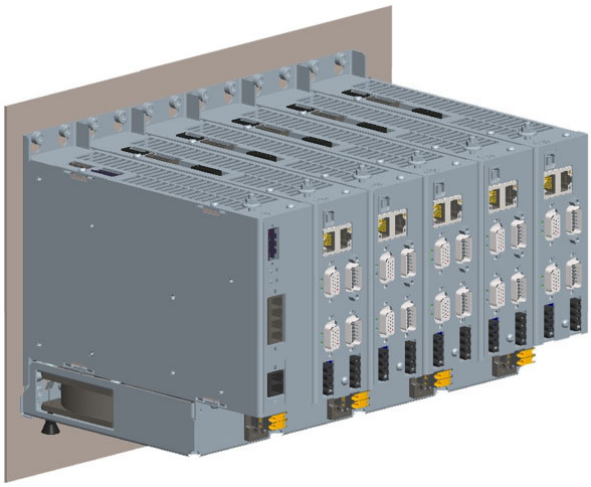
Step 5





Legs of the mounting bar

Put the power supply as mentioned above. The legs at the bottom of the power must be inserted between each leg of the mounting bar

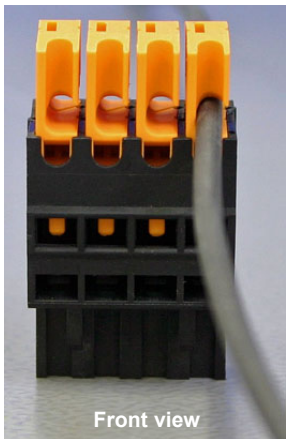
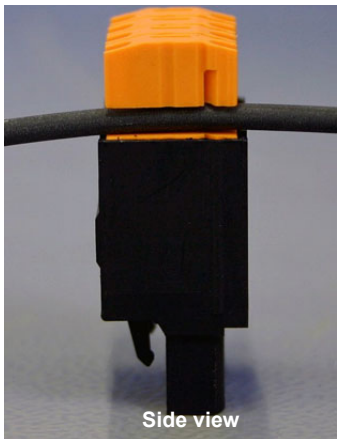
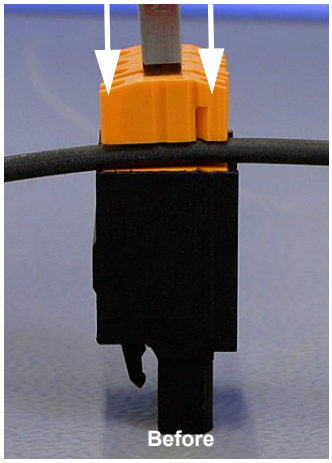
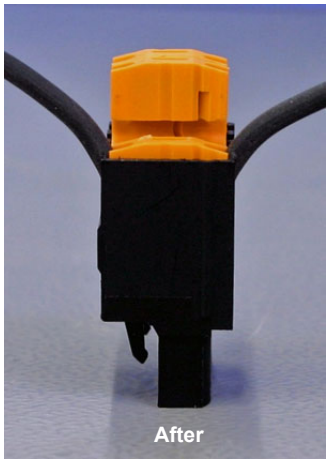
Step 6	Step 7
	
Push the power against the back panel, then against the fan and finish to screw the top screws.	Proceed as mentioned in step 5 and 6 to mount the controllers.

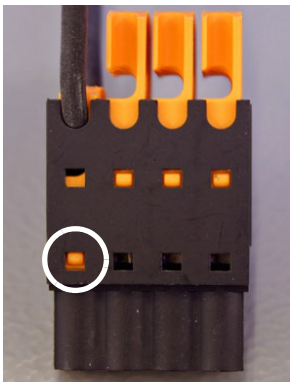
Remark: **ETEL's mounting bar and fans are identical whichever AccurET modular product is used.**

2.4.2 Fan power and control input wiring

The power input voltage connector of the fans as well as those of the control input voltage of the controller (going from the top of the power supply to all connected controllers) are all connected together with the type of connector delivered by ETEL. These connectors are self-strip connectors and are delivered only if the connector kit is ordered. The user must correctly size the power supply according to the number of controllers (with or without optional board) to be connected together.

Here is the procedure to manufacture the wiring:

 	1) Insert the cable in the slot. **Caution: Use only wire with a section from 0.5 mm^2 (AWG 20) to 1 mm^2 (AWG 18).**
 	2) Push down the upper clip (orange) with a screwdriver for example. **Caution: It is forbidden to carry out this operation with the connector plug on the controller. It must be done before plugging it into the controller.** **Be careful, not to get your fingers caught when pushing down the clip.**



3) To check if the upper part has been pushed down enough, the orange pin must be visible in the black cut-out.

4) Repeat steps 1 to 3 for the other wires. 4 wires are needed per control input connector and 2 for the fan power connector.

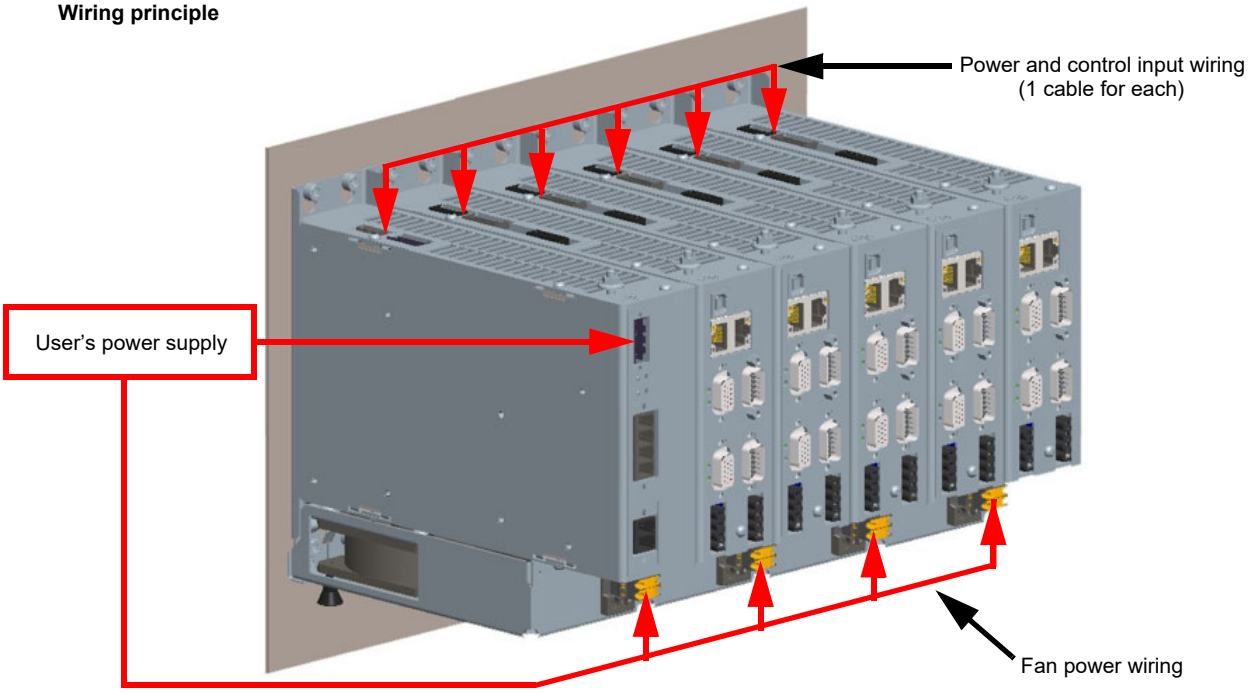
5) Repeat steps 1 to 4 for the other connectors. There are as many control input connectors as controllers. The number of fan power connectors depends on the width of the fan (refer to §2.5.2).

6) There must be no unused length of wire before the first connector of the chain or after the last one. The wires must be cut short.

Here is an example with a power and a single controller.

Caution: the length of the wires between 2 connectors must take into account the length lost inside the connector and the fact that the distance may change depending on the controller's width.

Wiring principle



2.5 Ordering information

Here is the ordering information describing the meaning of each digit present on each product:

2.5.1 Position controller

EA	-	P	2	M	-	300	-	07/15A	-	0	0	0	0	-	0	1

Family code:
EA = Electronics AccurET

Product type / technology:
P = PWM

Axis number:
2 = Dual axis

Format:
M = Modular

Maximum operating DC voltage:
300 = 340 VDC

Continuous / peak current:
4/7.5A = 4 / 7.5 Arms
07/15A = 07 / 15 Arms

Reserved

Optional board slot:
0 = No
1 = Yes

Standard:
0 = UL 508C compliant(*)
9 = Not UL 508C compliant(**)

Software options:
0 = No EtherCAT, TransnET only
1 = No EtherCAT, TransnET only, Functional Safety Certified -STO
2 = EtherCAT supported (option)
3 = EtherCAT supported (option), Functional Safety Certified -STO

Hardware revision:
01 = Standard product: hardware revision 2 (***)

(*): By default, all products are compliant.
(**): May exceptionally occur during product life time. Should this happen, customer would be officially notified in case it may be unacceptable.
(***): AccurET 300 was designed from the beginning on the revision 2 hardware platform, meaning “00” & “01” are the same for this specific product.

2.5.2 Cooling unit

EA	-	CU	M	-	125	-	BT	-	0	0

Family code:
EA = Electronics AccurET

Product type / technology:
CU = Cooling Unit

Format:
M = modular

Size:
75 = 75 mm
100 = 100 mm
125 = 125 mm

Type:
BT = Bottom to Top air flow (by default)
TB = Top to Bottom air flow (performances 25 % lower compared to BT)

Reserved

Reserved

Remark: The width of the fans depends on the width of the selected controllers.
ETEL's fans are identical whatever the AccurET modular product.

2.5.3 Power supply

EA	-	S	0	M	-	300	-	40/80A	-	0	0	0	0	-	0	0

Family code:
EA = Electronics AccurET

Product type / technology:
S = power Supply

Reserved

Format:
M = Modular

Maximum operating DC voltage:
300 = 340 VDC

Peak current:
40/80A = 40 Arms peak

Reserved

Reserved

Standard:
0 = UL 508C compliant(*)
9 = Not UL 508C compliant(**)

Reserved

Hardware revision:
00 = Standard product

(*): By default, all products are compliant.
(**): May exceptionally occur during product life time. Should this happen, customer would be officially notified in case it may be unacceptable.

2.5.4 Mounting bar

EA	-	MB	M	-	300	-	0	0

Family code:
EA = Electronics AccurET

Product type / technology:
MB = Mounting Bar

Format:
M = modular

Size:
300 = 300 mm

Reserved

Reserved

Remark: The mounting bar is identical whatever the AccurET modular product.

2.5.5 AccurET kits

EA	-	BCK	-	P2M	-	300	-	01

Family code:
EA = Electronics AccurET

Product type / technology:
BCK = Black Connectors Kit
STK = Starting Kit
SHK = Shielding kit

Product type:
P2M = Modular position controller 2 axes
S0M = Modular power supply

Voltage:
300 = suitable for 340 VDC controller or power supply

Reserved

3. Electrical interface

This chapter describes the pin assignment for every connector. More detailed explanations for proper connections are given in each case.

Here is the list of the groups of connectors, according to their function:

Communication connectors (refer to §3.1).

Encoders connectors (refer to §3.2).

Inputs / outputs connectors (refer to §3.3).

Motor connectors (refer to §3.4).

Power connectors (refer to §3.5).

Relay connector (refer to §3.6).

Download key connector (refer to §3.7).

Node number switch (refer to §3.8).

Optional board slot (refer to §3.9).

Remark: **To prevent damage, ensure correct alignment of male and female connectors as well as insertion of correctly mated connectors.**

In the following paragraphs, connectors with male pins are indicated with the '•'symbol (full), and female pins are represented with the 'o' symbol (empty).

	**High voltage may be present on the power and motor connectors. Before connecting or disconnecting a cable on one of these connectors or touching the controller, turn off all the power supplies and wait 10 minutes to allow the internal DC bus capacitors to discharge. Always connect the ground prior to any other connections.**
	**Low voltage and data signals are not insulated from Protective Earth (PE). The motor connectors must always be correctly screwed onto the controller.**
	**All the connectors must be handled in an ESD protected environment.**
	**This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.**

3.1 Communication connectors

	**Signals are not insulated from Protective Earth (PE).**
	**The communication connectors must be handled in an ESD protected environment, only.**

The communication between a host (PC) and a controller is made via a USB protocol (connector X00). The communication between the controllers and the master (UltimET) is obtained via a TransnET (ETEL's proprietary) protocol. To do so, the connectors X01 and X02 are used to make a daisy chain with standard RJ-45 cables.

3.1.1 USB communication (connector X00)

The USB 2.0 (full speed) communication is used for the setting and monitoring of the controller. The USB connector is a «Type B» connector.

3.1.2 TransnET / Ethernet input (connector X01)

This input, labeled «COM IN» (COMmunication INput) on the front panel of the controller, is used to connect the input cable of the ETEL TransnET or the Ethernet communication. **Both communications are not possible at the same time**. The Ethernet connection is used to directly connect the PC to a single controller.

Remark: The RJ-45 cable must meet the following characteristics: 1:1 shielded cable, category 5E SFTP with 8 wires. The cumulated length of all TransnET cables must not exceed 100m.

3.1.3 TransnET output (connector X02)

The TransnET output, labeled «COM OUT» (COMmunication OUTput) on the front panel of the controller is used to connect the output cable of ETEL's TransnET communication. For the last controller, this connector is not used as the incoming and outgoing data run through the same cable.

Remark: The RJ-45 cable must meet the following characteristics: 1:1 shielded cable, category 5E SFTP with 8 wires. The cumulated length of all TransnET cables must not exceed 100 m.

3.2 Encoder connectors (connectors X10 and X20)

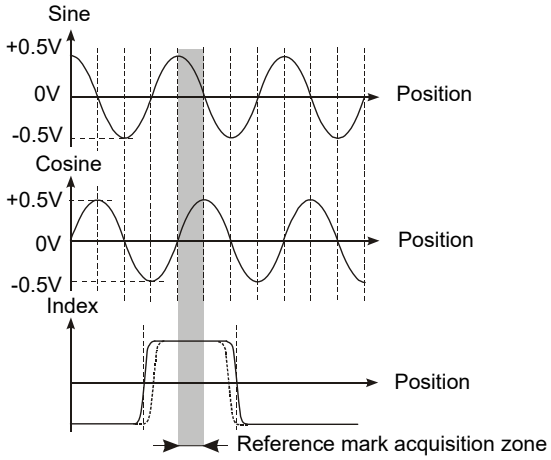
	**Signals are not insulated from Protective Earth (PE). Avoid proximity with noisy power cable.**
	**The encoder connectors must be handled in an ESD protected environment, only.**

Remark: The encoder cable(s) connected to the controller must be shielded (refer to §3.11.1).
The connector X10 is used to connect the encoder of motor 1 and X20 for the one of motor 2.

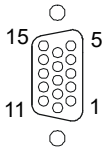
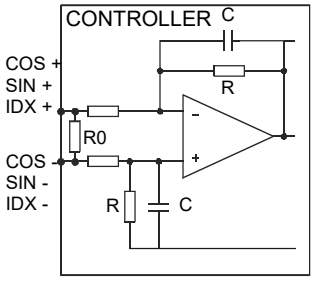
Three different types of encoder can be connected to the encoder connectors: either an incremental analog 1 Vpp encoder or an absolute encoder (EnDat 2.1 and 2.2) or a true TTL encoder.

3.2.1 Incremental analog encoder (1 Vpp)

The incremental analog encoder has 1Vpp signals with a load resistor R_0=120 Ω. It determines the motor position thanks to two sinusoidal signals with a 90° phase-shift (sine and cosine). A third signal, the index (also called reference mark) gives the absolute motor position:



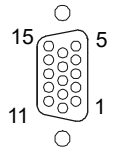
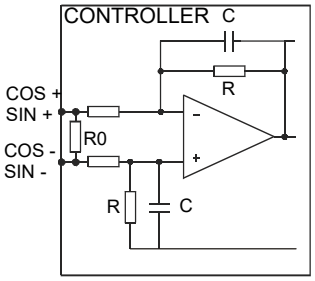
D-SUB, 15 pins, high density, female

Encoder	Pin #	Signal	Function	Interface
X10 & X20 	1	Reserved	**Do not connect**	
	2	Reserved	**Do not connect**	
	3	Reserved	**Do not connect**	
	4	+5 VDC	Encoder supply output (protected by fuse F3 of 1.5 A)	
	5	GND	Encoder supply output (0 V)	
	6	COS -	Cosine - signal input	
	7	SIN -	Sine - signal input	
	8	IDX -	Index - signal input	
	9	Reserved	**Do not connect**	
	10	EHO/L1	Encoder home switch input EHO or encoder limit switch L1 (TTL signal)	
	11	ELS/L2	Encoder limit switch input ELS or encoder limit switch L2 (TTL signal)	
	12	GND	Encoder supply output (0 V)	
	13	COS +	Cosine + signal input	
	14	SIN +	Sine + signal input	
	15	IDX +	Index + signal input	

Remark: The +5 VDC encoder supply output is protected by the fuse F3 (1.5 A) on X10 and X20.
Refer to the corresponding **'Operation & Software Manual'** for more information about the use of the EHO/L1 and ELS/L2 signals.
The connector X10 is used to connect the encoder of motor 1 and X20 for the one of motor 2.

3.2.2 Absolute encoder (EnDat 2.1)

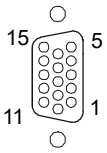
The EnDat 2.1 is an **absolute encoder**. It has 1Vpp signals with a load resistor R_0=120 Ω. Its signals are similar to the incremental encoders (without the index), but it additionally includes a RS485 serial link (EIA standard, EnDat 2.1 interface) for the absolute position measure: EDT (serial data) and ECL (clock). The ECL (clock) signal is received from the controller. From its first falling edge (latch signal), the **absolute position will be defined within one incremental signal period** (depending on the encoder type)

D-SUB, 15 pins, high density, female				
Encoder	**Pin #**	**Signal**	**Function**	**Interface**
X10 & X20 	1	EDT +	EnDat serial data I/O + / RS485	
	2	ECL +	EnDat clock output + / RS485	
	3	ECL -	EnDat clock output - / RS485	
	4	+5 VDC	Encoder supply output (protected by fuse F3 of 1.5 A)	
	5	GND	Encoder supply output (0 V)	
	6	COS -	Cosine - signal input	
	7	SIN -	Sine - signal input	
	8	Reserved	**Do not connect**	
	9	EDT -	EnDat serial data I/O - / RS485	
	10	Reserved	**Do not connect**	
	11	Reserved	**Do not connect**	
	12	GND	Encoder supply output (0 V)	
	13	COS +	Cosine + signal input	
	14	SIN +	Sine + signal input	
	15	Reserved	**Do not connect**	

Remark: The +5 VDC encoder supply output is protected by the fuse F3 (1.5 A) on X10 and X20.
The cable used with an absolute encoder (EnDat 2.1) must have power wires with a minimum section to guarantee a sufficient voltage at the terminals of the encoder (refer to the data sheet of the encoder for more information).
The connector X10 is used to connect the encoder of motor 1 and X20 for the one of motor 2.

3.2.3 Absolute encoder (EnDat 2.2)

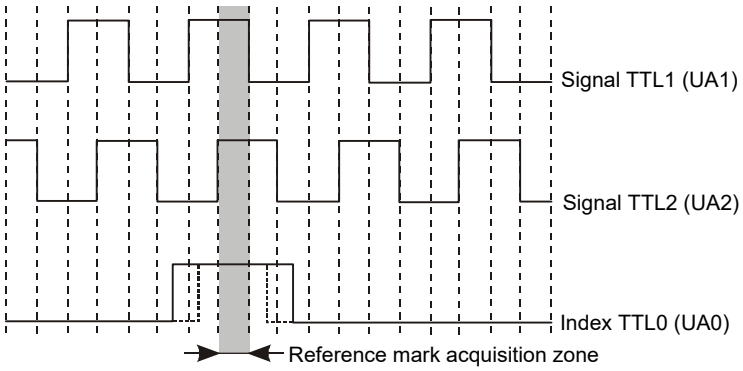
The EnDat 2.2 is an **absolute encoder**. It includes a RS485 serial link (EIA standard, EnDat 2.2 interface) for the absolute position measure: EDT (serial data) and ECL (clock). The ECL (clock) signal is received from the controller. Refer to the HEIDENHAIN's documentation for more information about the EnDat 2.2.

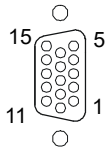
D-SUB, 15 pins, high density, female			
Encoder	**Pin #**	**Signal**	**Function**
X10 & X20  	1	EDT +	EnDat serial data I/O + / RS485
	2	ECL +	EnDat clock output + / RS485
	3	ECL -	EnDat clock output - / RS485
	4	+5 VDC	Encoder supply output (protected by fuse F3 of 1.5 A)
	5	GND	Encoder supply output (0 V)
	6	Reserved	**Do not connect**
	7	Reserved	**Do not connect**
	8	Reserved	**Do not connect**
	9	EDT -	EnDat serial data I/O - / RS485
	10	Reserved	**Do not connect**
	11	Reserved	**Do not connect**
	12	GND	Encoder supply output (0 V)
	13	Reserved	**Do not connect**
	14	Reserved	**Do not connect**
	15	Reserved	**Do not connect**

Remark: The +5 VDC encoder supply output is protected by the fuse F3 (1.5 A) on X10 and X20.
The cable used with an absolute encoder (EnDat 2.2) must have power wires with a minimum section to guarantee a sufficient voltage at the terminals of the encoder (refer to the data sheet of the encoder for more information) and a length of maximum 40 m.
The connector X10 is used to connect the encoder of motor 1 and X20 for the one of motor 2.

3.2.4 TTL encoder

TTL encoders measure the motor position with 2 phase-shifted TTL signals. Each change of state of one of the signals corresponds to an increment of the motor position. A third signal (index) gives the motor reference position. The encoder TTL signals have to be compatible with the EIA standard RS422. These signals have the following form:

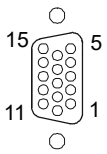


D-SUB, 15 pins, high density, female			
Encoder	**Pin #**	**Signal**	**Function**
X10 & X20 	1	UA1 +	TTL1 + signal input
	2	UA2 +	TTL2 + signal input
	3	UA2 -	TTL2 - signal input
	4	+5 VDC	Encoder supply output (protected by fuse F3 of 1.5 A)
	5	GND	Encoder supply output (0 V)
	6	Reserved	**Do not connect**
	7	Reserved	**Do not connect**
	8	Reserved	**Do not connect**
	9	UA1 -	TTL1 - signal input
	10	UA0 -	TTL0 - signal input
	11	UA0 +	TTL0 + signal input
	12	GND	Encoder supply output (0 V)
	13	Reserved	**Do not connect**
	14	Reserved	**Do not connect**
	15	Reserved	**Do not connect**

Remark: The +5 VDC encoder supply output is protected by the fuse F3 (1.5 A) on X10 and X20.
The connector X10 is used to connect the encoder of motor 1 and X20 for the one of motor 2.
The period frequency (2.5MHz) is one fourth of the counter frequency (10MHz).

3.2.5 Dual encoder feedback

The dual encoder feedback is only possible with 1Vpp, TTL and absolute EnDat 2.2 encoders. Here are the 3 possible configurations:

D-SUB, 15 pins, high density, female			
		1 Vpp / TTL (K76=1)	**1 Vpp / EnDat 2.2 (K76=2) & EnDat 2.2 / 1 Vpp (K76=3)**
Encoder	**Pin #**	**Signal**	**Signal**
X10 & X20 	1	UA1 +	EDT +
	2	UA2 +	ECL +
	3	UA2 -	ECL -
	4	+5 VDC	+5 VDC
	5	GND	GND
	6	COS -	COS -
	7	SIN -	SIN -
	8	IDX -	IDX -
	9	UA1 -	EDT -
	10	EHO/L1 or UA0 -	EHO/L1
	11	ELS/L2 or UA0 +	ELS/L2
	12	GND	GND
	13	COS +	COS +
	14	SIN +	SIN +
	15	IDX +	IDX +

Remark: Refer to the corresponding encoder table to know the function of each signal.

3.3 Input / output connectors (connectors X11 and X21)

	**Signals are not insulated from Protective Earth (PE).**
	**The inputs/outputs connectors must be handled in an ESD protected environment.**

Remark: The input/output cable(s) connected to the controller must be shielded (refer to §3.11.1).

The controller has:

- 4 standard digital inputs (DIN1, DIN2, DIN9 and DIN10) per motor and 6 **fast** digital inputs (FDIN1 to FDIN6) for both motors.
- 2 standard digital outputs (DOUT1 and DOUT2) per motor and 4 **fast** digital outputs (FDOUT1 to FDOUT4) for both motors.

Only the input and output **interfaces** are considered here. Refer to the corresponding **'Operation & Software Manual'** for more information about the use of these inputs and outputs.

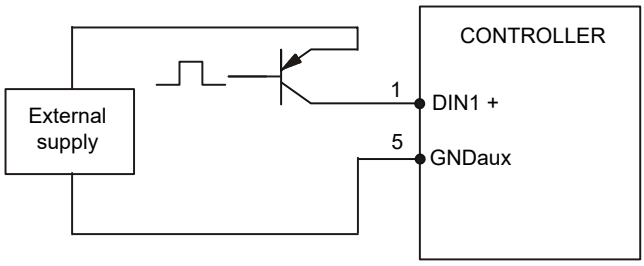
3.3.1 Digital inputs (connectors X11 and X21)

- **Standard digital inputs**

The digital inputs switch to ’1’ when a voltage ranging between +14 VDC and +28 VDC is applied between pins DIN+ of the corresponding input and GND.
The digital inputs switch to ‘0’ when a voltage ranging between 0 VDC and +3 VDC to is applied between pins DIN+ of the corresponding input and GND. Any voltage between +3 VDC and +14 VDC will give an uncertain input value.

Remark: When using an external ‘positive limit switch’, connect it to DIN10.
When using an external ‘negative limit switch’, connect it to DIN9.
When using an external ‘home switch’, connect it to DIN2.

The auxiliary supply can be external to the controller, as shown below:



The commutation times of the above-mentioned inputs are as follows:

	Status	Maximum	Unit
DINs	0 => 1	30	ns
	1 => 0	30	ns

Remark: The above-mentioned times takes only the hardware into account and are dependent on the input capacitance (1 nF).

- **Fast digital inputs**

The fast digital inputs are common to both motors and can be used by the customer for synchronization, position capture, etc. The digital inputs switch to ’1’ when a voltage ranging between +2 VDC and +5 VDC is applied between pins DIN+ of the corresponding input and GND.

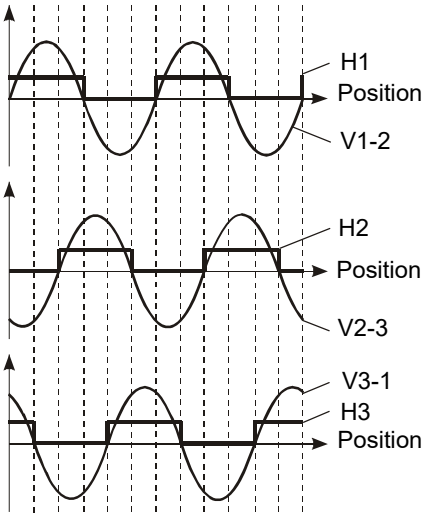
The digital inputs switch to '0' when a voltage ranging between 0 VDC and +0.8 VDC is applied between pins DIN+ of the corresponding input and GND. Any voltage between +0.8 VDC and +2 VDC will give an uncertain input value. The commutation times of the above-mentioned inputs are as follows:

	Status	Maximum	Unit
FDINs	0 => 1	30	ns
	1 => 0	30	ns

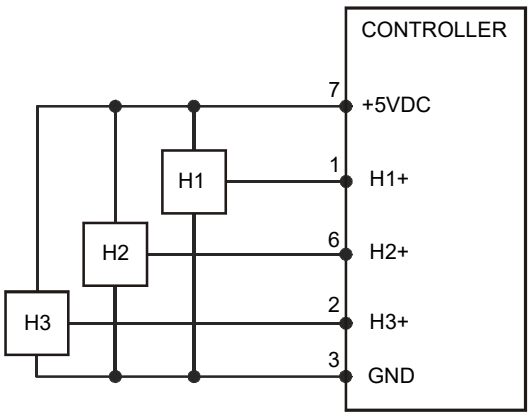
Remark: The above-mentioned times takes only the hardware into account and are dependent of the input capacitance (1nF).

- **Digital Hall effect sensor**

3 digital inputs (H1+, H2+ and H3+) which correspond to the 3 fast digital inputs, are used to connect a digital Hall effect sensor. This sensor is used for the motor commutation thanks to three digital signals (one for each Hall effect sensor). On the following graph, the Hall signals and the sine voltages between the motor phases are displayed:



The digital Hall effect sensors (H1, H2 and H3) must be connected as shown below:



External pull up resistors are not required. As described in §3.3.2, H1+, H2+, H3+ are connected internally to +5 V through a 3 KΩ pull up.

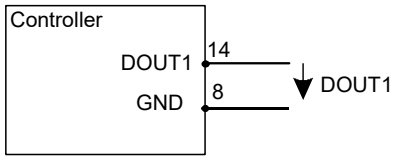
Refer to §3.3.2 for the pin assignment of the connector.

Remark: The connector X11 is used to connect the inputs/outputs of motor 1 and X21 for the ones of motor 2.

3.3.2 Digital outputs (connectors X11 and X21)

- **Standard digital outputs**

The +Vaux voltage used to supply the digital output is the same as the one present on the control input connector (X100). **Do not supply Vaux voltage on connector X11 or X21 but only on connector X100.** There are 2 A shared out between the digital outputs and the +24 V of the optional board (1 A max.). The maximum current provided per digital output is limited to 500 mA (4 x 500 mA if no optional board is used).



Remark: This diagram shows the use of DOUT1, but it is the same with DOUT2.

The commutation times of the above-mentioned outputs are as follows:

	Status	Maximum	Unit
DOUTs	0 => 1	500	µs
	1 => 0	500	µs

Remark: The above-mentioned times takes only the hardware into account.

- **Fast digital outputs**

The fast digital outputs are common to both motors and can be used by the customer for triggers, encoder signals outputs, etc.

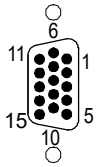
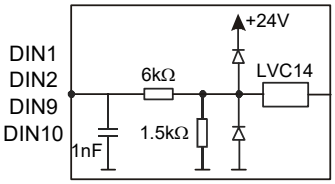
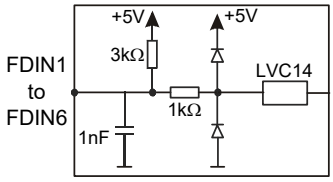
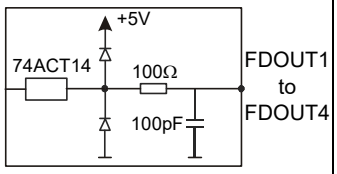
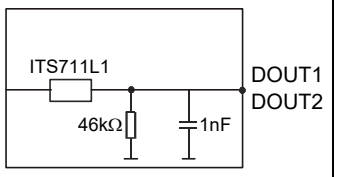
The commutation times of the above-mentioned outputs are as follows:

	Status	Maximum	Unit
FDOUTs	0 => 1	30	ns
	1 => 0	30	ns

Remark: The above-mentioned times takes only the hardware into account and not the output cable capacitance.

The connector X11 is used to connect the inputs/outputs of motor 1 and X21 for the ones of motor 2

D-SUB, 15 pins, high density, male

I / O	Pin #	Signal	Function	Interface
X11 & X21 	1	FDIN1 (X11) / FDIN4 (X21)	Fast digital input 1 + (H1+)	
	2	FDIN3 (X11) / FDIN6 (X21)	Fast digital input 3 + (H3+)	
	3	GND	External supply input (0V) for FDIN and FDOUT (linked to the 0 VDC of the connector X100)	
	4	DIN2 +	Digital input 2 +	
	5	DIN10 +	Digital input 10 +	
	6	FDIN2 (X11) / FDIN5 (X21)	Fast digital input 2 + (H2+)	
	7	+5 VDC	Power supply output for Hall sensor (max 100 mA)	
	8	GND	External supply input (0V) for DIN and DOUT (linked to the 0 VDC of the connector X100)	
	9	DIN1 +	Digital input 1 +	
	10	DIN9 +	Digital input 9 +	
	11	FDOUT1 (X11) / FDOUT3 (X21)	Fast digital output 1 + (±24 mA)	
	12	FDOUT2 (X11) / FDOUT4 (X21)	Fast digital output 2 + (±24 mA)	
	13	+Vaux	Power supply output provided by +24 VDC on connector X100.	
	14	DOUT1	Digital output 1 +	
	15	DOUT2	Digital output 2 +	

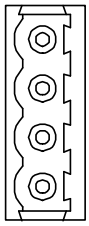
3.4 Motor connectors (connectors X12 and X22)

	**High voltage may be present on the motor connectors.** **Before connecting or disconnecting the motor cable or touching the controller, turn off all the power supplies and wait 10 minutes to allow the internal DC bus capacitors to discharge.** **Always connect the ground prior to any other connection.**
	**The motor connectors must be insulated (no contact) from the power and the mains. The motor connectors must always be correctly screwed onto the controller to respect the EMC standard.**
	**The motors connectors must be handled in an ESD protected environment.**

Remark: The motor cables connected to the controller must be shielded (refer to §3.11.1).

The controller can drive single-phase, two-phase and three-phase motors. Connectors X12 and X22 enable the supply of the motor phase(s).

Phoenix Contact IC 2.5/4-G-5,08 BK (plastic connector)

Motor	Pin #	Signal	Function		
			1-phase motor	2-phase motor	3-phase motor
X12 & X22 1  4	1	PE	Protective earth	Protective earth	Protective earth
	2	PH1	Motor phase +	Motor phase 1 +	Motor phase 1
	3	PH2	Motor phase -	Motor phase 1 - / 2 - (*)	Motor phase 2
	4	PH3	**Do not connect**	Motor phase 2 +	Motor phase 3

(*): With two-phase motor, the current in 'motor phase 1- / 2-' is equal to (√2 x motor phase 1+) or (√2 x motor phase 2+). Be careful to use the suitable cable diameter.

Remark: The connector X12 is used to connect the motor 1 and X22 for the motor 2.
It is compulsory to use the metallic cover described in §3.11.2.
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

3.5 Power connectors

	**High voltage may be present on the power connectors.** **Before connecting or disconnecting the power cables or touching the controller, turn off all the power supplies and wait 10 minutes to allow the internal DC bus capacitors to discharge.** **Always connect the ground prior to any other connection.**
	**The power connectors must be handled in an ESD protected environment.**

Remark: The power cables connected to the controller must be shielded (refer to §3.11.1).

3.5.1 At the power supply level

3.5.1.1 Control input (connector P00)

Phoenix Contact MSTB 2.5/4-G BK (plastic connector)			
Control input	**Pin #**	**Signal**	**Function**
P00 1 2 3 4	1	+24 VDC	Control input (+24 VDC (±10%))
	2	0 VDC	Control input (0 VDC)
	3	ERC -	External Relay Command output (0 VDC)
	4	ERC +	External Relay Command output (+24 VDC)

For safety reasons, always connect first the protective earth (PE) to the dedicated screws!

Remark: The control input shall be supplied by an isolated power supply with SELV outputs (Isolated secondary output), rated 24 VDC (±10 %). The external power supply must ensure the reinforced insulation between mains and output and provide overvoltage category II (refer to EN 61800-5-1 and UL 508C standards for more information).
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

The +24 VDC input of this connector is internally connected to the +24 VDC of the control output (refer to §3.5.1.4). The ERC outputs signals command the external input relay connected on the AC power line. In case of problem detected on the controllers or on the power supply side, a zero volt is applied between these 2 contacts to open this relay.

3.5.1.2 Power input (connector P01)

This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

Phoenix Contact PC 4/4-G-7.62 BK (plastic connector)			
Power input	**Pin #**	**Signal**	**Function**
P01 1 2 3 4	1	PE	Protective earth
	2	L	Mains line supply input for power
	3	N	Neutral
	4	NC	**Not Connected**

For safety reasons, always connect first the ground as mentioned in §3.10!

Remark: **Limit to one switch on/off per minute!**
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

3.5.1.3 *Brake resistor (connector P02)*

Use only resistor with thermal shutdown protection. The resistor minimal value is 39Ω. The use of an undersized power and energy withstand capability resistor could cause an explosion.

Phoenix Contact PC4/2-G-7.62 BK (plastic connector)			
Brake resistor	**Pin #**	**Signal**	**Function**
P02 1 2	1	BR+	Connect the + of the external brake resistor, if needed
	2	BR-	Connect the - of the external brake resistor, if needed

If you determine that a brake resistor is needed, select it to fit your application (refer to §4. for more information about the sizing). This resistor **must** include a thermal circuit breaker. Example of resistor used by ETEL: Frizlen GmbH (Germany), cemented, double pipe resistor, type FZZG 400x65, 39 Ω, 1200 W at 300 °C. Metallic case protection (shielding), shielded connector.

Remark: The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

3.5.1.4 *Control output (connector P100)*

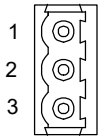
Phoenix Contact MSTB 2.5/4-G BK (plastic connector)			
Control output	**Pin #**	**Signal**	**Function**
P100 1 2 3 4	1	+24 V	Control output (+24 VDC (±10%))
	2	0 V	Control output (0 VDC)
	3	PSY	Power supply ready (output for the power supply) A high level (24 VDC) on this output indicates everything is OK. A low level indicates an error or an inrush mode not completed. This low level disables the controllers. The inrush relay is closed for PS RDY = 1 and opened for 0.
	4	PSO	Power supply open (input for the power supply) A high level (24 VDC) on this output, coming from the controller, disables the power supply. The inrush relay is opened as well as the external input relay.

For safety reasons, always connect first the ground as mentioned in §3.10!

Remark: The control output connector is located on the top of the power supply.
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

The +24 V output of this connector is internally connected to the +24 V coming from the control input (refer to §3.5.1.1). This control output connector is connected with a 1:1 cable to all the control input connectors (connector X100) of the controllers.
The 'PSY' (Power Supply readY) signal comes from the ETEL power supply and indicates the status of the voltage present on the DC bus (0 V = DC power not ready and 24 V = power supply ready).
The 'PSO' (Power Supply Open) signal comes from each controller asking for a power interrupt (internal relay opened) (0V = normal condition and 24 V = PS OPEN asked).

3.5.1.5 Power output (connector P104)

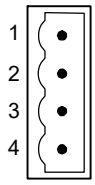
Phoenix Contact IC 2.5/3-G-5.08 BK (plastic connector)			
Power output	**Pin #**	**Signal**	**Function**
P104  1 2 3	1	+Uz	Power output +
	2	-Uz	Power output -
	3	PE	Protective earth

For safety reasons, always connect first the ground as mentioned in §3.10!

Remark: **For safety and ESD reasons, it is forbidden to touch this connector and its cable as long as the power supply is powered.**
The power output connector is located on the top of the power supply.
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

3.5.2 At the position controller level

3.5.2.1 Control input (connector X100)

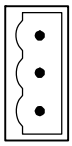
Phoenix Contact MSTBA 2.5/4-G BK (plastic connector)			
Control input	**Pin #**	**Signal**	**Function**
X100  1 2 3 4	1	+24 V	Control supply input (24 VDC (±10 %))
	2	0 V	Control supply input (0 V)
	3	PSY	Power supply ready input (for the controller)
	4	PSO	Power supply opened output (for the controller)

For safety reasons, always connect first the ground as mentioned in §3.10!

Remark: To ensure proper operation of the controller, it is recommended to wait for 1 second between two successive ON or OFF cycles (1s minimum for the OFF state when ON/OFF/ON cycle and 1s minimum for the ON state when OFF/ON/OFF).
The control input shall be supplied by an isolated power supply with SELV outputs (Isolated secondary output), rated 24 VDC (±10 %).
To avoid any insecure connection (damage or hazard), coding parts on both the X100 connector and the mating connector of X104 can be used (Phoenix Contacts ref: CR-MSTB for X100 and CP-MSTB for X104).
The control input connector is located on the top of the controller.
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

The control input connectors of the controllers are connected to each other and to the control input connector of the power supply (connector P100) with a 1:1 cable (refer to §2.4.2 for more information).
The 'PSY' (Power Supply readY) signal comes from the ETEL power supply and indicates the status of the voltage present on the DC bus (0 V = DC power not ready and 24 V = power supply ready). If a third party power supply is used, the user must provide this signal otherwise the controller will enter in error mode when a power on is done.
The 'PSO' (Power Supply Open) signal comes from each controller asking for a power interrupt (internal relay opened) (0 V = normal condition and 24 V = PSO asked).

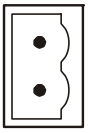
3.5.2.2 Power input (connector X104)

Phoenix Contact MSTBA 2.5 HC/3-G BK (plastic connector)			
Power input	**Pin #**	**Signal**	**Function**
X104 1 2 3 	1	+Uz	Power input +
	2	-Uz	Power input -
	3	PE	Protective earth

The power input connectors of the controllers are connected to each other and to the power output connector of the power supply (connector P104) with a 1:1 cable (refer to §2.4.2 for more information).

Remark: **For safety and ESD reasons, it is forbidden to touch this connector and its cable as long as the controller is powered.**
To avoid any insecure connection (damage or hazard), coding parts on both the X100 connector and the mating connector of X104 can be used (Phoenix Contacts ref: CR-MSTB for X100 and CP-MSTB for X104).
The power input connector is located on the top of the controller.
The associated connector can be ordered through the connector kit (refer to §2.5.5). If not, be sure to use a connector compatible with the above-mentioned one.

3.5.3 At the fan level

Phoenix Contact DFK-MSTB 2.5/2-G BK (plastic connector)			
Power input	**Pin #**	**Signal**	**Function**
2 1 	2	0 V	Supply input (0 V)
	1	+24 V	Supply input (24 VDC (±10 %))

The power input connectors of the fans are connected to each other with a 1:1 cable (refer to §2.4.2 for more information).

Remark: The current requirement according to the fan's width is as follows:
0.2 A for the 75 mm, 0.3 A for the 100 mm and 0.5 A for the 125 mm.

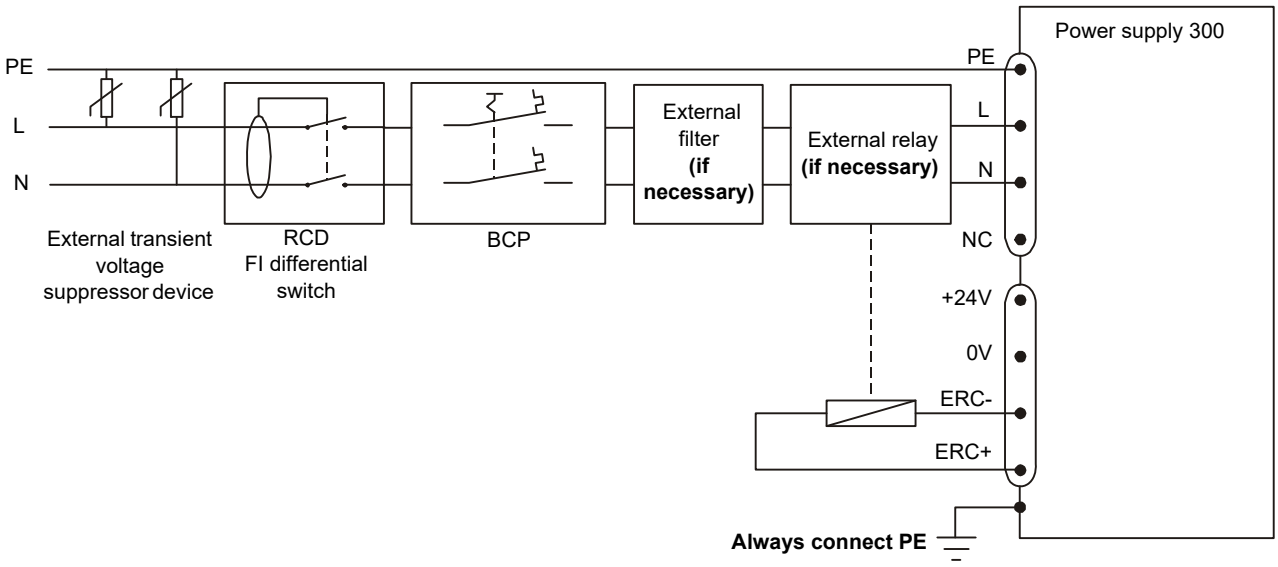
3.5.4 Connection to the mains

For safety reasons, always connect first the protective earth (PE) to the dedicated screw, before wiring any other connection!
Machinery including a power supply and controller(s) should be equipped with additional emergency stop, brake and protection devices to protect the personnel against any contact with high temperatures, moving parts and high voltage. These devices are not included in the power supply, they must be provided by the machinery manufacturer.

Remark: It is strongly recommended to connect the control input **before** the power input.

The input filter of the power supply enables the use of a high sensitivity differential switch (the use of RCD with long motor cable or highly capacitive motor has to be tested):

Caution: **This is a product of the restricted distribution class according to IEC61800-3. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.**
Only TT and TN power systems are allowed. Any other grounding systems such as: corner ground, starpoint to earth with high impedance and isolated,... are forbidden.



Remark: RCD = Residual Current Device (also called Electrical Leakage Circuit Breaker or FI).
The use of a RCD (type B) is mandatory. The RCD as well as the corresponding ΔI must be selected according to the machine as the leakage current depends on the motor type and the cable lengths.
BCP = Branch Circuit Protection.
If the power supply is used in a UL compatible system, the manufacturer of this system must use a BCP (listed RK5 fuses rated 600 V, 30 A (max. 300 % of rated current), 200 kA or a listed circuit breaker rated 277/480 V, 13 A, 14 kA) otherwise a 16 A circuit breaker is suitable for non-UL system.
An external transient voltage suppressor devices is required to reduce overvoltage spikes and suppress their influence on the controller behavior. For example, connect one varistor (ex: S14K420) between AC line (L) and PE, and another one between neutral (N) and PE.
The AccurET already includes an in-built filter. An additional filter can be added (for example Schaffner FN2080-16-06) to reduce further electromagnetic disturbances.

3.6 Relay / STO (connector X103)

Phoenix Contact MC 1.5/5-G-3.81 (plastic connector)			
Relay	**Pin #**	**Signal**	**Function**
X103 1 2 3 4 5	1	FB1 (Feedback 1)	Feedback control 1 of the relay (24 V / 0.8 A max)
	2	FB2 (Feedback 2)	Feedback control 2 of the relay (24 V / 0.8 A max)
	3	PSR	Relay supply input (+24 VDC ±10%) from control input
	4	+24 V	Control supply output (+24 VDC). 40 mA max. To bypass the STO function, connect this pin to pin 3 (PSR), otherwise let this pin not connected.
	5	0 V	Control supply (0 VDC) internally connected to GNDaux (pin 2 of X100)

Remark: The +24 V (pin 4) is internally connected to +24 V (pin 1 of X100).
Pin 4 must not be used to power something else than the power relay.
The associated connector can be ordered through the connector kit (refer to §2.5.5). Always use a connector compatible with the above-mentioned one.
The relay connector is located on the top of the controller.

The AccurET modular 300 is available with certified Functional Safety STO (Safe Torque Off). Refer to the dedicated Functional Safety User's Manual.

	**The user must have read and understood the Functional Safety User's Manual in case of usage of the Functional Safety of the AccurET Modular 300. Please contact ETEL S.A. or authorized distributors in case of questions regarding the installation procedures, safety or any other issues.**
	**ETEL S.A. disclaims all responsibility for accidents and damages if the safety instructions, the procedures and the usage described in the corresponding manuals are not followed.**

The STO circuit contains a relay (internal relay) including a main contact (+15 VDC) to allow power transmission to motors and a feedback contact to detect anomalies. The STO function simultaneously manages all the motors outputs of the controller. Both motors outputs are enable or both are disabled at the same time. The STO is active by default, preventing the controller to provide power to the motors. To permanently bypass the STO function and to allow the power transmission to the motors, the relay can be activated by connecting X103 pin 3 (PSR) and X103 pin 4 (+24 V).

Danger	
	**Bypass of the safety function:** - ETEL disengages from any consequence of the bypass of the safety function by the customer. - Be sure to understand entirely the effect of bypassing safety function.

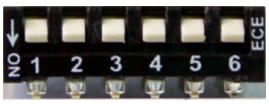
3.7 Download key (connector X102)

If the controller does not switch to 'wait for program' when the user wants to download a new firmware, there is a hardware override possibility to force this mode. To do so, plug the jumper (in any horizontal or vertical position) on the X102 connector, switch off and on the power, and the controller will switch to 'wait for program' to download a new firmware.

Remark: The download key jumper is located on the top of the controller.

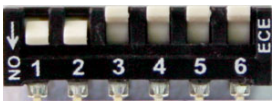
3.8 Axis number selection (connector X101)

In addition to the software, it is possible to assign or to change the axis number of the controller with a DIP switch. After each start-up, the controller takes the axis number given by the DIP switch except when all the switches are in the down position which means set to 1 (like in the picture below). In this case the axis number is set by the AXI command or the value previously saved in the controller or by the default value always equal to 1 (this default value is used when no AXI command has been executed or no save has been done).



The value given on the DIP switch represents a binary value (64 possibilities). The axes are numbered from 0 to 62 because the node 63 is reserved. If the DIP switch is not used, all the bits must be set to 1 (low position).

Example:



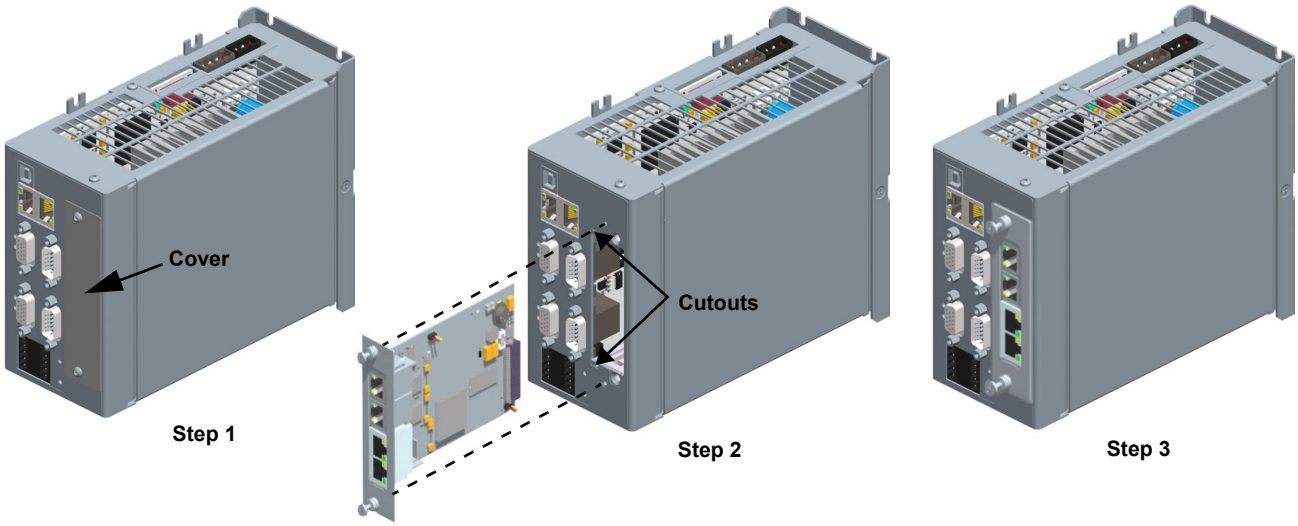
The axis number given by this DIP switch is equal to: $2^0 + 2^1 = 3$. Then, the second axis of the controller will have the number 4.

Remark: **Each axis number must be different from all the others connected to the same TransnET communication bus. It is forbidden to have twice the same axis number on the same TransnET communication bus.**
The DIP switch is located on the top of the controller.

3.9 Optional board

To install an optional board (like the UltimET light motion controller for example) inside the position controller, the user must use the following procedure:


- Work in an ESD protected environment with operator ground connected.
- Turn off all the power supplies (main and control) and wait 10 minutes to allow the internal DC bus capacitors to discharge.
- Unplug all the cables connected to the position controller.
- Unscrew the two screws fastening the cover of the optional board area on the front panel of the controller (step 1)
- Carefully slide the optional board inside the controller by putting the PCB in the two cutouts (step 2)
- Push the board in until the connection is made with the internal back panel connector.
- Screw the two screws present on the front panel of the optional board (step 3)



Remark: Follow in the reverse order the opposite actions of the above-mentioned steps to remove the UltimET light from the controller.
Refer to the ordering information (§2.5) to know which controller can accept an optional board.

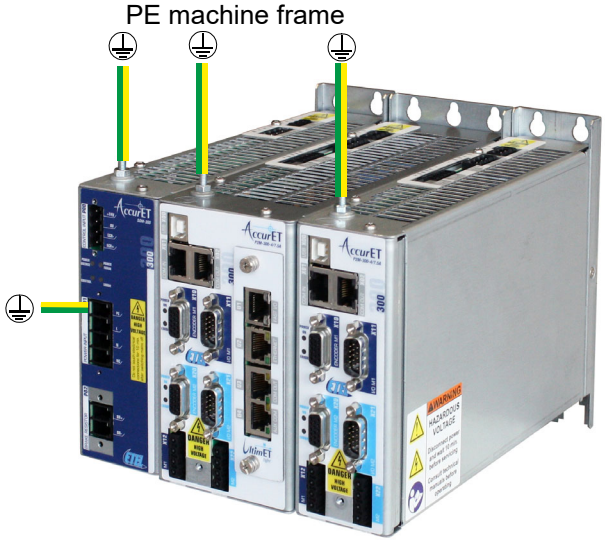
3.10 Ground connection

	**Always connect the ground prior to any other connection.**

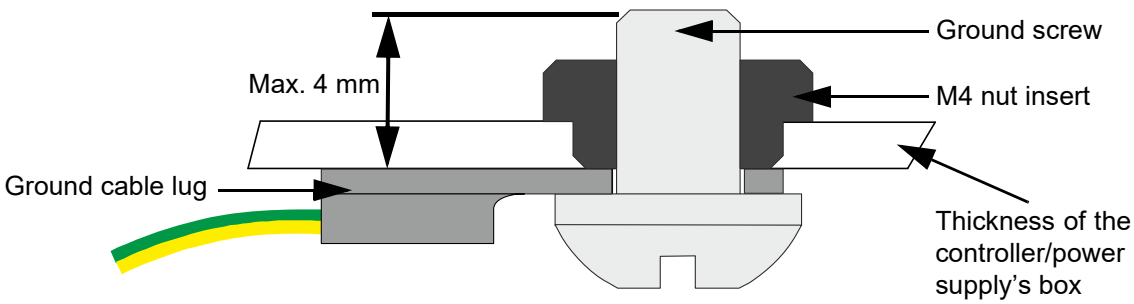
We recommend to connect the ground cables as follows:

Each controller and the power supply must be individually connected to the M4 threaded rod present at the top of each of them. Each ground wire (green and yellow cable) must have a section at least equal to the wires L and N present on the 'power input' connector (P01) of the corresponding power supply and must be connected to the machine frame (PE machine) according to the norms applicable.

On top of this ground cable, the one present on the 'power input' connector (P01) of the corresponding power supply MUST also be connected with a section at least equal to the wires L and N present on the 'power input' connector (P01).



Remark: It is also possible to connect the ground cable to the M4 threaded hole present under the controller/power supply instead of the connection to the M4 threaded rod present on the top of the controller/power supply. In this case, the length of the screw (not provided) must not exceed 4 mm from the external surface of the controller/power supply box.



3.11 Cables manufacturing

If you do not use the cables delivered by ETEL, follow the shield recommendations below for those cables:

- The encoder cables: X10 and X20
- The inputs/outputs cables: X11 and X21
- The motor cables: X12 and X22

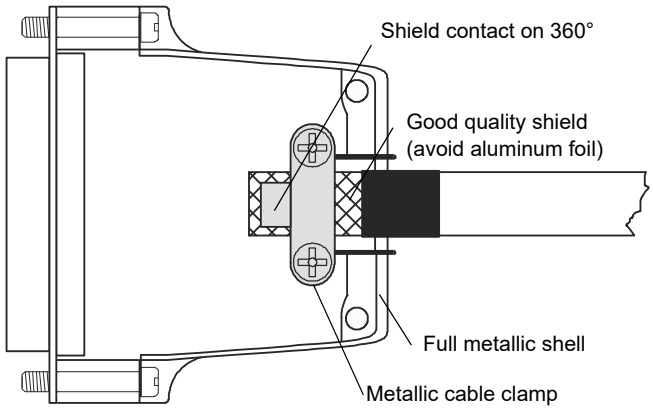
Simple shielded cable **must** be linked to the connector shells on both cable ends. Only full metallic conductive connector shells must be used. Shield with only aluminum foil (metallized plastic film is forbidden!). Use only copper braid (85 % covering shield). The shield must entirely cover all wires. 'Pig tail' connections are forbidden! The shield contact on 360° and a metallic cable clamp is necessary.

Remark: All the cables connected to the controller must have copper conductors only and an insulation standing at least 75 °C.
A bad shielding connection can perturb the encoder signal, phasing, etc.

3.11.1 Encoder and input/output cables

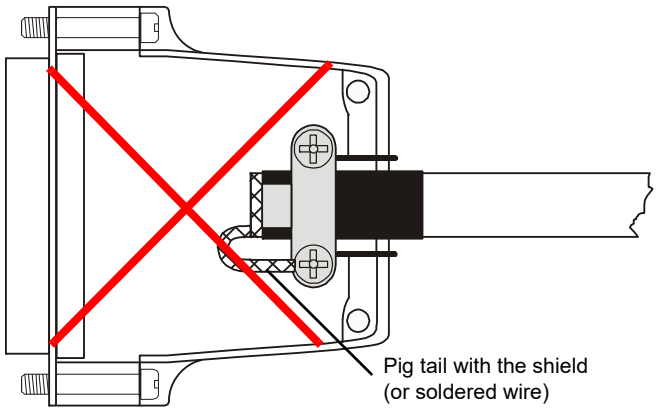
Here is an example of good shielding connection:

Good shielding connection

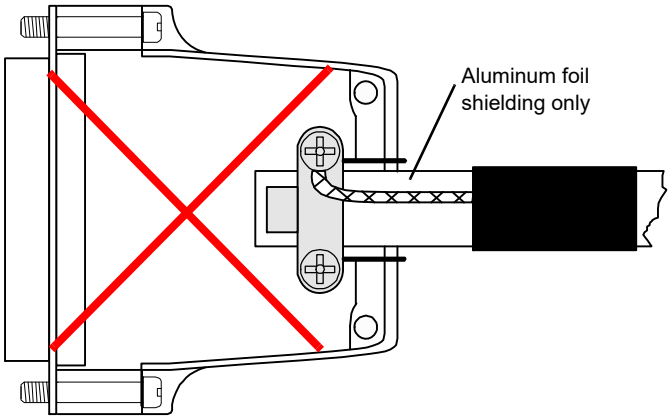


Here are two examples of bad shielding connections:

Bad shielding connection

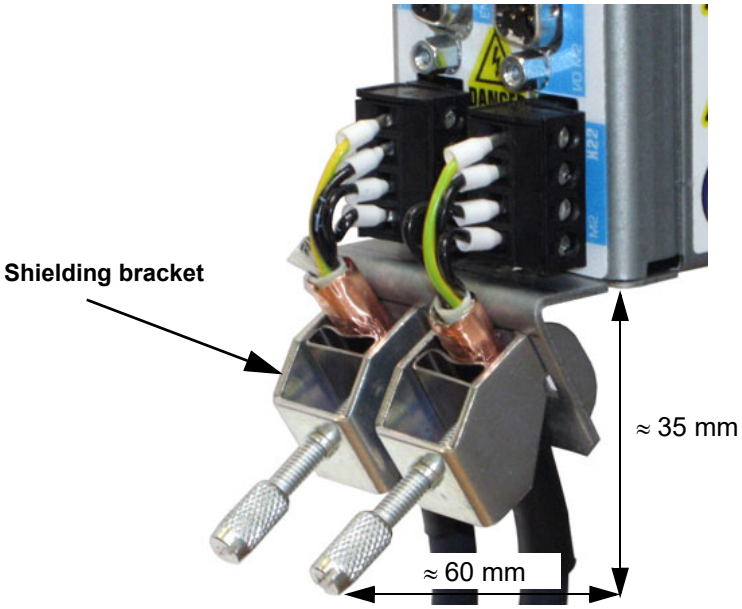


Bad shielding connection



3.11.2 Motor cable

To respect the EMC standard, the following shielding bracket must be used with the motor connector. **It is compulsory to screw it to the front panel of the controller.**



Remark: The cable's bend radius must be taken into account when adjusting the distance between the front plate of the controller and the cabinet.
The shielding bracket can be ordered through the connector kit (refer to §2.5.5).

3.12 LEDs meaning

3.12.1 At the power supply level

- The **'Power voltage'** LED (green) and the **'Power error'** LED (red) present on the power supply have the following meaning when the power supply (and the controller) are switched on:

Both LEDs status	Meaning
ON and then the 'Power error' LED turns off	**Power input and control input are switched on:** both LEDs are simultaneously switched on. After about 2 seconds, you hear a «click» coming from the inrush protection device relay. At the same time, the 'Power error' LED turns off. During this time, the controller has initiated its self-test process.
OFF	**Only control input is switched on:** both LEDs are switched off but the communication with the controller(s) is possible.
ON	**Only power input is switched on:** Both LEDs are simultaneously switched on and remain on.

- The **'Error'** LED (red) and **'Control'** LED (green) present on the power supply has the following meaning:

LEDs	Status	Meaning
Control (green)	ON	The AC voltage is present
	OFF	The MOV (transient voltage suppressor device) is broken
Error (red)	ON	There is a default on the brake resistor output
	OFF	Standard functioning (no problem detected)

Remark: After having removed the cause of the error, it is necessary to switch off and on the power supply to reset it.

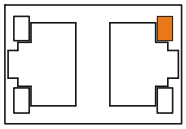
- There is also a red LED present inside the controller and visible through the top grid. If this LED is switched on, there is a problem with the cooling system of the power supply.

3.12.2 At the position controller level

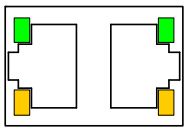
The different LEDs present on the controller have the following meaning:

3.12.2.1 Communication

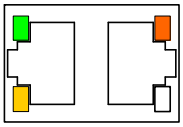
- **The position controller is switched on without connection to a communication bus**

LED regarding the communication	Meaning
COM IN X01  COM OUT X02	Orange LED is ON => The controller is switched on.

- **The position controller is switched on and connected to a TransnET communication bus**

LED regarding the communication	Meaning
COM IN X01  COM OUT X02	Green LEDs is ON => The connection (link) is detected on each connector. Yellow LEDs is ON => The TransnET data are running on each connector. The 'COM OUT' connector of the last controller on the TransnET bus is not connected, however, the green and yellow LEDs are also on to indicate that the TransnET bus loops correctly on itself.

- **The position controller is switched on and connected to an Ethernet communication bus**

LED regarding the communication	Meaning
COM IN X01  COM OUT X02	Orange LED is ON => The controller is switched on. Green LED is ON => The connection (link) is detected. Green LED is blinking => The controller is waiting for an IP address from a DHCP server Yellow LED is flashing => An activity is running on the Ethernet

3.12.2.2 Motor

LED regarding motor 1 / 2	Status	Meaning
Red LED 'ERROR'	ON	Error on motor 1 / 2 => check monitoring M64
	OFF	No error on motor 1 / 2
Green LED 'POWER ON'	ON	Motor 1 / 2 is in 'power ON'
	OFF	Motor 1 / 2 is in 'power OFF' (*)

Remark: If the red LED 'ERROR' and the green LED 'POWER ON' are ON at the same time (not blinking), then the controller is waiting for the end of a firmware download ('Wait for program' mode). Refer to the corresponding 'Operation & Software' for more information.

The red LED 'ERROR' and the green LED 'POWER ON' can be OFF together when the motor 1 / 2 is without error and in power OFF

(*): If the dynamic braking is activated due to an error (refer to the Operation & Software manual), the power bridge transistors are still switching (shortcut at the motor phases output) while the 'POWER ON' green LED is OFF.

3.12.2.3 Other error

The **LEAK OVERCUR ERROR** (#130) can occur. It is due to a short-circuit of the PE (or Uz+, Uz-) and means bad cabling, insulation failure, etc. This additional protection monitors the differential input current and disables the power bridge in case of fault. A hot plug of power voltage (Uz) could generate a false trigger. This error is resettable with a RST command.

4. Brake resistor sizing

A motor coupled with a load has a certain amount of energy. This energy is mainly kinetic when the load is moving or rotating. When the system brakes, the energy must be either stored or dissipated. It may be gravitational potential energy in addition to kinetic energy if the load movement is not horizontal (in case of a linear motor), or could be stored in a spring or in any outer system. In this case, the energy must be either stored or dissipated when the system is braking, and sometimes also when the system is at constant speed in descent direction. The AccurET and the corresponding power supply contain capacitors that are capable of storing a certain amount of energy. If the energy is too big, then a brake resistor is needed.

4.1 How big is the energy stored in my system?

In a standard direct drive application, the energy balance can be written as follows:

$$E_M = (\underbrace{E_K + E_P}_{\text{System energy}}) - (\underbrace{E_{Co} + E_F}_{\text{System losses}})$$

With:
E_M = Total energy of motor/load minus the system losses [J]
E_K= Kinetic energy of motor/load [J]
E_P = Gravitational potential energy of motor/load [J]
E_{Co} = Energy lost in the motor copper (Ohm losses) [J]
E_F = Energy lost by friction [J]

4.1.1 Torque motor case, standard configuration (E_P term equal to zero)

$$E_M = \underbrace{\frac{1}{2} \cdot (J_M + J_L) \cdot \omega_M^2}_{\text{Kinetic energy}} - \underbrace{3 \cdot I_M^2 \cdot \left(\frac{R_M}{2}\right) \cdot t_d}_{\text{Copper losses}} - \underbrace{\frac{t_d \cdot \omega_M}{2} \cdot T_F}_{\text{Friction losses}}$$

With:
J_M= Rotor inertia [kgm^2]
J_L= Load inertia [kgm^2]
ω_M= Motor speed before deceleration [rad/s]
I_M= Motor current during deceleration [A_{rms}/phase]
R_M= Motor resistance [Ω] terminal to terminal
t_d= Time to decelerate [s]
T_F= Friction torque [Nm]

Remark: A rotary axis may have in addition: gravitational potential energy (in case of non-direct drive, if the load is non horizontal), spring stored energy, etc.

4.1.2 Linear motor case with gravitational potential energy

$$E_M = \underbrace{\frac{1}{2} \cdot (m_M + m_L) \cdot v_M^2}_{\text{Kinetic energy}} + \underbrace{(m_M + m_L) \cdot g \cdot (h_{initial} - h_{final})}_{\text{Gravitational potential energy}} - \underbrace{3 \cdot I_M^2 \cdot \left(\frac{R_M}{2}\right) \cdot t_d}_{\text{Copper losses}} - \underbrace{\frac{t_d \cdot v_M}{2} \cdot F_F}_{\text{Friction losses}}$$

With:
m_M = Motor mass [kg] moving part of motor only
m_L = Load mass [kg]
v_M = Motor speed before deceleration [m/s]
g = Gravitational acceleration [m/s2]
$h_{initial}$ = Initial load altitude [m]
h_{final} = Final load altitude [m]
I_M = Motor current during deceleration [A_{rms}/phase]
R_M = Motor resistance [Ω] terminal to terminal
t_d = Time to decelerate [s]
F_F = Friction force [N]

Remark: For a constant speed system (like a long stroke conveyor for example), all the terms of the above-mentioned equation have the same meaning except for:

v_M = Motor speed (constant) during the travel [m/s]
I_M = Motor current during travel at constant speed [A_{rms}/phase]
t_d = Time to travel [s]

4.2 Is a brake resistor needed?

If the following condition is true, then a brake resistance is needed. For a n axes system plugged on the same power supply (all negative E_M terms are set to zero in order to have the worst case).

$$\sum_{j=1}^{n} E_{Mj} > \underbrace{\frac{1}{2} \cdot C \cdot (U_{MAX}^2 - U_{Nom}^2)}_{\text{Maximal energy storable in the capacitors}}$$

With: E_M = Total energy of motor/load minus the system losses [J]
C = Total capacitance seen from the bus [F] (refer to §4.5)
U_{MAX} = Maximal allowed bus voltage [V] (refer to §4.5)
U_{Nom} = Nominal bus voltage [V] (refer to §4.5)

4.3 How to determine the resistance value?

For an n axes system plugged on the same power supply:

$$R_{MAX} = \frac{U_{MAX}^2}{\sum_{j=1}^{n} U_{Bj} \cdot I_{Mj} \cdot \sqrt{3}}$$

With: R_{MAX} = Brake resistance maximal value [Ω]
U_{MAX} = Maximal allowed bus voltage [V] (see table 1)
U_B = Motor back EMF less motor losses [V] (refer to §4.3.1 and §4.3.2)
I_M = Deceleration current in motor [A_{rms}/phase]

4.3.1 Torque motor case

$$U_B = \underbrace{K_u \cdot \omega_M}_{\text{Back EMF}} - \underbrace{I_M \cdot \left(\frac{R_M}{2}\right) \cdot \sqrt{3}}_{\text{Phase voltage}}$$

With: K_u = Back EMF constant [V/(rad/s)] terminal to terminal

4.3.2 Linear motor case

$$U_B = \underbrace{K_u \cdot v_M}_{\text{Back EMF}} - \underbrace{I_M \cdot \left(\frac{R_M}{2}\right) \cdot \sqrt{3}}_{\text{Phase voltage}}$$

With: Ku = Back EMF constant [V/(m/s)] terminal to terminal

4.4 How to determine the resistance dissipated power

For an n axes system plugged on the same power supply (all negative E_M are set to zero):

With: P_{AV} = Average power to be dissipated by the brake resistance [W]

$$P_{AV} = \frac{\sum_{j=1}^{n} E_{Mj} - \left(\frac{1}{2} \cdot C \cdot (U_{MAX}^2 - U_{HYS}^2)\right)}{t_{CYCLE}}$$

U_{HYS} = Hysteresis point of power supply [V] (refer to §4.5)
t_{CYCLE} = Longest (time between two consecutive decelerations) of the n axis system [s]

When the time between two consecutive decelerations becomes very large, the average power is not a meaningful number. In this case, the peak power is the main concerned:

$$P_{PK} = \frac{V_{MAX}^2}{R_{REGEN}}$$

With: P_{PK} = Peak power dissipated by the regenerative resistance [W]
R_{REGEN} = Brake resistance value [Ω]

4.5 AccurET specifications

	C	U_{MAX}	$R_{internal}$	U_{Nom}	U_{HYS}
AccurET 300	94 µF	390 V	-	340 V	370 V
Power supply 300	984 µF	390 V	-	340 V	370 V

Remark: In the case of one power supply and n AccurET controller, C is calculated as follows:

$$C[\mu F] = 984 + n \cdot 94$$

5. Service and support

For any inquiry regarding technical, commercial and service information relating to ETEL S.A. products, please contact your ETEL S.A. representative:

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