BERGER POSITEC
motion technology

Berger Positec s.r.o. www.regulacni-pohony.cz

USER MANUAL SD2204

2-phase stepper motor drive

INDEX

REVISIONS

Revision	Date	Notes
Rev. 01	March 2019	Draft
Rev. 02	August 2019	Update of sections “CE installation” and “Motor cables connection”
Rev. 03	April 2020	Addition of Modbus RTU protocol
Rev. 04	December 2020	Addition of SMD2204H version
Rev. 05	November 2021	Addition of Profinet protocol

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TRADEMARKS AND DISCLAIMER

SafEty pRECautIoNs

Important

In order to avoid damages to machineries and devices, and injuries to the installation staff, it is recommended to follow the instructions below.

In this manual, the following symbols are used to identify warning levels you may occur if you don't follow instructions.

DANGER Identifies conditions that may cause death or serious injures if precautions are not observed.

CAUTION Identifies conditions that may cause injuries, damages to the product or malfunctioning, if precautions are not observed. In some cases, failure to follow precautions may cause serious consequences.

The following symbols identify forbidden and mandatory operations.

FORBIDDEN Identifies forbidden actions, which must NEVER be done.

MANDATORY Identifies mandatory actions, which MUST be done.

The following symbols are used to identify important information, which are useful for a correct installation.

IMPORTANT Identifies important information, included precautions like warnings you should consider in order to avoid to damage the device.

INFORMATION Identifies additional information.

DANGER

Read full instructions before checking, transporting, stocking, installing, wiring, functioning, inspectioning or disposing of the devices.

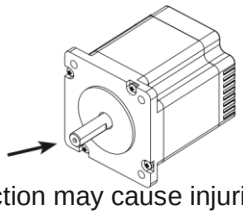
Make sure that cables and connectors have been connected correctly. excessive traction or pressure, or to objects that could cause crushing.

Wrong wiring may cause electric shocks, Breaking or dispersing cables may cause fire, damages to the devices or injuries. electric shocks, fire, damages to the device or injuries.

Do not expose cables to sharp objects or edges,

Never touch any rotating part of the motor while drive before removing or altering wiring, or inspectioning device.

Rotor



Failure to follow this instruction may cause injuries.

Wait at least 5 minutes after the shut down of the drive and motor are operating.

This operation must be carried out only by skilled staff.

Failure to follow this instruction may cause electric shocks.

Never touch internal parts of the drive.

Failure to follow this instruction may cause electric shocks or damages to the devices

Don't remove cables, connectors, protection elements or optionals while power supply is active, or without proper safety systems.

Failure to follow this instruction may cause injuries.

Do not approach the machinery immediately after resetting temporary power drop, to avoid unexpected reboots. Their surfaces may reach high temperatures.

Never touch motor or drive while they are operating.

Failure to follow this instruction may cause injuries.

Failure to follow this instruction may cause burns.

Do not subject the product to water, corrosive liquids, flammable gases or combustible.

Failure to follow this instruction may cause fire

Do not apply loads greater than indicated in the technical documentation.

Failure to follow this instruction may cause malfunctions or injuries.

During the installation, must be provided protections against over-current, mass dispersion protections, over temperature protections, as well as emergency stop devices.

In absence of protections, faults may cause electric shocks, fire or injuries.

Do not trample. Do not put heavy objects on the product.

Failure to follow this instruction may cause malfunctions or injuries.

DANGER

Read full instructions before checking, transporting, stocking, installing, wiring, functioning, inspectioning or disposing of the devices.

Strictly follow instructions and procedures inclu- this manual when checking correct instal- ed out by authorized personnel. lation.

Malfunctions due to wrong installation may and may cause accidents fire electric shocks, fire, injuries, damages or injuries.

Installation, wiring and inspections must be carrided in

Failure to follow this instruction may cause damage devices and malfunctions.

Install an emergency stop device on-board the machinery.

Failure to follow this instruction may cause injuries.

Applications and installations must meet all applicable safety requirements.

In absence of protections, faults may cauelectric shocks, fire or se injuries.

Make sure of proper grounding devices. Connect grounding terminal, in accordance with the standards for electrical installations. (Mass Resistance <= 100Ω)

Failure to follow this instruction may cause damages or injuries.

Use properly sized equipments for the type of the load to be handled.

Failure to follow this instruction may cause electric shocks.

CAUTION

Do not carry the drive or the motor taking by cables or motor shaft.

Failure to follow this instruction may cause malfunctions or injuries.

• Do not stock or install the product in the following locations:

• Locations subject to temperatures outside the permitted ranges.

- **Locations subject to humidity outside the permitted ranges.**
- **Locations subject to condensation.**
- **Locations exposed to corrosive, explosive or flammable gases.**
- **Locations exposed to dust, salt or metal powders agents.**
- **Places exposed to water, oil or chemicals agents.**
- **Locations subject to shock or vibration.**

Failure to follow this instruction may cause malfunctions or damages of the product.

Do not cover inputs, outputs and ventilation slots of the drive. Prevent foreign objects such as metal fragments or liquids from entering the product.

Failure to follow this instruction may cause deterioration of internal components and malfunctions

Supply the drive only with insulated voltages from main power supply, inside the allowed range.

Failure to follow this instruction may cause malfunctions, fire or electric shocks.

Keep specified distances between the drive and other devices.

Failure to follow this instruction may cause malfunctions fire.

Safely connect the power supply terminals. Use cables of proper section for their use.

Failure to follow this instruction may cause fire.

Functioning tests must be carried out only with motor shaft disconnected from the machinery.

Failure to follow this instruction may cause serious injuries.

Make sure to meet all installation conditions

Failure to follow this instruction may cause malfunctions, fire or electric shocks.

AEC drives are precision devices. Prevent shocks during transport, installation and function.

Failure to follow this instruction may cause malfunctions

Make sure that the drive is correctly connected.

Failure to follow this instruction may cause malfunctions, fire or electric shocks.

In the case of use in vertical axes, install safety devices to prevent possible falls of parts in case of emergency or fault.

Failure to follow this instruction may cause malfunctions or injuries.

Keep supply lines and signal lines at a distance of at least 300 mm. Use twisted pairs or shielded cables.

Failure to follow this instruction may cause malfunctions.

When an alarm occurs, turn the power off, remove the cause that triggered the alarm. Make sure that system is safe before turn the power.

Failure to follow this instruction may cause injuries.

Consider these products as general industrial waste when disposing them.

NotEs oN safEty

Products for automation manufactured by AEC must be handled, installed and maintained only by skilled and authorized personnel, that must be qualified and instructed to install components for automation. Devices must be installed only for the purposes described in the user's guide. The installer should pay particular attention to potential risks caused by mechanical and electrical hazards.

It is very important that all applications and installations meet all applicable safety requirements.

The installers must take responsability to verify their knowledge and understanding of all applicable safety standards.

Installations which are not complying with safety requirements can damage equipment and injure the user.

AEC s.r.l. will not be liable and will not take any responsability for damages caused by products handled or installed improperly, or if the customer have given permission or performed modifications and/or repairs not authorized from AEC s.r.l.

AEC's motion control equipment are high-performances devices for automation, able to producing high forces and rapid movements.

Pay high attention, in particular during installation and development of applications.

Use properly sized equipments for the type of application.

AEC's devices must be considered as components for automation. They are sold as end-user products, and must be installed only by qualified personnel, in accordance with all applicable safety requirements.

Skilled staff must be able to recognize possible dangers that may result from programming, modifying parameter's values and, generally, that may result from using mechanical, electric and electronic equipment.

The drive must be installed in closed cabinets, so that any parts thereof is not reachable while system is powered on.

AEC s.r.l strongly recommends to always follow safety requirements and security rules. Failure to follow this instruction may cause and/or injuries. *General precautions*

- The images contained in this manual are for demonstration purposes, and may differ from the products received.
- This manual is subject to changes due to improvement of the products, modification of specifications, or manual thereof improvement.
- AEC s.r.l. is not responsible for any damage to property or injury that could result from improper installation and/ or not authorized modification to products.

AEC's drive systems are are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. **The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment**. *For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.*

To prevent personal injury and damage to property, damaged drive systems must not be installed. Changes and modifications of the drive systems are not permitted, and if made all no warranty and liability will be accepted.

MAINTENANCE AND INSPECTION

To ensure a proper and satisfactory performace of the drives and the motors, equipments and installations need periodic inspections and checks.

Notes for maintenance pesonnel

After shutdown, the internal capacity will remain charged, at high voltages, for a short period of time. Wait at least 10 minutes after PWR led goes off, before working on the device.

Drives and motors can reach high temperatures during functioning, therefor it is recommended to wait for them to cool before touching any of their surfaces. in all cases, be careful.

Never plug or unplug any connector when power is connected.

Control cycles checklist

Correct operating conditions:

Operating temperature : 30° C (annual average)

Hours of work : 24 hours per day

Periodically check the correct operation of the equipments by following this checklist:

Type of inspection	Frequency	Checklist
Weekly check	Weekly	1. Operating temperature, humidity, dust, particles or foreign matter 2. Vibrations or not standard noises 3. Main and auxiliary supply voltage 4. Odors 5. Obstruction of ventilation slots 6. Cleaning of drive and connectors 7. Correct insertion of connectors 8. Integrity of the cables
Periodically check	Annual	1. Verify the correct closure of the fixing screws 2. Signal malfunction or overheating

In case that operating conditions are different from the recommended ones, carry out inspections more frequently.

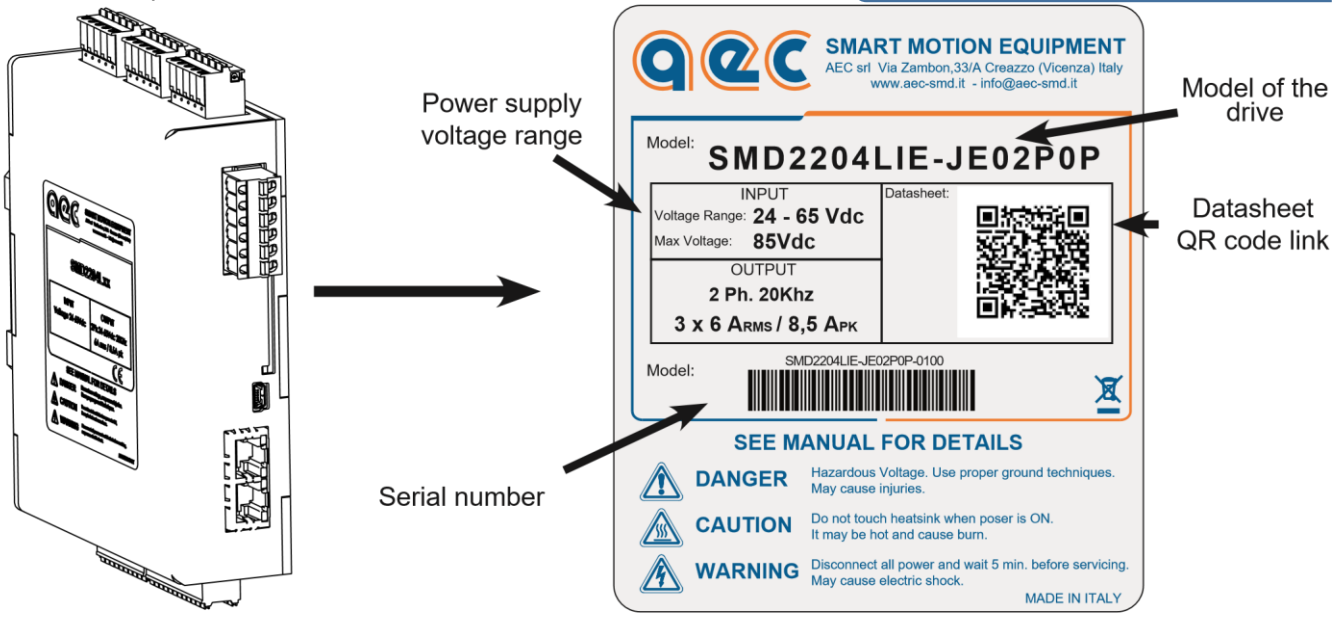
BEFORE USE

This chapter contains general informations about operations to be carried out when receiving products, and before the installation of the drives and axis controllers for stepping motors manufactured by AEC s.r.l.

PRODUCTS VERIFICATION

Upon receipt of the goods, verify that the product received is the ordered one, by checking that order code corresponds with ID label code.

In case of wrong code, damaged parts or missing components, please contact the dealer or the distributor where the product has been purchased.



MODEL CODE

SMD 2204 L I E- J E 0 2 P 0 P

Stepper motor drive SMD

2204 Series

Power supply voltage range

L : 24 - 85 V_{DC}
H : 24 - 135 V_{DC}

I : Programmable
U: USB indexer
S: Step and direction
A: Parameterizable

Communication interface

M : Modbus RTU
C : CANopen
P : Profibus
E : Modbus TCP/IP
T : EtherCAT
N : ProfiNET

Indexer type

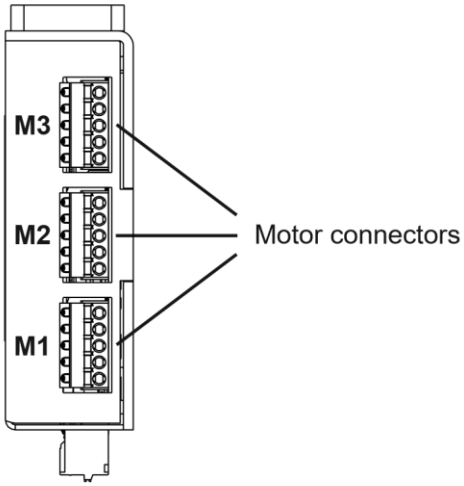
Terminal block

1 : Single terminal block
1 : Double terminal block

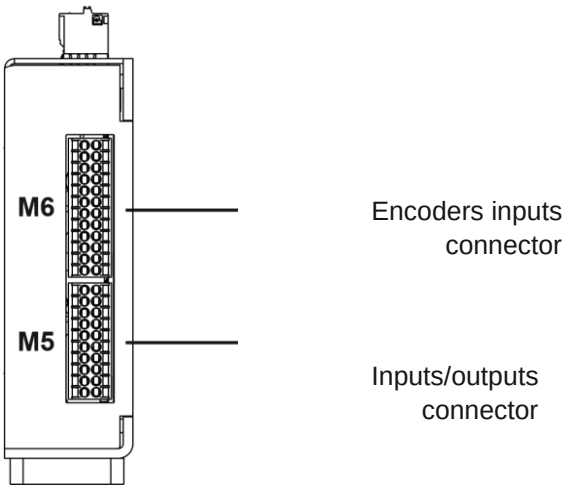
Communication connector

U : USB
D : DB9
J : RJ45

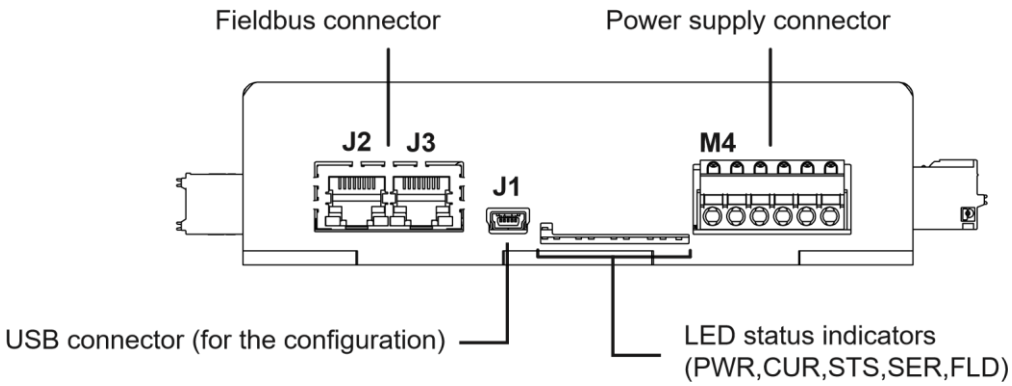
Top view



Bottom view



Front view


Fieldbus connector
Power supply connector
J2
J3
J1
M4
USB connector (for the configuration)
LED status indicators
(PWR,CUR,STS,SER,FLD)

European directives

CE

Our drives comply with the following directives:

Low voltage directive 2014/35/UE

Standard EN 61800-3: 2004
Adjustable speed electrical power drive systems - Safety requirements – Electrical, thermal and energy

EMC Directive 2014/30/UE

Standard EN 61800-5-1:2007
Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

Note:

In order to comply with the directives mentioned above, the drives must be installed in accordance with the instructions described in the user manual of the product.

Since the drives are installed into a system, they need a new confirmation of compliance after the installation.

Since the drives are components to be incorporated into a machinery, it is necessary to verify that the complete machinery comply with the requirements of the current machinery directive before putting it in service.

The SMD2204xxx is a full-digital drive for stepping motor. It can operate in three modes of control: stepper-mode, smartmode or servo-mode.

In stepper-mode, the drive works with an open loop field oriented vector-space stepless current control technique, in order to obtain smooth and vibration-less function.

In servo-mode, the stepping motor (with encoder feedback) can be controlled as a DC brushless motor, working in closed loop with torque control, position mode or velocity mode.

The SMD2204xxx can work in stand-alone mode, or connected to a Modbus TCP/IP, CANopen, EtherCAT or Profinet communication network.

In stand-alone mode, the drive can generate complex profiles, controlled by the integrated user program, it can handle inputs and outputs, receive data or commands by a communication bus.

If connected to a communication network, it can be totally controlled by an host computer, or it can work in mixed mode.

The drive SMD2204xxx must be supplied with a DC voltage obtained from a switching power supply or by rectifying and filtering the secondary of a transformer.

The drive features a useful function that allows to keep “alive” the axis controller even if the motor stage isn’t supplied.

Stepper-mode

In stepper-mode, the drive works in open loop with a stepless regulation of the current that permits to obtain an evolved and optimized vector control.
The system allows to adapt to load conditions, and to drastically reduce thermal dissipation and mechanical resonances. The result is a smooth and silent movement, thanks to the sinusoidal current management, free from parasitic harmonics.

Smart-mode

In smart-mode, the stepper motor works as a servo-motor controlled in closed loop.
The drive uses the encoder to maintain the position and the velocity of the motor, modifying the driving parameters in order to follow the theoric profiles to be executed.
The supply of the current during the movement is constant at the nominal level. While the motor is in standstill, the current is brought to the reduced current level, in order to maintain the position. The drive can be configured to work in current loop, velocity loop or torque loop.

Servo-mode

In servo-mode, the stepper motor works as a real servo-motor controlled in closed loop.
The drive uses the encoder to maintain the position and the velocity of the motor, modifying the driving parameters in order to follow the theoric profiles to be executed. Unlike smart-mode, the supply of the current is not a constant level, but varies depending on the error breadth and the requested torque. This reduces the thermal dissipation and the energetic consumtion of the system.
The drive can be configured to work in current loop, velocity loop or torque loop.

The configuration of the SMD2204xxx is very easy and intuitive with the software StepControl.

The drive communicates with the PC with a USB 2.0 connection. All of the parameters and registers can be configured through software.

It is possible to adjust manually all of the parameters of the drive, in order to obtain the highest performances, even in particularly difficult condtions.

The drive configuration can be saved in a file, duplicated and loaded to other drives, in order to make easier to configure further axis.

With StepControl you can display graphics and charts showing register or internal variable's datas, you can display warnings and alarms which may occur, or control the axis with the manual consolle.

CoomuNICatIoNs aND fIElDBus

It is possible to assign a communication address to the drive, in order to connect more drives into the same communication network.

The SMD2204xxx drive series supports the following communication bus:

1. Modbus RTU
2. Modbus TCP/IP
3. CANopen
4. EtherCAT
5. Profinet

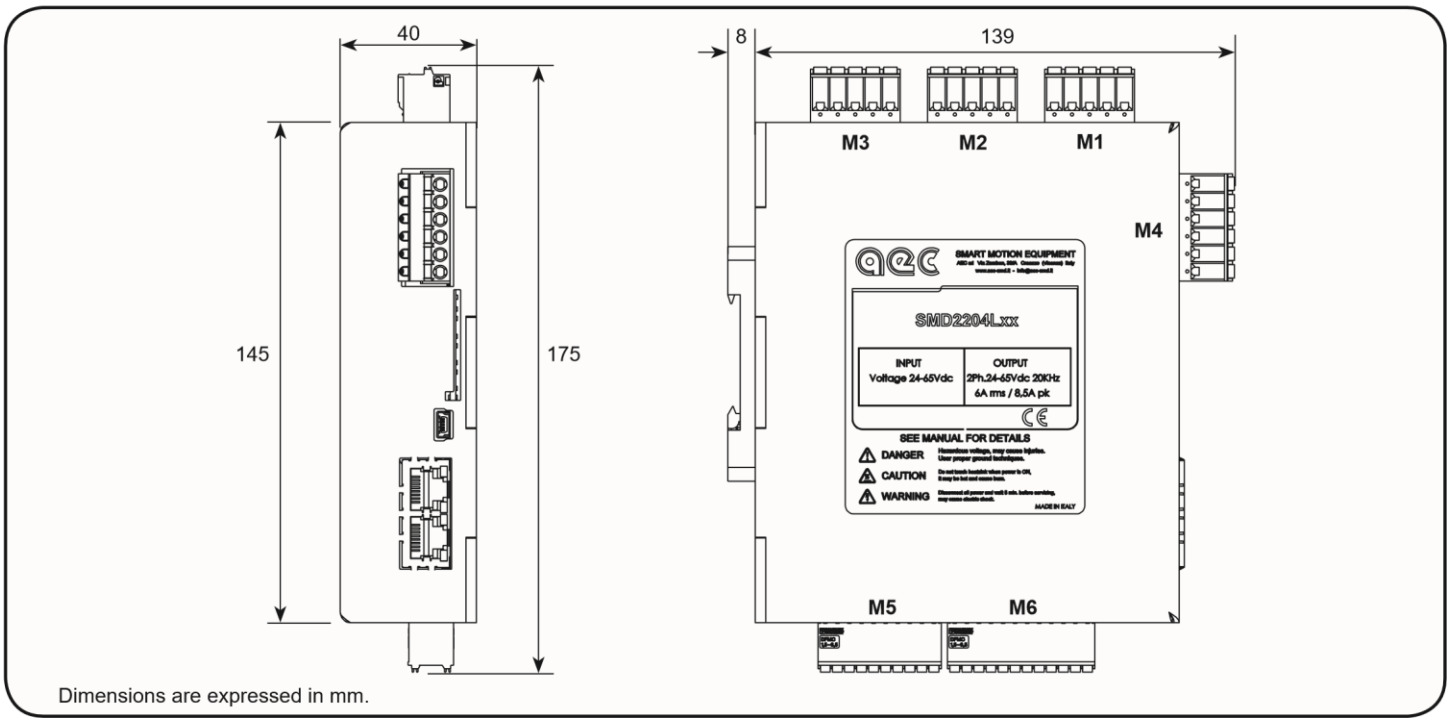
INSTALLATION

This chapter contains general information about operations to carry out in order to complete a correct mechanical installation of stepping motor drives manufactured by AEC s.r.l.

INSTALLATION CONDITIONS

Characteristic		Specification
Operating temperature		0°C … +50°C
Cooling		Ventilate the drive in case of continuous operation
Operating humidity		95% RH or less (no condensation)
Stocking temperature		–20°C … +70°C
Stocking humidity		95% RH or less (no condensation)
Installation location		Free of corrosive gases Free of dust and iron dust Not subject to humidity or oil lubricant such as cutting oil
Altitude		1.000 m or less
Vibration resistance		4,9 m/s2
Shock resistance		19,6 m/s2
Operationg conditions		Installation category (overvoltage category): III Polution degree: 2 or better Protection class: IP3X (EN50178)
Installation location	Installation in a control panel	Design the control panel dimensions, the module layout and cooling method so that the temperature in proximity of the drive does not exceed 50°C. Note: In order to increase product lifespan and ensure reliability, we advice to keep the temperature inside the ontrol panel below 40°C.
	Installation in proximity of a heating module	Minimize the thermal radiations coming from the heating module and any increases in temperature caused by natural convection, in order to ensure that the temperature in proximity of the drive does not exceed 55°C
	Installation in proximity of a source of vibration	Install a vibration dampener under the drive, in order to avoid to subject the device to excessive vibrations.
	Installation in a location subject to corrosive gases	Corrosive gases do not have an immediate effect over the drive, but in the long terms, they cause electronic components malfunctions. Take appropriate measures in order to prevent corrosive gases presence.

DIMENSIONS of thE DRIvE



Dimensions are expressed in mm.

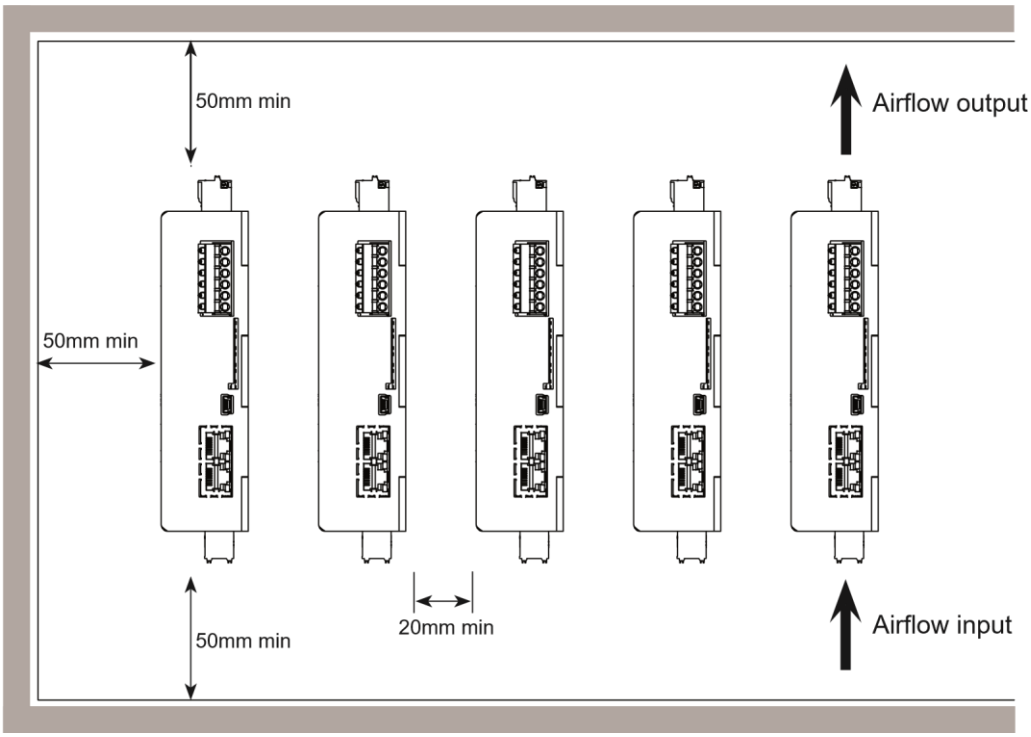
Characteristic	Specification
Weight	490 g

aBout INstallatIoN

Install vertically, securely fixing the drive with the DIN rail guide bracket.

If installed inside an electric cabinet, leave a free space of at least 50 mm around the module in case of a single drive installation.

In case of installation of more than one drive, leave free spaces between contiguous drives, as it can be seen in the following picture, in order to ensure airflow and modules cooling.



CAUTION

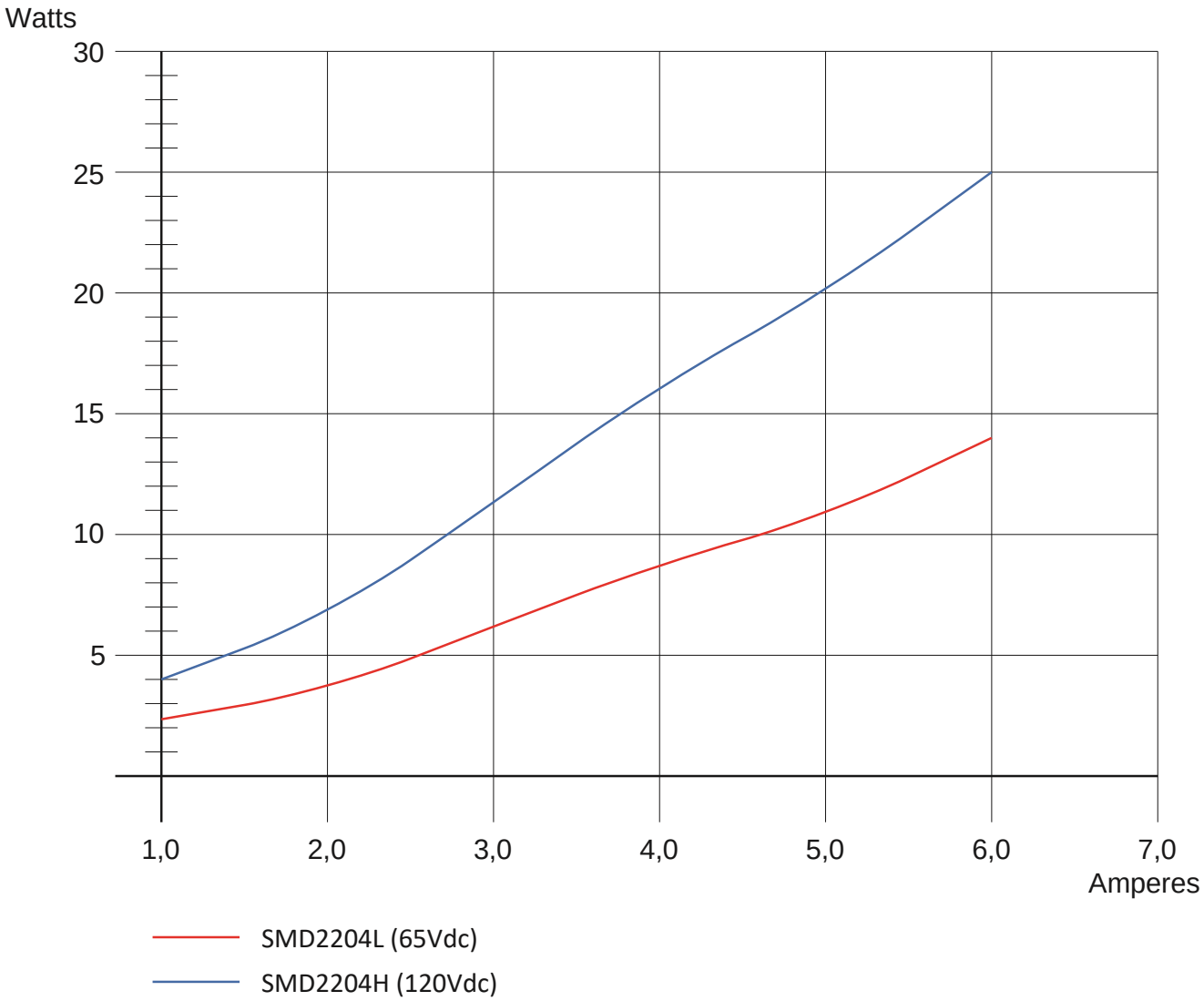
Do not cover ventilation slots and prevent foreign objects such as metal fragments or liquids from entering the product.

It is expressly forbidden to carry out modifications of any mechanical part of the drive.

Failure to follow this instruction may cause deterioration of internal components, fire and malfunctions

thERmal DIssIpatIoN

The following chart shows the trend of thermal dissipation, **for each motor output,** in relation to the output current.



StEppER-moDE fuNCtIoN

This function mode is very similar to the traditional method of control of stepper motors.

In fact, the drive works in open loop and generates the motion profile and the current levels, basing on internal registers (without direct feedback from the motor).

The drive behaves like a costant current generator and provides the configured nominal current, indipendently from the torque required by the movement.

The indexer updates the parameters of the movement in real-time, permitting to realize complex linked movements in speed (JOG) or in position (GO, absolutes and relative).

The VectorStep drives use the innovative control algorithm EVSC (Enhanced Vector Step Control), which permits to obtain a smoother and efficient handling of the stepper motor, as opposed to the traditional impulsive type control.

StEplEss tEChNology

The stepless control allows to set any level of current within the operation range of the drive, and to decrease at minimum the commutation losses due to eddy currents, to reduce the overheating of the motor, to decrease mechanical vibrations caused by the jerky movement (steps) of the motor and, last but not least, to reduce drastically mechanical noise.

One of the prerogatives of stepper motors is the possibility to generate movements, even complex, without the aid of sensors (Hall, encoder, resolver, or other).

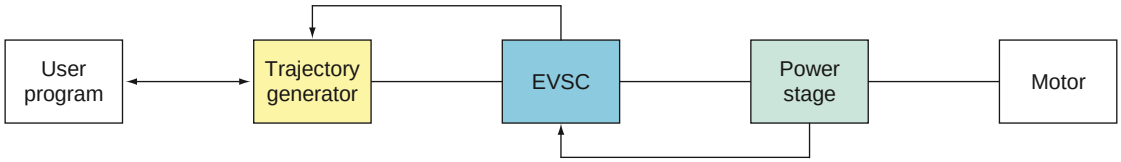


Diagram of the open loop chain of control

fRaCtIoNatIoN of thE stEp

The fractionation of the step in stepper motors is always has been one of the main nodes to obtain good performances, both in terms of speed and in terms of noise and precision.

With the traditional systems of control (with setting of the hardware resolution), the user was forced to choose a single “compromise” resolution that met up all of the needs.

A high resolution, in fact, guaranteed a smooth and silent movement, but forced the user to utilize axis controllers with very high output frequences: a low resolution, on the other hand, allowed to obtain high dynamics of movement, but with less precision and a higher noise.

The EVSC, thanks to the stepless technology, introduces an innovative concept in the use of stepper motors.

The VectorStep series is composed of microstep drives that work with a high-resolution of 1/1024th step (204800 steps per revolution). However, while maintaining the same physical resolution, it is possible to modify the working resolution through software, up to a 1/1 ratio.

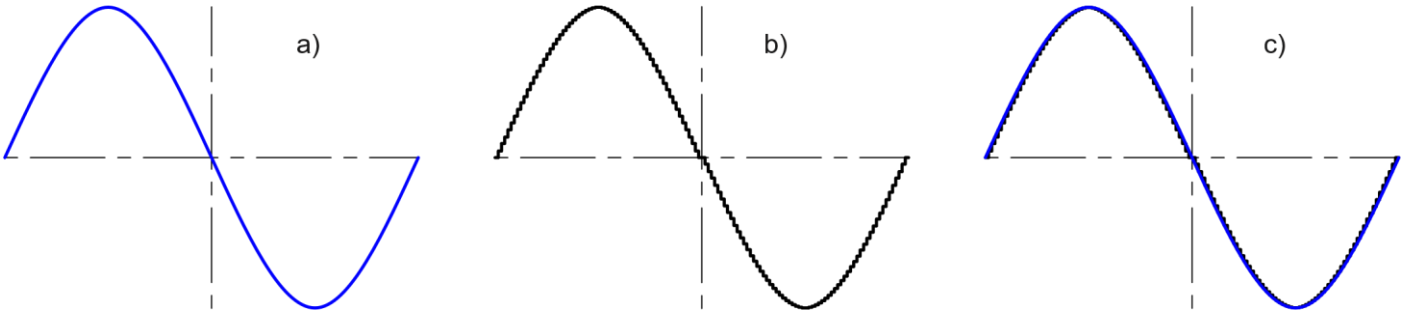
Even in case of full step function, the movement of the rotor will be performed by interpolating the position between the two steps, in order to obtain the same behaviour as if maximum resolution was set.
This type of technology offers multiple advantages. It permits to: quickly change the resolution of the motor,

without causing undesired movements of the motor keep constant the positioning precision with different

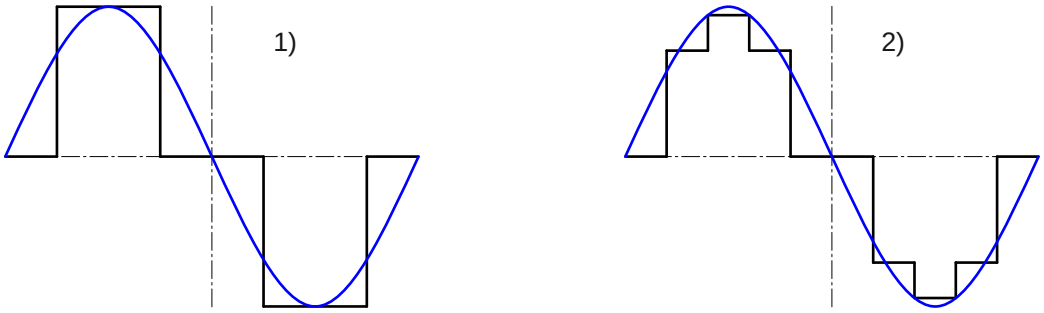
resolutions set through software perform movements with different resolutions (e.g. full step approach; then

working at 1/1024th) reduce mechanical resonances being able to use the motor at the maximum resolution

even with axis controllers with limited output frequency.



Profile of current to the motor : a) VectorStep with stepless technology b) Traditional microstep drive c) Comparison of profiles



Difference between the profile of current of a traditional drive and a VectoStep drive at full step (1) and at half step (2)

CuRRENt CoNtRol

The drive in open loop, manages three pre-set levels of current: reduced current (Rcurred), nominal current (Rcurnom) and boost (Rcurboost).

The boost current, usually greater than nominal current, can be applied during acceleration and deceleration ramps. The time of the boost can be set in milliseconds and indicates the maximum time of the boost; in case that the time of the ramp is greater than the time of the boost, the current will be re-set at nominal value, even if the ramp is not ended.

During the normal function of the motor, like during constant speed rotation, the drive delivers the nominal current. The value of the current for each level can be set in mA.

The drive uses an I2T algorithm to protect the motor from overheating, by monitoring real-time the power supplied to the motor and the work cycles, in order to keep the temperature of the motor itself inside the allowable range.

CuRRENt CoNtRol aDvaNCED fuNCtIoNs

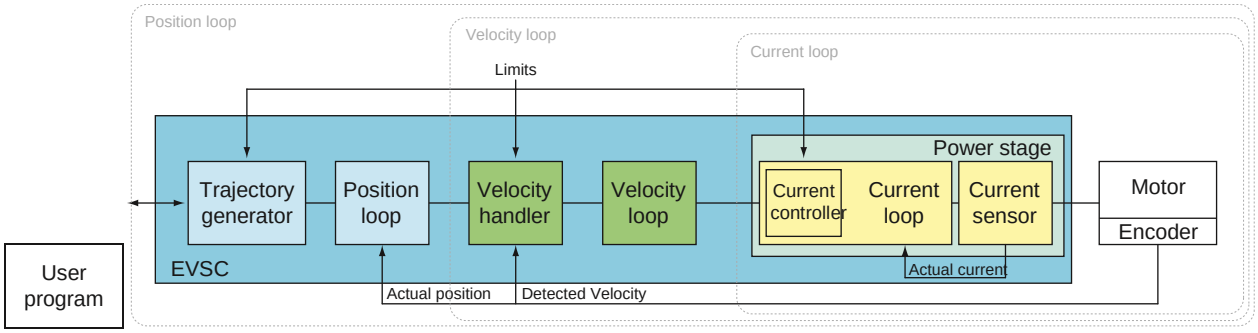
The Field oriented control (FOC), implemented in AEC drives, uses advanced algorithms for current control that permit to adapt the drive to any load typology or required performance.

The EVSC (Enhanced Vector Step Control) allows to: modify the PID of the current loop, in order to adapt the system to every type of motor; modify the phase angle of the curent, thus to to reduce resonances; deflux the motor, in case of high speed applications; modify the harmonic spectrum, so that the rotation of the motor is smooth and quiet, with reduced vibrations.

SmaRt-moDE fuNCtIoN

Smart-mode function includes two different types of operation:

1. velocity control function 2.
position control function



This mode is an hybrid between the Stepper-mode and the Servo-mode.

The drive works by using the encoder of the stepper motor to obtain a the position feedback, but at the same time it operates like a constant current generator, supplying the configured nominal current independently by the torque required by the movement.

This permits to manage the torque at the motor shaft, but with a current which is constant both during the movement and during the standstill moments, eliminating the oscillations due to the current regulation.

Gli azionamenti VectorStep in modalità Smart-Mode utilizzando l'innovativo algoritmo di controllo EVSC (Enhanced Vector Step Control) permettono di lavorare in controllo di coppia, in controllo di velocità anche con riferimenti di velocità esterni (ingresso analogico o tramite fieldbus) oppure di ottenere un posizionatore con tempi di risposta e dinamiche particolarmente performanti.

Regarding the fractionation of the step and the current control, the Smart mode works like the Stepper mode.

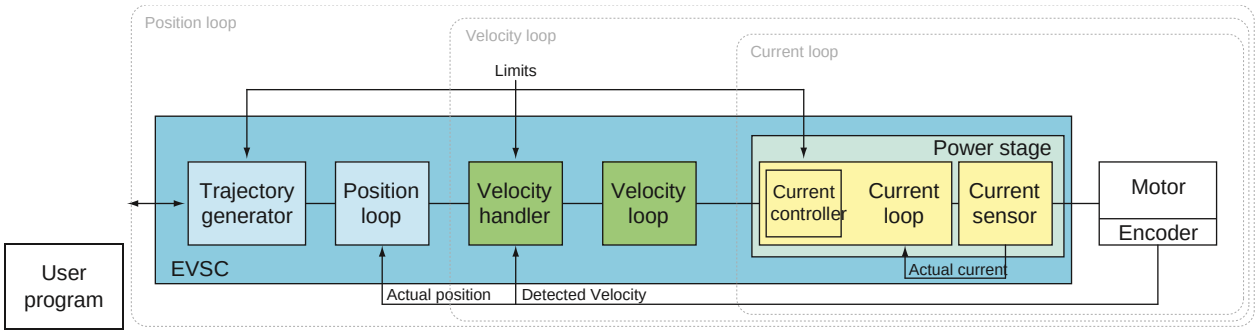
SERvo-moDE fuNCtIoN

Servo-mode function includes three different types of

operation: current control function (torque) velocity control

function position control function

These modes of operation are defined nested, because position control interacts with velocity control, that in turn interacts with current control.



Servo-mode function is realized by using a stepper motor with an encoder feedback, in order to obtain a position feedback. The encoder doesn't only control the motor position, but, thanks to the EVSC, becomes an electronic collector which permits the drive to react real-time to load variations.
The closed loop control allows to optimize current and torque management of the motor, reducing thermal dissipation and exploiting 100% of the deliverable torque of the motor.
Servo-mode function permits to operate in torque control, velocity control (also with external references like analog input or fieldbus), or to get a positioner with very performant dynamics and response times.

REsolutIoN of thE motoR

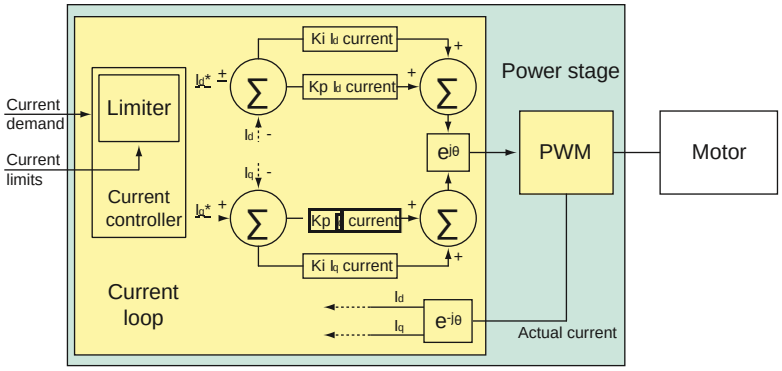
In Servo-Mode, the resolution of the motor is not given by the configured microsteps, but by the encoder resolution. The AEC integrated encoders has a fixed resolution of 512 ppr. Read in quadrature, it is possible to obtain a fixed resolution of 2048 steps/rev.

CuRRENt loop

The VectorStep drives use the most advanced technologies in stator current control, which permit to optimize the effect of torque currents and to reduce the effect of dissipation currents (direct current).

Thanks to the EVSC, the thermal dissipation effects are reduced, and the control of resonances and form factor of output current are particularly accurate.

The current loop accepts in input the requested current, conditions its value (applies the limits) and generates a request of torque current and direct current. The actual current, given by current feedback, is deducted from demanded current, obtaining a current error that will be then processed to get a proportional contribution (proportional gain Kp) and a integral contribution (integral gain Ki). The resulting data are transformed in commands to be sent to the PWM controller, and then applied to the motor.



Requested current

In current control mode (or Torque) the requested current is set by the user.

When working with velocity or position control mode, instead, the requested current is generated from the velocity loop.

Current limits

The current limitator utilizes the following parameters:

Parameter	Name	Description
Rcurboost	Boost current	Maximum current peak that the drive can generate for a brief time of time. (This value must NEVER exceed the maximum current of the drive)
Rcurnom	Current limit	Maximum current that can be generated in continuous mode.
Rcurmax	Maximum current	Maxim current supplied by the drive. If this value is exceeded, an overcurrent fault will be generated.
RmaxI2T	Maximum I^2T	I^2T maximum value. If this value is exceeded, an I^2T fault will be generated.

Current loop gains

The current loop uses 4 gain parameters:

Parameter	Name	Description
Rkpiq	Torque current proportional gain (Kp)	The torque current error, obtained from the sum (Requested current - Actual current) is multiplied by this value. Increasing the Kp, the bandwidth increases, so the response time to the step is reduced. Too high values may cause system instability.
Rkiiq	Torque current integral gain (Ki)	The integral of the current error is multiplied by this value. The contribution of the integral action permits to bring the actual current exactly at the level of requested current. The integral error is the sum accumulated over the time by the actual error value.
Rkpid	Direct current proportional gain (Kp)	The direct current error, given by the sum (Requested current - Actual current) is multiplied by this value. Increasing the Kp, the bandwith increases, so the response time to the step is reduced. Too high values may cause system instability.

Rkiid	Direct current integral gain (Ki)	The integral of the current error is multiplied by this value. The contribution of the integral action permits to bring the actualcurrent exactly at the level of demanded current.The integral error is the sum accumulated over the time by the actual error value.

VEloCIty loop

The velocity loop is the conjunction element between the position loop and te current loop.

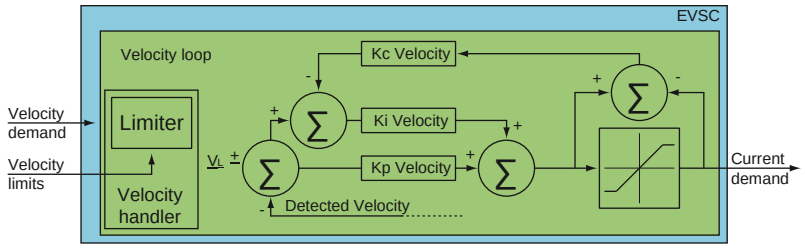
The data processed by the velocity loop produce a request of current that, sent to the current loop, generates the motor rotation.

The velocity loop accepts in input a requested velocity, conditions its value (applies the limits), and generates a request of current that is then sent to the current loop.

The actual velocity (detected by the encoder) is deducted from the demanded velocity, obtaining a velocity error that will be then processed to get a proportional contribution (proportional gain Kp) and an integral contribution (integral gain Ki).

The integral action is controlled by an anti-wind-up loop (filling dynamic gain Kci), that keeps under control the integral error in case of saturation of the same.

The resulting data are transformed into a current request, to be sent to the current loop.



Requested velocity

In velocity control mode, the requested current is generated by the velocity loop.
When working in position control mode, instead, the requested velocity is generated from the position loop.

Velocity limits

Velocity limitator utilizes the following parameters:

Parameter	Name	Description
Rvelmax	Closed loop maximum velocity	Sets the maximum value that the requested velocity can take when working in closed loop.
Rdeceme	Emergency deceleration	Sets the deceleration ramp to be used in case of emergency stops, due to Abort or Fault.

Velocity loop gains

The velocity loop utilizes 3 gain parameters:

Parameter	Name	Description
Rkpvel	Velocity proportional gain (Kp)	The velocity error, obtained from the sum (Requested velocity - Actual velocity) is multiplied by this value. Increasing the Kp, the bandwidth increases, so the response time to the step is reduced. Too high values may cause system instability.
Rkivel	Velocity integral gain (Ki)	The integral of the velocity error is multiplied by this value. The contribution of the integral action permits to bring the actual velocity exactly at the level of demanded velocity. The integral error is the sum accumulated over the time by the actual error value.

Rkcvel	Velocity conditional integral gain (Kc)	The error due to the saturation (wind-up) of the velocity loop is multiplied by this value, and deducted from the velocity error integral. Increasing the Kc, the bandwith increases, so the response time to the step is reduced, even in case of sudden variations of the input signal (Requested velocity). Too high values may cause system instability.

Position loop

The position loop can receive the target from the internal program, from the inputs, or from the fieldbus.

When the trajectory generator receives a new target, it updates real-time the motion profile, transferring to the position loop the instant requestd position, that, deducted from the actual position detected by the encoder, generates a position error.

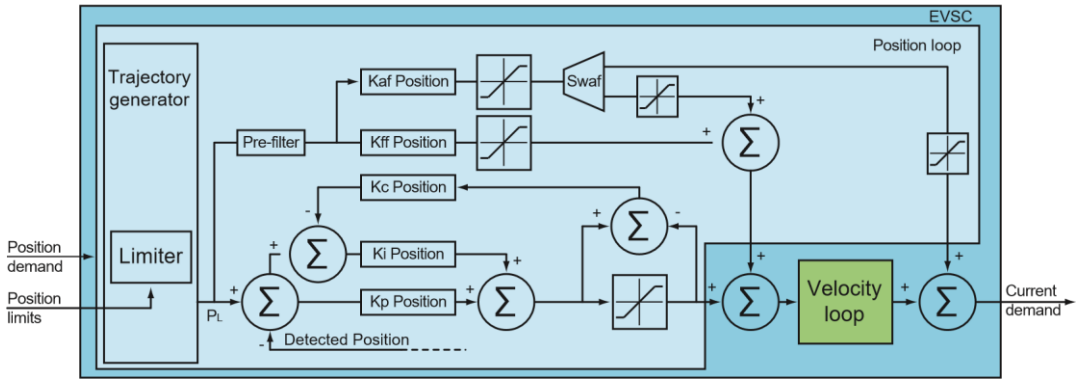
The resulted error is then processed to get a proportional contribution (proportional gain Kp) and an integral contribution (integral gain Ki). The integral action is controlled by an anti-wind-up loop (filling dynamic gain Kci), that keeps under control the integral error in case of saturation of the same.

The resulted data are transformed into a velocity request, to be sent to the velocity loop.

Parameter	Name	Description
Rkppos	Position proportional gain (Kp)	The position error, obtained from the sum (Requested position - Actual position) is multiplied by this value. Increasing the Kp, the bandwidth increases, so the following error is reduced. Too high values may cause system instability.
Rkipos	Position integral gain (Ki)	The integral of the position error is multiplied by this value. The contribution of the integral action permits to bring the actual position exactly to the demanded position. The integral error is the sum accumulated over the time by the actual error value.

Rkcpos	Position conditional integral gain (Kc)	The error due to the saturation (wind-up) of the position loop is multiplied by this value, and deducted from the position error integral. Increasing the Kc, the bandwith increases, so the following error is reduced, even in case of sudden variations of the input signal (Requested position). Too high values may cause system instability.

In order to make position control the most stable and efficient possible, some predictive-type loops have been implemented, like feed forward e acceleration forward, that work for compensate the dynamical friction and the inertia of the load.



Requested position

The requested position can be set from the internal program, from the fieldbus or manually from the user.

Trajectory limits

Trajectory limitator uses the following parameters:

Parameter	Name	Description
Rupplim	Maximum limit quota	Sets the maximum value that the quota requested by the trajectoy generator may take.
Rlowlim	Minimum limit quota	Sets the minimum value that the quota requested by the trajectoy generator may take.
Rvelmax	Closed loop maximum velocity	Sets the maximum value that the demanded velocity can take when working in closed loop.
Rdeceme	Emergency deceleration	Sets the deceleration ramp to be used in case of emergency stops, due to Abort or Fault.

Velocity loop gains

Position loop uses 5 gain parameters and 1 selection parameter:

Rkffpos	Feed-Forward position gain (Kff)	The Feed-forward loop operates in a predictive way, by requesting the velocity loop to give a proportional contribution (Kff) to the demanded velocity. The Feed-forward loop compensates the dynamic frictions, resulting in reduction of position error. A correct adjustment of the Kff gain permits to reduce, or eliminate, the integral contribution, obtaining a most rapid response during the transistors. This contribution must be regulated by observing the following errors at constant velocity. It can be observed that increasing this contribution, the integral part can be decreased.
Rkafpos	Acceleration Forward position gain (Kaf)	The Acceleration-Forward loop operates in a predictive way, by requesting the velocity loop or the current loop to give a proportional contribution (Kaf) to the demanded acceleration. The Feed-forward loop compensates the inertia of the load during velocity variations. By supplying in advance a current request (recommended), the following errors decrease. This contribution is to be used very carefully, by observing the following errors in acceleration phases, and must not be used in applications with variable inertia. Too high Acceleration-Forward values may cause system instability.
Rswacfw	Action selection Switch Acceleration-Forward	Allows to choose if the Acceleration-Forward must generate a current contribution (recommended) or a velocity contribution.

---

1 $T = J * \alpha$ (α = angular acceleration, T = torque, J = inertia)

The output of the Acceleration-Forward loop is:

$OutAfw(t) = Kafw * \alpha_R(t)$ (where $\alpha_R(t)$ is the requested acceleration)

pHasE aDvaNCE

The Phase Advance control permits to progressively modify the drive angle of the vector, so that to reduce the counterelectromotive force (fcem) and to modify the effect of the torque current.

The applicable shift is inversely proportional to the load and the inertia of the same: greater is the load, lower must be the applicated shift.

Too high values of the Phase Advance may cause the instability of the current loop.

The Phase Advance control uses the following parameter:

Parameter	Name	Description
Rphgain	Phase Advance gain	FOCONTROL Phase Advance gain

powER supply stagE

The choice of the power supply stage is the first step to obtain the best performances from an automation system.

Each drive is a particularly heavy load for a power supply, because it generates voltage peaks or important energy requests in short times, during acceleration or deceleration phases.

It is therefore important to size correctly the power and the output capacity of the power supply.

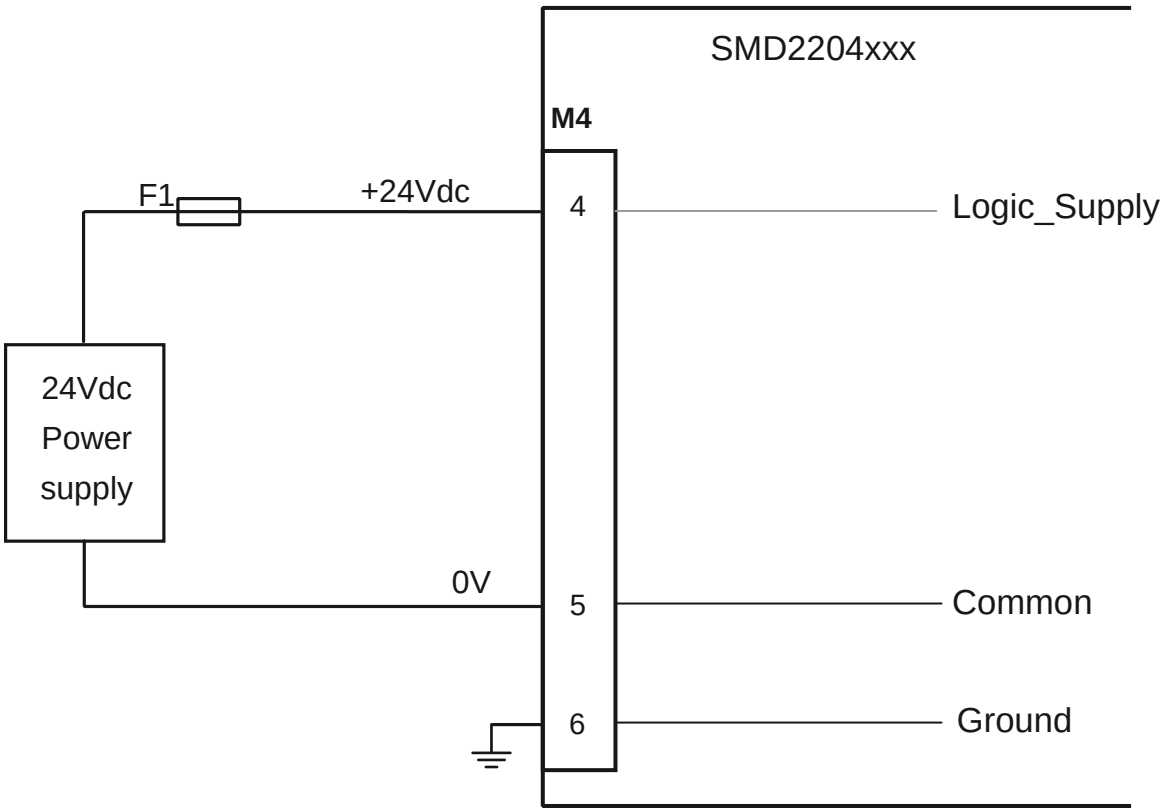
The SMD2204Lxx drives need a power supply voltage between 24 and 85Vdc insulated with respect to the main network (for the power stage), and a 24Vdc voltage (for the logic stage).

The SMD2204Hxx drives need a power supply voltage between 24 and 130Vdc insulated with respect to the main network (for the power stage), and a 24Vdc voltage (for the logic stage).

It is required to supply the power stage and the logic stage separately, in order to permit to maintain active the indexer also in absence of supply to the power stage.

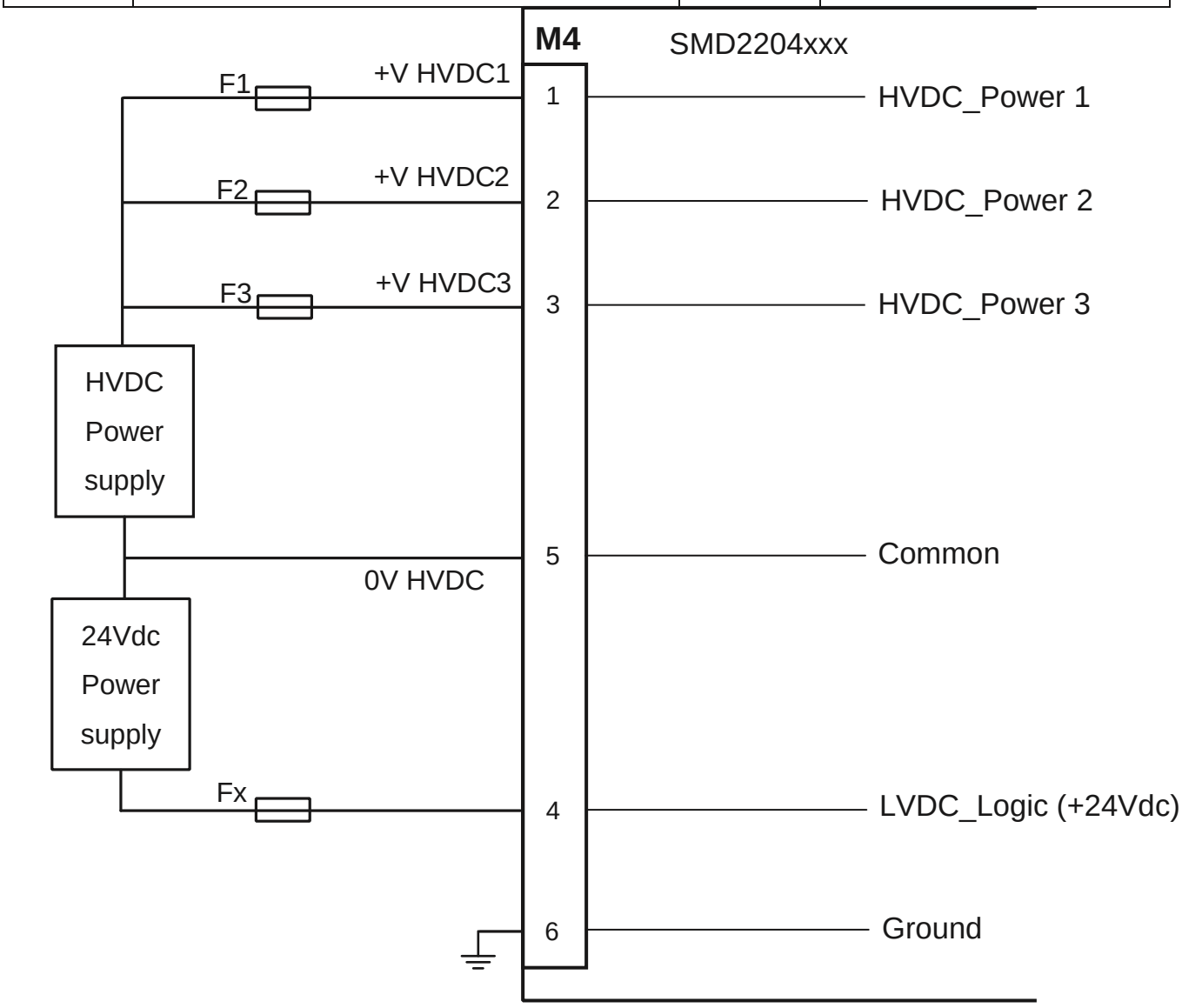
Logic stage power supply

DC power supply		Min.	Typ.	Max.	Units
Voltage	Nominal value, ±10% ripple included	22	24	26	Vdc
	Absolute maximum values in continuous operation §	22	24	26	Vdc
Current	Nominal value	150		1500	mA
Protection	External fuses	3A			



DC power supply

			Min.	Typ.	Max.	Units
Voltage	Nominal value, ±10% ripple included	SMD2204L	24	65	85	Vdc
		SMD2204H	24	120	135	
	Absolute maximum values in continuous operation §	SMD2204L	24	65	85	Vdc
		SMD2204H	24	120	135	
Current	Peak value		0		6 x motor	A
	RMS sinusoidal value		0		4 x motor	A
Protection	External fuses		10A delay-action x motor			



Power stage supply circuit

The configuration of the input circuit independently supplies the control stage with respect to the power stage.

This solution allows to keep active the indexer (axis controller) in an absolutely safe condition.

Note: it is not possible to move the motor in any way, if HV_Power voltage is not supplied.

Use a proper cross section cable and a correctly sized contactor to supply the HV_Power voltage to the drive.

typEs of powER supplIEs

A power supply is a device able to deliver the proper voltages (and so the currents) to an electronic circuit, in order to permit its proper operation.

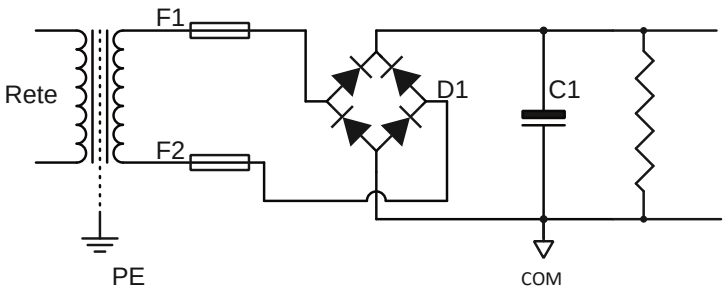
In general, the task of a power supply is to transform a certain type of voltage in another, having the proper characteristics for the device that has to be feeded.

There are many types of solutions to manufacture a power supply:

- Unregulated power supplies
- Regulated power supplies

In the first case, which is the simpler, the device is composed of a transformer, a rectifier bridge and a filter capacitor.

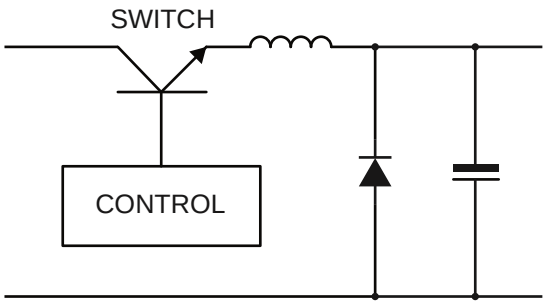
It is a simple and cheap system, but it has the disadvantage of having an output voltage that may vary depending on the input voltage and on the load.



Power stage supply circuit

In the second case the output voltage of the device is regulated and maintained constant, also if load varies, thanks to a switching or linear controller.

The switching technology permits to obtain very efficent and compact power supplies, but it is more complicated and expensive to be made.



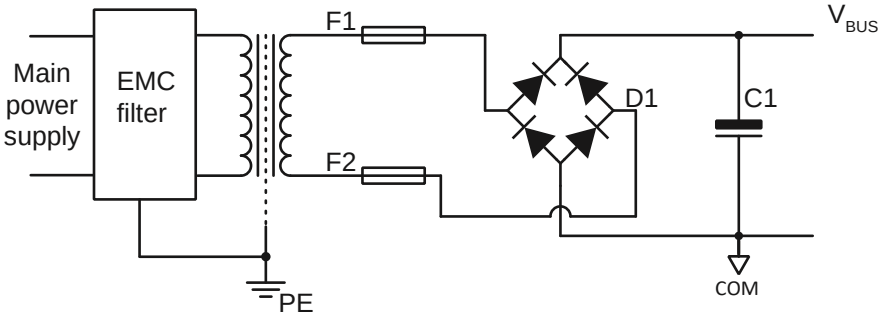
Power stage supply circuit

In case of use of regulated power supplies, it is necessary to put a diode with the cathode facing outward, in series with the output of the power supply, in order not to let the supply going into protection.

NotEs oN uNREgulatED powER supplIEs

Following you can find the typical configuration of an unregulated power supply.

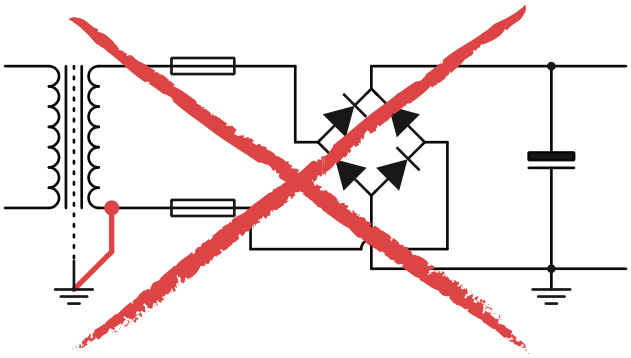
It is one of the most adopted solutions for its simpleness and cheapness, but it is important to follow some guidelines in order to obtain a reliable and efficent feeder.



In order to reduce the influence of EMI disturbances, it is recommended the use of our AC/DC converters with intergrated filters AL1120 or AL2620, or as an alternative, of a specific network filter (like CORCOM 10AYO1 in case of three-phase supply, or CORCOM 10VT1 in case of single-phase supply).

Use transformers with shield between primary and secondaries, and connect it to earth (PE).

<u>NEVER connect the secondary of the transformer to earth; this type of connection causes a short-circuit on the diodes of the bridge rectifier D1.</u>



One of the most important component of a power supply is the output capacitor of the same.

C1 must be able to absorb the energy generated by the drive during brakings, and must supply energy during accelerations (current request), monitoring the voltage fluctuations on the bus.

In case of a single axis, the energy can be considered proportional to the current and to the supply voltage , therefore capacity must be choose in order to absorb the energy generated from the nominal current of the motor and the voltage of the bus.

With the decreasing of the supply voltage , it will be necessary to increase the value of the capacitor, considering that the capacitance of a capacitor to absorb energy decreases with the square of the voltage.

<u>Choice of the transformer</u>

Make sure that the electric characteristics of the transformer guarantee its correct functioning in case it works with the maximum possible voltage and the minimum admitted line frequency

The peak voltage of the bus (excluding spikes generated by commutations of current or regenertive effects) is, with good approximation, equal to:

Single-phase connection	$V_{bus} = \sqrt{2}\ xV_{secRMS}$-1,5 V
Delta/wye three-phase connection	$V_{bus} = \sqrt{3}\ xV_{secRMS}$-1,5 V
Wye/delta three-phase connection	$V_{bus} = 1/\sqrt{3}\ xV_{secRMS}$-1,5 V

Example:

In case that RMS voltage at secondary is equal to $48V_{AC}$, the voltage of the bus will be equal to:

- 1.4142 x 48 - 1,5 = 66 V_{DC} in case of single-phase connection
- 1.7320 x 48 - 1,5 = 82 V_{DC} in case of delta/wye three-phase connection
- 0.5773 x 48 - 1,5 = 26 V_{DC} in case of wye/delta three-phase connection

Usually, the rating plate data of the transformer indicates the voltage at the secondary at a specific current (nominal current).

In case that the current absorbed by the load is lower than the nominal current, output voltage will increase inversally to the absorbed current.

The following chart summarizes the possible deflectings of the output voltage in relation to the the power of the transformer:

Power (VA)	Maximum deflecting of V_{SEC}
1 - 100	10%
100 - 350	8%
> 500	5% or less

When the system works close to the maximum values allowed by the drive, it is important to consider this effect, toghether with the fluctuations of the line voltage, in order to avoid that the voltage of the bus exceeds the maximum value allowed by the drive.

Apply voltages higher than those allowed may cause damages to the device, fire or injuries!

The power of the transformer depends on the current set in the drive, and on the number of drives connected toghether.

To optimize the sizing of the power supply stage, it is recommendable measuring the current absorbed by the device in the worst condition possible. In case of difficulties in measuring, assume that the required current is equal to the set nominal current.

In multi-axis configurations the maximum current peak depends on the number of drives simultaneously active; the stopped drives need a reduced power if in “current reduction” or “no current”.

Choice of the fuse

It is recommended to use 8A delay-action fuses in case the drive is setted at 4 A.

In case of setting of lower currents, it is possible to choose fuses of equal characteristics, but with lower rated current.

The use of fuses as protection system is essential. Possible faults or short-circuits, in absence of such safety device, may cause explosions, fire, or damage to the equipment.

Notes on energy regeneration

During decelerations, the drive may generate a voltage that tends to increase the voltage level of V_{BUS}. In fact, in phase of decelerations, the motor becomes a generator which converts mechanical energy into electric energy.

If the mechanical energy of the system is lower than the losses of the system, then V_{BUS} will not be subject to alterations, else, it will increase proportionally to the mechanical energy of the system.

Mechanical energy is given by:

$$E_M = 1/2 \times J \times \omega^2$$

where:

E_M = Kinetic energy

(joules) J = Inertia ($Kgxm^2$)

ω^2 = Speed (rpm)

If all the kinetic energy were converted to electric energy, V_{BUS} would increase as following:

$$V_{BUS} = \sqrt{V_0 + \frac{2E_M}{C}}$$

where:

E_M = Kinetic energya (joules)

C = Total capacity (Farad)

V_0 = Initial voltage (Volt)

In most cases, kinetic energy is dissipated and dispersed from the drive, so the “pump” effect on the V_{BUS} voltage assumes negligible levels.

In some cases, when the system works with high speeds, with high inertia loads, the regenerational effect may assume important levels, and it may be necessary to adopt circuital solutions in order to contain the increase of the V_{BUS} voltage (CLAMP circuits).

To verify the influences of the regenerational effect to the bus voltage, it is possible to measure with an oscilloscope the V_{BUS} voltage during the brakings of the drive. (As an alternative, it can be used a peak detector, made with a diode and a capacitor, and measure the voltage at the ends of the capacitor with a multimeter.)

By slowly increasing the slope of the deceleration ramps, it is possible to measure the rise of the V_{BUS} voltage due to the “pump” effect.

The V_{BUS} voltage must never exceed the maximum allowable voltage of the drive.

Supply CoNfIguRatIoN

Disconnector

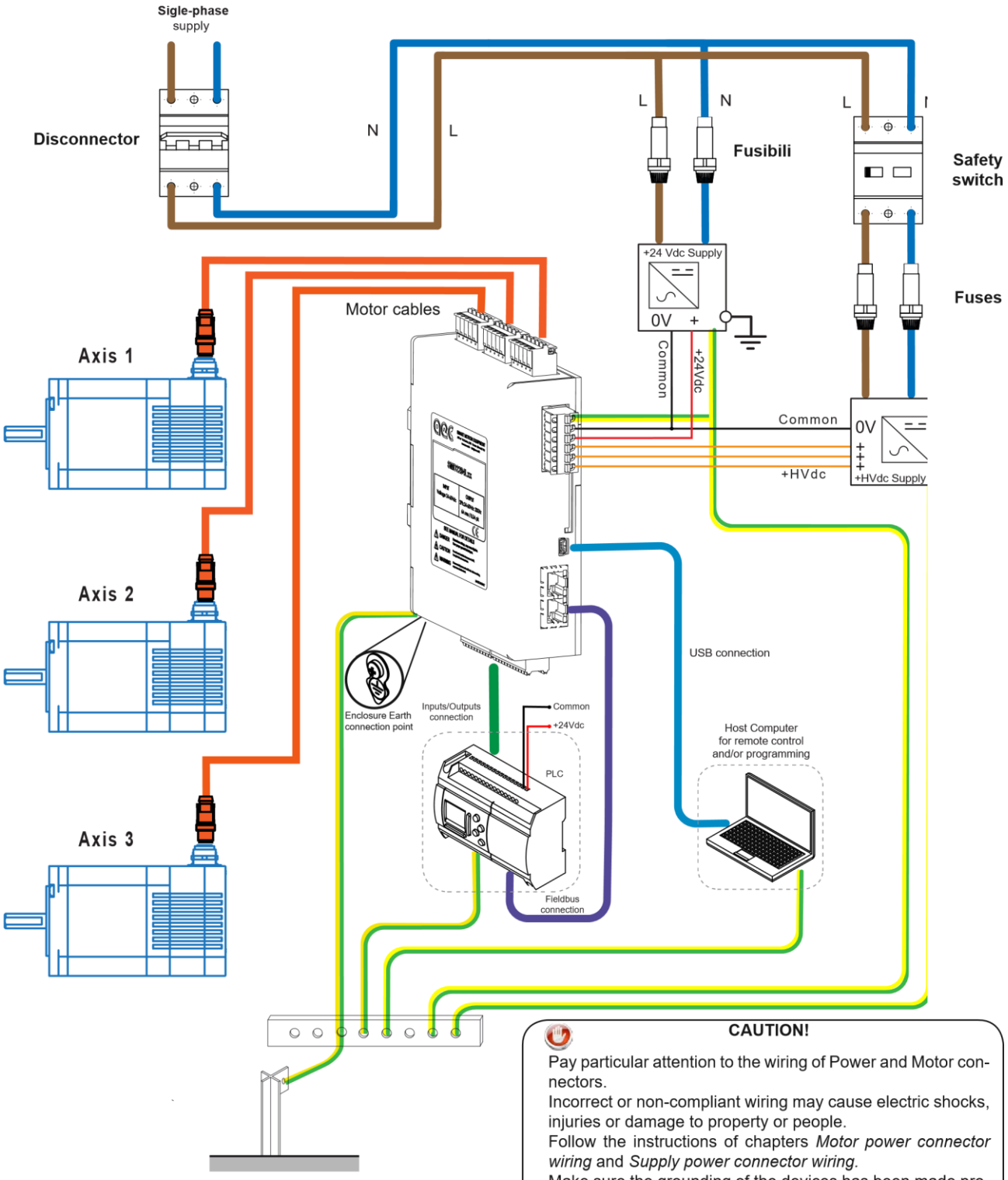
Always provide a disconnector in order to protect devices.

Safety switch

It is used to deactivate power supply of the drive in case of emergency.

Fuses

Always provide fuses to protect devices.

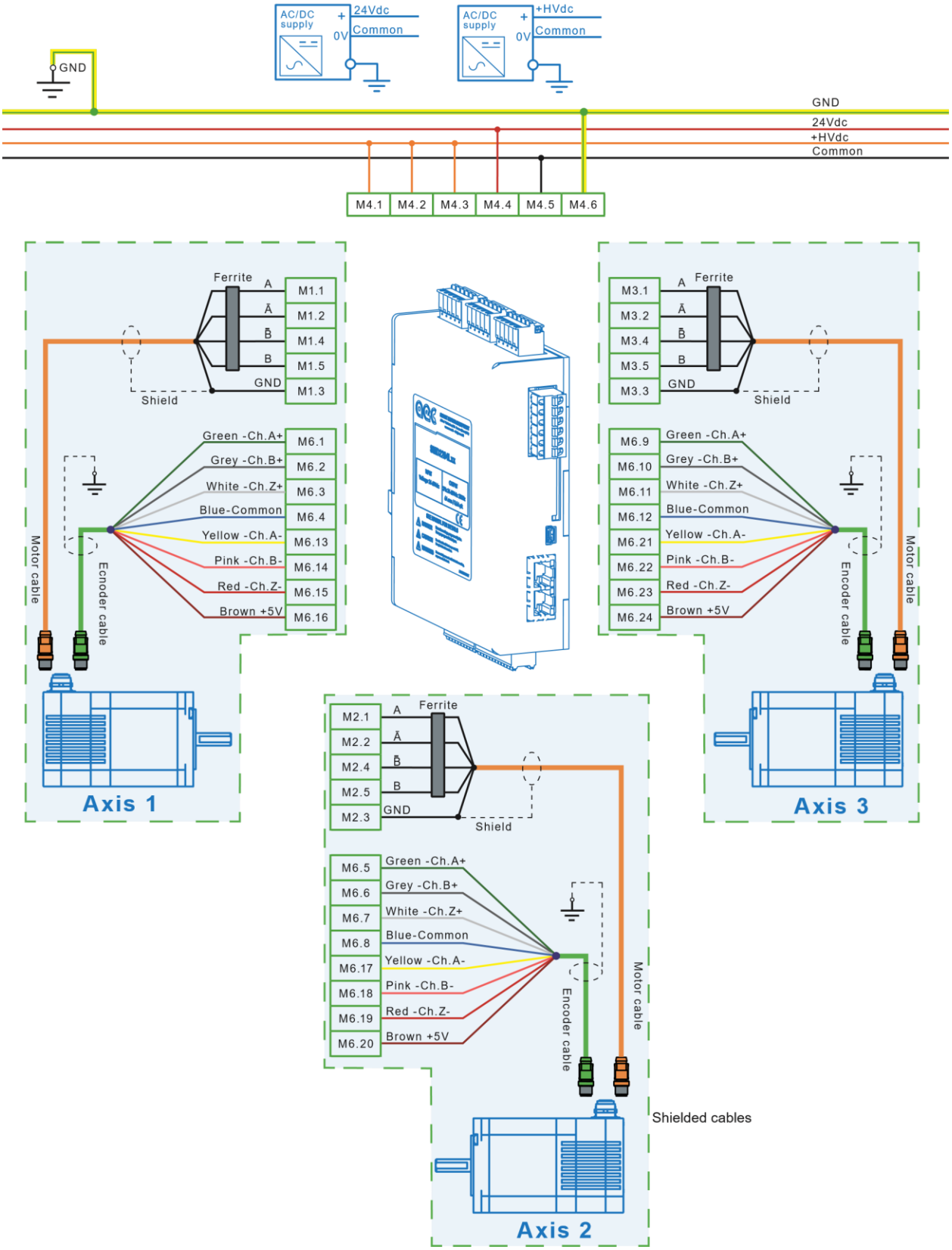


CAUTION!

Pay particular attention to the wiring of Power and Motor connectors.
Incorrect or non-compliant wiring may cause electric shocks, injuries or damage to property or people.
Follow the instructions of chapters *Motor power connector wiring* and *Supply power connector wiring*.
Make sure the grounding of the devices has been made properly.

Devices sorrounded by the dashed box are not required for system operation, but they extend the potential of the same.

TYPICAL WIRING



The components must be mounted close together on a common galvanized mounting plate and connected to it with a large conductive surface. This mounting plate, in turn, must have a conductive connection with a large contact surface with the motors or the machine. The painted walls of electric cabinets or mounting plates and rails or similar means of mounting with reduced surface of contact, do not meet these requirements. Use transformers with shield between the primary and secondary. Always connect the shield of the transformer to the ground bar.

CAUTION

- Make sure of proper grounding of the drive and the motor.
- The ground connection must provide a preferential path for the discharge to ground of the leakage currents.
- The shield of each cable must be connected to earth.
- The ground connections must merge into a single point to prevent the formation of ground loops.
- To configure a safe system, install a protective device against overload and short-circuits.
- The wiring must be carried out by authorized personnel, specialized in electrical works.
- Make sure you have carried out proper connection of power supply stage.
- Use shielded twisted pairs of proper section for power and motor connection.
- Use copper cables with temperature range of 75°C or more.
- Do not bend or apply mechanical tension to cables or connectors.
- All protection devices must be evaluated and sized correctly according to the application.
- Keep a distance of at least 300 mm between the power cables and signal cables.
- The residual voltage let the motor rotate for some seconds after that power is turned off, until the complete discharge of capacity.
- Make sure to fully stop the motor by interrupting the connection of power supply of the power stage (emergency stop)
- The information contained in the internal registers are not usually stored in the drive, therefore they will be lost in case power supply of the control stage is turned off. In case you want to save these information, activate the NVRAM saving procedure.
- In the case of use of a motor in vertical axes, install safety devices to prevent possible falls of parts in case of emergency or fault. The fall of parts may cause injuries.

CAUTION

- **Avoid short-circuits, incorrect connection of the mass conductors and polarity inversions.**
- **Before inserting the power connector, check the voltage levels.**
- **Always connect the ground terminal.**

pRotECIoN foR thE powER supply lINE

Use a disconnector device and a fuse to protect the power supply line. The SMD2204xxx can be supplied by rectifying and filtering the secondary of a three-phase transformer (or single-phase); use transformers with shield between the primary and the secondaries, in order to guarantee a good immunity to line disturbances.

EaRth CoNNECtIoN, mass CoNNECtIoN aND shIElDINg

The grounding connection must meet all local applicable requirements about industrial installations.

The grounding of the drive and the motor must be carried out in a workmanlike manner

For the grounding of one or more drives, use a copper earth bar, fixed to the galvanized bottom of the electric cabinet using insulated supports.

The ground connection must have a R_{EG} resistance equal to 100**Ω**, or preferably less.

Length (mm)	Section (mm^2)
500 - 1000	4
1000 - 2000	5

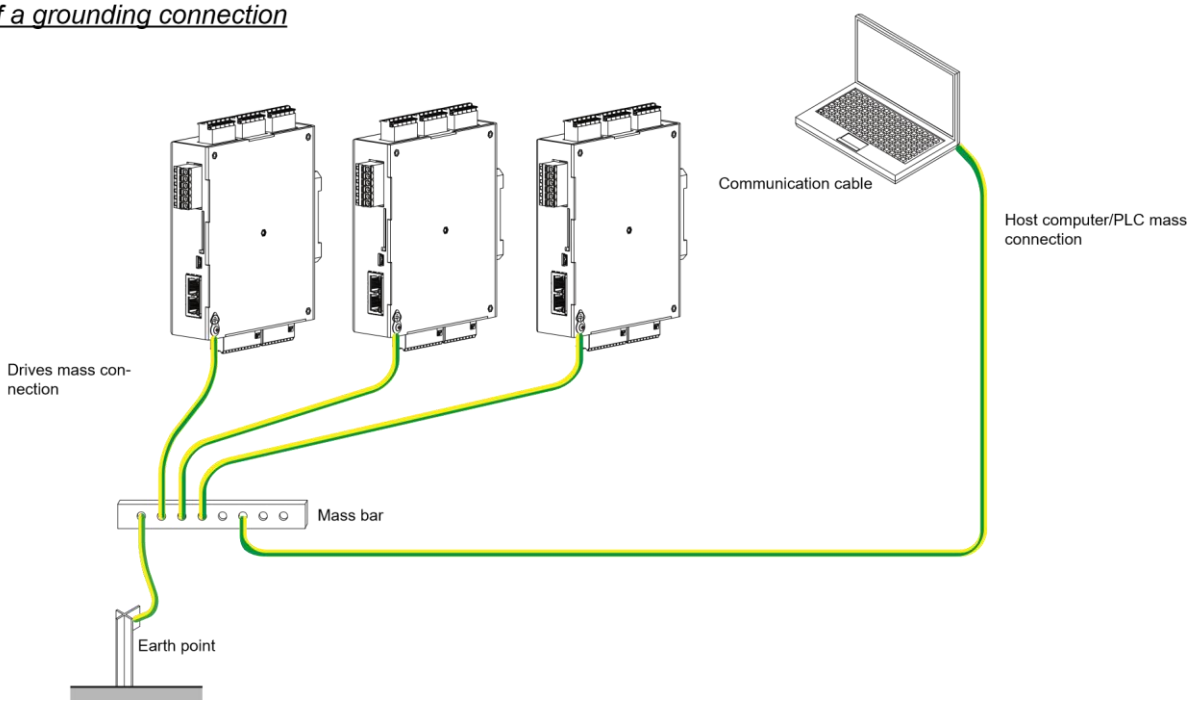
The following parts must be connected to the mass bar:

- The cover and /or the heatsink of each drive.
- The shield of each cable.
- The earth conductors of control or display units (PC, PLC, terminals, HMI, CNC).

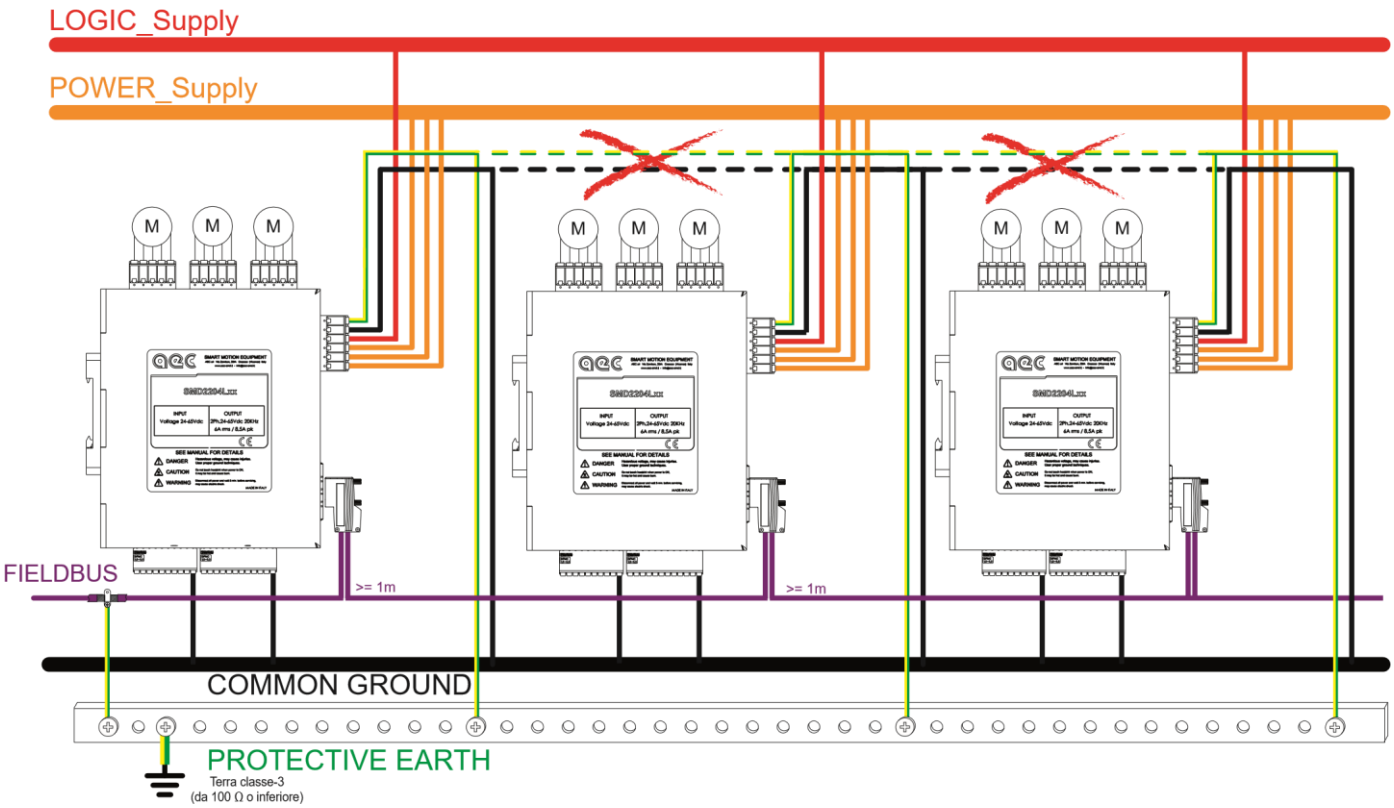
Connect the bar to the ground point of the electric cabinet (stud copper), using a cable with secion of al least 4 mm^2 .

Connect the front panel to the ground point with a copper braided cable.

Example of a grounding connection



Example of connection of three drives



CAUTION !!! A wrong positioning, connection, shielding or grounding of the drives or devices connected to the drives, may cause electromagnetic disturbances.
The presence of EMC disturbances in electric cabinets may cause malfunctioning of high speed inputs and communication lines.

tIps foR DIstuRBaNCEs pREvENtIoN

The electromagnetic compatibility of the installation must be checked and guaranteed before starting the system. If the instructions below are followed, the drive system will meet the requirements of CE Directive on EMC environmental immunity in accordance with DIN EN 61800-3: 2001-02. To meet the limit values for EMC immunity and radiated inter ference for it is necessary to earth the drive.

- The use of twisted cables, even without shield, allows to reduce low-frequency interference. However, modern applications require fully-shielded installations in order to ensure a greater disturbance immunity.
- A good ground connection is essential to ensure signals high quality, whether they are inputs/outputs or communication lines.
- The following cables must be shielded:
    1. Communication cables (Modbus RTU, Modbus/TCP, CANopen or EtherCAT)
    2. Supply Voltage HV_POWER
    3. 24V interface signals
    4. Motor andd encoder cables
- A proper connection ensures that the eddy currents are closed towards the earth of the system, rather than recirculate through signal cables.
- Keep cables as short as possible.

- Keep cables lying.
- During the connection pay particular attention not to create ground loops, which produce common mode currents that are the main source of disturbances in electrics and electronics systems.
- The ground connections must merge into a single point to prevent the formation of ground loops.
- In order to avoid disturbances, the shieldings must be connected on both sides. Potential differences can result in unacceptable currents on shieldings, which must be neutralized through potential equalisation conductor. If conductors are more than 100 m lenght, follow these instructions: up to a lenght of 200 m, a section of 16 mm^2 is enough; in case of lenght of more than 200 m, it is required a section of 20 mm^2.
- Do not connect inductive loads (such as electric motors, relays, electromagnetic brakes or switching devices) on the auxiliary supply line (+24Vdc);
- If lines are interrupted, make sure to connect them with connectors, paying attention that cables insulation is not uncovered for more than 50 mm lenght;
- Avoid inductive and capacitive couplings, which may result in disturbances. Do not twist cables. If cables are too long and are twisted, inductance and mutual indiction will increase, causing malfunctioning.

typEs of CaBlEs

Length and section of power cables are very important aspects to obtain a safe and performant system.

The section of the cable varies as a function of current and length. In the following table you can find the recommended sections.

Recommended sections for power and motor cables

1 APK					
Length (m)	3	7,5	15	22,5	30
Minimun section (mm^2)	0,75	0,75	1	1	1,25

2 APK					
Length (m)	3	7,5	15	22,5	30
Minimun section (mm^2)	0,75	1	1,25	1,5	1,5

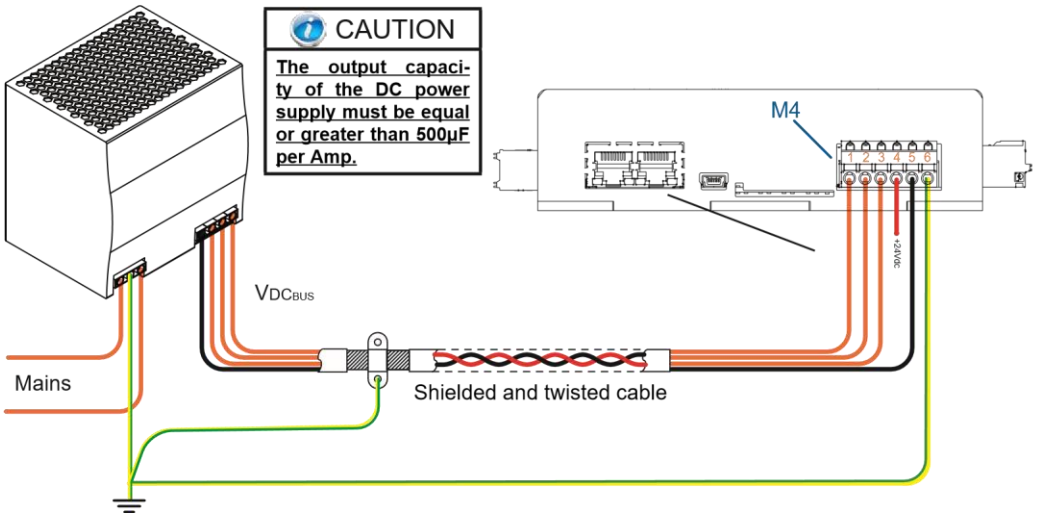
3 APK					
Length (m)	3	7,5	15	22,5	30
Minimun section (mm^2)	1	1,25	1,5	2	2

4 APK					
Length (m)	3	7,5	15	22,5	30
Minimun section (mm^2)	1	1,25	1,5	2	2

5 APK					
Length (m)	3	7,5	15	22,5	30
Minimun section (mm^2)	1,25	1,5	2	2	2

6 APK					
Length (m)	3	7,5	15	22,5	30
Minimun section (mm^2)	1,25	1,5	2	2	2

DC connection with cables



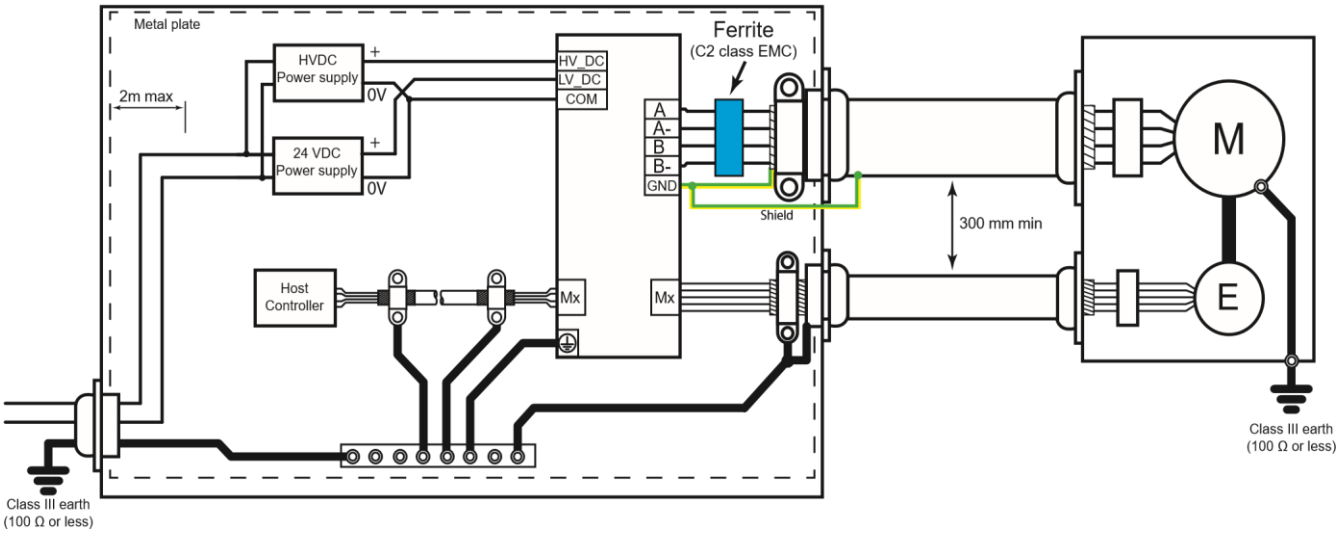
of length lower than 15m

For high distances between the power supply stage and the drives, it is recommended to use alternating voltages and to install AC/DC conversion systems close to the drive. Also in this case it is recommended the use of shielded and twisted cables.

CE CompliaNt INstallatIoN

In order to obtain an installation compliant with the EMC directives (EN61800-5-1), it is necessary to meet the following conditions:

- the drive must be installed inside a metal box (electric cabinet);
- use shielded cables for I/O lines and communication lines;
- use shielded cables for motor connection;
- all the cables coming out from the electric cabinet must be wired in metal conduits;
- the shield of the cables must be directly connected to the earth bar.
- install on the unsheathed part of the cables FAIR-RITE ferrites mod. 0431167281 or similar (optional, in order to bring the EMC emissivity level to Class C2)



CAUTION!!! Wrap the cables for a turn and a half around the ferrite! <u>Shield wire and Earth wire must not be passed through the ferrite, but externally.</u>

CAUTION!!! In order to comply with the directives mentioned above, the drives must be installed in accordance with the instructions described in the user manual of the product.

Since the drives are installed into a system, they need a new confirmation of compliance after the installation.

Since the drives are components to be incorporated into a machinery, it is necessary to verify that the complete machinery comply with the requirements of the current machinery directive before putting it in service.

The use of the ferrite is optional. It is useful to bring the emissivity levels within the EMC C2 Class. In case it is not used, the device is classified as C3.

pOwER CoNNECtoR wIRINg

CAUTION

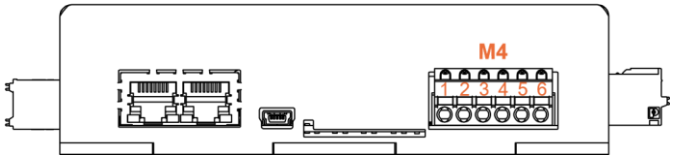
During M4 connector wiring (power connector), take the following precautions.

1. **Remove the terminal block from the drive.**
2. **Insert only one conductor for each contact on the connector.**
3. **Make sure that there aren't exposed parts of the conductor which may create short-circuits.**

Power connector

Description	Removable spring-cage terminal block, 6 positions
Dimensions of conductor	12 - 24 AWG

Terminal block pinout

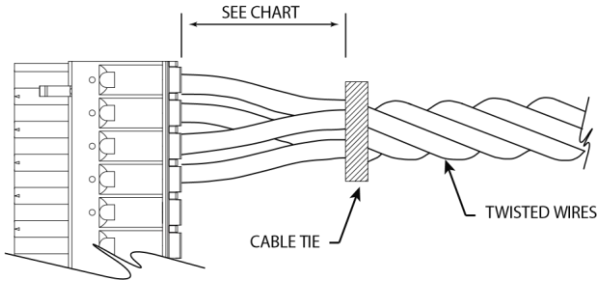


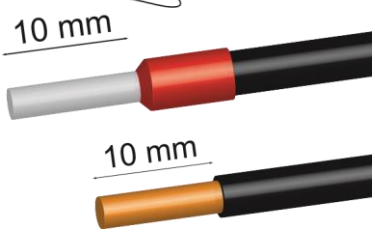
Pin	Signal name	Description
1	Power supply 1	Axis 1 HVdc power supply
2	Power supply 2	Axis 2 HVdc power supply
3	Power supply 3	Axis 3 HVdc power supply
4	Logic supply	24Vdc supply of control and output stage
5	Common	Common reference of the power supply voltages
6	Ground	Mass

Thr SMD2204 is supplied with a DC voltage (HVdc) for the power stage (one terminal block for each axis) and with a 24Vdc voltage for the logic stage.
The separate power supply of the control stage with respect to the power stage permits to keep the axis control active even in case of emergency situations.
By feeding only the power stage, the logic stage will not be activated, and the drive will result switched off. Conversely, by feeding only the logic stage, the logic will be active, but it won't be possible to energize the phases of the motor.

It is reccomended to use cables with minimum section of 1 mm^2 in case of connections of less than 20 m lenght, and section of 2,5 mm^2 in case of connection with greater lenghts. (Maximum allowable lenght = 50 m). Use cables with twisted pair shielded conductors.

Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analog, high speed inputs). Do not lock up or pass the motor cable in the same conduit of signal cables.
Provide grounding connection for motor housing.



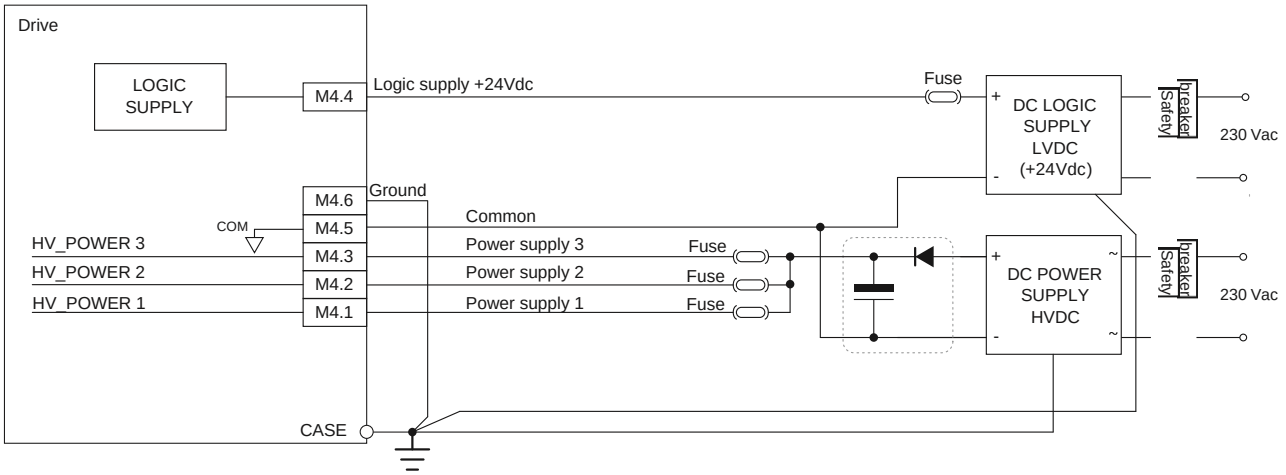


Conductor characteristics	mm^2
Conductor cross section solid	0,2 - 2,5
Conductor cross section stranded	0,2 - 2,5
Conductor cross section stranded, with ferrule without cable clip	0,2 - 2,5
Conductor cross section stranded, with ferrule with cable clip	0,2 - 2,5
Stripping lenght or cable lug lenght (mm)	10

In case of twisted wires, fix the twist with a cable tie e let the cables free for the minimum distance you can see in the table.

Nr. of conductors	Minimum distance (mm)
2 - 8	12.7
10 - 16	19.1
18 - 24	25.4

DC voltage power supply (with switching power supply)



Diodes and capacitors must be installed in case the device is connected to a swithing power supply.

Specifications for ferrites and EMI shielding

In order to reduce EMI disturbances, it is required the installation of a ferrite filter on the cables of the motor phases, close to the terminal block. The filter is composed of low-grade ferrite, which has high losses at radio frequences. In this way the filter works as a high impedance at those frequences Recommended ferrites:

Manufacturer	FAIR-RITE	Würth Elektronik
Code	1463444	74271132
External diameter	23,7 mm	24,5 mm
Internal diameter	10,15 mm	8,5 mm
Lenght	39,4 mm	40,5 mm
Impedance at 25MHz	144 Ω	141 Ω
Impedance at 100 MHz	240 Ω	241 Ω

CAUTION

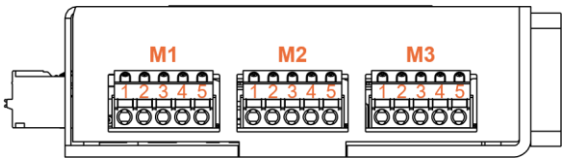
During M1, M2, M3 connector wiring (motor connectors, take the following precautions.

1. **Remove the terminal block from the drive.**
2. **Insert only one conductor for each contact on the connector.**
3. **Make sure that there aren't exposed parts of the conductor which may create short-circuits.**

Motor connector

Description	Removable spring-cage terminal block, 5 positions
Dimensions of conductor	12 - 24 AWG

Piedinatura della morsettiera



M1		
Pin	Signal name	Description
1	Phase A+	Output Phase A+
2	Phase A-	Output Phase A-
3	GND	Ground
4	Phase B-	Output Phase B-
5	Phase B+	Output Phase B+

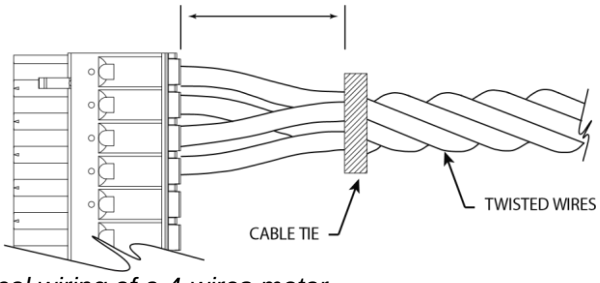
M2		
Pin	Signal name	Description
1	Phase A+	Output Phase A+
2	Phase A-	Output Phase A-
3	GND	Ground
4	Phase B-	Output Phase B-
5	Phase B+	Output Phase B+

M2		
Pin	Signal name	Description
1	Phase A+	Output Phase A+
2	Phase A-	Output Phase A-
3	GND	Ground
4	Phase B-	Output Phase B-
5	Phase B+	Output Phase B+

It is reccomended to use cables with minimum section of 1 mm^2 in case of connections of less than 20 m lenght, and section of 2,5 mm^2 in case of connection with greater lenghts. (Maximum allowable lenght = 50 m). Use cables with twisted pair shielded conductors.

Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analog, high speed inputs). Do not lock up or pass the motor cable in the same conduit of signal cables. Provide grounding connection for motor housing.

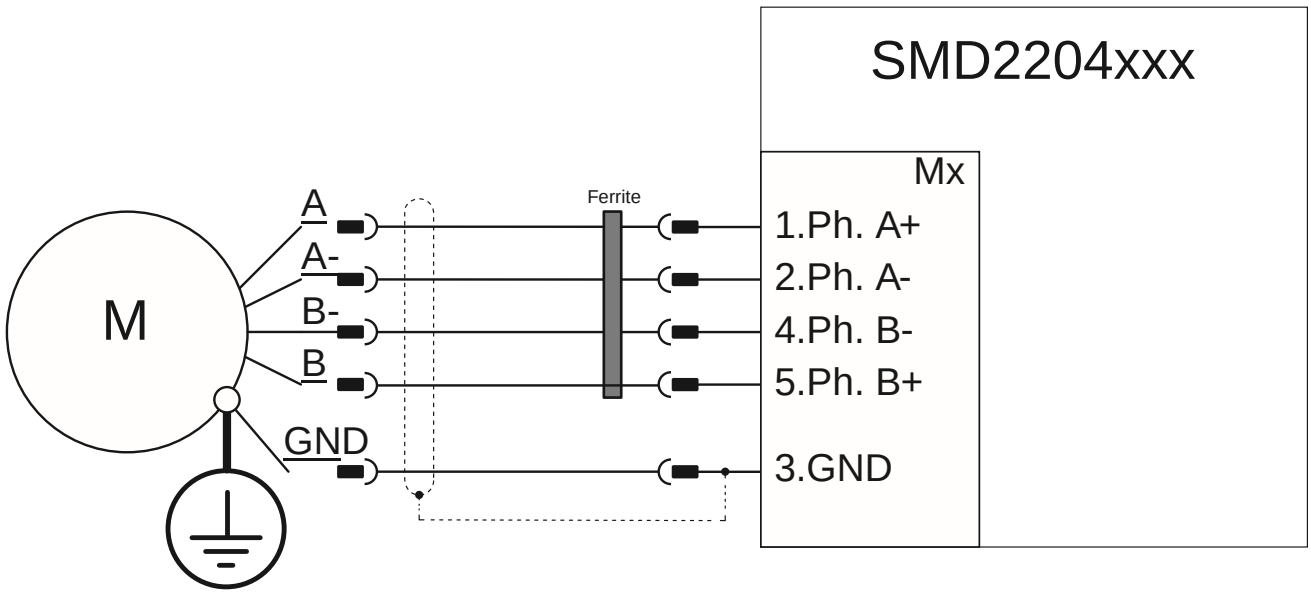
Conductor characteristics	mm^2
Conductor cross section solid	0,2 - 2,5
Conductor cross section stranded	0,2 - 2,5
Conductor cross section stranded, with ferrule without cable clip	0,2 - 2,5
Conductor cross section stranded, with ferrule with cable clip	0,2 - 2,5
Stripping lenght or cable lug lenght (mm)	10



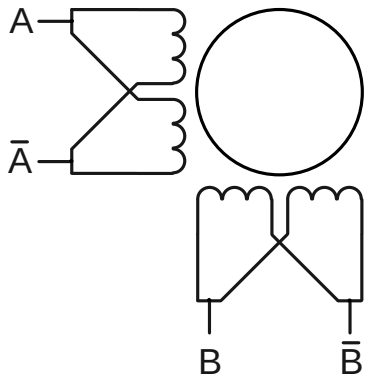
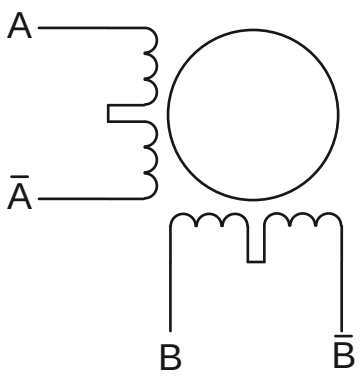
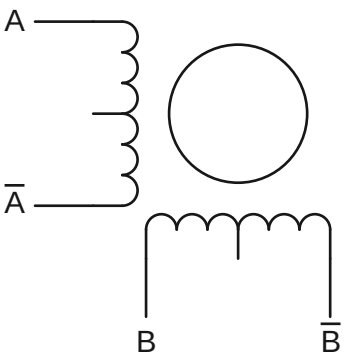
Typical wiring of a 4-wires motor

SEE CHART In case of twisted wires, fix the twist with a cable tie e let the cables free for the minimum distance you can see in the table.

Nr. of conductors	Minimum distance (mm)
2 - 8	12.7
10 - 16	19.1
18 - 24	25.4



Other connection types

8-wires-parallel	8-wires, series	6-wires
		

CuRRENt CoNtRol

The SMD2204 uses an advanced current control algorythm (REVC - Real-time Enhanced Vector control), developed by AEC thanks to the experience in stepper motor control.

The REVC permits to make a high performances field-oriented sinusoidal vector control, which eliminates some of the major limitations of stepper motors, such as:

- the noise at low speeds
- the vibrations due to the slip-stick movement of the rotor
- the high operating temperatures
- the eddy currents

The vector technology also permits to use the motor in Smart mode or Servo mode (closed loop), with the possibility to realize position, speed or torque loops, in addition to eliminating the possibility of syncronism loss.

powER output

		Min.	Typ.	Max.	Units
Nominal current	Discontinuous mode	-8,5		8,5	A_{PK}
	Continuous mode	-6		6	A_{RMS}
BOOST current	2 seconds max.	-8,5		8,5	A
Short-circuit current		-15		15	A

typEs of CoNtRol

		Min.	Typ.	Max.	Units
PWM update	Frequency		20		KHz
	Time		50		µs
PWM type	Dual MOSFET H-bridges, 20 KHz center-weighted PWM field oriented space-vector modulation, based on DSP technology				
PWM ripple frequency			40		KHz
V_{BUS} compensation	V_{BUS} variations does not affect current control				

CoNtRol ChaRaCtERIstICs

Type	Stepper mode	Current loop	Full digital
	Servo mode	Current loop	
		Velocity loop	
		Position loop	
	Smart Mode	Current loop	
Sample time	Stepper mode	Current loop	20 KHz (50 µs)
	Servo mode	Current loop	20 KHz (50 µs)
		Velocity loop	4 KHz (250 µs)
		Position loop	1 KHz (1 ms)
	Smart Mode	Current loop	20 KHz (50 µs)
Compensazione V_{BUS}	V_{BUS} variations does not affect current control		

INputs/Outputs INtERfaCE

The SMD2204 drives are equipped with 8 general purpose digital inputs/outputs, 6 limit switches inputs, 3 push-pull/ line-driver encoder inputs, 3 analog inputs 0/+10V at 12 bit and 1 analog output 0/+10V at 10bit, which permit to interface with multiple external devices

It is possible to connect encoders, limit-switches sensors, analog references, or in frequency, or use the i/o as general purpose, programming their functions.

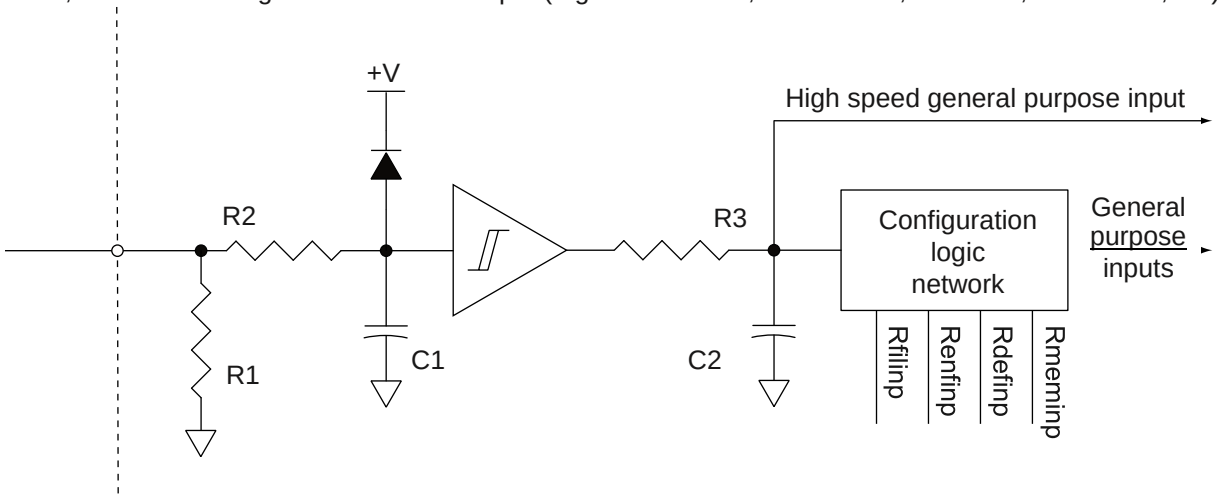
Inputs are PNP type, and they accept input voltages between 5Vdc and 24Vdc without the use of external components. The outputs are PNP typer, adn they are protected against short-circuits.

DIgItal INputs

The digital inputs can be read and configured with the software StepControl, or directly via Modbus RTU, Modbus TCP, CANopen, EtherCAT or Profinet.

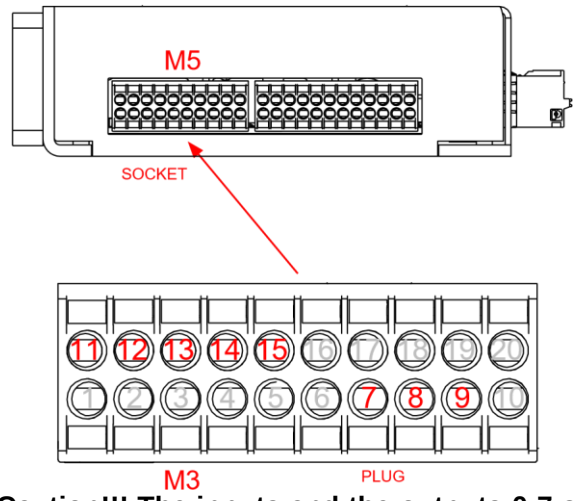
Below are the internal registers associated with the inputs, and their functions:

Rinp - read the state of the physical inputs
Rhsinp - read the state of the high speed physical inputs
Rfilinp - add a digital filter (input stabilization time)
Renfinp - enable the digitla filter for each single input
Rdefinp - define the activation state (active low/avtive high)
Rmeminp - input activation memory (input latch)
Rfuni0, Rfuni1, ... Rfuni9 - assign a funtion to the input (e.g. Axis homins, Alarm reset, JOG CW, JOG CCW, etc)



Type	Schmitt triggered with RC filter
Logic	PNP TTL compatible up to + 27 Vdc with internal pull-down
Scan time	1 ms for the register Rinp, 250 µs for the register Rhsinp
Digital filter	Programmable (0 - 16 ms) via Rfilinp and maskable (Renfinp)
Input threshold	Configurable via software at 2,5V or 12V
Active state	High or Low configurable by the user (Rdefinp)

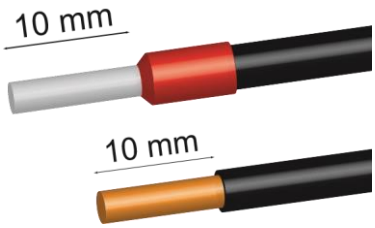
		Min.	Typ.	Max.	Units
Input voltage	Logic state LOW	Configurable via software			V
	Logic state HIGH	Configurable via software			
	Maximum permitted values (500ms)	0		27	
Absorbed current	Logic state LOW		0,01		mA
	Logic state HIGH	0,1		1	
Frequency	Standard inputs		4		KHz



Pin	Signal name	Description
1	BLS_1	Back limit switch axis 1
2	FLS_1	Forward limit switch axis 1
3	BLS_2	Back limit switch axis 2
4	FLS_2	Forward limit switch axis 2
5	BLS_3	Back limit switch axis 3
6	FLS_3	Forward limit switch axis 3
7	Input / Output 0	Input / Output 0
8	Input/ Output 1	Input / Output 1
9	Input/ Output 2	Input / Output 2
10	Common	Inputs common
11	Input/ Output 3	Input / Output 3
12	Input/ Output 4	Input / Output 4
13	Input/ Output 5	Input / Output 5
14	Input/ Output 6	Input / Output 6
15	Input/ Output 7	Input / Output 7
16	Analogue input	Analog input
17	Analogue input 1	Analog input 1
18	Analogue input 2	Analog input 2
19	Analog common	Analoh in/out common
20	Analog output	Analog output

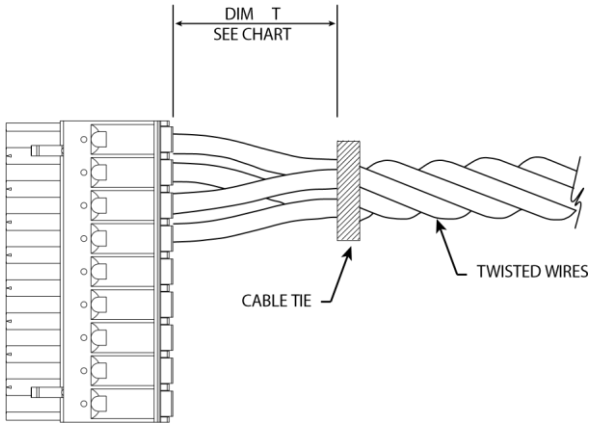
Caution!!! The inputs and the outputs 0-7 share the same pinout. In order to avoid damages to the connected devices, never active an output when the same pin is used as an input.

Disable the output current to the motor before making any modification, either electric or configuration, to the inputs. Failure to observe this rule may result in unexpected movements of the motors, with consequent damages or injuries.



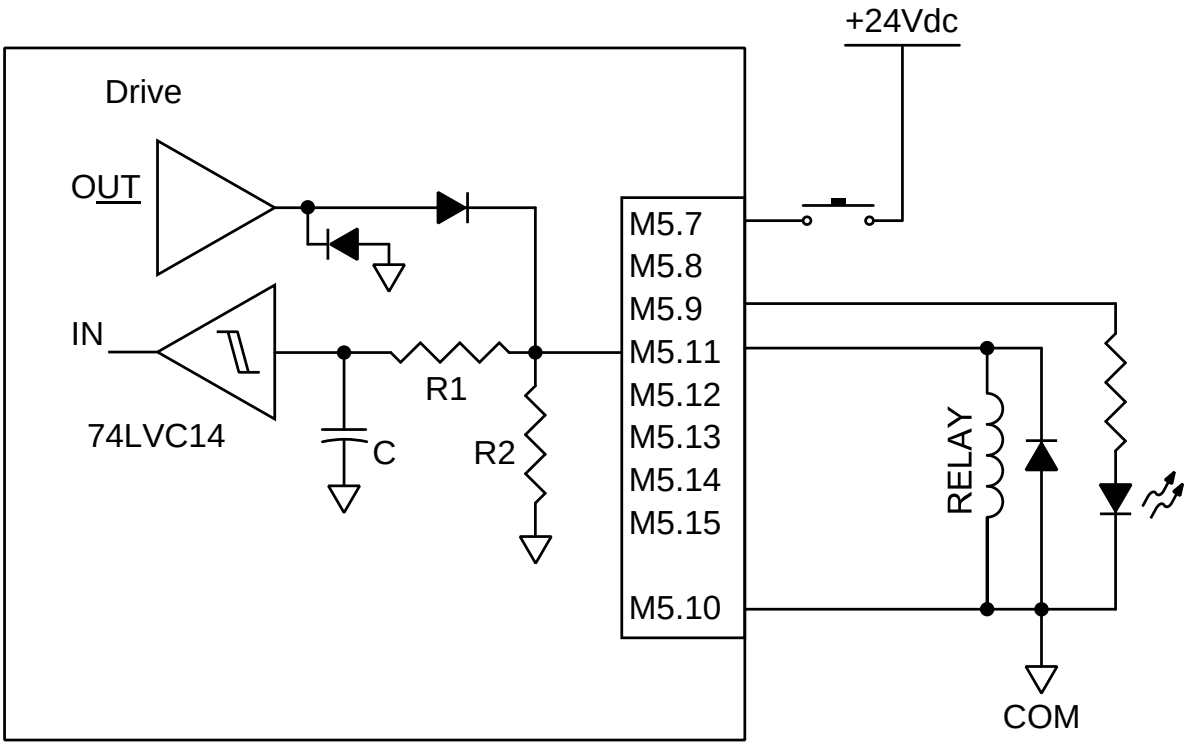
Conductor characteristics	mm^2
Conductor cross section solid	0,2 - 1,5
Conductor cross section stranded	0,2 - 1,5
Conductor cross section stranded, with ferrule without cable clip	0,2 - 1,5
Conductor cross section stranded, with ferrule with cable clip	0,2 - 0,75
Stripping lenght or cable lug lenght (mm)	10

Nr. of conductors	Minimum distance (mm)
2 - 8	12.7
10 - 16	19.1
18 - 24	25.4



In case of twisted wires, fix the twist with a cable tie e let the cables free for the minimum distance you can see in the table.

I/O connection example



Caution!!! In case you need to drive inductive loads (like relays, electro-valves, etc.) connect a flyback diode (1A @1000V) in parallel to the load.

Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analogic, fast inputs). Do not lock up or pass the motor cable in the same conduit of signal cables.

Digital outputs

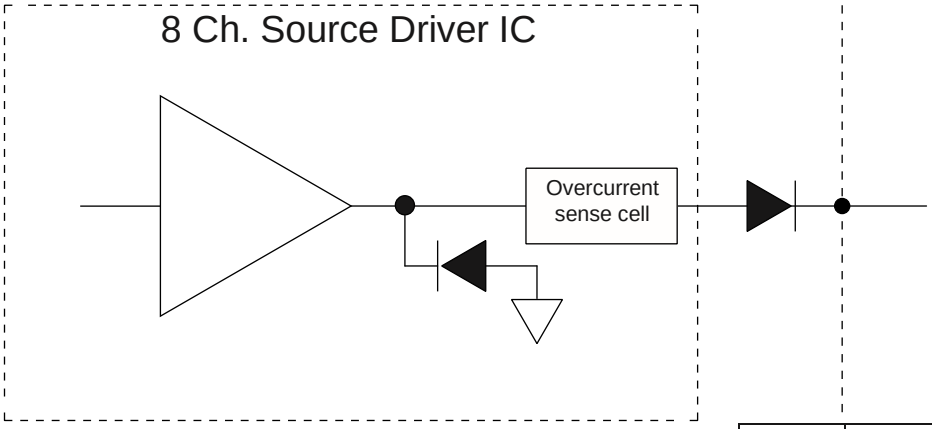
The digital outputs can be read, configured and enabled with the software StepControl, or directly via Modbus RTU, Modbus TCP, CANopen, EtherCAT or Profinet.

Below are the internal registers associated with the outputs, and their functions:

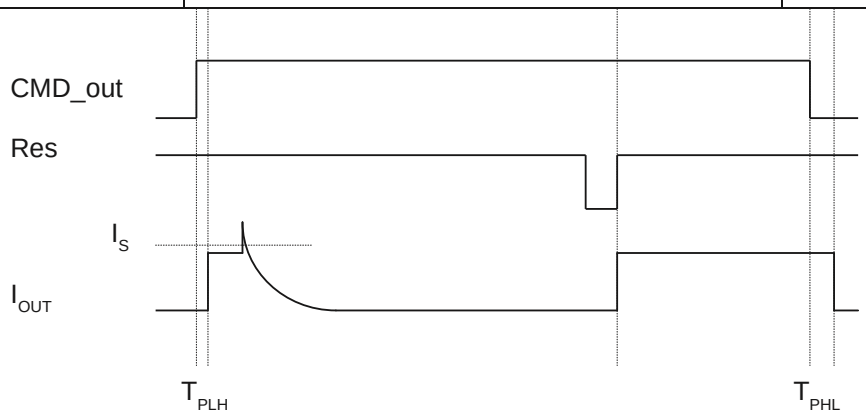
Rout - change or read the state

Rdefout - define the activation state (active low/active high)

Rfuno0, Rfuno1 - assign a funtion to the output (e.g. Synchronized axis, motor in movement, alarm)

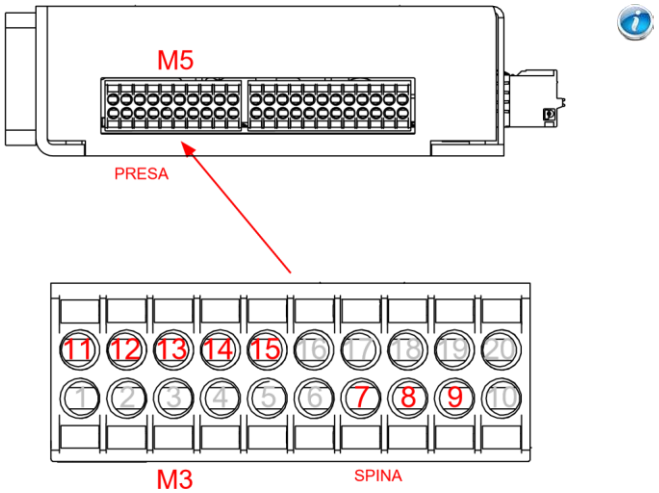


		Min.	Typ.	Max.	Units
Operating voltage		7	24	27	V
Output voltage			V_{PWR} - 2		V
Overcurrent protection			200		mA
T_{FAULT} intervention delay				< 1	µs
Propagation time	T_{PLH} R_L = 100 Ω		0,3	0,6	µs
	T_{PHL} R_L = 100 Ω		2,0	4,0	



Behavior of an output in case of overload

In case an output is overloaded, the output is automatically switched off by the drive; after about 1 second it is re-activated and, in case of persistent overload, it is switched off again. This procedure is carried out three times before generating an output stage overload alarm (bit 5 of the register Ralarm).



Pin	Signal name	Description
1	BLS_1	Back limit switch axis 1
2	FLS_1	Forward limit switch axis 1
3	BLS_2	Back limit switch axis 2
4	FLS_2	Forward limit switch axis 2
5	BLS_3	Back limit switch axis 3
6	FLS_3	Forward limit switch axis 3
7	Input / Output 0	Input / Output 0
8	Input/ Output 1	Input / Output 1
9	Input/ Output 2	Input / Output 2
10	Common	Inputs common
11	Input/ Output 3	Input / Output 3
12	Input/ Output 4	Input / Output 4
13	Input/ Output 5	Input / Output 5
14	Input/ Output 6	Input / Output 6
15	Input/ Output 7	Input / Output 7
16	Analogue input	Analog input
17	Analogue input 1	Analog input 1
18	Analogue input 2	Analog input 2
19	Analog common	Analoh in/out common
20	Analog output	Analog output

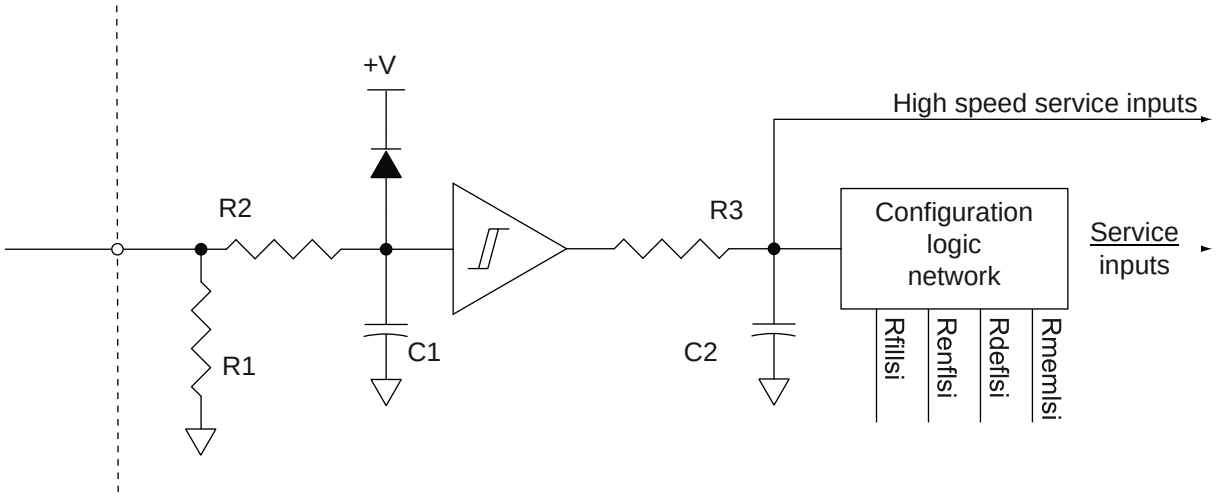
Caution!!! The inputs and the outputs 0-7 share the same pinout. In order to avoid damages to the connected devices, never active an output when the same pin is used as an input.

SERvICE INputs

The service inputs are high speed digital inputs that can be read and configured with the software StepControl, or directly via Modbus RTU, Modbus TCP, CANopen, EtherCAT or Profinet.

Below are the internal registers associated with the service inputs, and their functions:

Rlsi - read the state of the physical inputs
Rhslsi - read the state of the high speed physical inputs
Rfillsi - add a digital filter (input stabilization time)
Renflsi - enable the digitla filter for each single input
Rdeflsi - define the activation state (active low/avtive high)
Rmemlsi - input activation memory (input latch)
Rencext - encoder inputs value in quadrature



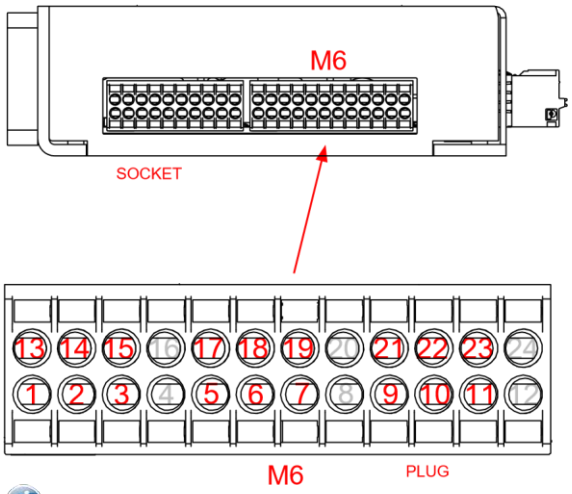
Type	Schmitt triggered with RC filter
Logic	PNP TTL up to + 27 Vdc with internal pull-down
Scan time	real-time input capture, 1 ms for the register Rlsi, 250 µs for the register Rhslsi
Digital filter	Programmable (0 - 16 ms) via Rfillsi and maskable (Renflsi)
Active state	High or Low configurable by the user (Rdeflsi)

		Min.	Typ.	Max.	Units
Input voltage	Logic state LOW	0	0	1,2	V
	Logic state HIGH	2,4	5 / 24	27	
Absorbed current	Logic state LOW		0,01		mA
	Logic state HIGH	0,1		1	
Frequency	Service inputs			70	KHz

Disable the output current to the motor before making any modification, either electric or configuration, to the inputs. Failure to observe this rule may result in unexpected movements of the motors, with consequent damages or injuries.

Service inputs/outputs connector

Description	Removable spring-cage terminal block, 12x2 positions
Dimensions of conductor	16 - 24 AWG



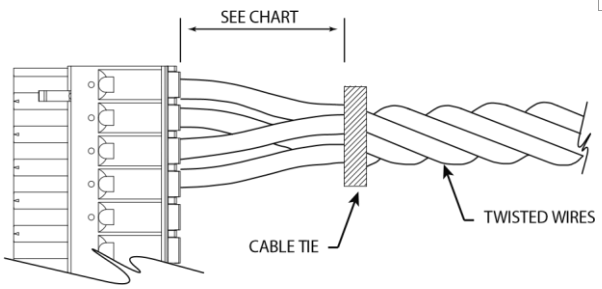
Pin	Signal name	Description
1	Motor 1 encoder A+	Axis 1 encoder channel A+
2	Motor 1 encoder B+	Axis 1 encoder channel B+
3	Motor 1 encoder Z+	Axis 1 encoder channel Z+
4	Common	Inputs common
5	Motor 2 encoder A+	Axis 2 encoder channel A+
6	Motor 2 encoder B+	Axis 2 encoder channel B+
7	Motor 2 encoder Z+	Axis 2 encoder channel Z+
8	Common	Inputs common
9	Motor 3 encoder A+	Axis 3 encoder channel A+
10	Motor 3 encoder B+	Axis 3 encoder channel B+
11	Motor 3 encoder Z+	Axis 3 encoder channel Z+
12	Common	Inputs common
13	Motor 1 encoder A-	Axis 1 encoder channel A-
14	Motor 1 encoder B-	Axis 1 encoder channel B-
15	Motor 1 encoder Z-	Axis 1 encoder channel Z-
16	+5Vdc out (max 100mA)	Output +5Vdc (max 100mA)
17	Motor 2 encoder A-	Axis 2 encoder channel A-
18	Motor 2 encoder B-	Axis 2 encoder channel B-
19	Motor 2 encoder Z-	Axis 2 encoder channel Z-
20	+5Vdc out (max 100mA)	Output +5Vdc (max 100mA)
21	Motor 3 encoder A-	Axis 3 encoder channel A-
22	Motor 3 encoder B-	Axis 3 encoder channel B-
23	Motor 3 encoder Z-	Axis 3 encoder channel Z-
24	+5Vdc out (max 100mA)	Output +5Vdc (max 100mA)

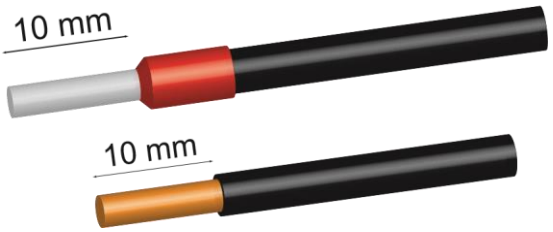
Caution!!!

The +5Vdc output can be used only to supply the encoders, and it has an output maximum capacity of 100mA.
In case of overload the output protects itself by limiting the supplied current.

Notes:

The encoder inputs can be connected both in single ended mode (NPN or PNP) and in Line Driver, and they accept input voltages between +5Vdc and +24Vdc. The BLS and FLS inputs are single ended PNP inputs, and they accept input voltages between +5Vdc and +24Vdc.





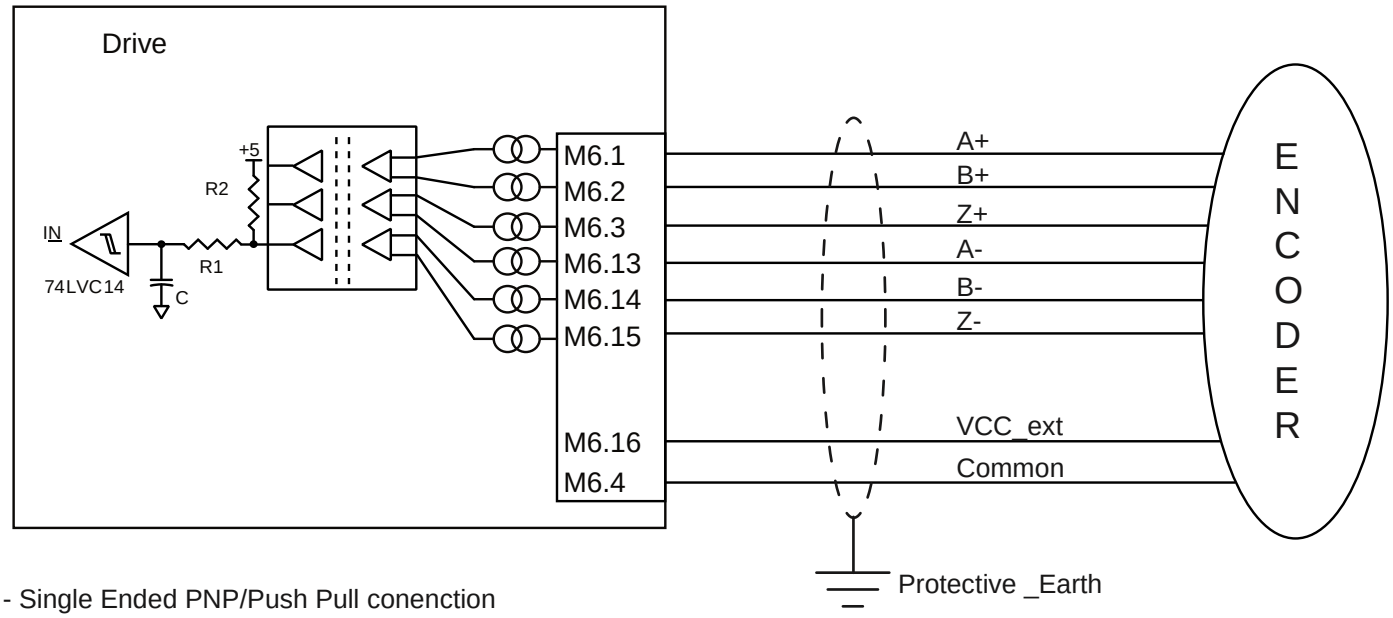
In case of twisted wires, fix the twist with a cable tie e let the cables free for the minimum distance you can see in the table.

Nr. of conductors	Minimum distance (mm)
2 - 8	12.7
10 - 16	19.1
18 - 24	25.4

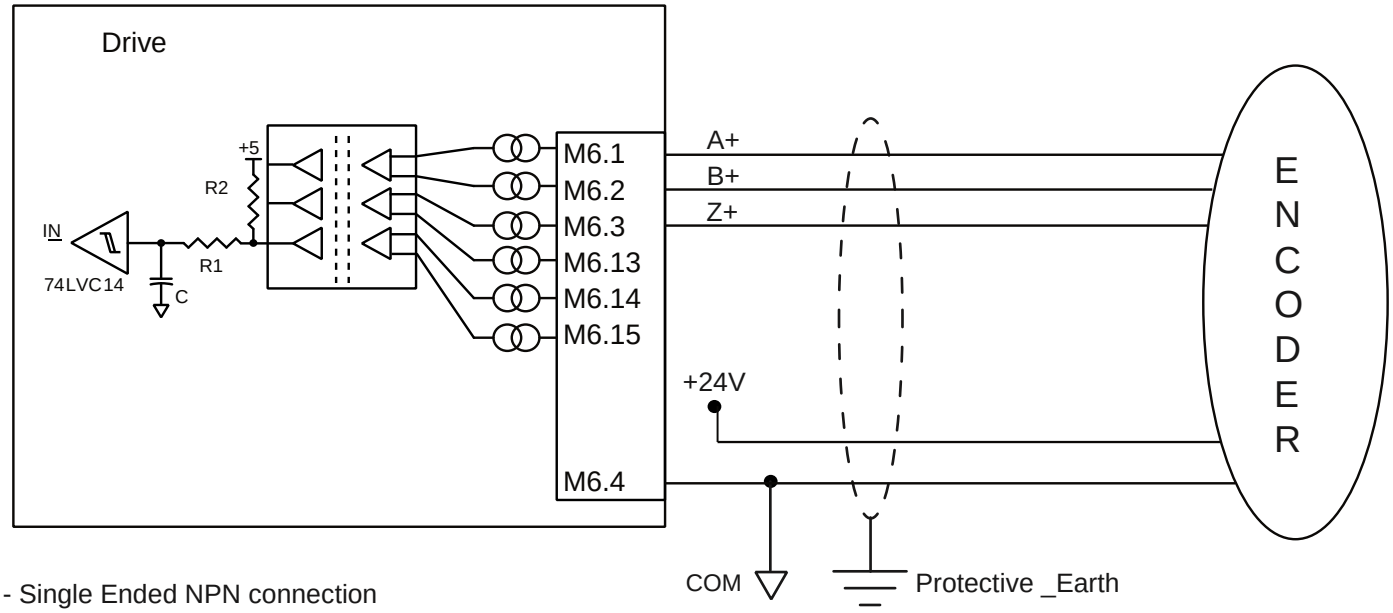
Conductor characteristics	mm^2
Conductor cross section solid	0,2 - 1,5
Conductor cross section stranded	0,2 - 1,5
Conductor cross section stranded, with ferrule without cable clip	0,2 - 1,5
Conductor cross section stranded, with ferrule with cable clip	0,2 - 0,75
Stripping lenght or cable lug lenght (mm)	10

Motor encoder connection examples:

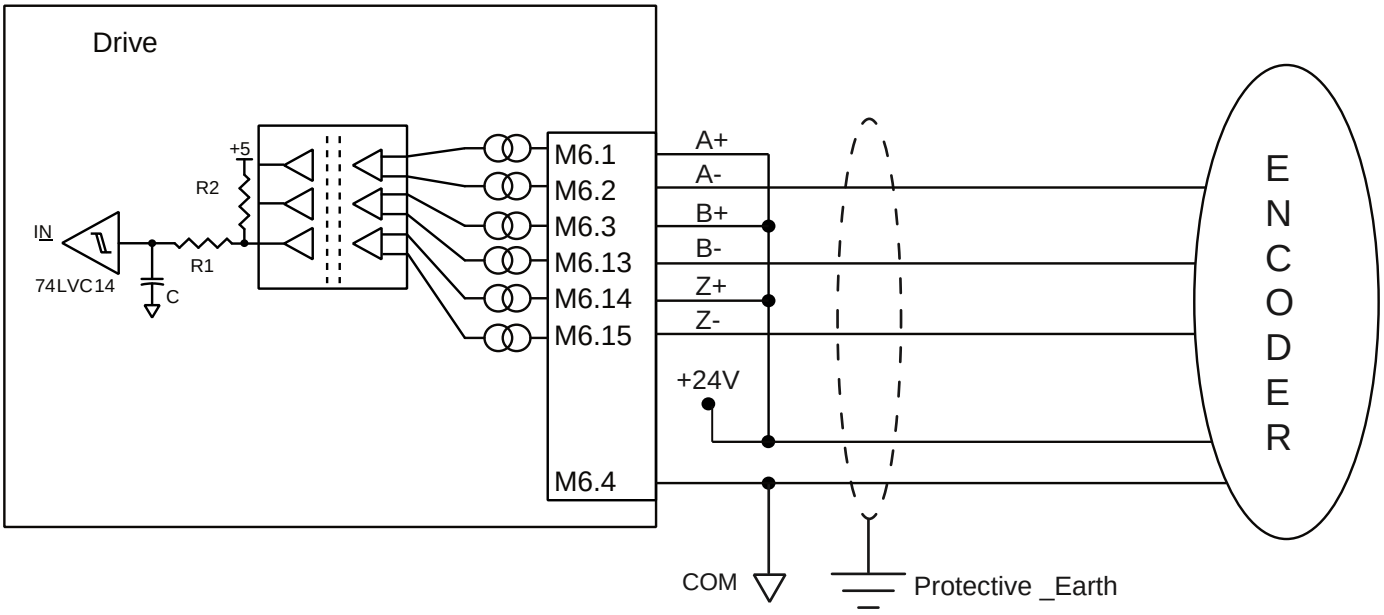
- Line Driver connection



- Single Ended PNP/Push Pull conenction



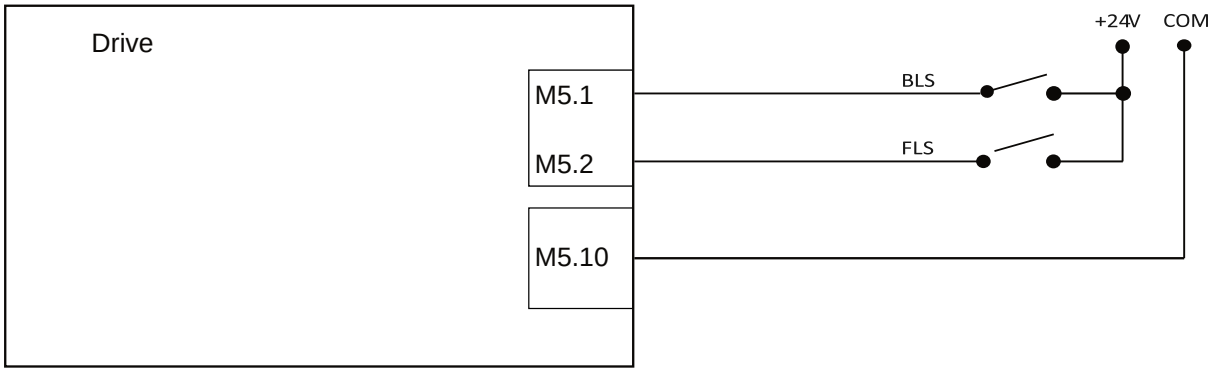
- Single Ended NPN connection



Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analogic, fast inputs). Do not lock up or pass the motor cable in the same conduit of signal cables.

Limit switch connection example:

- Limit switch connection



aNalog INput

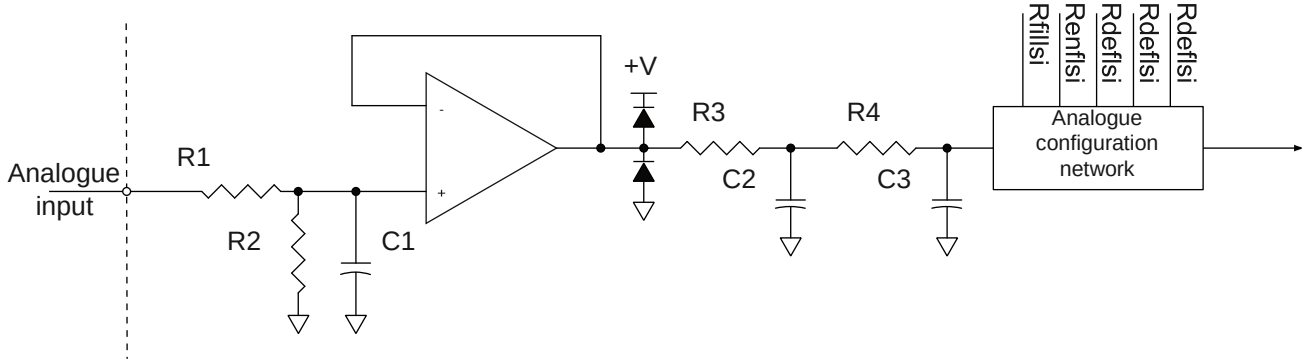
The SMD2204 has three single-ended type 0 - 10Vdc analog inputs.

The conversion stage is composed by a 12MSPS Sample&Hold type 12-bit high speed A/D converter, with convertion time of 80ns.

The acquired value can be read and configured with the software StepControl, or directly via Modbus RTU, Modbus TCP, CANopen, EtherCAT or Profinet.

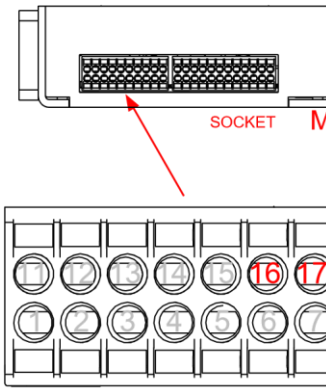
Below are the internal registers associated with the analog inputs, and their functions:

Ranainp - read the value of the analog input
Rmulanainp - condition the value read from the analog input (multiplication factor)
Rshiftanainp - condition the value read from the analog input (division factor)
Ranaidb - set a dead band
Ranaofs - set an offset
Rdefanainp - assign a function to the analog input (e.g. Position reference, Velocity reference, etc...)



Type	0 - 10 Vdc single ended
Conversion	12MSPS high speed Sample&Hold
Scan time	1ms
Conditioning	Dead-band (Ranaidb) and programmable offset (Ranaofs)
Function	Programmable via Rdefanainp

		Min.	Typ.	Max.	Units
Measure range		0		10	V
Input impedance	Minimum value	100			KΩ
Input voltage	Maximum permitted value			12	Vdc
LSB value			2.44		mVdc
Resolution			12		bit
Conversion time	SH conversion at 12MSPS		80		ns
Scan time			1		ms
Temperature coefficient			50		PPM/°C
Linearity error			±1		LSB



M5

aNalog output

Pin	Signal name	Description
16	Analog input	Analog input
17	Analog input 1	Analog input 1
18	Analog input 2	Analog input 2
19	Analog Common	Analog I/O common

The SMD2204xxx has one single-ended type 0 - 10Vdc analog output.

The conversion stage is composed by a 10bit high speed A/D converter/ 187kSPS and conversion time of 250ns.

The acquired value can be read and configured with the software StepControl, or directly via Modbus RTU, Modbus TCP, CANopen, EtherCAT or Profinet.

Below are the internal registers associated with the analog output, and their functions:

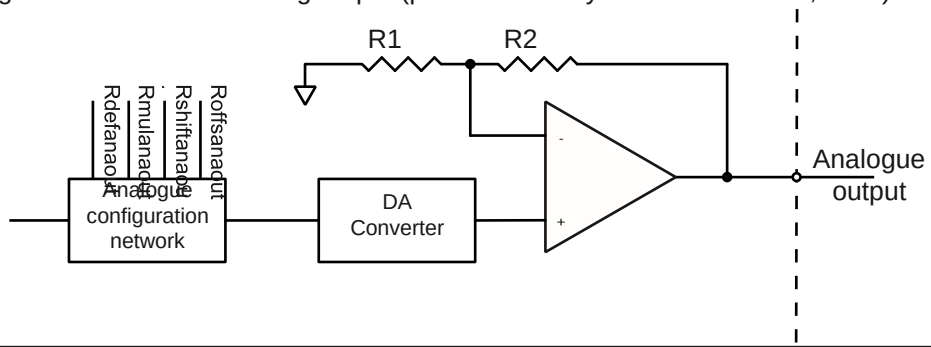
Ranaout - read the value

Rmulanaout - condition the value read from the analog output (multiplication factor)

Rshiftanaout - condition the value read from the analog output (division factor)

Rofsanaout - set an offset

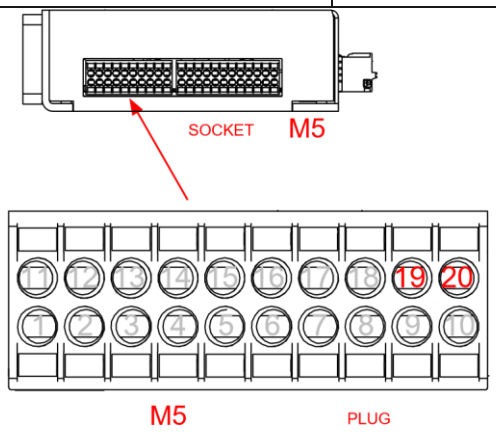
Rdefanaout - assign a function to the analog output (position/velociry/current reference, etc...)



Tipo	0 - 10 Vdc single ended
Conversione	DA holded
Tempo di aggiornamento	1ms
Condizionamento	Multiplier (Rmulanaout) Divider (Rshiftanaout) and programmable offset (Ranaofs)
Functions	Programmable (Rdefanaout)

		Min.	Typ.
Measure range		0	
Input impedance			1
Zero error			5
Resolution		10	
Conversion delay			7

Scan time			1
Short-circuit current			20
Linearity error			-0.15



Pin	Signal name	Description
19	Analog Common	Analog I/O common
20	Analog Output	Analog output

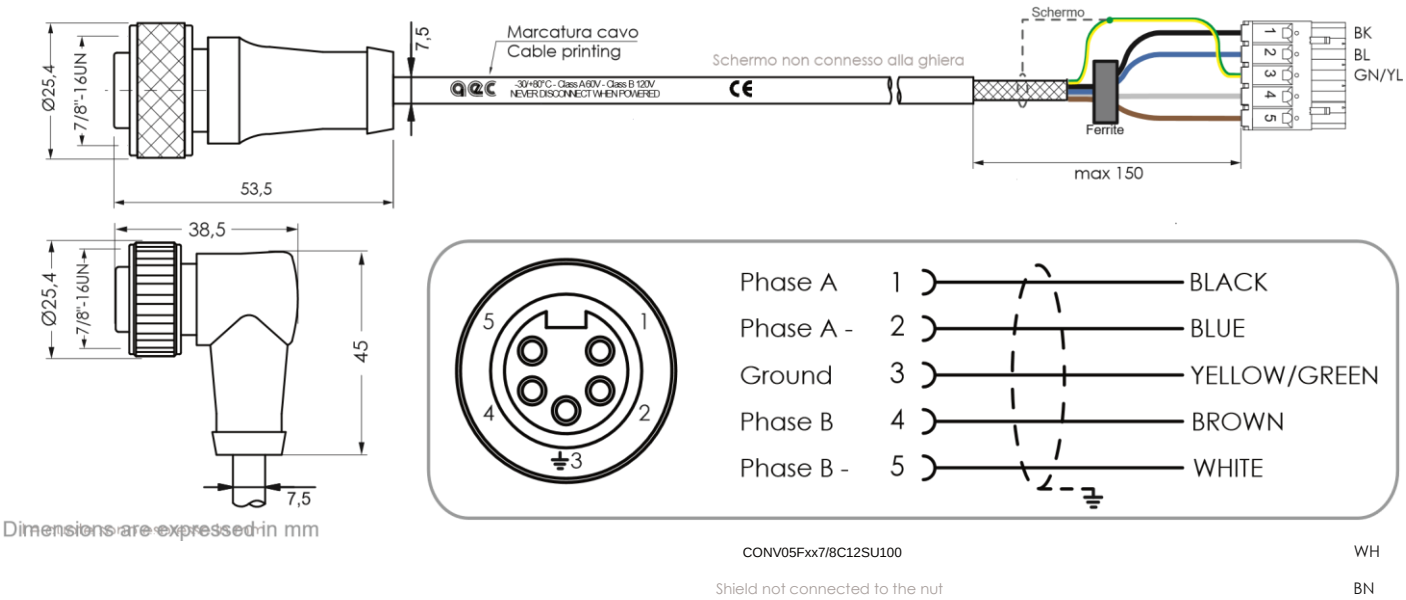
MotoR CoNNECtIoN CaBlEs

CoNv05f_xx7/8Cxxx

Shielded dynamic laying cables for stepper motors series M86SHxx and M110SHxx.

SPECIFICATIONS	UM	
Temperature range (flexible installation)	°C	-30 .. +80
Temperature range (fixed installation)	°C	-40 .. +80
Stranding	nr x mm	cl 6
Minimum bending radius	mm	10 x Ø
Nominal voltage	V	300
Sheath material		Opaque PUR Halogenfree
Insulation material		PP 9Y Halogenfree
Bending cycles		> 2 millions
Maximum acceleration	m/s^2	2
Maximum translation speed	m/min	200

Model	Connector	Nr. of conductors	Cross section	Characteristics	External diameter	Length
		N	mm^2		mm	m
CONV05FDR7/8C12SU100	Straight	4 + 1	1,00	UL-CSA 300 V 80°C	7,4	12
CONV05FDR7/8C04SU100	Straight	4 + 1	1,00	UL-CSA 300 V 80°C	7,4	4
CONV05F907/8C12SU100	Angled	4 + 1	1,00	UL-CSA 300 V 80°C	7,4	12
CONV05F907/8C04SU100	Angled	4 + 1	1,00	UL-CSA 300 V 80°C	7,4	4



Caution!!!

Don't connect or disconnect the circular connector or the terminal block in presence of voltage. The connection in presence of voltage may result in electrical discharges that are potentially harmful to the equipment, the connectors and the user.

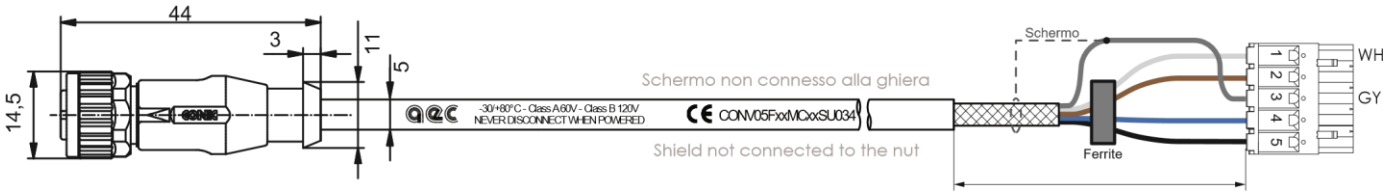
Caution!!!

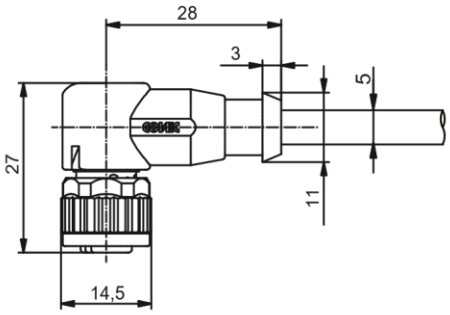
Don't install cables with bending radius lower than those indicated; avoid the contact with sharp edges or abrasive surfaces. Periodically check the integrity of the insulating sheath.

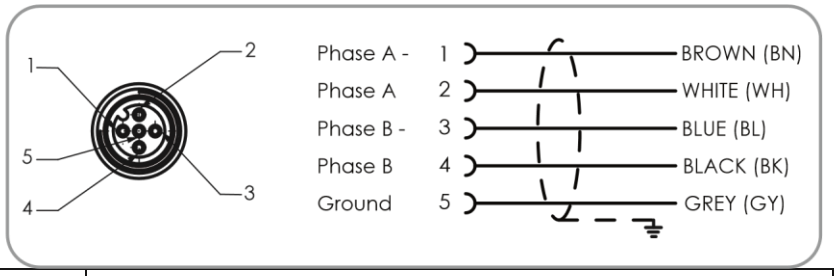
CoNv05fxxm12Cxxx

Shielded dynamic laying cables for stepper motors series M42SHxx, M57SHxx and M60SHxx.

SPECIFICATIONS	UM	
Temperature range (flexible installation)	°C	-15 .. +80
Temperature range (fixed installation)	°C	-30 .. +80
Minimum bending radius	mm	10 x Ø
Nominal voltage	V	300
Sheath material		TPE-U (PUR) oil resistant DIN EN 60811-2-1
Insulation material		PP 9Y







Bending cycles		> 2 millions
Maximum acceleration	m/s^2	5
Maximum translation speed	m/min	200

Model	Connector	Nr. of conductors	Cross section	Characteristics	External diameter	Length
		N	mm^2		mm	m
CONV05FDRM12C04SU034	Straight	5	0,25	UL20549	5,8	4
CONV05FDRM12C12SU034	Straight	5	0,25	UL20549	5,8	12
CONV05F90M12C04SU034	Angled	5	0,25	UL20549	5,8	4
CONV05F90M12C12SU034	Angled	5	0,25	UL20549	5,8	12

BN

BL
BK

max 150

Caution!!!
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Caution!!!
Don't install cables with bending radius lower than those indicated; avoid the contact with sharp edges or abrasive surfaces. Periodically check the integrity of the insulating sheath.

ENCoDER CoNNECtIoN CaBlEs

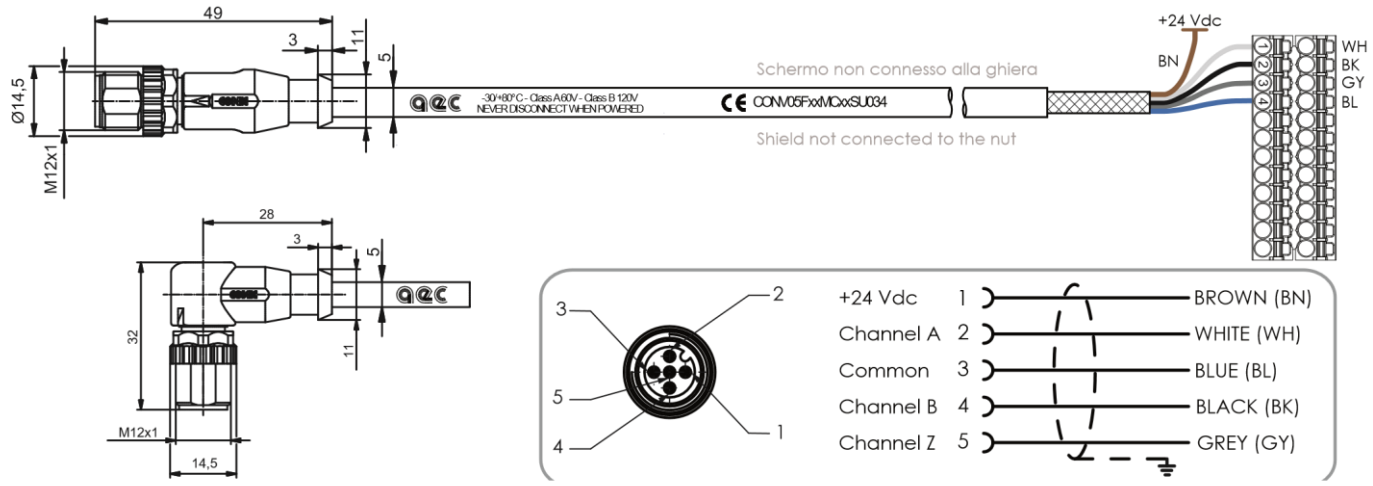
CoNv05m xxm12Cxxx

Shielded dynamic laying cables for AEC integrated Push Pull encoders.

SPECIFICATIONS	UM	
Temperature range (flexible installation)	°C	-15 .. +80
Temperature range (fixed installation)	°C	-30 .. +80
Minimum bending radius	mm	10 x Ø
Nominal voltage	V	300
Sheath material		TPE-U (PUR) oil resistant DIN EN 60811-2-1
Insulation material		PP 9Y
Bending cycles		> 2 millions
Maximum acceleration	m/s^2	5
Maximum translation speed	m/min	200

Model	Connector	Nr. of conductors	Cross section	Characteristics	External diameter	Length
		N	mm^2		mm	m
CONV05MDRM12C04SU025	Straight	5	0,25	UL20549	5,5	4
CONV05MDRM12C12SU025	Straight	5	0,25	UL20549	5,5	12
CONV05M90M12C04SU025	Angled	5	0,25	UL20549	5,5	4
CONV05M90M12C12SU025	Angled	5	0,25	UL20549	5,5	12

Axis 1



Caution!!!

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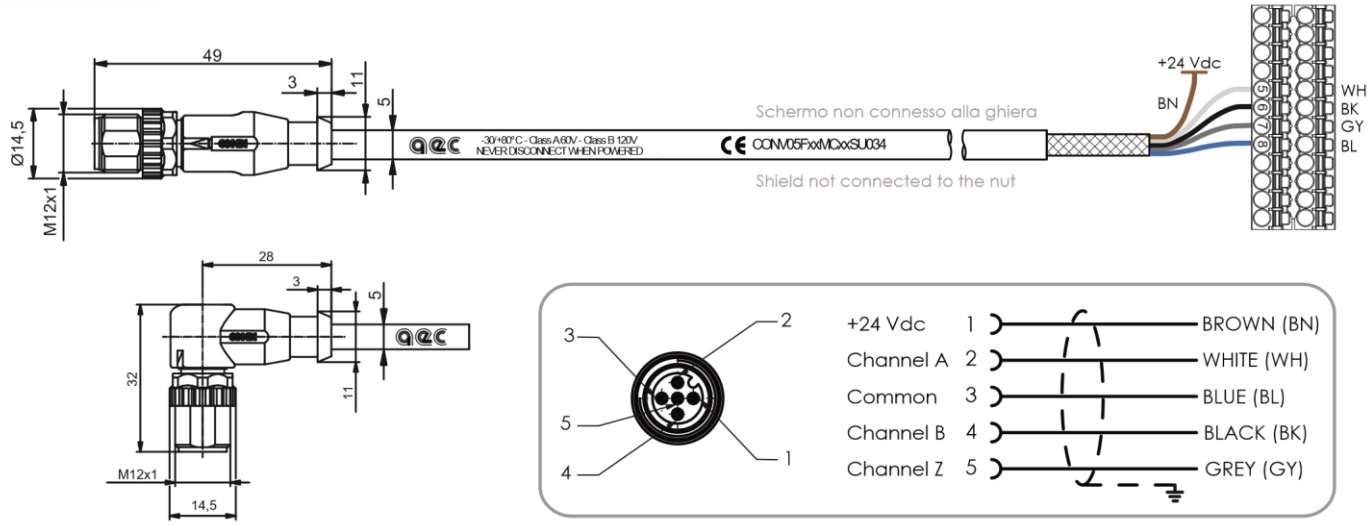
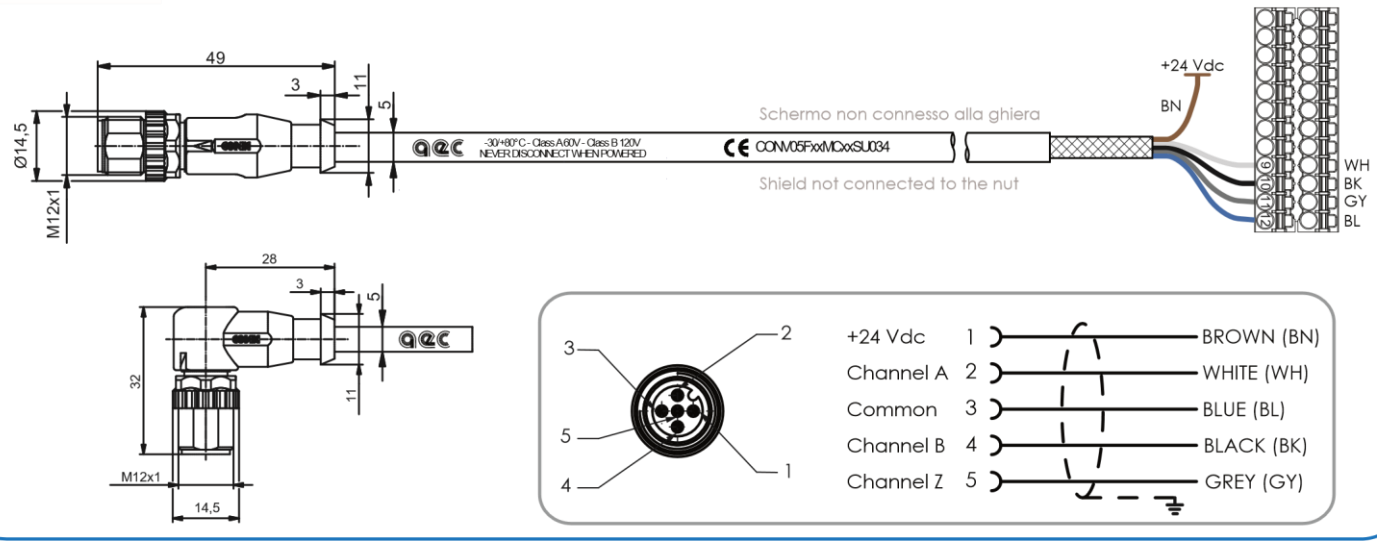
Caution!!!

Don't install cables with bending radius lower than those indicated; avoid the contact with sharp edges or abrasive surfaces. Periodically check the integrity of the insulating sheath.

Axis 2



Axis 3



Caution!!!
Don't connect or disconnect the circular connector or the terminal block in presence of voltage. The connection in presence of voltage may result in electrical discharges that are potentially harmful to the equipment, the connectors and the user..

Caution!!!
Don't install cables with bending radius lower than those indicated; avoid the contact with sharp edges or abrasive surfaces. Periodically check the integrity of the insulating sheath.

CoNv08f xxm12Cxxx

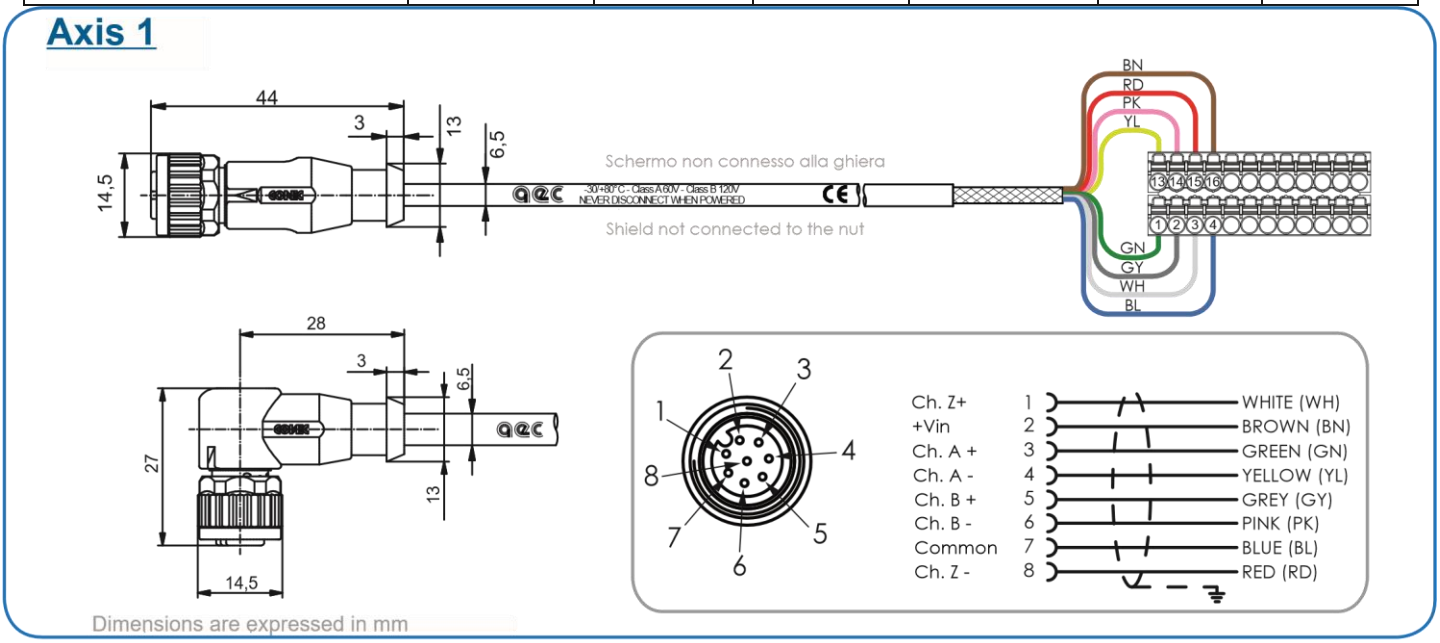
Shielded dynamic laying cables for AEC integrated Line Driver encoders.

SPECIFICATIONS	UM	
Temperature range (flexible installation)	°C	-15 .. +80

Temperature range (fixed installation)	°C	-30 .. +80
Minimum bending radius	mm	10 x Ø
Nominal voltage	V	300
Sheath material		TPE-U (PUR) oil resistant DIN EN 60811-2-1
Insulation material		PP 9Y
Bending cycles		> 2 millions
Maximum acceleration	m/s^2	5
Maximum translation speed	m/min	200

Model	Connector	Nr. of conductors	Cross section	Characteristics	External diameter	Length
		N	mm^2		mm	mm
CONV08FDRM12C04SU025	Straight	8	0,25	UL20549	5,5	4
CONV08FDRM12C12SU025	Straight	8	0,25	UL20549	5,5	12
CONV08F90M12C04SU025	Angled	8	0,25	UL20549	5,5	4
CONV08F90M12C12SU025	Angled	8	0,25	UL20549	5,5	12

Axis 1



Caution!!!

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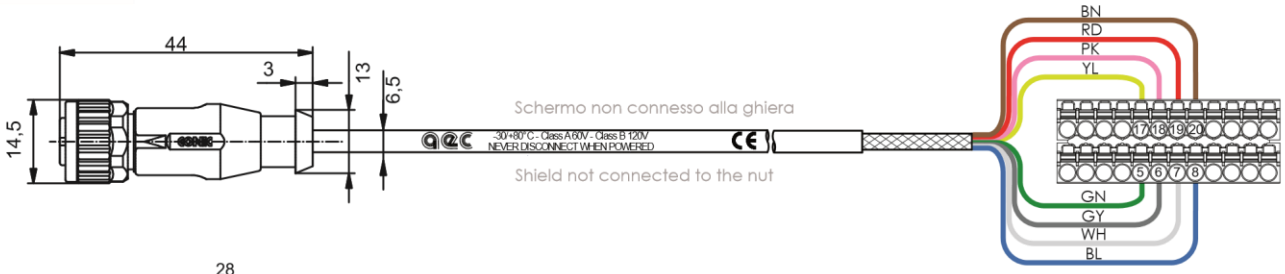
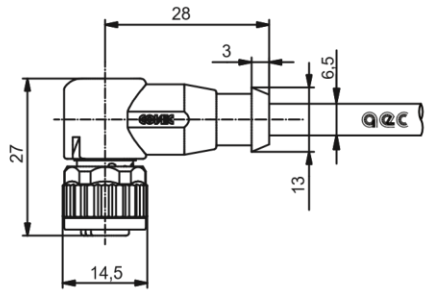
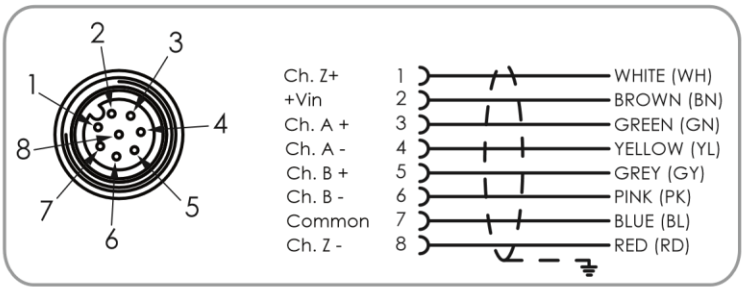
Caution!!!

Don't install cables with bending radius lower than those indicated; avoid the contact with sharp edges or abrasive surfaces. Periodically check the integrity of the insulating sheath.

Axis 2

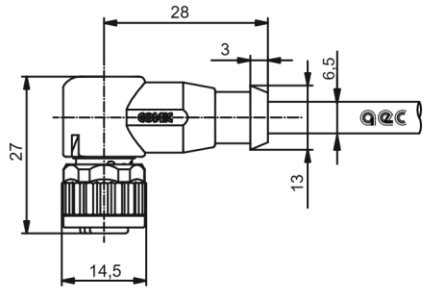


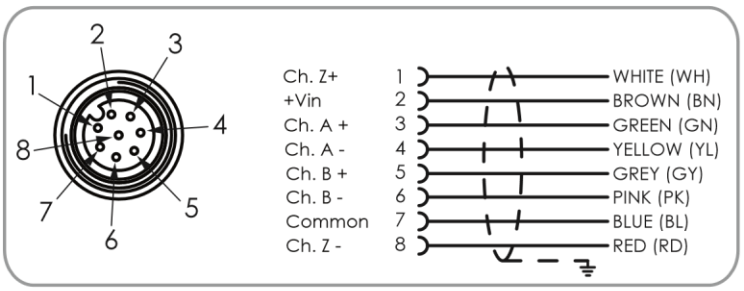




Dimensions are expressed in mm

Axis 3





Dimensions are expressed in mm

Caution!!!
Don't connect or disconnect the circular connector or the terminal block in presence of voltage. The connection in presence of voltage may result in electrical discharges that are potentially harmful to the equipment, the connectors and the user..

Caution!!!
Don't install cables with bending radius lower than those indicated; avoid the contact with sharp edges or abrasive surfaces. Periodically check the integrity of the insulating sheath.

CommuNICatIoN INtERfaCE

The SMD2204 drives are provided with multiple communication channels, which permit to connect with external devices by using widespread standard protocols.

All the products of the family are able to communicate with a USB connection, which is used to parameterize, configure and program the axis controller.

In addition to the standard USB communication channel, it is possible to have other communication lines: Modbus RTU (SMD2204xIM), Modbus TCP (Model SMD2204xIE), CANopen (SMD2204xIC), EtherCAT (Model SMD2204xIT) or Profinet (SMD2204xIN).

These solutions allow the drive to communicate with all control devices (PC, PLC) or visualization devices (HMI) available on the market, in a simple and quick way.

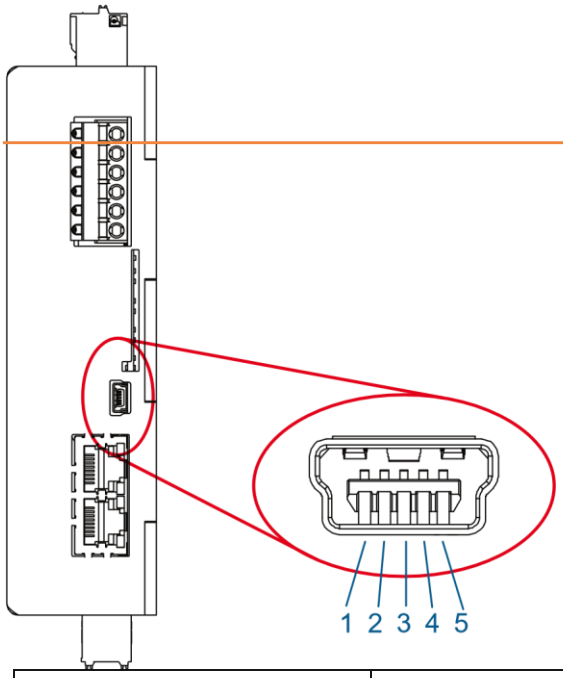
usB INtERfaCE

Pin	Symbol	Signal name	Description
1	V_{BUS}	Bus Voltage	USB port power supply
2	D-	Data -	USB channel Data -
3	D+	Data +	USB channel Data +
4	NC	Not Connected	Not connected
5	GND	Common TX	Communication signals common

Type	Full Speed USB 2.0 Composite Device CDC
Number of channels	1
Insulation	-
Functions	Configuration and parameterization, programming, diagnostic and remote control

		Min.	Typ.	Max.	Units
Signals	V_{BUS}, D+, D-, GND				
Baudrate	Fixed		9600		Baud
Parity	Fixed		NONE		
Number of bit	Fixed		8		
Stop bit number	Fixed		1		bit
Protocol			Modbus RTU		
ESD Protection	Human Body Model		±15		kV

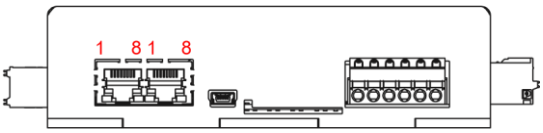
Modbus



Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analogic, fast inputs). Do not lock up or pass the motor cable in the same conduit of signal cables.

Type	TIA/EIA-485A
Number of channels	1
Insulation	High speed capacitive digital insulator (25Mbps)
Functions	Configuration and parameterization, programming, diagnostic and remote control

		Min.	Typ.	Max.	Units
Signals	D+, D-, GND				
Baudrate	Configurable *(Rserbaud)*	1200	9600	115200	Baud
Parity	Configurable *(Rserpar)*		EVEN, NONE, ODD		
Number of bit	Fixed		8		
Stop bit number	Configurable *(Rserpar)*		1	2	bit
Protocol			Modbus RTU		
ESD protection	Human Body Model		±15		kV
Number of nodes			256		



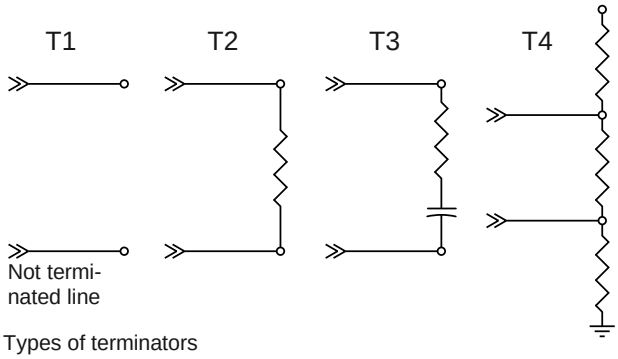
Pin	Signal name	Description
1	Shield	Shield
2	Not Connected	Not connected
3	Not Connected	Not connected
4	Not Connected	Not connected
5	Common TX	Communication signals common
6	Not Connected	Not connected
7	Data +	Data + RS-485
8	Data -	Data - RS-485

9	Common TX	Communication signals common

The RS-485 serial interface permits to connect multiple devices in the same communication network, reducing wiring complexity and required resources.

To obtain the maximum efficiency from a RS-485 serial network, it is preferrable to adopt all the linear topographies (daisy-chain, token-ring) rather than star topographies, because each deviation (stub) may create line reflection or communication problems.

In case of open lines, it is necessary to terminate the free ends of the line with a properly sized terminator.



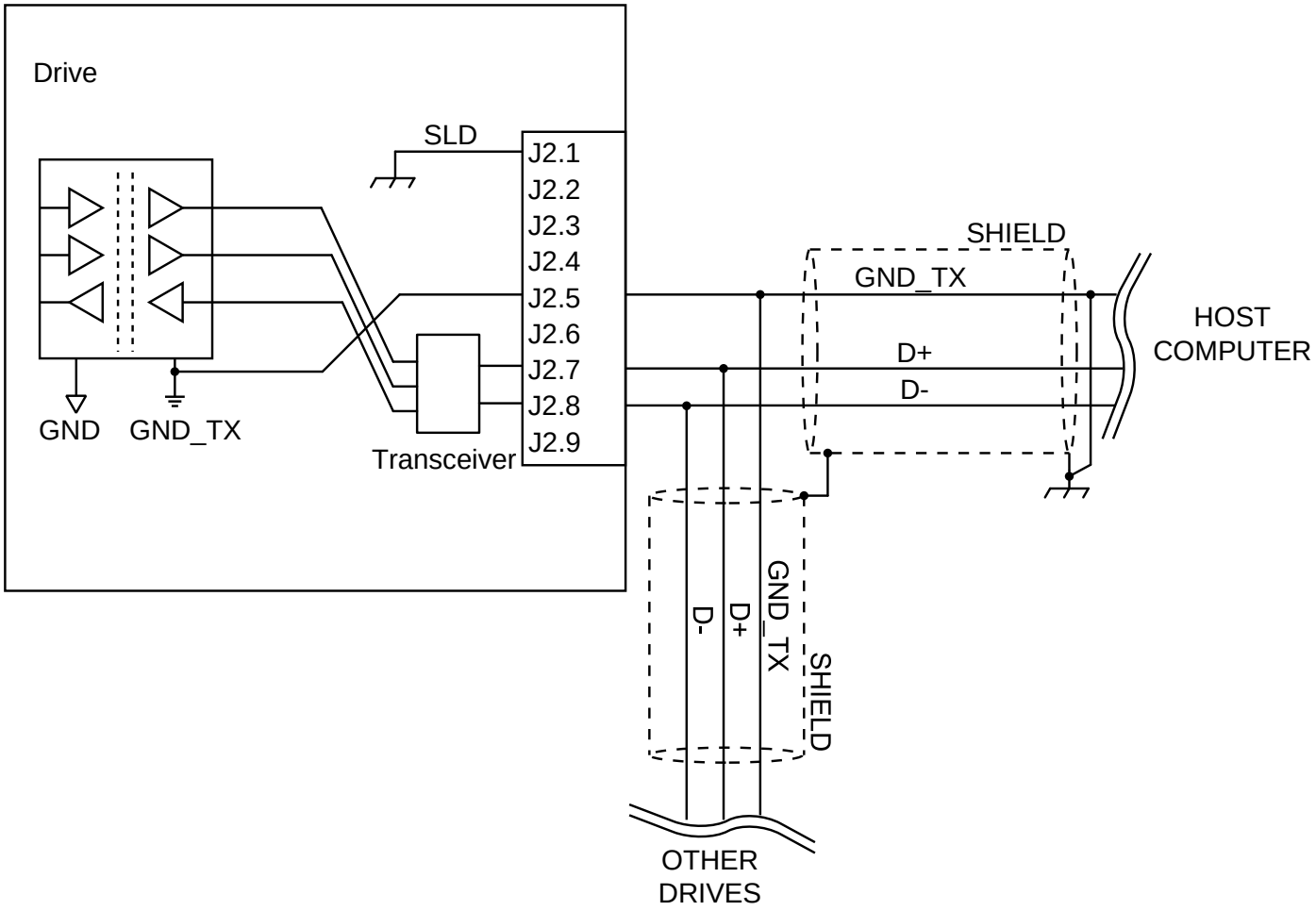
Types of terminators

Terminators characteristics

Reference	T1	T2	T3	T4
Type of thermination	None	Parallel	RC	Failsafe
Data rate	Low	High	Medium	High
Quality of the signal	Limited	Excellent	Limited	Excellent
Power	Low	High	Low	High

The most used termination method is he parallel terminator, made with a 120 **Ω** ½W resistance.

RS-485 connection example



MODBUS TCP/IP INTERFACE (ONLY SMD2204XIE)

The following table summarizes the specifications of Modbus TCP/IP communication.

Standard	IEC61158 Type 12
Physical level	Ethernet - 100Base-TX
Bus topology	Line Tree
Modulation type	Baseband
Transmission speed	100Mbps
Communication cable	Category 5 or higher (cable with double aluminum tape and braided shielding is recommended.)
Connector	RJ45 (Shielded)
Communication distance	Distance between nodes (slave): 100m max
Noise resistance	Conform to IEC61000-4-4, 2kV criteria A

LED	L/A IN (Link activity IN): 1 L/A OUT (Link activuty OUT): 1 ECAT RUN (Green): 1 ECAT ERR (Red): 1

Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analogic, fast inputs). Do not lock up or pass the motor cable in the same conduit of signal cables.

CANopen INTERFACE (ONLY SMD2204XIC)

Type	Full CAN V.2.0b physical layer for high-speed connections compliant
Number of channels	1
Insulation	High speed (5Mbps) capacitive digital insulator
Functions	Real-time motion control, configuration and parameterization, programming, diagnostic

		Min.	Typ.	Max.	Units
Protocol	Motion Control Device according to DSP-402 V.1.1 specifications of the applicative layer of CANopen DS-301 V.4.0 (EN50325-4)				
Supported modes	Profile Velocity Mode, Torque Profile Mode, Homing mode, Profile Position Mode, Interpolated Position Mode				
Signals		CAN_H, CAN_L, CAN_GND			
Baudrate	Configurable *(Rcanbaud)*	10		1000	KB/s
Addressing	Software address *(Rcanaddr)*				
Termination	120Ω external resistance				
Error control	Node guarding, Life guarding, Heartbeat				
Number of PDO	Mappable	4 Rx		4 Tx	
PDO modes	Event Triggered, Sync (cyclic), Sync (acyclic), RTR				
PDO linking	NO				
PDO mapping	Variable (granularity 8 bit)				
Number of SDO		1 Server		0 Client	
Emergency messages	Yes				
Framework	No				

Vendor ID	*AEC srl*	00 00 00 BCh

Cable characteristics:

Parameter	< 300 m	> 300 m
Type	Lumberg STL253 2 x 0,25 mm² (twisted pair with shield) 2 x 0,34 mm² (twisted pair with shield)	Lumberg STL253 2 x 0,82 mm² (twisted pair with shield) 2 x 1,50 mm² (twisted pair with shield)
Resistance	≤ 40 Ω/km	≤ 40 Ω/km
Capacity	≤ 130 nF/km	≤ 130 nF/km
Matches	Pair 1 (Black / Red): CAN-GND and +Vs Pair 2 (White / Blu): CAN-HIGH and CAN-LOW	

To obtain a communication network which is immune to noise, respect the recommended maximum lengths and sections, remove possible potential differences between the nodes by connecting all the nodes to earth or by using an additional potential compensation cable.

Maximum permitted lengths for cables and stubs

The length of cables and stubs depends on the working baud-rate of the network.

Baudrate (Kb/s)	**10**	**20**	**50**	**100**	**125**	**250**	**500**	**800**	**1000**
Maximum length of the network (m)	5000	3000	1000	500	400	200	75	30	25
Maximum length of the stubs (m)	1360	875	350	175	140	70	35	20	17
Maximum length of each stub (m)	270	175	70	35	28	14	7	4	3

The maximum length of each single segment depends also on the cable section and on the number of nodes connected to the segment itself.

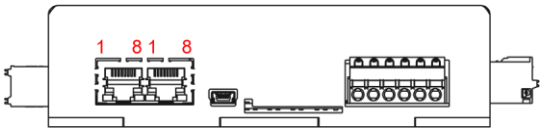
Number of connected nodes	**Cable section**		
	0,75 mm²	**0,5 mm²**	**0,25 mm²**
x < 32	550	360	200
32 < x < 64	470	310	175
64 < x <100	410	270	150

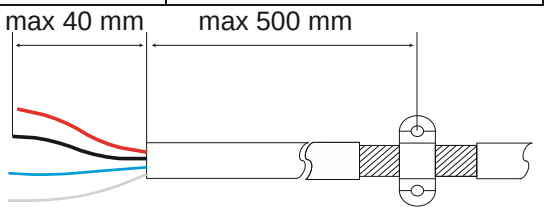
Measures are expressed in m.

For bus lengths exceeding 1000 m it is recommendable to insert bridges or repeaters.

Connector pinout

Pin	Symbol	Signal name	Description
1	CAN_H	CAN H Line	CAN recessive line
2	CAN_L	CAN L Line	CAN dominant line
3	CAN_GND	Common TX	Communication signals common
4	-	Reserved	Reserved
5	-	Reserved	Reserved
6	CAN_SHLD	CAN Shield	Shield
7	CAN_GND	Commmon TX	Communication signals common
8	-	Reserved	Reserved





CAN communication networks must ALWAYS terminate with a 120Ω resistance both ant the beginning and at the end.

In case of particular topographies, e.g. star networks or divided into more sections, each branch must be terminated.

EthERCat INtERfaCE (oNly smD2204xIt)

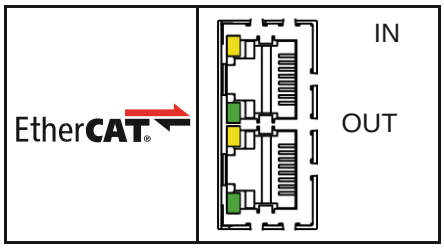
The following table summarizes the specifications of EtherCAT communication.

Standard	IEC61158 Type 12
Physical level	Ethernet - 100Base-TX
Bus topology	Line Tree
Modulation type	Baseband
Transmission speed	100Mbps
Communication cable	Category 5 or higher (cable with double aluminum tapeand braided shielding is recommended.)
Connector	RJ45 (Shielded) ECAT IN : EtherCAT Input ECAT OUT: EtherCAT Output
Communication distance	Distance between nodes (slave): 100m max
Noise resistance	Conform to IEC61000-4-4, 2kV criteria A
EtherCAT Device ID	Set physical address at master: 1-65535
Support protocol	CoE (CANOpen application protocol over EtherCAT)
Control profile	CiA DS402 drive profile (IEC61800-7)

Supported operation modes	8 - Cyclic Synchrounous Position Mode 6 - Homing Mode 1 - Profile Position Mode -1 - Manufacturer JOG Mode
Distribuited clock	Free Run SM event mode DC Mode
Processing Data	8 Configurable PDO Mapping (1600-1607) 8 Configurable PDO Mapping (1A00-1A07) 8 Single object per PDO
Mailbox (CoE)	SDO requests, SDO responses
LED	L/A IN (Link activity IN): 1 L/A OUT (Link activuty OUT): 1 ECAT RUN (Green): 1 ECAT ERR (Red): 1

Place the motor cable at a distance of at least 300 mm from signal cables (encoder, analogic, fast inputs). Do not lock up or pass the motor cable in the same conduit of signal cables.

CONNECTOR



PROFINET INTERFACE (ONLY SMD2204XIN)

The following table is an overview for the PROFINET features supported by SMDyyyyxIN drives

PROFINET RT	✓
PROFINET IRT (RT_CLASS_3)	✓
Advanced Startup	✓
Legacy Startup	✓
Minimum cycle time, RT	250us (motor controlled every 1ms)
Minimum cycle time, IRT	250us (motor controlled every 1ms)
Enhanced Configuration Support	✓
Support of I&M5	✓
Simple Network Management Protocol (SNMP)	✓
MRP Client (Media Redundancy Protocol)	✓
Number of ARs / Shared Device capable	1

IO Supervisor AR	1 (only device access)
Acyclic communication	Read/Write Record
Alarm Types	Process Alarm, Diagnostic Alarm, Plug Alarm, Pull Alarm, Return of Submodule Alarm
Identification & Maintenance	I&M0-5
Topology recognition	LLDP, SNMP V1, MIB2, PDEV
Media Redundancy	MRP client
Additional supported features	DCP, 802.1q Priority
Data rate / duplex	100 MBit/s, Full Duplex
Data transport layer	Ethernet II, IEEE 802.3
PROFINET IO specification	V2.35

tEChNICal Data

Type	Ethernet network
Cable	Ethernet CAT. 5e
Function	Real-time motion control, setup and parameterization, programming, diagnostics
Protocol	PROFIdrive according to Profile Drive Technology version 4.1, May 2006 (IEC 61800-7)
Error checking	Checksum
Supported Masters	Class 1, Class 2
Application Class	3 (Single axis positioning drive, with local motion control)
Number of port	2

REstRICtIoNs

Following restriction apply:

- RT over UDP not supported
- DHCP is not supported
- Fast Startup iso not supported
- Shared Inputs are not supported
- Multicast cammunication not supported
- Only 1 Input-CR and 1 Output-CR per AR is supported
- System Redundancy (SR-AR) and Configuration-in-Run (CiR) are not supported
- The amount of configured IO-data influences the minimum cycle time that can be reached.

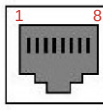
EmC ImmuNIty

To prevent them from being created EMI disturbances caused by cables or devices contained in the same power panel, the drive must be properly connected to protective earth as described in the in the manual.
AEC does not guarantee proper EMC behavior unless thes PE requirements are fulfilled

The shield of the RJ45 connector is not connected directly to PE. As all nodes in a Profinet network have to share earth connection, the Profinet cable shield has to be connected to the earth ai each node in the network.

For further information, see “PROFINET Installation Guideline for Cabling and Assembly, no. 8072” available to download at www.profinet.com

CoNNECtoR plNout



Pin no	Description
1	TD+
2	TD-
3	RD+
4, 5, 7, 8	Connected to ground over serial RC circuit
6	RD-
Housing	Cable Shield

CERtIfICatIoN

The SMDyyyyxIN device was tested with the official PROFINET IO Test Bundle of PI (Release 2017-04-05) at ComDeC test lab (Würzburger Straße 121, 90766 Fürth, Germany).

StaND-aloNE CoNtRol

The VectorStep drives can be controlled in different modes:

- Stand-alone
- Direct with Modbus TCP, CANopen, EtherCAT or Profinet
- Mixed
- Through inputs

This makes the devices very flexible and suitable for a high nember of different applications.

The control modes are simultaneouslyactive inside the drive, allowing a continuous interation between them.

gENERal ChaRaCtERIstICs

The SMD2204 units are “intelligent” and programmable drives, able to execute complete small automations without being connected to further control devices as a PC or a PLC.

Exploiting the flexibility of the axis control, it is possible to realize complex movement and logic sequences, electronic cams, positionings in absolute or relative quota, to manage of digital and analog inputs, to drive external devices through digital or analog outputs, to interface with visualization devices such as HMI.

The SMD2204 is able to manage interrupt events and to monitor inputs and outputs, also during a positioning.

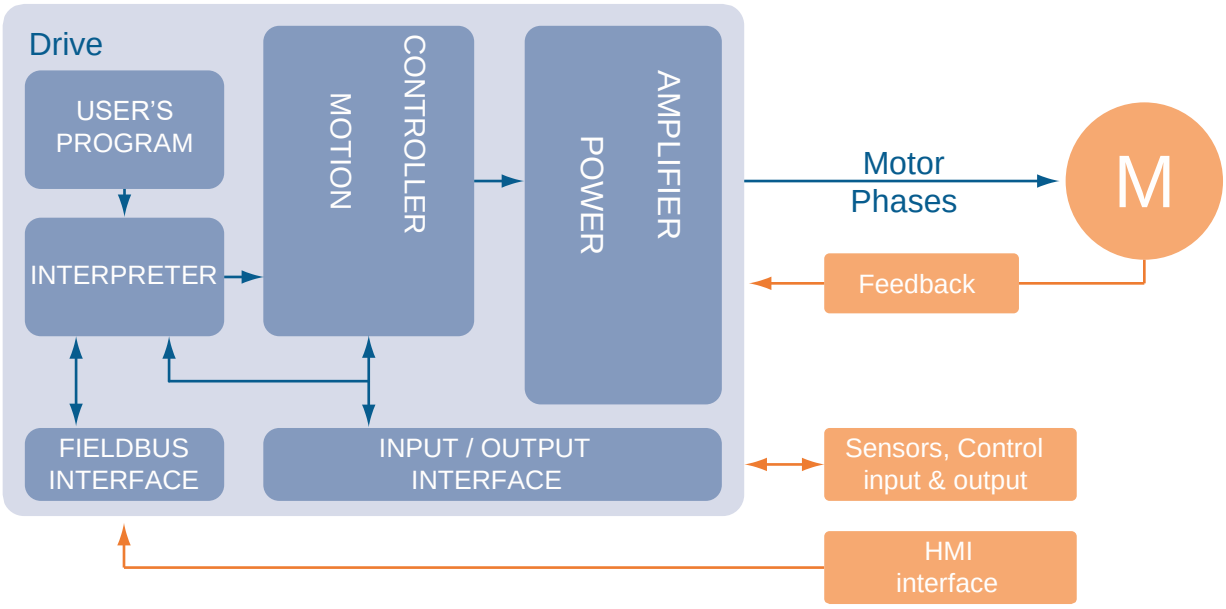
aRChItECtuRE

The control chain of the VectorStep drives is composed in levels, in order to guarantee the maximum efficiency and safety in the management of movements and control signals of the motor.

The “thinking head” of the system is the motion controller, which has the task to collect the commands and the information from the “external world” and to elaborate and convert them in signals to be sent to the power stage.

The information elaborated by the motion controller may result from multiple channels:

- digital and/or analog inputs/outputs interface;



- user program;
- fieldbus interface;

The commands sent from the user program or from the fieldbus, before being sent to the motion controller, are translated (interpreted) from the interpreter so that to standardize the requests.

SuppoRtED fuNCtIoNs

The SMD2204 is equipped with a programmable axis control, which supports multiple function modes, listed below:

Function	Description
Autorun	Define which operations must be automatically executed by the drive at start-up. Permit to load the parameters and to start automatically the execution of the program at the startup of the drive, to enable the management of the hardware and software limits and to set the default movement parameters.
Positioning	Permit to execute positionings in absolute or relative quota with specific parameters. The movement commands can be queued or over-imposed in order to change the target “on the fly”. The over-imposed movement commands also permit to change the acceleration and deceleration parameters druing the movement.
Jog	Permit to execute movement in velocity without target quota. It is possible to update the speed and acceleration/deceleration parameters without stopping the motor.
Stop	Permit to stop the motor in ramp or in emergency ramp. The STOP can be given with a direct command (fieldbus or user program), received from digital inputs or generated by an event (defined via program).
Homing	Permit to sychronize the linear or rotative axis on a zero point by using automatic search sequences.
Electronic cam	Permit to execute movement profiles, more or less complex, in synchronism with a master encoder.
Setup	Permit to modify the current levels, the step resolution and to enable or disable the drive during the execution of the user program.
Interrupt	Permit to manage in asynchronous way the inputs, the limits, and events such as alarms, warnings or custom events, also during a positioning. The interrupt management can be activated on the rising edge, on the falling edge or on both edges. VectorStep drives can manage up to 10 interrupts simultaneously.
Inputs management	Permit to verify the state of the digital or service (BLS, FLS) inputs of the drive. It is also possible to interrupt the execution of the program, waiting an input or a input sequence, as well as to verify the state of the registers memory latch. At each digital input, it is possible to pre-assign some specific functions such as “go to quota”, “axis homing”, “move forward”, “alarms reset”, “enable drive” ecc.
Outputs management	Permit to set, reset, invert or test the state of the digital outputs of the drive. As for the inputs, it is possible to pre-assign some specific functions such as “drive in alarm”, “drive in movement” ecc.
Calculations	Permit to perform mathematical or logical operations on internal data, registers and variables.
Tests and jumps	Permit to verify events or conditions (both value and bit) and change the working flux in relation to the tests results.
Timer	Permit to insert delays or time-out cycles to synchronize movements or logical sequences.
Save	Permit to save the internal variables in the NVRAM to keep the data also with the drive switched off.

User program	It is a instructions sequence which permits the drive to perform any logial, movement or mixed sequence. It can be written directly by he final user, choosing between two programming methods: visual (simplier and more intuitive) or text-based (more complex, but more powerful and flexible).

PROGRAMMING METHODS

The drives SMD2204 support two programming methods:

- Visual
- Text-based

Visual programming

Unlike the task method, besides movement sequences, the visual programming allows to realize logical sequences, conditioned by inputs and outputs.

Thanks to the intuitive graphical interface, it becomes easy to create structured programs, which permit to manage not only the movement of the motor, but also limit switches, buttons, digital and/or analog sensors, electrovalves etc.

The visual programming provides to the user a series of macro-commands, where is sufficient to insert the requested parameters to generate a command to be sent to the drive.

Command	Description
	Positioning commands. GO (go to absolute quota), GOR (go to relative quota), JOG (move forward or backward without target quota). For each movement it is possible to define velocity, acceleration and deceleration parameters.
	Homing commands. Define the type of homing to be performed and the zero point search parameters
	Stop commands. Stop the movement or the task in progress, in ramp or in emergency ramp. It is possible to indicate if the stop must be executed immediately or condition it to the occurrence of an event.
	Gearing commands. Enable and configure the management of an electronic cam.
	Setup commands. Enable or disable the drive, set the current level, the step resolution of the motor, and define th automatic current reduction parameters.
	Interrupt commands. Enable the interrupt management on the rising or falling edge of inputs or events, manages the return from an interrupt routine and the re-enabling of the same.
	Data management. Permit to copy or shift data between variables and/or registers, reset or invert the state of the bit of any parameter, or define the pointer variables.
	Calculation commands. Permit to perform mathematica operations (additions, subtractions, multiplications and divisions) or logical (AND, OR, XOR, NOT) between different types of data (variables, registers, direct values).
	Input commands. Test or wait the state of digital and service inputs (limit switches, encoder etc.) of the drive. In addition, permit to verify the state of inputs memory registers.

	Output commands. Set, reset, invert or test the state of a digital output.
	Test commands. Compare two values (variables, register or direct values), or verify the state of the bit of the indicated parameter.
	Jump commands. Inserted after a test instruction, permit to modify the execution flow of the user program basing on the test result. Also permit to call sub-routines or return from sub-routines.

Command	Description
	Timer commands. Stop the execution of the program for the indicated time.
	Save commands. Save in the NVRAM the indicated variable.
	Custom commands. Permit to write in Text-based mode a customized command, in case of particular needs.

TexT-Based programming

Text-base mode is a low-level programming method, wich permits to exploit the 100% opf the VectorStep drives functionalities.

The programming system is based on MIL language (Mnemonic Indexer Language), developed by AEC thanks to the experience in motion control and stepper motors management.

The instructions set includes commands for data management, calculations, save and test.

Family	Command	Description
Positioning	GO	Absolute quota positioning.
	GOR	Relative quota positioning.
	JOG	Move forward or bckward without target quota.
Homing	HOME	Axis homing
Stop	STOP	Stop the movement in ramp
	ABORT	Stop the movement in emergency ramp
	ESTOP	Stop the movement on event (value)
	BESTOP	Stop the movement on event (bit)
Gearing	CAM	Enable electronic cam
Setup	CUR_ON	Enable drive
	CUR_FULL	Set the nominal current level
	CUR_RED	Set the reduced current level
	BOOST	Set the boost current level
	CUR_OFF	Disable drive
Interrupt	ONH	Enable interrupt management on the rising edge
	ONL	Enable interrupt management on the falling edge
	RTE	Return to program from the interrupt
Data management	MOVE	Shift or copy the value of the variable or register, or assign a direct data
	BSET	Set bit
	BRES	Reset bit
	BCHG	Invert bit
	RIND	Index pointer variable
Calculation	ADD	Add two values (register, variable, direct data)
	SUB	Subtract two values (register, variable, direct data)
	MUL	Multiplies two values (register, variable, direct data)
	DIV	Divide two values (register, variable, direct data)
	AND	Logical AND between two values (register, variable, direct data)
	OR	Logical OR between two values (register, variable, direct data)
	XOR	Logical XOR between two values (register, variable, direct data)
	NOT	Logical NOT of a variable (registrer, variable)
	INC	Increase variable or register
	DEC	Decrease variable or register
Inputs management	BTEST	Test the value of a bit
	BWAIT	Stop the program until the value of a bit meets the condition
	BTEST	Test the value of a bit

Outputs management	BSET	Set bit
	BRES	Reset bit
	BCHG	Invert bit
Test	TEST	Compare two values (register, variable, direct data)
	BTEST	Test the value of a bit

Family	Command	Description
Jump	JMP	Conditioned or unconditioned jump to a program label
	JSR	Conditioned or unconditioned call to a subroutine
	RTS	Return to program from a sub-routine
Timer	TIMER	Stop the execution of a program for the indicated time
Save	VSAVE	Save in NVRAM the indicated variable

StaRt-Up CoNfIguRatIoN

One of the main issues of stand-alone devices is to define their behaviour at start-up, determine if the user program must be run automatically at the start-up, load the minimum needed parameters to let the drive work without parameterizing it via PC, and define the enabling staus of the drive at start-up.
The configuration of these last parameters (enabling and configuration) could be superfluous in case the drive contains a user program, but the are fundamental in case of task programming and macro-functions associated to inputs. In this last case, in fact, movement and homing parameters, and the associated functions, would result not initialized, and the drive would not perform any command.
The SMD2204 integrates a set of registers which contains the start-up settings to let the drive auto-configure at the start-up.
Below are the registers:

<table>
<tr><th>Registro</th><th>Name</th><th>Description</th></tr>
<tr><td>Rstrconf</td><td>Configuration at start-up</td><td>Define the configuration mode at start-up
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>No configuration</td></tr>
<tr><td>0x01</td><td>Reserved</td></tr>
<tr><td>0x02</td><td>Stepper-mode speed</td></tr>
<tr><td>0x03</td><td>Stepper-mode position</td></tr>
<tr><td>0x04</td><td>Stepper-mode Step/Dir</td></tr>
<tr><td>0x05</td><td>Servo-mode torque</td></tr>
<tr><td>0x06</td><td>Servo-mode speed</td></tr>
<tr><td>0x07</td><td>Servo-mode position</td></tr>
<tr><td>0x08</td><td>Servo-mode Step/Dir</td></tr>
<tr><td>0x09</td><td>Closed Loop / Speed (with tachometric – Only DMD)</td></tr>
<tr><td>0x10</td><td>Reserved</td></tr>
<tr><td>0x11</td><td>Smart Mode / Speed</td></tr>
<tr><td>0x12</td><td>Smart Mode / Position</td></tr>
<tr><td>0x13</td><td>Smart Loop / Step-Direction</td></tr>
</table></td></tr>
<tr><td>Rstrtmode</td><td>Operation mode at start-up</td><td>Operations to be executed at start-up
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Load the registers from NVRAM</td></tr>
<tr><td>0x01</td><td>Load the registers and set the operation mode</td></tr>
<tr><td>0x02</td><td>Load the registers, set the operation mode and enable the drive</td></tr>
<tr><td>0x03</td><td>Load the registers, set the operation mode, enable the drive and run the program</td></tr>
</table></td></tr>
<tr><td>Rstrpostarg</td><td>Default target position</td><td>Set the target position at start-up (pulse)</td></tr>
<tr><td>Rsrtvel</td><td>Default translation speed</td><td>Set the translation speed at start-up (rps x100)</td></tr>
<tr><td>Rstrtvss</td><td>Default start/stop speed</td><td>Set the start/stop speed at start-up (rps x100)</td></tr>
<tr><td>Rstrtacc</td><td>Default acceleration</td><td>Set the default acceleration ramp (rps^2 x10)</td></tr>
<tr><td>Rstrtdec</td><td>Default deceleration</td><td>Set the default deceleration ramp (rps^2 x10)</td></tr>
<tr><td>Rstrthacc</td><td>Acceleration during homing</td><td>Set the acceleration/deceleration ramp during home (rps^2 x10)</td></tr>
</table>

<table>
<tr><td>Rstrthmode</td><td>Default homing mode</td><td>Set the homing mode at start-up
<table>
<tr><th>Value</th><th>Descripion</th></tr>
<tr><td>0</td><td>No homing function requested</td></tr>
<tr><td>-1</td><td>Homing only with BLS in negative direction</td></tr>
<tr><td>-2</td><td>Homing only with BLS in positive direction</td></tr>
<tr><td>-3</td><td>Homing with BLS + TOP rising edge, negative direction</td></tr>
<tr><td>-4</td><td>Homing with BLS + TOP rising edge, positive direction</td></tr>
<tr><td>-5</td><td>Homing only with TOP in negative direction</td></tr>
<tr><td>-6</td><td>Homing only with TOP in positive direction</td></tr>
<tr><td>-7</td><td>Homing with backward mechanical limit + axis measure</td></tr>
<tr><td>-8</td><td>Homing with forward mechanical limit + axis measure</td></tr>
<tr><td>-9</td><td>Homing with backward mechanical limit</td></tr>
<tr><td>-10</td><td>Homing with forward mechanical limit</td></tr>
<tr><td>-11</td><td>Homing with backward mechanical limit + encoder TOP (only SmartMode and Closed Loop)</td></tr>
<tr><td>-12</td><td>Homing with forward mechanical limit + encoder TOP (only SmartMode and Closed Loop)</td></tr>
<tr><td>-13</td><td>Homing on FLS, negative direction</td></tr>
<tr><td>-14</td><td>Homing on FLS, positive direction</td></tr>
<tr><td>-15</td><td>Homing on FLS + motor encoder TOP, negative direction</td></tr>
<tr><td>-16</td><td>Homing on FLS + motor encoder TOP, positive direction</td></tr>
</table></td></tr>
<tr><td>Rstrthvh</td><td>Speed during limit switch search</td><td>Set the homing speed during the limit switch search (rps x100)</td></tr>
<tr><td>Rhvl</td><td>Speed during 0 point search</td><td>Set the homing speed during the 0 point search (rps x100)</td></tr>
</table>

DIRECt CoNtRol

The VectorStep drives can be controlled in different modes:

- Stand-alone
- Direct with Modbus TCP, CANopen, EtherCAT or Profinet
- Mixed
- Through inputs

This makes the devices very flexible and suitable for a high nember of different applications.

The control modes are simultaneouslyactive inside the drive, allowing a continuous interation between them.

gENERal ChaRaCtERIstICs

Unlike the stand-alone control, a drive controlled directly doesn't execute any operation on its own initiative (no resident program), but waits for commands from a Host computer, a PLC, a PC, or via fieldbus.

The drive SMD2204xIM supports Modbus RTU, the SMD2204xIE supports Modbus TCP/IP, the SMD2204xIC supports CANopen, SMD2204xIT supports EtherCAT and the SMD2204xIN supports Profinet.

Through the USB port, with the software StepControl, it is possible to monitor the state of the drive and the internal parameters, also when the drive is communicationg with a network.

With the available fieldbus it is possible to access to all the resources of the device:

- Drive parameters;
- Motor parameters;
- Encoder parameters;
- Movement management Controlword or advanced functions;
- Communication parameters;
- Start-up parameters;
- Registers;
- Variables;
- Tasks management;
- NVRam management.

With this type of control it is possible to avoid the parameterization via StepControl, by sending the configuration data via communication bus.

aRChItECtuRE

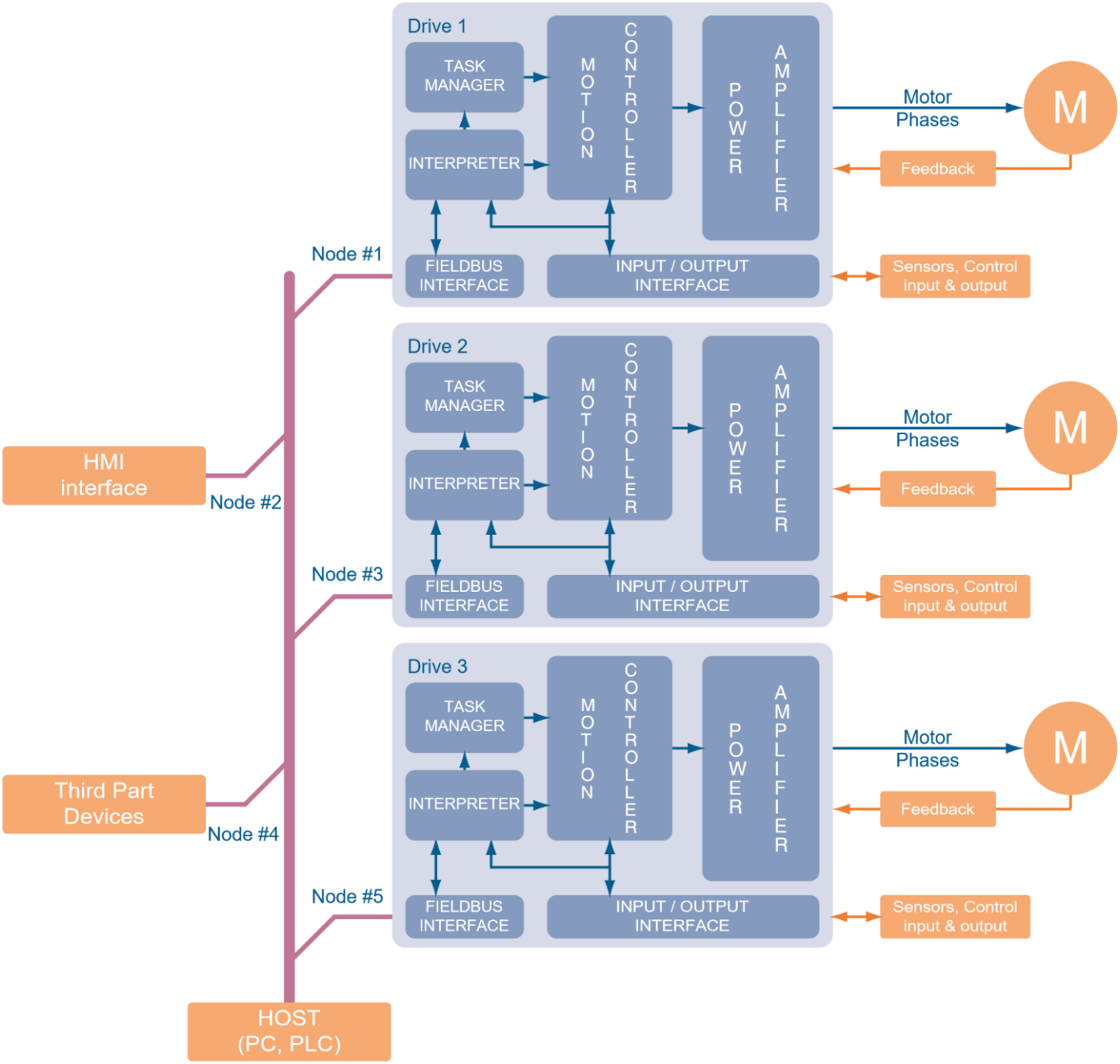
The control chain of the VectorStep drives is composed in levels, in order to guarantee the maximum efficiency and safety in the management of movements and control signals of the motor.

The “thinking head” of the system is the motion controller, which has the task to collect the commands and the information from the “external world” and to elaborate and convert them in signals to be sent to the power stage.

The information elaborated by the motion controller may result from multiple channels:

- digital and/or analog inputs/outputs interface;
- fieldbus interface;

The commands sent from the user program or from the fieldbus, before being sent to the motion controller, are translated (interpreted) from the interpreter so that to standardize the requests.



CoNtRol vIa MoDBus Rtu (smD2204xIm)

Modbus is a serial communication procol created by Modicon in 1979, in order to put into communication their PLC. It in fact became an industrial standard since 1979, MODBUS permits million automation devices to communicate between each other, by using a request/response type communication, and services defined by function codes. The main reasons for such a wide utilisation of Modbus compared to other protocols are the following:

- 1. It's a royalty-free and openly published protocol
- 2. It can be implemented in few days
- 3. It moves raw bits and words without putting many restrictions

gENERal ChaRaCtERIstICs

The SMD2204xxM can receive commands or parameters via RS-485 serial communication.

The communication protocol (Modbus RTU) defines the syntax and the codification of the data sent through the physical channel.

The Modbus RTU is a hexadecimal compact data representation, to which a cyclic redundancy check (CRC) checksum field is queued.

The Modbus RTU is a binary communication method in which all the 256 values of a byte carry information. The start and the end of the frame occur by detecting pause times between a frame and another and between a character and another.

If it's detected a pause of 3.5 times the transmission time of a character in the serial line, it means that the frame is ended, and it is possible to proceed with its analysis.

The response of the slave takes place after a minimum pause of 3.5 characters between the frame received and theone to be transmitted.

If it's detected a pause of 1.5 characters between a character and another, instead, the current message is discarded and the device starts receiving a new message.

In this way, all the data can be tranmitted without any conversion, maintaining a limited number of bytes for each frame,with the advantage to obtain a quicker communication.

The Modbus RTU protocol doesn't indicate a specific function profile for motion control, but only the standardization of communication commands.

SuppoRtED fuNCtIoNs

The Modbus RTU functions code supported by the VectorStep drives are:

Function Code	Name	Description
0x03	Read Holding Register	Read 'n' contiguous Modbus registers (1 register = 16bit)
0x06	Preset Single Register	Write a single Modbus register (16 bit)
0x08	Diagnostic	Provide information on the communication status
0x10	Preset Multiple Register	Write 'n' contiguous Modbus registers

Using that functions and writing in the internal registers, it is possible to modify parameters, read the state of the inputs and outputs, activate outputs, monitor other active communications (CANopen, Profibus DP, EtherCAT) if present and command movements.

aRChItECtuRE

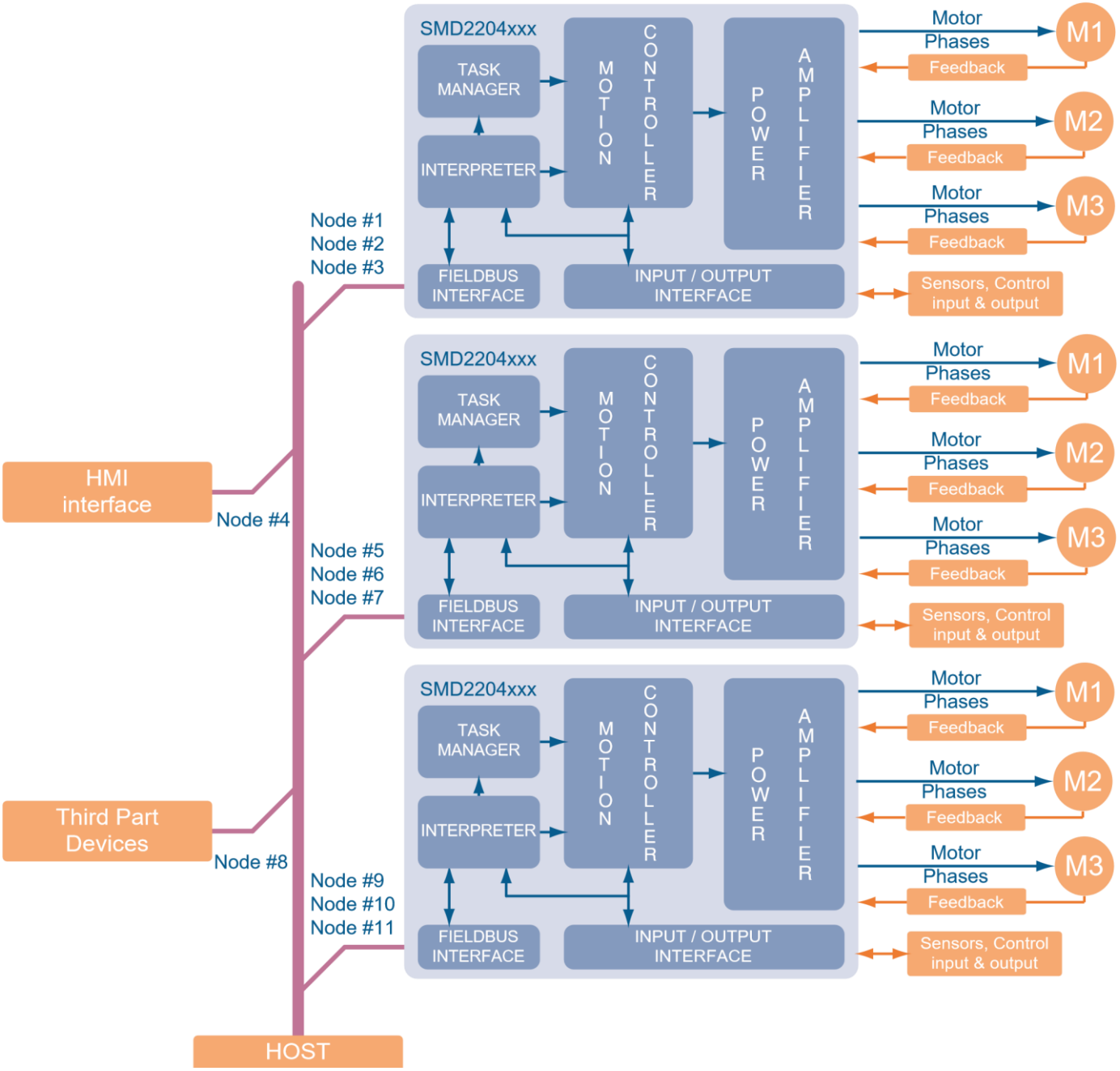
The control chain of the VectorStep drives is composed in levels, in order to guarantee the maximum efficiency and safety in the management of movements and control signals of the motor.

The “thinking head” of the system is the motion controller, which has the task to collect the commands and the information from the “external world” and to elaborate and convert them in signals to be sent to the power stage.

The information elaborated by the motion controller may result from multiple channels:

- digital and/or analog inputs/outputs interface;
- fieldbus interface;

The commands sent via Modbus RTU, before being sent to the motion controller, are translated (interpreted) from the interpreter so that to standardize the requests.



The SMD2204xxM is able to communicate with a baudrate between 1200 and 115200 bps.

Ina ddition to the communication speed it is possible to configurate the number of stop bits, the parity and the type of access to multiple registers.

<table>
<tr><th>Register</th><th>Nome</th><th>Description</th></tr>
<tr><td>Rserbaud</td><td>Serial Baudrate</td><td>Set the serial communication speed:
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>1200 bps</td></tr>
<tr><td>0x01</td><td>2400 bps</td></tr>
<tr><td>0x02</td><td>4800 bps</td></tr>
<tr><td>0x03</td><td>9600 bps</td></tr>
<tr><td>0x04</td><td>19200 bps</td></tr>
<tr><td>0x05</td><td>38400 bps</td></tr>
<tr><td>0x06</td><td>57600 bps</td></tr>
<tr><td>0x07</td><td>115200 bps</td></tr>
</table></td></tr>
<tr><td>Rserpar</td><td>Serial parameters</td><td>Set the communication parameters (parity and bit stop number):
<table>
<tr><th rowspan="2">Value</th><th colspan="2">Description</th></tr>
<tr><th>Parity</th><th>Stop bit</th></tr>
<tr><td>0x00</td><td>None</td><td>1</td></tr>
<tr><td>0x01</td><td>Even</td><td>1</td></tr>
<tr><td>0x02</td><td>Odd</td><td>1</td></tr>
<tr><td>0x03</td><td>None</td><td>2</td></tr>
<tr><td>0x04</td><td>Even</td><td>2</td></tr>
<tr><td>0x05</td><td>Odd</td><td>2</td></tr>
</table></td></tr>
<tr><td>Rserdly</td><td>Serial reply delay</td><td>Set the drive response delay to a request in ms. (Used when communicating with autpo-switch converters)</td></tr>
</table>

<table>
<tr>
<td>Rintmot</td>
<td>Multiple access data format</td>
<td>Define the access method to multiple registers (32bit) via Modbus:
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Little Endian (INTEL)
When accessing a 32 bit data (2 holding registers) the least significant bit (LSB) is transferred before the most significant bit (MSB).
Host → LSB MSB → SMD2204xx</td></tr>
<tr><td>0x01</td><td>Big Endian (MOTOROLA)
When accessing a 32 bit data (2 holding registers) the most significant bit (MSB) is transferred before the least significant bit (LSB).
Host → MSB LSB → SMD2204xx</td></tr>
</table>
</td>
</tr>
</table>

A RS-485 Modbus RTU network normally supports up to 32 nodes (in case of standard transceiver), and up to 128 nodes if low consumption interfaces are used.

The VectorStep drives use a low consumption RS-485 transceiver, so, in case the master supports it, they can be inserted into networks with a high number of nodes.

In a RS-485 network, each node must have a unique address which identifies it.

The communication address is set with StepControl, in the section " Communication parameters", or through the register Rseraddr.

Inside a Modbus RTU network, the multi-axis drive SMD2204xIM is seen as three single independent drives.With StepControl, it is necessary to set the drive of the axis 1. The axes 2 and 3 will automatically take the next two addresses.
Example:
Axis 1 = Node ID 4 (set with StepControl)
Axis 2 = Node ID 5
Axis 3 = Node ID 6

CoNtRol vIa MoDBus tCp/Ip (SMD2204xIE)

g ENERal ChaRaCtERIstICs

The drive SMD2204 LIE with Modbus TCP/IP fieldbus is equipped with a standard Ethernet 100Mb interface.

What is Modbus TCP/IP?

Modbus TCP/IP (or Modbus-TCP) is a version of Modbus RTU protocol, equipped with a TCP interface that runs on Ethernet.

The Modbus messaging structure is the application protocol that defines the rules for organizing and interpreting the data independently of the data transmission medium.

TCP/IP refers to the Transmission Control Protocol and Internet Protocol, which provides the transmission medium for Modbus TCP/IP messaging.

In simple terms, the TCP/IP standard allows blocks of binary data to be exchanged between computers. It is also a world-wide standard that serves as the foundation for the World Wide Web.

The primary function of TCP is to ensure that all packets of data are received correctly, while IP makes sure that messages are correctly addressed and routed.

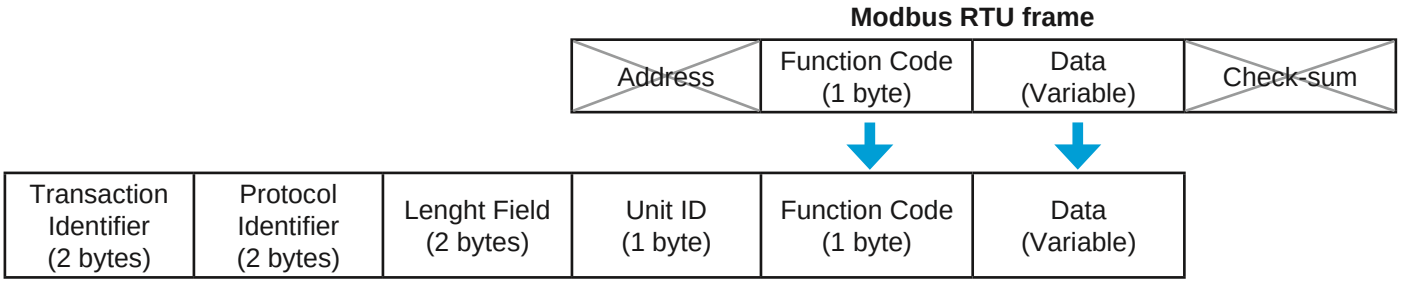
It's important to note that the TCP/IP combination is merely a transport protocol, and does not define what the data means or how the data is to be interpreted (this is the job of the application protocol, Modbus in this case).

So in summary, Modbus TCP/IP uses TCP/IP and Ethernet to carry the data of the Modbus message structure between compatible devices.

Modbus TCP/IP combines a physical network (Ethernet), with a networking standard (TCP/IP), and a standard method of representing data (Modbus as the application protocol).

Essentially, the Modbus TCP/IP message is simply a Modbus communication encapsulated in an Ethernet TCP/IP wrapper.

Modbus TCP embeds a standard Modbus data frame into a TCP frame, without the Modbus check-sum, as shown in the following diagram:



The Modbus commands and user data are themselves encapsulated into the data container of a TCP/IP telegram without being modified in any way.
However, the Modbus error checking field (check-sum) is not used, as the standard Ethernet TCP/IP link layer checksum methods are instead used to guaranty data integrity.
Further, the Modbus frame address field is supplanted by the unit identifier in Modbus TCP/IP, and becomes part of the Modbus Application Protocol header.

Which TCP port is used by Modbus TCP/IP?

The complete Modbus TCP/IP Application Data Unit is embedded into the data field of a standard TCP frame and sent via TCP to well-known system port 502, which is specifically reserved for Modbus applications. Modbus TCP/IP clients and servers listen and receive Modbus data via port 502.

ARCHITECTURE

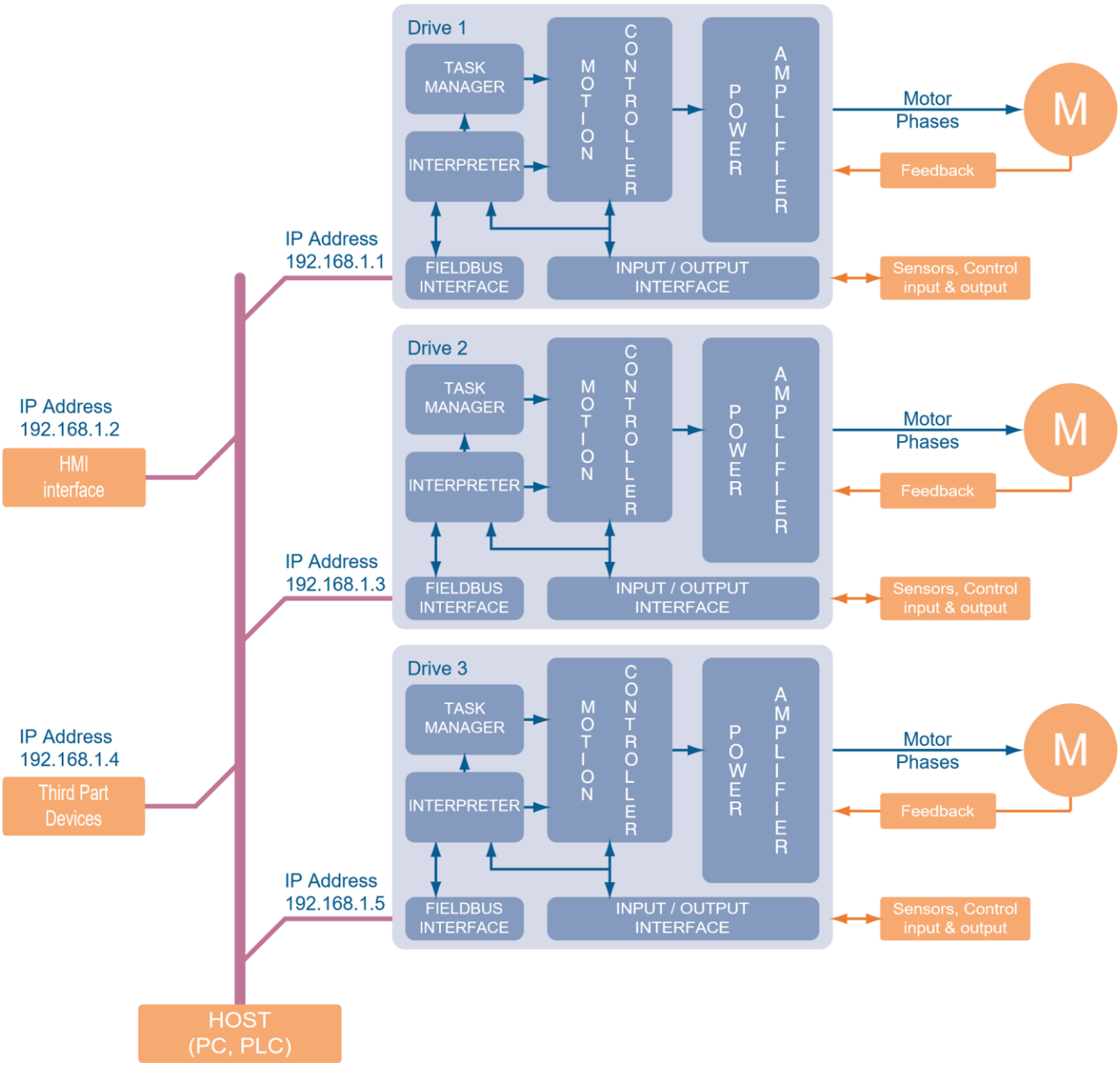
The control chain of the VectorStep drives is composed in levels, in order to guarantee the maximum efficiency and safety in the management of movements and control signals of the motor.

The “thinking head” of the system is the motion controller, which has the task to collect the commands and the information from the “external world” and to elaborate and convert them in signals to be sent to the power stage.

The information elaborated by the motion controller may result from multiple channels:

- digital and/or analog inputs/outputs interface;
- fieldbus interface;

The commands sent via Modbus TCP/IP, before being sent to the motion controller, are translated (interpreted) from the interpreter so that to standardize the requests.



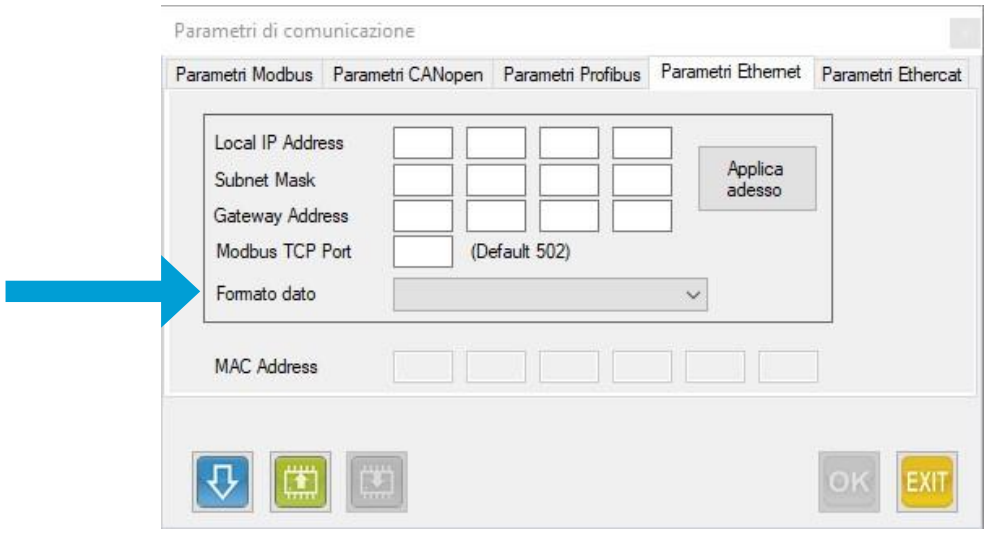
CommuNICatIoN paRamEtERs

The SMD2204xIE supports The modbus communication both with TCP and UPD protocol.

<table>
<tr><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td>Rmdbport</td><td>TCP port number</td><td>TCP port number (default is 502)</td></tr>
<tr><td>Rintmot</td><td>Multiple access data format</td><td>Define the access method to multiple registers (32bit) via Modbus:
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Little Endian (INTEL)
When accessing a 32 bit data (2 holding registers) the least significant data (LSB) is transferred before the most significant data (MSB).
Host → [ ] → SMD2204xx</td></tr>
<tr><td>0x01</td><td>Big Endian (MOTOROLA)
When accessing a 32 bit data (2 holding registers) the most significant data (MSB) is transferred before the least significant data (LSB)
Host → [ ] → SMD2204xx</td></tr>
</table></td></tr>
<tr><td>Rethlocipaddr32</td><td>Ethernet local IP address</td><td>Byte 3 - Byte 2
Ethernet local IP address</td></tr>
<tr><td>Rethlocipaddr10</td><td>Ethernet local IP address</td><td>Byte 1 - Byte 0
Ethernet local IP address</td></tr>
<tr><td>Rethgwaddr32</td><td>Gateway address ethernet</td><td>Byte 3 - Byte 2
Gateway address ethernet</td></tr>
<tr><td>Rethgwaddr10</td><td>Gateway address ethernet</td><td>Byte 1 – Byte 0
Gateway address ethernet</td></tr>
<tr><td>Rethsubnet32</td><td>Subnet ethernet</td><td>Byte 3 - Byte 2
Subnet ethernet</td></tr>
<tr><td>Rethsubnet10</td><td>Subnet ethernet</td><td>Byte 1 - Byte 0
Subnet ethernet</td></tr>
</table>

Ip aDDREss sEttINg

To set the IP address, you have to connect the PC to the drive using a USB cable and StepControl software.
Once in the StepControl environment, go to “Parameters” menu and select “Communication Parameters”.
In the tab “Ethernet Parameters” (see the picture below), it is possible to set the Modbus TCP. parameters.
The “Data format” indicates the 32 bit read/write mode.



It is possbile to choose between “Intel (Little Endian)” 32 bit mode (first read/write the lowest 16 bit word then the highest 16 bit word) or (Motorola (Big Endian)” 32 bit mode (first read/write the highest 16 bit word then the lowest 16 bit word).

After that, go to “Ethernet parameters” tab and set the local IP address, local sub-net mask, and the gateway IP address (not important).

Once all the requested data have been typed, press “Send data” (the blue down arrow button) to send the data to the drive. If the data must be stored in the non volatile memory, click on “Save data” (the green down arrow button).

If you want to apply the network address without switching off the drive, you can press “Apply now” and the network address change immediately.

Please note that the parameter “Data format” is updated only by switching off and restarting the drive.

The multi-axis drive SMD2204xIE have a unique IP address inside a Modbus TCP/IP network. In order to send a data to the single axis, set the “Unit ID” in the Master controller (1 for axis 1, 2 for axis 2, 3 for axis 3). In order to send the same data to all the three axes, send the data to the “Unit ID” 0.

CoNtRol vIa CaNopEN (SMD2204xIC)

CAN (Controller Area Network) fieldbus had been originally developped for the automotive market, with the aim of reducing the complexity of the connections needed to put into communication the various electronic devices present in a normal car (ABS, Airbag, SRS etc).

Thanks to its characteristics, like easy wiring and reliability, it was increasigly used in the industrial sector to control complex machineries with distributed intelligence.

Besides the DS301, the devices defined as CANopen compatible must have a further particularization, depending on the segment of devices to which they belong, in order to conform the front-end of the communication on the fieldbus side.

gENERal ChaRaCtERIstICs

The drives SMD2204xIC can receive commands and parameters via CAN bus communication network.

CAN bus defines the connections standards, the signals levels and the physical characteristics of the communication channel.

The communication protocol (CANopen) defines the syntax and the coding of the data sent via physical channel.

With the purposes to standardize the interfacement mode between the various devices, and to make simple the use of CAN fieldbus to the user, an organization named Cia has been established. The Cia (Can in automation, website www.can-cia.de) is responsible for the definition of the communication standards. Among several standards, the standard communication protocol named CANopen has been defined.This standard is explained in the Draft Standard DS301 for what it concerns the part common to all the devices that belong to CANopen world.

Besides the DS301, the devices defined as CANopen compatible must have a further particularization, depending on the segment of devices to which they belong, in order to conform the front-end of the communication on the fieldbus side.

These specializations are called “Device Profile”, and they are defined in the DS4xx drafts.

As an example, DS401 for I/O modules, DS402 for motion control devices (drives), etc.

Moreover, a CANopen compatible device must comly with the defined type of connectors and their pinouts.

All this gives a significant advantage to the end user, that can switch between a type of drive to another, being sure that nothing will change for what concerns the CAN communication.

SuppoRtED fuNCtIoNs

NMT	Slave
Error Control	Node Guarding, Life Guarding, Heartbeat
Node ID	Software
Nr. of PDOs	4 Rx - 4 Tx
PDO modes	Event triggered, Sync (cyclic), Sync (acyclic)
PDO linking	No
PDO mapping	Variable (granularity 8bit)
Nr. of SDOs	1 Server, 0 Client
Emergency Message	Yes
CANopen Version	DS301 V4.01
Framework	No
Device Profile	DSP-402 V1.1
AEC's Vendor ID	00 00 00 BC

SuppoRtED opERatIoN moDEs

The VectorStep drives support the following operation modes:

Value	Type	Description
-1	AEC_Velocity	Permit to move the axis in velocity (JOG) by setting direction, velocity and accelration and deceleration ramps.
1	Profile Position mode	Permit to perform positionings in absolute or relative quota, by setting direction, velocity, acceleration/deceleration ramps and target quota.
6	Homing mode	Used for the search of the zero point of the axis.
7	Interpolated mode	Permit to perform interpolated movements.

aRChItECtuRE

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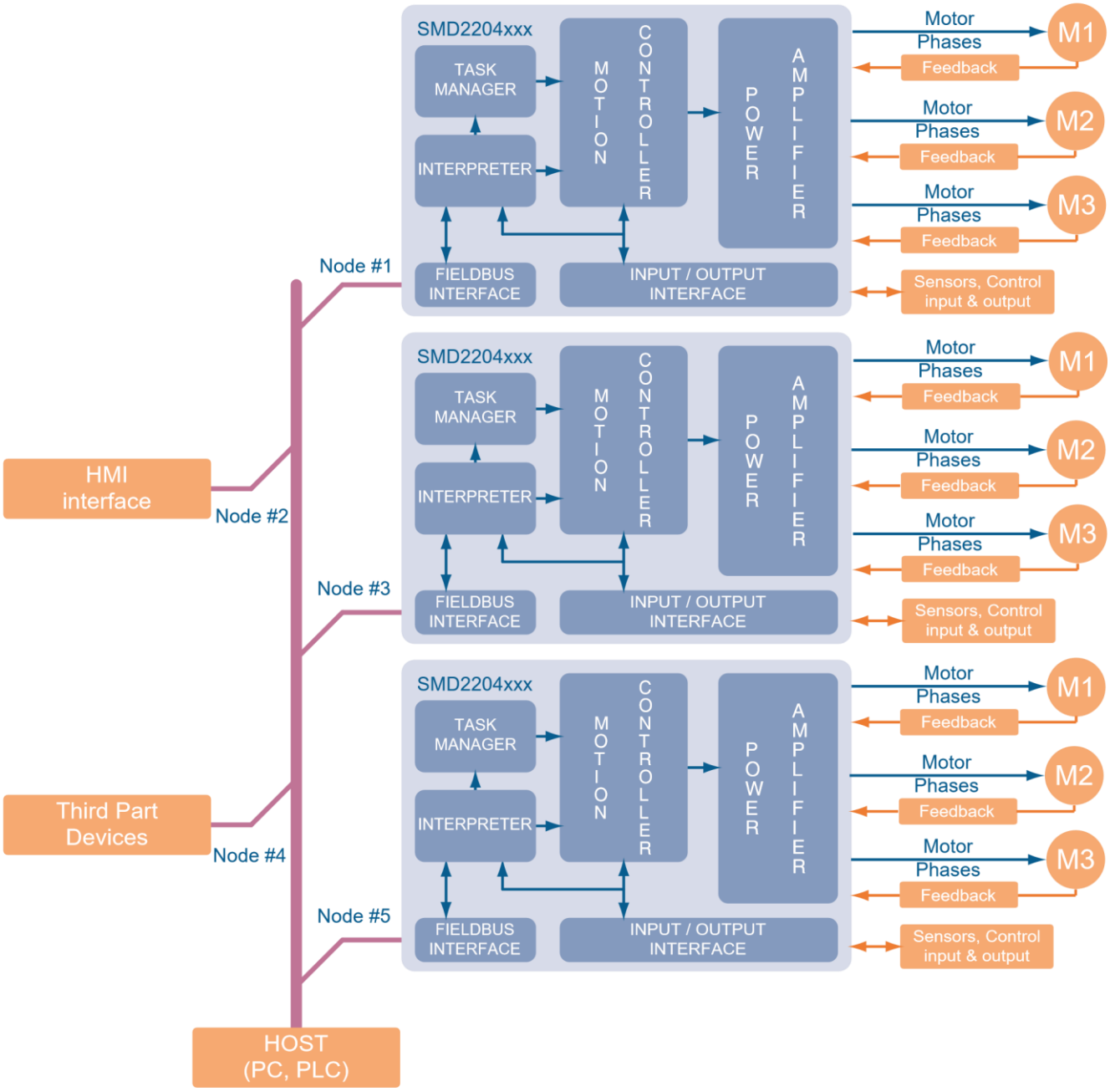
The commands sent from the CANopen network, before being sent to the motion controller, are translated (interpreted) from the interpreter so that to standardize the requests.


SMD2204xxx
TASK MANAGER
INTERPRETER
MOTION CONTROLLER
POWER AMPLIFIER
FIELDBUS INTERFACE
INPUT / OUTPUT INTERFACE
Motor Phases
Feedback
M1
M2
M3
Sensors, Control input & output
Node #1
Node #2
Node #3
Node #4
Node #5
HMI interface
Third Part Devices
HOST (PC, PLC)

CommuNICatIoN spEED

The SMD2204xIC is able to communicate with a baudrate between 10Kbps and 1000 Kbps. aDDREssINg

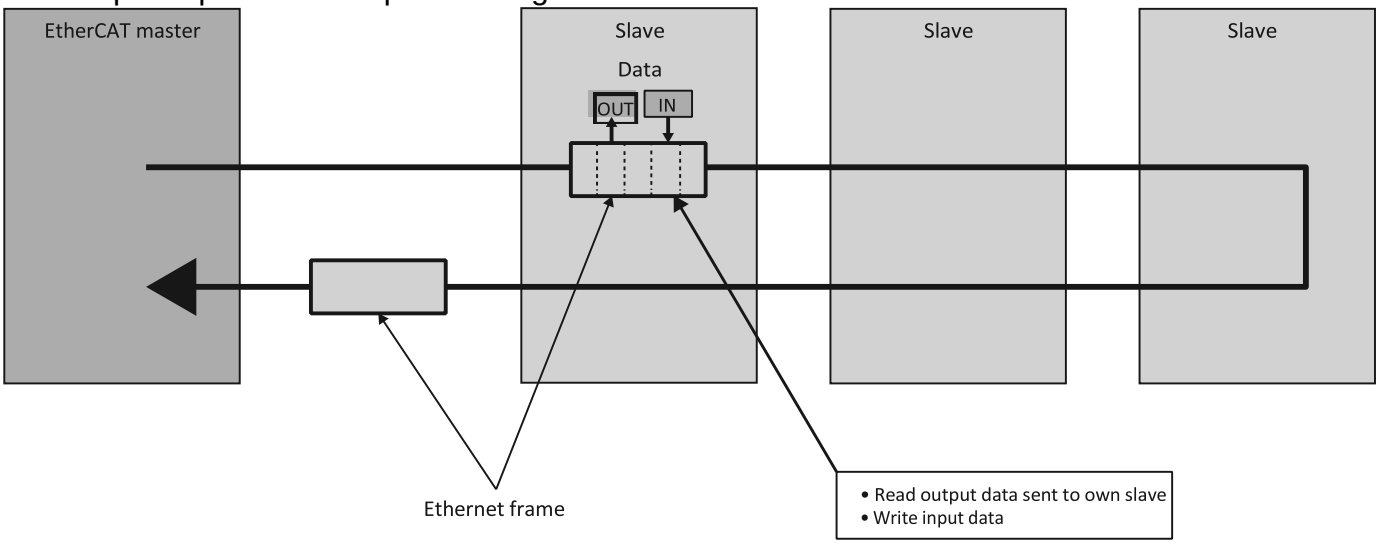
A CANopen network can support up to 127 nodes; each node must have a unique and valid address in the range 1-127 (Node ID). The address 0 is reserved for the broadcast messages.

The address of the node can be configured with the software StepControl, by setting the register Rcanaddr.

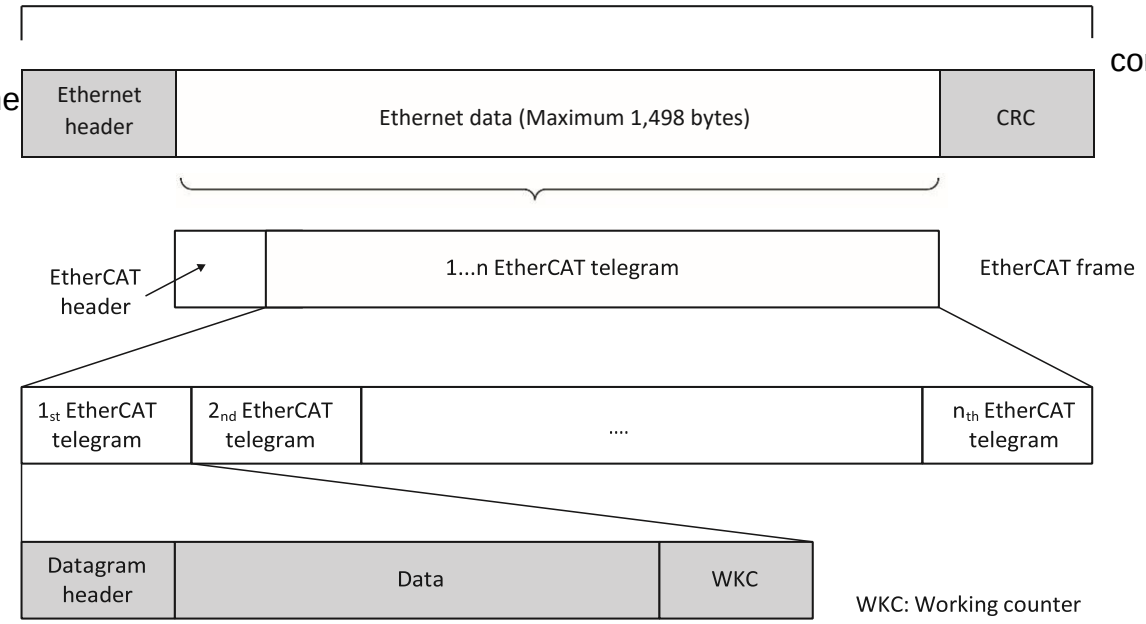
CoNtRol vIa EthERCat (smD2204xIt)

gENERal ChaRaCtERIstICs

EtherCAT (Ethernet Control Automation Technology) is a real-time industrial network system based on the Ethernet system, that can achieve faster and more efficient communications. Despite being a unique communication protocol, it uses the standard frames and the physical layers from the Ethernet standard IEEE 802.3.
Each node achieves a short cycle time by transmitting Ethernet frames at high speed.
Each bus participant only takes the data which are intended for it, while the telegram which is sent by the bus master passes through it. Output data is inserted into the telegram in the same way. At the same time, the telegram is forwarded with a slight delay (a few nanoseconds). The bus participant recognises the commands which are intended for it and executes these. The last bus participant returns the completely processed telegram, so that it can be sent to the controller by the first bus participant as a response telegram.



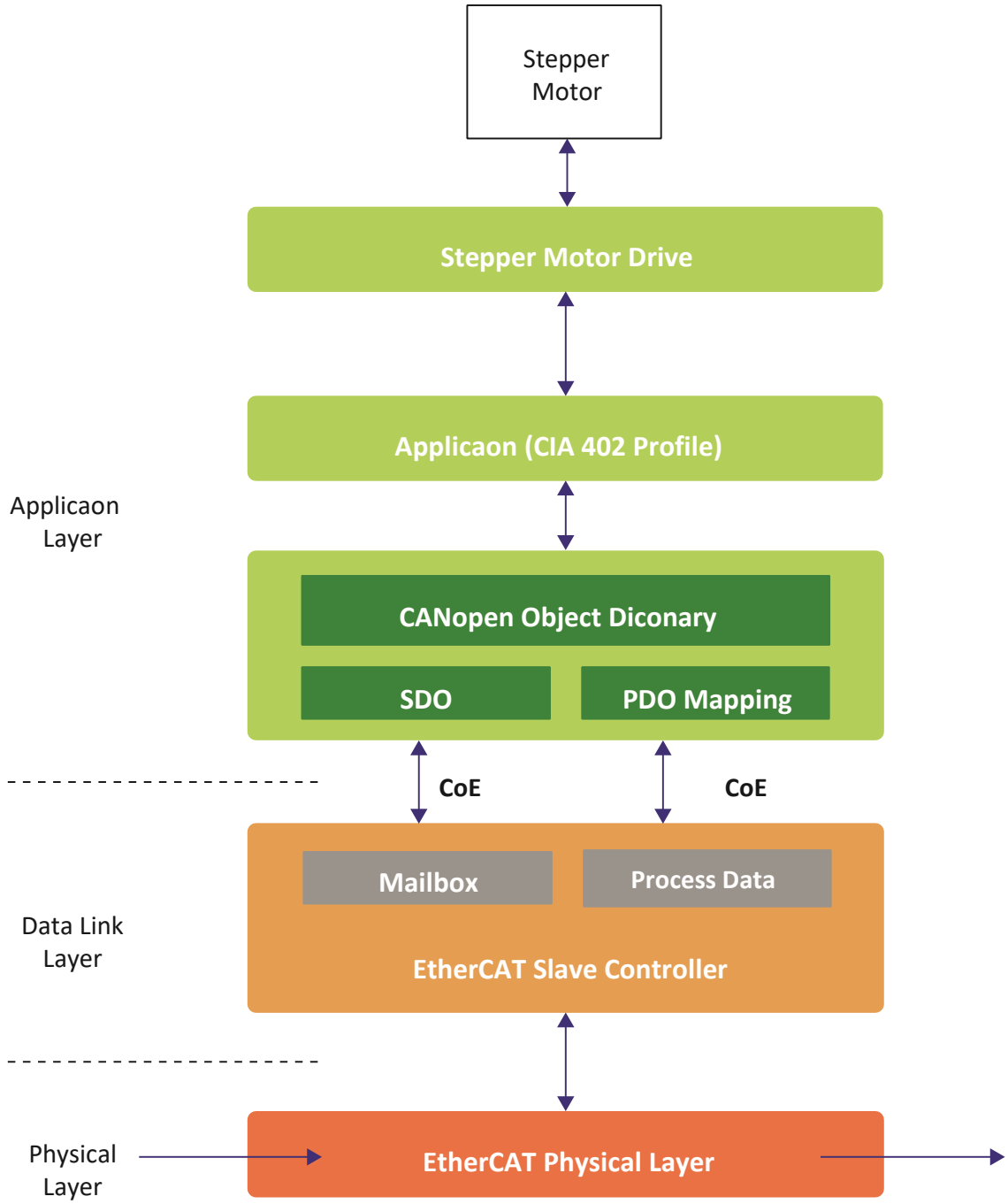
The EtherCAT protocol transports data directly within a standard Ethernet frame.
Data is communicated between master and slaves in the form of process data objects (PDOs). Each PDO has an address to one particular slave or multiple slaves, and this “data and address” combination (plus the working counter for



validation) makes up an EtherCAT telegram. If an Ethernet frame is compared to a “train,” an EtherCAT telegram would be a “compartment.”

CaN applICatIoN pRotoCol ovER EthERCat

SMD1204xIT , SMD2204xIT and SMD5106xIT drives support CAN application protocol over EtherCAT (CoE). EtherCAT Slave structure is as below.


Stepper Motor
Stepper Motor Drive
Applicaon (CIA 402 Profile)
Applicaon Layer
CANopen Object Diconary
SDO
PDO Mapping
CoE
CoE
Mailbox
Process Data
Data Link Layer
EtherCAT Slave Controller
Physical Layer
EtherCAT Physical Layer

Object Dictionary

In CANopen and EtherCAT, the object dictionary is a special area for the storage of parameters, application data and the PDO mapping, i.e. the mapping information between process data and application data.

The object dictionary is based on the CANopen standard which has later been extended by EtherCAT.

There are two types of communication functions are available with EtherCAT: Mailbox communication and Process data communication.

Mailbox Communication (SDO Communication)

Access to the object dictionary is possible via Service Data Objects (SDO) which provide a mailboxbased access functionality.

The EtherCAT master sends a command to the slaves, and then the slaves return a response to the EtherCAT master.

This communication can be used under Pre-Operation, Safe-Operation, Operation status of controller.

Process Data Communication (PDO Communication)

This refers to a cyclic (I/O) communication.

A cyclic (I/O) communication between the master and the slaves is achieved by mapping the logical process data space (cyclic data space) to each slave node by the EtherCAT master.

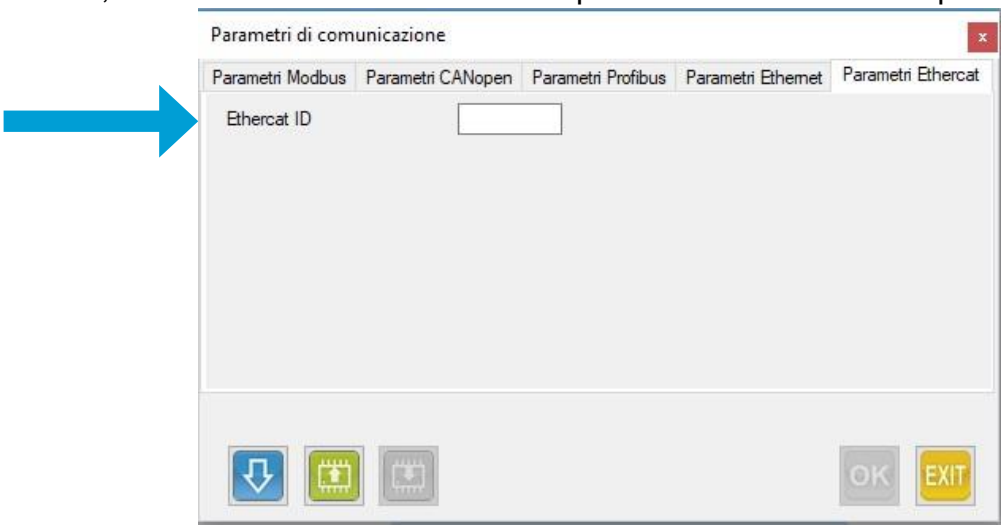
PDO communication is categorized as transmission PDO (following Tx PDO), which delivers controller status information and Receipt PDO (following Rx PDO), which delivers commands from master.

Rx PDO can be used under Operational status of controller.

Following is an example of PDO communication.

EthERCat ID sEttINg

It is possible to assign a different EtherCAT ID than the default one assigned by the master by using the register “Rethercatid” (EtherCAT address 0x2165), or with the software StepControl (from the menu bar, “Parameters” - “Communication parameters” - “EtherCAT parameters”).



N.B.: For the changes to take effect, the drive needs to be rebooted.

CoNtRol vIa pRofINEt (smD2204xIN)

o vERvIEw

The drives Profinet SMD1204xIN, SMD2204xIN e SMD5206xIN support several application profiles based on cyclic and acyclic communication services:

- PROFIdrive v.4.1 - Standard Telegram 9
- PROFIdrive v.4.1 - Base Mode Parameter Access (Acyclic Data Exchange)

CyCIIC aND aCyCIIC sERvICEs

Normally, the data exchange uses cyclic and acyclic services.
For the cyclic data, the application profiles define:

- data indipendent from the manufacturers
- specific data for the manufacturer

The fixed setting and the use of the indipendent data from the manufacturer, permit to switch between them masters of different brand.

aCyCIIC REaD/WRItE sERvICEs

The acyclic Read/Write services provide access to data or parameters which cannot be accessed with cyclic data exchange.

EIECtRoNIC fIlE DEsCRIptIoN

The drives mod. SMD1204xIN, SMD2204xIN e SMD5206xIN are described by a GSDML file, used by Profinet configuration tools to obtain information on the devices themselves
GSDML files and icon files of the AEC's drives can be downloaded from the website www.aec-smd.it
The GSDML file and the icons are compressed into a .zip file, that has to be decompressed in the same folder of the hard disk.

THE DEVICES MAY PUT THEMSELVES INTO OPERATION WITHOUT NOTICE
Do not alter in any way the GSDML file. The alteration of the GSDML file may cause unexpected behaviour of the drives.

Failure to observe this precaution may cause injuries or damages to devices.

CAUTION!!! Any alteration to the GSDML file will void the AEC guarantee with immediate effect.

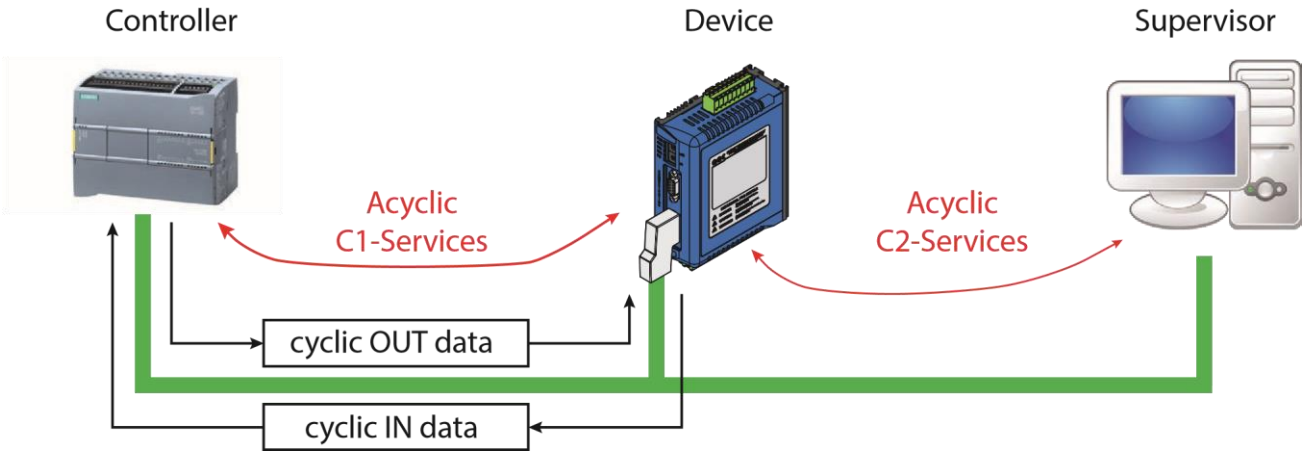
This chapter describes the functions and the procedures to use AEC's drives in Profinet.
Please refer to Profinet Nutzerorganisation e.V. or visit the website www.profibus.com for further information on acyclic communication Profinet.

Profinet introduces a new service of acyclic read/write ; these communication services are embedded into special telegrams, that are inside the normal cyclic operativity of the bus.

The acyclic service permits to exchange volumes of data greater than the ones allowed by the cyclic service. At the same time, the communication will not be overloaded, because the acyclic communication telegram is added to the bus cycle only on request.

The Acyclic communication permits many features to the user:
- the master C1 can access in read/write to all the configuration and statuts parameters: registers, variables and tasks of the slave, and not only to the data contained in the cyclic process;
- the master C2 can access in read/write to all the configuration and statuts parameters: registers, variables and tasks of the slave;
- permits the access to the I&M (Information & Maintenance) of the drive

The following scheme summarizes the features of Profinet.



Nome	Descrizione
Controller	In a Profinet network, different classes of masters can coexist. The Controller manages the cyclic exchange with the slaves. Normally is the Controller (PLC), that manages the system automation. In case that the acyclic communication functionalities are enabled through the GSDML file, the acyclic connection between the Controller and Device is automatically enabled, in conjunction with the activation of the cyclic connection. In a Profinet network it is possible to use only one Controller.
Supervisor	The Supervisor are not able to execute cyclic exchange data with the Device. Normally, the Supervisor are visualization systems (eg. HMI) or analyses systems (network analyzers, notebook, PC), used only to monitor the state of the slaves or to alter some of their parameters.
Device	Stepper drive

Configuration slot

SMD2204xIN 3 axis board, ProfiNet Slots Structure

Slot 0 (API=0)	Slot 1 (API = 0x3A00 PROFIDrive)			Slot 2 (API = 0x3A00 PROFIDrive)			Slot 3 (API = 0x3A00 PROFIDrive)		
Subslot 0	Subslot 0	Subslot 1	Subslot 2	Subslot 0	Subslot 1	Subslot 2	Subslot 0	Subslot 1	Subslot 2
		Module Access Point (MAP)	Standard Telegram x (submo-dule ID = PROFIDrive telegram number)		Module Access Point (MAP)	Standard Telegram x (submo-dule ID = PROFIDrive telegram number)		Module Access Point (MAP)	Standard Telegram x (submo-dule ID = PROFIDrive telegram number)
		Contains parameters Access Point and alarm			Contains parameters Access Point and alarm			Contains parameters Access Point and alarm	
P-Device	Drive Object 1			Drive Object 2			Drive Object 3		

SMD1204xIN
SMD5206xIN **1AxLE board, PrifiNet slots structure**

CoNtRol thRough INputs/outputs

The drives of the SMD2204 family are provided with a powerful and flexible digital/analog interface, which permits the control of the drive in a simple and intuitive way, without the necessity to build a program in the drive or to have complex control systems.

gENERal ChaRaCtERIstICs

The SMD2204xxx drives are equippeed with 8 general purpose digital inputs/outputs, 6 limit switches inputs, 3 pushpull/line-driver encoder inputs, 3 analog inputs 0/+10V at 12 bit and 1 analog output 0/+10V at 10bit.

It is possible to assign specific functions to the configurable inputs and outputs by setting few parameters.

Each input/output is associated with a configuration register, containing the assigned function.

SuppoRtED fuNCtIoNs

Below are the functions that can be associated with the inputs and outputs, divided by category:

DIGITAL INPUTS

Configuration registers		Rfuni0, Rfuni1, Rfuni2, Rfuni3, Rfuni4, Rfuni5, Rfuni6, Rfuni7
Value	**Function**	**Description**
0	None	No associated function
1	Drive enable	Eanble the output current to the motor
2	JOG CW	Move the motor forward at the speed set in the register Rvel
3	JOG CCW	Move the motor backward at the speed set in the register Rvel
4	Go to target quota	Position the motor at the absolute quota indicated in the register Rpostarg
5	Shift of the target quota	Position the motor at the relative quota indicated in the register Rpostarg
6	Homing	Start the search of the zero position
7	Bit 0 task selection	Bit 0 for the selection of the positioning sequence
8	Bit 1 task selection	Bit 1 for the selection of the positioning sequence
9	Bit 2 task selection	Bit 2 for the selection of the positioning sequence
10	Bit 3 task selection	Bit 3 for the selection of the positioning sequence
11	Bit 4 task selection	Bit 4 for the selection of the positioning sequence
12	Bit 5 task selection	Bit 5 for the selection of the positioning sequence
13	Bit 6 task selection	Bit 6 for the selection of the positioning sequence
14	Start Task	Start the configured positioning sequence
15	Alarms reset	Delete the alarms present
16	Quota alignment	Realign the actual position
17	Current reduction	Reduce the current to the motor
18	Abort	Stop the motor in ABORT
19	Stop	Stop command

20	GEAR	Enable the GEAR function
21	Direction (reverse JOG direction)	Reverse JOG direction
22	Position recovery (only with encoder)	Recover the position

DIGITAL OUTPUTS

Configuration registers		Rfuno0, Rfuno1, Rfuno2, Rfuno3, Rfuno4, Rfuno5, Rfuno6, Rfuno7
Value	**Function**	**Description**
0	None	No associated function
1	Drive enabled	Indicate if the drive is enabled
2	Alarm	Indicate the presence of an alarm
3	Synchronized axis	Indicate if the axis is homed
4	Axis in movement	Indicate if the axis is moving
5	Task in progress	Indicate if the drive is executing a positioning task
6	I2T	Indicate the occurence of an I^2T alarm
7	Motor in position	Indicate that the motor has arrived to the position
8	Motor in actual movement	Motor in actual movement (for closed loop)
9	Motor in theoric+actual movement	Motor in theoric+actual movement (for closed loop)
10	Comando per freno esterno	Comando per freno esterno
11	Signal of changed quota while the drive was disableddisabilitato	Signal of changed quota while the drive was disabled (only with encoder)
12	Signal of changed quota while the drive was disabled	Signal of changed quota while the drive was disabled (only with encoder) + motor in position (When the drive is enabled: output=0 if motor not in position or moved while the drive was disabled / =1 if motor in position and not been moved while the drive was disabled).

ANALOG INPUT

Configuration registers		Rdefanainp
Value	**Function**	**Description**
137	None	No associated function
20	ESTOP delay	Set the number of steps to perform after a stop on event
24	STOP delay	Set the number of steps to perform after a stop
63	Speed	Set the rotation speed of the motor
67	Acceleration	Set the acceleration ramp
70	Deceleration	Set the deceleration ramp
83	Homing speed	Set the homing speed
87	Homing acceleration	Set the acceleration rampo during homing
213	Current limit	Set the current limit in closed-loop mode

USCITA ANALOGICA

Configuration registers		Rdefanaout
Value	**Function**	**Description**
137	None	No associated function

20	ESTOP delay	Set the number of steps to perform after a stop on event
24	STOP delay	Set the number of steps to perform after a stop
63	Speed	Set the rotation speed of the motor
67	Acceleration	Set the acceleration ramp
70	Deceleration	Set the deceleration ramp
83	Homing speed	Set the homing speed
87	Homing acceleration	Set the acceleration rampo during homing
213	Current limit	Set the current limit in closed-loop mode

StaRt-up paRamEtERs

gENERal ChaRaCtERIstICs

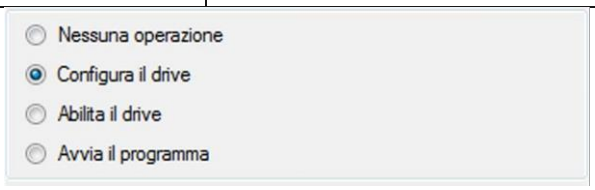
The SMD2204 are “smart” programmable drives, able to perform small stand-alone automations, without being connected to other control devices like PCs or PLCs.

For this reason, it is of utmost importance to define the behavior of the drive at the start-up.

it is possible to indicate if the drive must independently load the saved configuration, to set some default parameters and to enable hardware and software limits. aUtoRuN

The Autorun parameter defines the behavior of the drive at the start-up; it is possible to choose between three options:

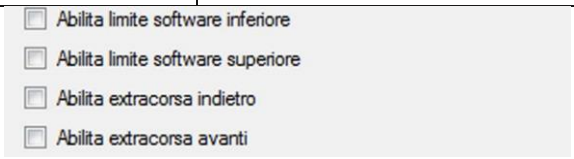
Register	Value	Function	Description
Rstrtmode	0	None	Load the default values without performing any other operation
	1	Configure the drive	Load the default values and set the operation mode
	2	Enable the drive	Load the default values,set the operation mode and enable the current output
	3	Start the program	Load the default values,set the operation mode, enable the current output and run the program



haRDwaRE aND softwaRE lImIts

Permits to enable the automatic management of the hardware limit switches and software limit quotas at the start-up.

Register	Bit	Function	Description
Rflag	2	Lower Limit	Enable the management of the lower software limit
	3	Upper Limit	Enable the management of the upper software limit
	4	Backward Limit Switch	Enable the management of the backward limit switch
	5	Forward Limit Switch	Enable the management of the forward limit switch



The intervention quotas of the software limits are defined by the registers Rupplim and Rlowlim.

In case of intervention of a limit switch, either software or hardware, the SMD2204 interrupts the movement in progress, sending an ABORT command, and disable any movement toward the direction of the intervened limit switch.

the re-enabling of the movement toward the direction of the intervened limit switch will automatically occur at the first movement in the opposite direction.

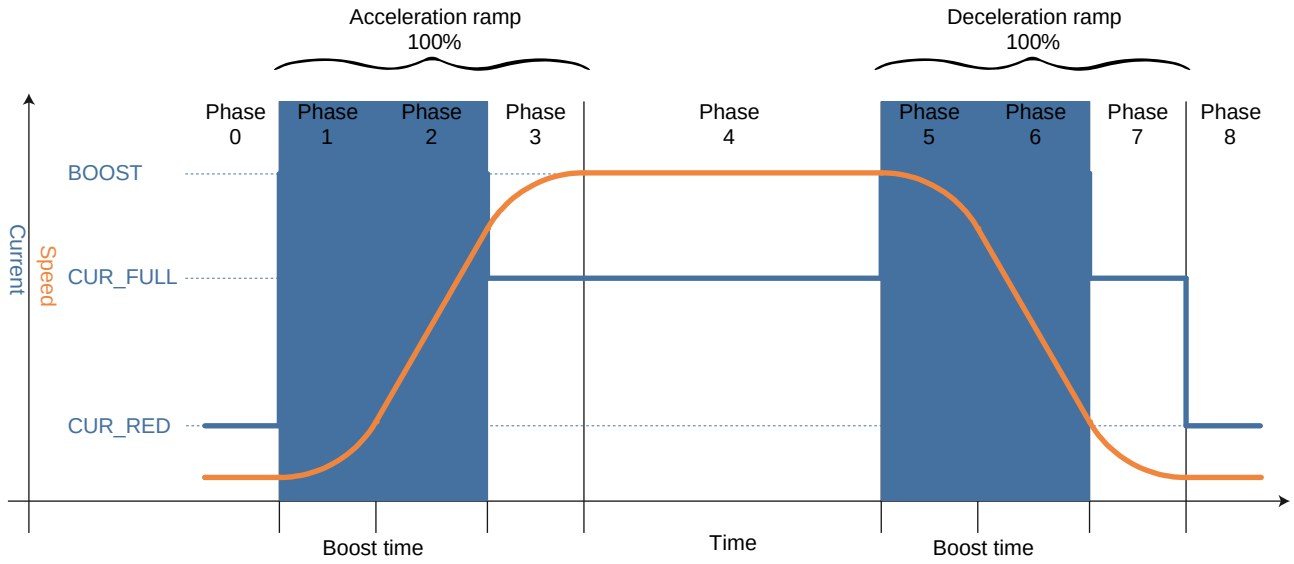
CAUTION!!! In case the axis physically exceeds the limit switch sensor during the stop in emergency ramp (ABORT), it is the user's responsibility to ensure that axis will be brought back inside the sensor itself before performing further movements toward the same direction. A too short movement in the opposite direction, infact, reactivates the possibilit to move in the direction of the intervened sensor,
but doesn't grant the return of the axis inside the limit switches sensors.

lEvEl of CuRRENt

As already mentioned above, the VectorStep drives are able to manage three levels of current.

The start-up parameter *Level of current* indicates to the drive the level of current to be used at power-on.

Register	Value	Function	Description
Rcurmode	0	No current	Set the level of current to 0 (I_{fase}= 0)
	1	Reduced current	Set the lreduced evel of current (I_{fase}= Rcurred)
	2	Nominal current	Set the nominal level of current (I_{fase}= Rcurnom)
	3	Boost current	Set the current boost (I_{fase}= Rcurboost during the acceleration/ deceleration ramps for a maximum time equal to Rtboost; I_{fase}= Rcurnom during the remaining part of the run)



movEmENt paRamEtERs

Questo set di parametri definisce i valori di default che devono assumere i Movement parameters all'accensione.

Sono particolarmente utili nel caso si utilizzi l'azionamento controllandolo tramite ingressi e uscite senza la possibilità di inviare dati tramite o fieldbus e senza la necessità di programmare il drive stesso.

I parametri impostabili sono:

Register	Parameter	Description
Rstrtvel	Velocity	Define the translation velocity at the start-up
Rstrtvss	Start/Stop velocity	Define the start/stop velocity at the start-up
Rstrtacc	Acceleration	Define the acceleration ramp at the start-up
Rstrtdec	Deceleration	Define the deceleration ramp at the start-up
Rstrtpostarg	Target position	Define the target quota at the start-up

These parameters are used by the movement functions associated with the inputs to generate the movement profiles.

homing parameters

This set of parameters defines the default valued that the homing parameters must take at the power-on.

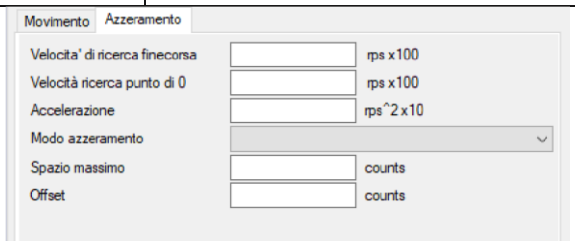
They are particularly useful in case the drive is used by controlling it via inputs and outputs, without the possibility to send data via fieldbus, and without the necessity to program the drive itself.

The configurable parameters are:

Register	Parameter	Description
Rstrthvh	Velocity during switch search	Define the velocity during the search of the limit switch
Rstrthvl	Velocity during zero point search	Define the velocity during the search of the zero point
Rstrthacc	Acceleration ramp	Define the homing acceleration ramp
Rstrthmode	Homing mode	Define the homing method
Rhmaxspc	Maximum space in Home	Define the maximum space during homing sequence

Value	Description
0	No homing function requested
-1	Homing only with BLS in negative direction
-2	Homing only with BLS in positive direction
-3	Homing with BLS + TOP rising edge, negative direction
-4	Homing with BLS + TOP rising edge, positive direction
-5	Homing only with TOP in negative direction
-6	Homing only with TOP in positive direction
-7	Homing with backward mechanical limit + axis measure
-8	Homing with forward mechanical limit + axis measure
-9	Homing with backward mechanical limit
-10	Homing with forward mechanical limit
-11	Homing with backward mechanical limit + encoder TOP
-12	Homing with forward mechanical limit + encoder TOP
-13	Homing on FLS, negative direction
-14	Homing on FLS, positive direction
-15	Homing on FLS + motor encoder TOP, negative direction
-16	Homing on FLS + motor encoder TOP, positive direction

Rhofs	Homing offset	Homing offset (Shift of the axis after home routine)



DRIvE gENERAl paRamEtERs

gENERAl ChaRaCtERIstICs

The general parameters of the drive are the general use parameters which permit to define and modify the working mode of the drive itself.

These include the control mode (Stepper mode, Servmo mode or Smart Mode), operation mode (Velocity, current, position or step/dir) and current level configuration registers.

CoNtRol moDEs

The control mode defines if the stepper motor must be controlled in open loop (Stepper mode) or closed loop (Servo Mode and Smart Mode).

CAUTION!!! It is possible to control the motor in closed loop only if the motor is equipped with an encoder. In case of use of the Servo Mode, the resolution of the motor (step/rev) depends on the number of pulses in quadrature of the encoder, not from the physical steps of the motor.

OpERAtIoN moDE

The operation mode defines the control method of the motor. The drive can control the motor in velocity, in postion or in current. Along with the *Control Modes* parameter, it sets the operation mode of the drive, by setting the value of the register Rconfig.

Register	Value	Description
Rconfig	0	Drive not configured
	1	Reserved
	2	Stepper Mode in velocity control
	3	Stepper Mode in position control
	4	Stepper Mode in step/direction control
	5	Servo Mode in current control
	6	Servo Mode in velocity control
	7	Servo Mode in position control
	8	Servo Mode in step/direction control
	9	Closed Loop / Speed (with tachometric – Only DMD)
	10	Reserved
	11	Smart Mode / Speed
	12	Smart Mode / Position
	13	Smart Loop / Step-Direction

SEttINg of thE CuRRENt

This set of registers assign the value to the three levels of current used by the drives; it is possible to set values between 0 and the drive maximum admitted limit, with increments of 1mA.

Register	Name	Description
Rcurnom	*Nominal current*	Set the level of nominal current supplied by the drive in mA.
Rcurred	*Reduced current*	Set the level of reduced current in mA. The level of reduced current can be activated via command, or automatically by setting the parameter *AutoCR delay.*
Rcurboost	*Current boost*	Set the level of boost current in mA. If enabled, the drive over-supplies the motor during the the acceleration or deceleration ramps, for the maximum time set in the parameter *Boost time.*
Rtcred	*AutoCR delay*	Set the activation delay of the automatic current reduction in ms. If *Rtcred* = 0 the automatic reduction is disabled and the drive always remains in nominal current, also in standstill.
Rtboost	*Boost time*	Set the maximum duration of the boost current pulse in ms.

CAUTION!!! Pay particular attention in setting the parameters of current. Don’t exceed the nominal current of the motor in order to avoid overheatings and fires. Make sure that power supplied to the motor complies the constructive characteristics of the same.

DRIvE aDvaNCED paRamEtERs

gENERal ChaRaCtERIstICs

This set of parameters permits to configure the advanced functions of the drives.

As already mentioned in the chapter 4.0, the drives SMD2204 uses a vector field oriented control technique, which permits to obtain an accurate and smooth control both in mechanical terms and in thermal dissipation.

The VectorStep drives are also provided with advanced controls on the profile of current, in order to optimize and compensate the deformations arising from costructive characteristics of the motor.

posItIoN loop

The Position Loop (PL) is the outermost part of the controller, which interfaces with the command interpreter from which it obtains the movement requests.

It is used only in Servo Mode, because in the traditional operation mode of stepper motors (Stepper Mode) and in Smart Mode it is virtually generated inside the positioner.

The PL has the task to generate the velocity commands to be sent to the drive, in order to follow in the most accurate way the position setpoint set, reducing as far as possible the following error.

For this purpose, the PL uses an advanced PID control with predictive functions, in order to make the system stable also in case of sudden variations of the setpoint.

Register	Name	Description
Rkppos	*Proportional gain*	Set the value of the proportional gain of the control loop. (affect the responsiveness of the system) $P(t)= Kp \times E_{pos}(t)$
Rkipos	*Integral gain*	Set the value of the integral gain of the control loop. (reduce the error in Permanent Regime [constant setpoint] but reduce the responsiveness) $I(t) = Ki \times \sum_i(t)$
Rkcipos	*Dynamic gain*	Set the emptying speed of the integral error. (in case of sudden variations of the setpoint, it limits and reduces the integral error in order to increase the responsiveness of the system) $\sum_i(t) = \sum_i(t-1) + Ktci \times E_{pos}(t)$
Rkffpos	*Feed-Forward gain*	Set the Feed-Forward gain of the control loop (it's an open loop predictive type of contribution in velocity or current, proportional to the requested velocity, which permits to compensate the dynamic frictions and to reduce the integral contributions)

Rkafpos	*Acceleration-Forward gain*	Set the Acceleration-Forward gain of the control loop (it's an open loop predictive type of contribution in velocity or current, proportional to the requested velocity, which permits to reduce the following error during the acceleration phases). *The use of this contribution is not advisable in variable inertia applications.*
Rswacfw	*Switch Acceleration Forward*	Set the loop on which the Acceleration-Forward control acts. **Value** / **Description** 0 – Current loop (Recommended) 1 – Velocity loop

Legend:
Kp = Proportional gain
Ki = Integral gain
Ktci = Dynamic integral coefficient

E_{pos} = Position error $\sum_i$ = Integral summation The Velocity Loop (VL) is interposed between the Position Loop, from which receives the velocity setpoint, and the Current Loop, to which sends the requests of current.

It is used only in Servo Mode, because in the traditional operation mode of stepper motors (Stepper Mode) and in Smart Mode it is virtually generated inside the positioner.

The VL has the task to generate the commands of current to be sent to the drive, in order to follow in the most accurate way the velocity setpoint set, reducing as far as possible the following error.

For this purpose, the VL uses an advanced PID control with a dynamic integrator, in order to make the system stable also in case of sudden variations of the setpoint.

Register	Name	Description
Rkpvel	*Proportional gain*	Set the value of the proportional gain of the control loop. (affect the responsiveness of the system) $V(t)= Kp \times E_{vel}(t)$
Rkivel	*Integral gain*	Set the value of the integral gain of the control loop. (in case of sudden variations of the setpoint, it limits and reduces the integral error in order to increase the responsiveness of the system) $I(t) = Ki \times \sum_i(t)$
Rkcivel	*Dynamicgain*	Set the emptying speed of the integral error. (in case of sudden variations of the setpoint, it limits and reduces the integral error in order to increase the responsiveness of the system) $\sum_i(t) = \sum_i(t-1) + Ktci \times E_{vel}(t)$

Legend:

Kp = Proportional gain
Ki = Integral gain
Ktci = Dynamic integral coefficient
E_{vel} = Velocity error
$\sum_i$ = Integral summation

CuRRENt loop

The Current Loop (CL) is the last loop of the chain of control, and its general task is to generate the requests of current needed to move the motor.

It is used in Stepper Mode and Smart Mode, where it works at constant current (the level of current is not affected by load variations), and in Servo Mode, where the level of current supplied is proportional to the torque requested by the load.

The CL has the task to generate the control currents of the stepper motor, in order to generate the movement requested by the upper loops (PL and VL).

For this purpose, the position loop uses a dual PID control which permits to act both on the torque current (current in quadrature) and in holding current (direct current).

Register	Name	Description
Rkpid	*Holding current proportional gain (I_d)*	Set the proportional gain value of the I_d control loop. $I_d(t)= Kp \times E_{id}(t)$
Rkiid	*Holding current integral gain (I_d)*	Set the integral gain value of the I_d control loop. $I_d(t) = Ki \times \sum_{id}(t)$
Rkpiq	*Holding current proportional gain (I_q)*	Set the proportional gain value of the I_q control loop. $I_q(t)= Kp \times E_{iq}(t)$
Rkiiq	*Holding current integral gain (I_q)*	Set the integral gain value of the I_q control loop. $I_q(t) = Ki \times \sum_{iq}(t)$

Legend:

Kp = Proportional gain
Ki = Integral gain
E_{id} = I_d error of current
E_{iq} = I_q error of current
$\sum_{id}$ = I_d integral summation
$\sum_{iq}$ = I_q integral summation

phasE aDvaNCE

The Phase Advance control permits to progressively modify the drive angle of the vector, so that to reduce the counterelectromotive force (fcem) and to modify the effect of the torque current.

The applicable shift is inversely proportional to the load and the inertia of the same: greater is the load, lower must be the applicated shift.

Too high values of the Phase Advance may cause system instability.

The Phase Advance control uses the following parameters:

Parameter	Name	Description
Rphgain	Phase Advance Gain	Set the Phase Advance gain.

In addition to obtain an increase of torque, the drive angle shift permits to reduce the system resonances.

CAUTION!!! Greater is the Phase Advance value, greater is the drive angle shift. Pay particular attention in adjucting this parameter. Too high values increase the instability of the system, bringing the drive in fault status.

MOTOR PARAMETERS

GENERAL CHARACTERISTICS

This set of parameters includes the physica and electric characteristics of the motor.

The configurations entered in these registers are used by the drive to rebuild the elctric model of the motor is use, in order to adapt the control loops and obtain the best performances.

Also, it is possble to choose the operating resolution of the motor, (setting it in a range between full step and 1/1024 of step) and to define the number of pulses per revolution of the motor encoder , in case it is present.

ELECTRIC CHARACTERISTICS

Indicate the electric resistance, the inductance and the nominal current of the motor in use:

Register	Name	Description
Rmotres	*Phase resistance*	Set the phase resistance of the motor in use, expressed in tenths of Ω.
Rmotind	*Phase inductance*	Set the phase phase of the motor in use, expressed in tenths of mH.
RmotIph	*Nominal current*	Set the nominal current of the motor in use, expressed in mA.

CAUTION!!! Entering wrong parameters may result in an increase of the resonances, of instabilities and in a non-optimal management of the motor.

PHYSICAL CHARACTERISTICS

Indicate the torque constant and the counter-electromotive force constant of the motor in use:

Register	Name	Description
Rmotkfm	*Counter-electromotive force constant*	Set the counter-electromotive force constant of the motor, expressed in hundredths of mHA (milliHenry per Ampere). *(see "Calculation of the counter-electromotive force constant")*
Rmotktq	*Torque constant*	Set the torque constant of the motor, expressed in mNm/A (milliNewtonmeter per Ampere) *(see "Calculation of the torque constant")*

Calculation of the torque constant:

Legend:

I_{NOM} = Nominal phase current (A)

T_{NOM} = Nominal torque (Nm)

K_{TQ} = Torque constant (mNm/A)

$$K_{TQ} = \frac{T_{NOM} \times 1000}{I_{NOM}}$$

Calculation of the counter-electromotive force constant:

Legend:

I_{NOM} = Nominal phase current (A)

L_{NOM} = Phase inductance (mH)

K_{FM} = Counter-electromotive force constant (mH/A)

$$K_{FM} = \frac{L_{NOM} \times I_{NOM} \times 100}{1000}$$

CAUTION!!! Entering wrong parameters may result in an increase of the resonances, of instabilities and in a non-optimal management of the motor.

STEP RESOLUTION

Set the operating resolution of the system:

Register	Name	Description			
Rstpres	*Step resolution*	Indicate the number of microsteps (software) in which a physical step will be divided (eg. with Rstpres = 2, each physical step is divided into 2 microsteps).			
		Value	**Description**	**Value**	**Description**

1	Full step	64	64th of step
2	Half step	128	128th of step
4	Quarter of step	256	256th of step
8	8th of step	512	512th of step
16	16th of step	1024	1024th of step
32	32th of step		

ENCODER RESOLUTION

Set the resolution of the motor encoder:

Register	Name	Description
Rmotencpuls	*Motor encoder resolution*	Indicate the number of pulses per revolution of the encoder connected to the motor.

CAUTION!!! Entering a wrong resolution will result in generating an encoder phasing alarm (with Smart mode and Servo mode).

INputs aND Outputs paRamEtERs

gENERaL ChaRaCtERIstICs

The VectorStep drives have multiple lines of digital I/O, which can be used for general purpose or with specific funtions (limit switches, zero TOP, encoder inputs), besides some analog I/O lines for general purpose. Each I/O line has some associated registers, which permit to define the operation modes.

SERvICE INputs

The service inputs are 8 lines of PNP/NPN or Line Driver (0-24Vdc and TTL compatible) digital inputs that, in particular situations, take a specific function.

The service inputs are associated with 5 registers that permit to know the state of each input and to configure the functioning:

<table>
<tr><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td>Rlsi</td><td>Service inputs state</td><td>Indica the state of each single service input (read only)
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>FLS (Forward limit switch)</td></tr>
<tr><td>1</td><td>BLS (Backward limit switch)</td></tr>
<tr><td>2</td><td>TOP_M (Motor encoder index)</td></tr>
<tr><td>3</td><td>CH.A_M (Motor encoder channel A)</td></tr>
<tr><td>4</td><td>CH.B_M (Motor encoder channel B)</td></tr>
<tr><td>5</td><td>TOP_A (Auxiliary encoder index)</td></tr>
<tr><td>6</td><td>CH.A_A (Auxiliary encoder channel A)</td></tr>
<tr><td>7</td><td>CH.B_A (Auxiliary encoder channel B)</td></tr>
</table></td></tr>
<tr><td>Rdeflsi</td><td>Service inputs definition</td><td>Define the active state of the input: if Bit = 0, active high, if Bit = 1, active low
(For the bit mapping, see Rlsi table)</td></tr>
<tr><td>Rfillsi</td><td>Service inputs digital filter</td><td>Set the digital filter time (expressed in ms) of the service inputs bank</td></tr>
<tr><td>Renflsi</td><td>Digital filter enabling mask</td><td>Permit to define on which inputs the digital filter must be activated, by raising the bit of the desired input (Bit = 1 → Filter enabled)
(For the bit mapping, see Rlsi table)</td></tr>
<tr><td>Rmemlsi</td><td>Service inputs state memory</td><td>Store the (active) state of each service input; the bit of the input remains high until the reset of the same by the user.
(For the bit mapping, see Rlsi table)</td></tr>
</table>

DIgItal INputs

The SMD2204 provides 8 lines of PNP digital inputs (0-24Vdc and TTL compatible) for general purpose; these inputs can be associated with specific functions.

The inputs are associated with 6 registers, which permit to know their state and to configure the functioning:

Register	Name	Description

<table>
<tr>
<td>Rinp</td>
<td>Inputs state</td>
<td>Indicate the state of each input (read only)
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>Input 0</td></tr>
<tr><td>1</td><td>Input 1</td></tr>
<tr><td>2</td><td>Input 2</td></tr>
<tr><td>3</td><td>Input 3</td></tr>
<tr><td>4</td><td>Input 4</td></tr>
<tr><td>5</td><td>Input 5</td></tr>
<tr><td>6</td><td>Input 6</td></tr>
<tr><td>7</td><td>Input 7</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td>Rdefinp</td><td>Digital inputs definition</td><td>Define the active state of the input: if Bit = 0, active high, if Bit = 1, active low
(For the bit mapping, see Rinp table)</td></tr>
<tr><td>Rfilinp</td><td>Inputs digital filter</td><td>Set the digital filter time (expressed in ms) of the digital inputs bank</td></tr>
<tr><td>Renfinp</td><td>Digital filter enabling mask</td><td>Permit to define on which inputs the digital filter must be activated, by raising the bit of the desired input (Bit = 1 → Filter enabled)
(For the bit mapping, see Rinp table)</td></tr>
<tr><td>Rmeminp</td><td>Inputs state memory</td><td>Store the (active) state of each service input; the bit of the input remains high until the reset of the same by the user.
(For the bit mapping, see Rinp table)</td></tr>
<tr><td>Rfuni0
Rfuni1
Rfuni2
Rfuni3
Rfuni4
Rfuni5
Rfuni6
Rfuni7</td><td>Functions associated with the inputs</td><td>For each input, there is a register that indicates the function of the same; to associate the input with a specific funtion, it is sufficient to write the function code inside the desired function register (eg. to associate the input 0 with the “Enable drive” function, → Rfuni0 = 1). The available functions are:
<table>
<tr><th>Func. Code</th><th>Description</th><th>Active on</th><th>Func. Code</th><th>Description</th><th>Active on</th></tr>
<tr><td>0</td><td>None</td><td>-</td><td>10</td><td>B3 Task select.</td><td>State</td></tr>
<tr><td>1</td><td>Enable drive</td><td>State</td><td>11</td><td>B4 Task select.</td><td>State</td></tr>
<tr><td>2</td><td>JOG CW</td><td>↑ edge</td><td>12</td><td>B5 Task select.</td><td>State</td></tr>
<tr><td>3</td><td>JOG CCW</td><td>↑ edge</td><td>13</td><td>B6 Task select.</td><td>State</td></tr>
<tr><td>4</td><td>GO target</td><td>↑ edge</td><td>14</td><td>Start Task</td><td>↑ edge</td></tr>
<tr><td>5</td><td>GOR target</td><td>↑ edge</td><td>15</td><td>Alarms reset</td><td>↑ edge</td></tr>
<tr><td>6</td><td>Stsrt Home</td><td>↑ edge</td><td>16</td><td>Realign quota</td><td>↑ edge</td></tr>
<tr><td>7</td><td>B0 Task select.</td><td>State</td><td>17</td><td>Reduce current</td><td>State</td></tr>
<tr><td>8</td><td>B1 Task select.</td><td>State</td><td>18</td><td>Abort</td><td>↑ edge</td></tr>
<tr><td>9</td><td>B2 Task select.</td><td>State</td><td>19</td><td>Stop</td><td>↑ edge</td></tr>
</table>
</td></tr>
</table>

CAUTION!!! On the falling edge of the movement commands (JOG CW, JOG CCW, GO, GOR, Start Home and Start Task), a Stop command is automatically generated, in order to interrupt the started procedure.

Register	Name	Description

<table>
<tr><td>Rout</td><td>Output state</td><td>Indicate or set the state of each output (read and write)
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>Output 0</td></tr>
<tr><td>1</td><td>Output 1</td></tr>
<tr><td>2</td><td>Output 2</td></tr>
<tr><td>3</td><td>Output 3</td></tr>
<tr><td>4</td><td>Output 4</td></tr>
<tr><td>5</td><td>Output 5</td></tr>
<tr><td>6</td><td>Output 6</td></tr>
<tr><td>7</td><td>Output 7</td></tr>
</table></td></tr>
<tr><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td>Rdefout</td><td>Digital outputs definition</td><td>Define the active state of the output: if Bit = 0, active high, if Bit = 1, active low
(For the bit mapping, see Rout table)</td></tr>
<tr><td>Rfuno0
Rfuno1
Rfuno2
Rfuno3
Rfuno4
Rfuno5
Rfuno6
Rfuno7</td><td>Functions associated with the outputs</td><td>For each output, there is a register that indicates the function of the same; to associate the input with a specific funtion, it is sufficient to write the function code inside the desired function register (eg. to associate the output 0 with the “Drive enabled” function, → Rfuno0 = 1). The available functions are:
<table>
<tr><th>Func. Code</th><th>Description</th></tr>
<tr><td>0</td><td>None</td></tr>
<tr><td>1</td><td>Drive enabled</td></tr>
<tr><td>2</td><td>Alarm</td></tr>
<tr><td>3</td><td>Synchronized axis</td></tr>
<tr><td>4</td><td>Axis in movement</td></tr>
<tr><td>5</td><td>Task in progress</td></tr>
<tr><td>6</td><td>I2T alarm</td></tr>
<tr><td>7</td><td>Axis in position</td></tr>
</table></td></tr>
</table>

CAUTION!!! The inputs 0-7 share the same terminals with the digital outputs 0-7, so if one of these signals are used, the relative output (or vice vesa) cannot be used.

Digital outputs

The SMD2204 provides 8 lines of general purpose PNP digital outputs (5-24Vdc), protected against overloads and short-circuits; such outputs can be associated with specific functions.

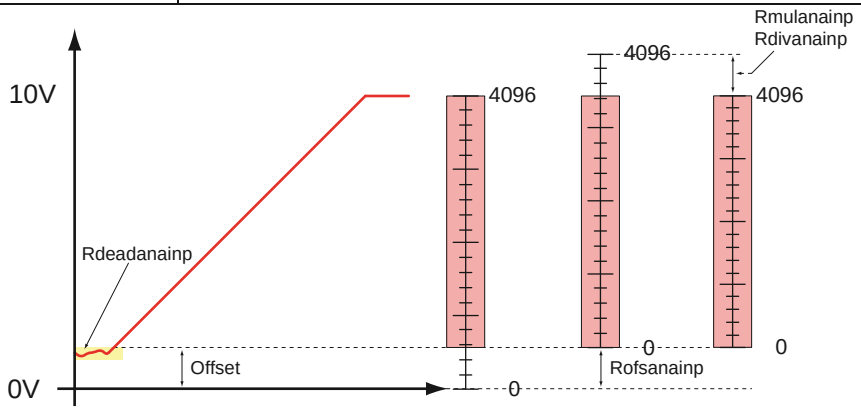
The outputs are associated with 3 registers, which permit to know their state and to configure the functioning:

aNalog INputs

The SMD2204 provides 3 precision analog inputs for general purpose (0-10V_{DC} at 12-bit); these inputs can be associated with specific functions.
The inputs are associated with 6 registers, which permit to know their state and to configure the functioning:

Register	Name	Description

<table>
<tr><td>Ranainp
Ranainp1
Ranainp2</td><td>Digitized value of the analog inputs</td><td>Show the digitized voltage value applied to the terminal of the analog input.
The A/D converter uses a 12-bit scale for the conversion of the signal (10V = 4096).</td></tr>
<tr><td>Rdefanainp
Rdefanainp1
Rdefanainp2</td><td>Analog input definition</td><td>The analog input can be used for the conditioning of some values inside the drive; this register sets which value is conditioned by the analog input.
The value of Ranainp is copied inside the associated register (the associated occurs by copying the function code in the register Rdefanainp):
<table>
<tr><th>Func. Code</th><th>Description</th></tr>
<tr><td>137</td><td>None</td></tr>
<tr><td>20</td><td>Event stop delay (ESTOP)</td></tr>
<tr><td>24</td><td>Stop delay</td></tr>
<tr><td>63</td><td>Velocity</td></tr>
<tr><td>67</td><td>Acceleration</td></tr>
<tr><td>70</td><td>Deceleraiton</td></tr>
<tr><td>83</td><td>Homing velocity</td></tr>
<tr><td>87</td><td>Homing acceleration</td></tr>
<tr><td>210</td><td>Limit of current</td></tr>
</table></td></tr>
<tr><td>Rmulanainp
Rmulanainp1
Rmulanainp2</td><td>Analog input multiplier</td><td>Set the multiplication constant of the analog input.
Along with the divider, the offset and the dead-band, permits to condition the value of the register Ranainp, in order to adapt to the characteristics of the analog signal applied or to the value which must be controlled</td></tr>
<tr><td>Rdivanainp
Rdivanainp1
Rdivanainp2</td><td>Analog input divider</td><td>Set the division constant of the analog input.
Along with the multiplier, the offset and the dead-band, permits to condition the value of the register Ranainp, in order to adapt to the characteristics of the analog signal applied or to the value which must be controlled</td></tr>
</table>



As shown above, it is possible: to create a dead band (yellow zone) in order to eliminate disturbances of the reference in proximity of the minimum value; to shift the analog register in order to let the 0 value coincide with the reference minimum value (Offset); to compress or to expand the scale in order to let the value 4096 (full scale) coincide with the maximum reference value (Rmulanainp and Rdivanainp). In this case, the value of the analog register will be:

$$K_{MUL}$$

se R_{ANAINP} < Dead-Band $R_{ANAINP} = 0$

Register	Name	Description
Roffsanainp Roffsanainp1 Roffsanainp2	*Analog input offset*	Set the analog input offset. Along with the multiplier, the divider and the dead-band, permits to condition the value of the register Ranainp, in order to adapt to the characteristics of the analog signal applied or to the value which must be controlled
Rdeadanainp Rdeadanainp1 Rdeadanainp2	*Analog input dead-band*	Set the analog input dead-band. Along with the multiplier, the divider and the offset, permits to condition the value of the register Ranainp, in order to adapt to the characteristics of the analog signal applied or to the value which must be controlled

$R_{ANAINP} = (V_{IN\_DIG} - R_{OFFSET}) \times K_{DIV}$

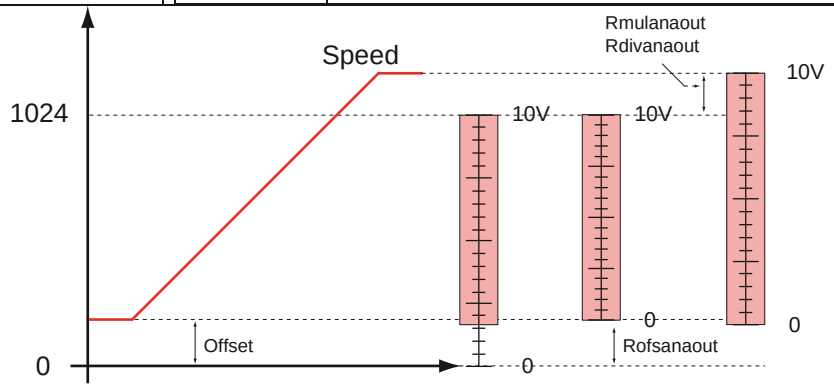
V_{IN_DIG} = Digitized input voltage (0..10V_{DC} = 0..4096)

aNalog output

The SMD2204 provides 1 analog output for general purpose (0-10V_{DC} at 10-bit); these output can be associated with specific functions.
The outpt is associated with 5 registers, which permit to know its state and to configure the functioning:

Register	Name	Description
Ranaout	*Digitized value of the analog output*	Show the digitized voltage value applied to the terminal of the analog output. The A/D converter uses a 10-bit scale for the conversion of the signal (1024 = 10V).
Rdefanaout	*Analog input definition*	The analog output can be used to show some values inside the drive; this register sets which value is shown by the analog output. The value of the associated register is copied in Ranaout (the association occurs by copying the function code in the register Rdefanaout):

Func. Code	Description
143	None
75	Actual velocity
378	Actual current
0	Actual position
153	Auxiliary encoder quota
151	Motor encoder quota



As shown above, it is possible to act on the offset register and on the multiplication and division constant in order to shift the analog register, with the purpose to let the value 0 coincide to the minimum reference value (Offset) and to compress or dilate the scale with the purpose to let the value 1024 coincide to the maximum reference value (Rmulanainp and Rdivanainp).

Register	Name	Description
Rmulanaout	*Analog output multiplier*	Set the multiplication constant of the analog output. Along with the divider and the offset, permits to condition the value of the register Ranaout, in order to adapt to the characteristics of the value which must be shown.
Rdivanaout	*Analog output divider*	Set the division constant of the analog output. Along with the multiplier and the offset, permits to condition the value of the register Ranaout, in order to adapt to the characteristics of the value which must be shown.
Roffsanaout	*Offset uscita analogica*	Offset da sommare al valore da impostare nell'uscita analogica. Along with the multiplier and the divider, permits to condition the value of the register Ranaout, in order to adapt to the characteristics of the value which must be shown.

In this case, the value of the analog register will be:

$$V_{OUT\_DIG} = (R_{ANAOUT} - R_{OFFSET}) \times \frac{K_{MUL}}{K_{DIV}}$$

V_{OUT_DIG} = Digitized input voltage (0..1024 = 0..10V_{DC})

alaRm paRamEtERs

g ENERal ChaRaCtERIstICs

The VectorStep drives are able to detect and manage different fault conditions, like: overvoltage, undervoltage, hardware or software overcurrent, overtemperature, positioning or phasing following errors, I^2T, digital outputs overload, phases wiring errors.
When a fault occurs, the drive disables the power stage, store the type of fault in the internal buffer and notices the anomaly on the STS LED (Red ON); the power stage will be re-enabled after the fault cause is removed, the alarm is reset and the enable command is sent.
The non-distructive alarms (undervoltage, following and I^2T) can be masked and made inactive.
The alarm interface is able to recognise pre-alarm thresholds (warnings) which permit to acknowledge anomalous or critic conditions before an hardware fault occurs. **alaRms CoNfIguRatIoN**

<table>
<tr><th>Register</th><th>Nome</th><th>Description</th></tr>
<tr><td>Rmaskalm</td><td>Alarms mask</td><td>Permit to disable non-distructive alarms
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>[0..1]</td><td>Reserved</td></tr>
<tr><td>2</td><td>I^2T alarm disabling</td></tr>
<tr><td>3</td><td>Position alarm disabling</td></tr>
<tr><td>4</td><td>Following error alarm disabling</td></tr>
<tr><td>[5..7]</td><td>Reserved</td></tr>
<tr><td>8</td><td>Undervoltage alarm disabling</td></tr>
<tr><td>12</td><td>Positioning timeout alarm disabling</td></tr>
</table></td></tr>
</table>

		[9..15] Reserved

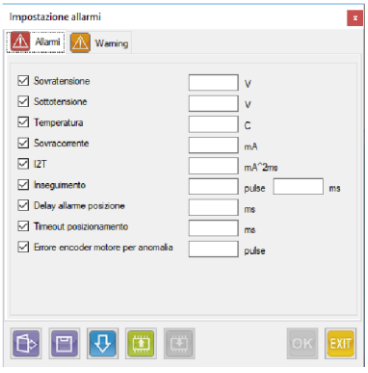
All the alarms managed by the drive have configurable thresholds, which permit to modify the sensitivity and the intervention points of the same.

Register	Description	Value		UM	Mask
		Min.	Max.		
Rtempalm	Overtemperature alarm threshold	25	120	C	No
Rtensmax	Overvoltage alarm threshold	30	65/120	V	No
Rtensmin	Undervoltage alarm threshold	20	60	V	Yes
Rcurmax	Overcurrent alarm threshold	0	15000	mA	No
Rflwmax	Following error alarm threshold	-2_{31}	$+2_{31}$	counts	Yes
Ri2tmax	I^2T alarm threshold	0	$+2_{32}$	mA^2ms	Yes
Rdeadpos	Position dead-band for positioning alarm	0	65535	counts	Yes
Rposalmtime	Time before positioning alarm in Closed Loop.	0	65535	ms	Yes
Rpostimeout	Time for positioning Time-out	0	65535	ms	Yes
Rflwencerr	Maximum counting error between motor encoder counter and motor steps	0	$+2_{31}$	counts	Yes

The non-distructive alarms can be masked by writing 1 on the relative bit in the register Rmaskalm:

WaRNINg CoNfIguRatIoN

Like the alarms, also the warnings managed by the drive have configurable thresholds, which permit to modify the sensitivity and the intervention point of the same.



The occurrence of a warning has no effects on the execution of a command or program, but has the purpose to notice a potentially critical situation to the user.

Register	Description	Value		UM	Mask
		Min.	Max.		
Rtempwrn	Overtemperature warning threshold	25	120	C	No
Rovvwrn	Overvoltage warning threshold	30	65/120	V	No
Runvwrn	Undervoltage warning threshold	20	60	V	Yes
Rovcwrn	Overcurrent warning threshold	0	15000	mA	No
Rflwwrn	Following error warning threshold	-2_{31}	$+2_{31}$	counts	Yes
Rwrni2t	I^2T warning threshold	0	$+2_{32}$	mA^2ms	Yes
Rposwrntime	Time before positioning warning in Closed Loop.	0	32000	ms	Yes
Rpostimeoutwrn	Time for positioning Time-out warning	0	65535	ms	Yes

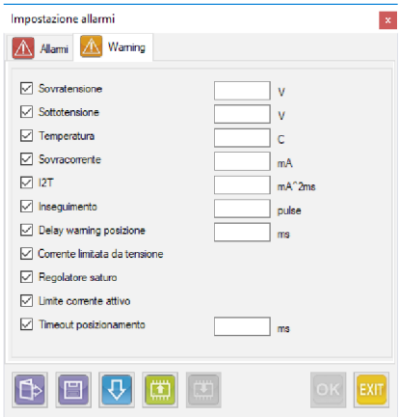
The warnings can be masked by writing 1 on the relative bit in the register Rmaskwrn:

Register	Name	Description
Rmaskwrn	*Warnings mask*	Permit to disable alarms

Bit	Description
[0..1]	Reserved
2	I^2T warning disabling
3	Position warning disabling
4	Following error warning disabling
[5..7]	Reserved
8	Undervoltage warning disabling
12	Positioning timeout warning disabling
[9..15]	Reserved

alarms history

The SMD2204 is able to stor and hold in memory (until the shut-down) up to 8 alarms.
The alarms history consists of a 8 positions buffer, where the last occurred alarm codes are saved.
In case an higher number of alarms occurs, the active alarm will overwrite the oldest saved alarm.



<table>
<tr><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td>Rbufalm0</td><td>Alarm buffer 0</td><td>Position 0 of the alarms history buffer</td></tr>
<tr><td>Rbufalm1</td><td>Alarm buffer 1</td><td>Position 1 of the alarms history buffer</td></tr>
<tr><td>Rbufalm2</td><td>Alarm buffer 2</td><td>Position 2 of the alarms history buffer</td></tr>
<tr><td>Rbufalm3</td><td>Alarm buffer 3</td><td>Position 3 of the alarms history buffer</td></tr>
<tr><td>Rbufalm4</td><td>Alarm buffer 4</td><td>Position 4 of the alarms history buffer</td></tr>
<tr><td>Rbufalm5</td><td>Alarm buffer 5</td><td>Position 5 of the alarms history buffer</td></tr>
<tr><td>Rbufalm6</td><td>Alarm buffer 6</td><td>Position 6 of the alarms history buffer</td></tr>
<tr><td>Rbufalm7</td><td>Alarm buffer 7</td><td>Position 7 of the alarms history buffer</td></tr>
<tr><td>Ralmcont</td><td>Alarms counter</td><td>Contain the number of faults occurred in the drive. At the shut-down of the drive, the counter is automatically saved.
To reset the counter, act on the register Ralmack.</td></tr>
<tr><td>Ralmack</td><td>Alarms acknowledge</td><td>Permit to delete the alarms history buffer and to reset the absolute counter:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>Alarms acknowledge</td></tr>
<tr><td>1</td><td>Alarms counter reset</td></tr>
<tr><td>[2..15]</td><td>Reserved</td></tr>
</table>
Each time the bit 0 is activated (Alarms acknowledge) the drive deletes the last position of the of the alarms history buffer.
If the buffer is full, in order to emptying it, it is necessary to send 8 acknowlegdes (starting from position 7).</td></tr>
</table>

CommuNICatIoN paRamEtERs

gENERal ChaRaCtERIstICs

The drives SMD2204 can communicate with the external (PLC, HMI, Host computer etc.) by using four fielbus: Modbus RTU (SMD2204xIM), Modbus TCP/IP (SMD2204xIE), CANopen (SMD2204xIC), EtherCAT (SMD2204xIT) or Profinet (SMD2204xIN).
Each of the se transmission channel can be configured in order to adapt its characteristics to the applicatio field. All the fildbus permit to access to any internal resource of the drive, from the process data to the configuration.

moDBus Rtu paRamEtERs (smD2204xIm)

The Modbus RTU communication channel can be used for the configuration and the programming of the drives. The serial communication uses a serial transmission interface:

- EIA RS-485

The RS-485 permits the multi-point connection, namely the simultaneous connection of more devices (up to 32) on the same communication network. In a multi-point network it is of fundamental importance that each device is uniquely defined by an address
The SMD2204xIM permits to define the following communication parameters:

<table>
<tr><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td>Rserbaud</td><td>Serial communication speed</td><td>Set the communication speed of the port:
<table>
<tr><th>Value</th><th>Communication speed (Baud-rate)</th><th>Value</th><th>Communication speed (Baud-rate)</th></tr>
<tr><td>0</td><td>1200</td><td>4</td><td>19200</td></tr>
<tr><td>1</td><td>2400</td><td>5</td><td>38400</td></tr>
<tr><td>2</td><td>4800</td><td>6</td><td>57600</td></tr>
<tr><td>3</td><td>9600</td><td>7</td><td>115200</td></tr>
</table></td></tr>
<tr><td>Rserpar</td><td>Serial port parameters</td><td>Set the communication parameters of the port (Parity and Stop Bit Nr.):
<table>
<tr><th>Value</th><th>Parity</th><th>Stop Bit</th></tr>
<tr><td>0</td><td>None</td><td>1</td></tr>
<tr><td>1</td><td>Even</td><td>1</td></tr>
<tr><td>2</td><td>Odd</td><td>1</td></tr>
<tr><td>3</td><td>None</td><td>2</td></tr>
<tr><td>4</td><td>Even</td><td>2</td></tr>
<tr><td>5</td><td>Odd</td><td>2</td></tr>
</table></td></tr>
<tr><td>Rserdly</td><td>Reply of theay</td><td>Set the reply of theay of the drive. It is particularly useful in case of use of Auto-switch RS-485 conversion interfaces, in order to adapt the reply times of the drive to the switch times of the interface.</td></tr>
<tr><td>Rseraddr</td><td>Serial address offset</td><td>In multiaxes drive SMD2204, ths register is used to configure the address of the node.</td></tr>
</table>

<table>
<tr>
<td>Rintmot</td>
<td>32bit data format</td>
<td>With double word data exchange (32bit), this parameter defines the order of sending and receiving of the double word.
<table>
<tr><th>Value</th><th>Parity</th><th>Stop Bit</th><th></th></tr>
<tr><td>0</td><td>Intel</td><td>Little Endian</td><td>LSB < -> MSB</td></tr>
<tr><td>1</td><td>Motorola</td><td>Big Endian</td><td>MSB < -> LSB</td></tr>
</table>
</td>
</tr>
</table>

All the communication parameters can be modified with the software StepControl, in the section “Communication parameters”

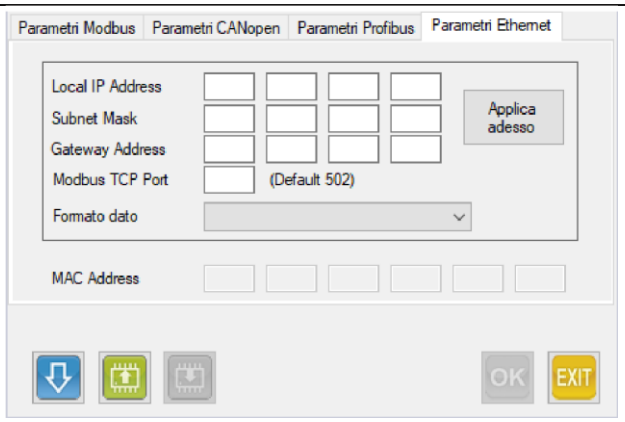
Inside a Modbus RTU network, the multi-axis drive SMD2204xIM is seen as three single independent drives.With StepControl, it is necessary to set the drive of the axis 1. The axes 2 and 3 will automatically take the next two addresses.
Example:
Axis 1 = Node ID 4 (set with StepControl)
Axis 2 = Node ID 5
Axis 3 = Node ID 6

MODBUS/TCP PARAMETERS (SMD2204XIE)

The Modbus TCP parameters permit to set the IP address, the Ethernet Subnet, the Gateway address, the Modbus TCP port, the data format and the MAC address.

Register	Name	Description
Rethlocipaddr32	*Byte 3 - Byte 2* *Ethernet local IP address*	Set the Byte 3 and the Byte 2 of the Ethernet local IP address
Rethlocipaddr10	*Byte 1 - Byte 0* *Ethernet local IP address*	Set the Byte 1 and the Byte 0 of the Ethernet local IP address
Rethsubnet32	Byte 3 - Byte 2 Ethernet Subnet	Set the Byte 3 and the Byte 2 of the Ethernet Subnet
Rethsubnet10	Byte 1 - Byte 0 Ethernet Subnet	Set the Byte 1 and the Byte 0 of the Ethernet Subnet
Rethgwaddr32	Byte 3 - Byte 2 Ethernet Gateway address	Set the Byte 3 and the Byte 2 of the Ethernet Gateway
Rethgwaddr10	Byte 1 – Byte 0 Ethernet Gateway address	Set the Byte 1 and the Byte 0 of the Ethernet Gateway
Rethmacaddr054	Byte 5 - Byte 4 MAC address 0 ethernet	Set the Byte 5 and the Byte 4 of the MAC Address
Rethmacaddr032	Byte 3 - Byte 2 MAC address 0 ethernet	Set the Byte 3 and the Byte 2 of the MAC Address
Rethmacaddr010	Byte 1 - Byte 0 MAC address 0 ethernet	Set the Byte 1 and the Byte 0 of the MAC Address

As an alternative to write each single register, it is possible to set the parameters by accessing the “Communication parameters” section in the software StepControl



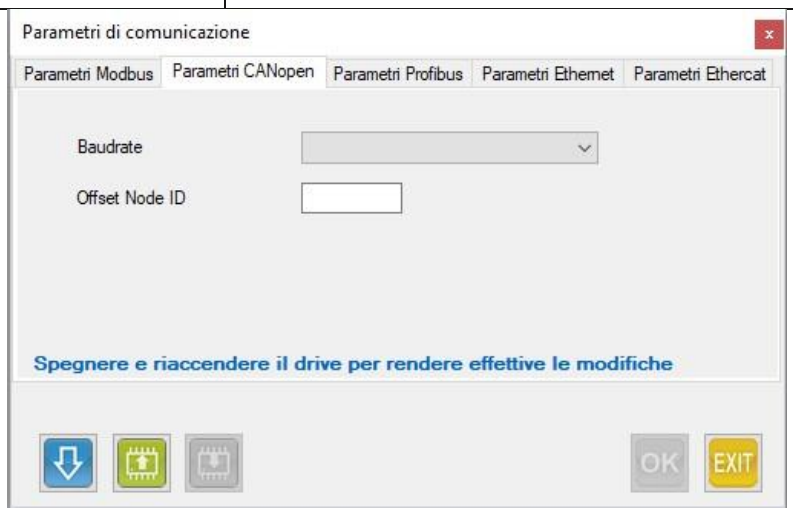
The multi-axis drive SMD2204xIE have a unique IP address inside a Modbus TCP/IP network. In order to send a data to the single axis, set the “Unit ID” in the Master controller (1 for axis 1, 2 for axis 2, 3 for axis 3). In order to send the same data to all the three axes, send the data to the “Unit ID” 0.

CANOPEN PARAMETERS (SMD2204XIC)

The CANopen parameters permit to set the communication speed of the bus, and, optionally, the software offset to be added to the hardware address.

Register	Name	Description

<table>
<tr><td>Rcanbaud</td><td>CANopen bus communication speed</td><td>Set the communication speed of the CANopen bus:
<table>
<tr><th>Value</th><th>Communication speed (Baud-rate)</th><th>Value</th><th>Communication speed (Baud-rate)</th></tr>
<tr><td>0</td><td>10Kb</td><td>4</td><td>250Kb</td></tr>
<tr><td>1</td><td>20Kb</td><td>5</td><td>500Kb</td></tr>
<tr><td>2</td><td>50Kb</td><td>6</td><td>800Kb</td></tr>
<tr><td>3</td><td>125Kb</td><td>7</td><td>1000Kb</td></tr>
</table></td></tr>
<tr><td>Rcanaddr</td><td>CAN address offset</td><td>In multiaxes drive SMD2204, ths register is used to configure the address of the node.</td></tr>
</table>



EthERCat paRamEtERs (smD2204xIt)

The EtherCAT parameters permit to set the EtherCAT ID .

Register	Name	Description
Rethercatid	*Explicite board ID Ethercat*	Manual setting of the EtherCAT ID

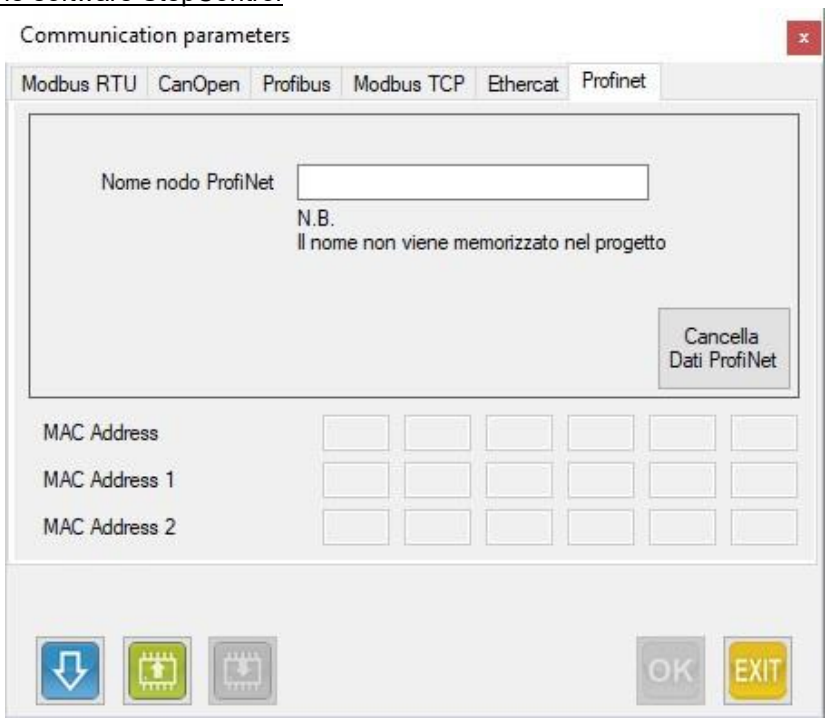
As an alternative to write the single register, it is possible to set the parameters by accessing the “Communication parameters” section in the software StepControl

CAUTION: If the mode 8 of the drive is in use (it is possible to verify it with StepControl, register “Rcanmodeofoperation”), it is necessary to set the maximum step resolution, in order to have a smooth and noiseless movement.

pRofINEt paRamEtERs (smD2204xIN)

The Profinet node-ID and the IP address can setting directy by the Profinet master

As an alternative to write the single register, it is possible to set the parameters by accessing the “Communication parameters” section in the software StepControl



hARDwaRE paRamEtERs

gENERal ChaRaCtERIstICs

The hardware parameters permit to configure the default rotation direction of the motor and the motor encoder, in order to adapt to existing mechanical solutions.

RotatIoN DIRECtIoN of thE motoR

Following the wiring instructions of the motor, the same rotates clockwise (CW) by default.
The SMD2204 permits to modify the rotation direction, by acting on the bit 2 of the register “Hardware config”:

Registro	Nome	Descrizione
Rhwconfig	*Hardware configuration*	Imposta il verso di rotazione predefinito del motore

Bit	Stato	Descrizione
2	L	Verso di rotazione standard (CW)
	H	Verso di rotazione invertito (CCW)

RotatIoN DIRECtIoN of thE motoR ENoCDER

Following the wiring instructions of the motor encoder, the increments occur by rotating clockwise (CW).
The SMD2204 permits to modify the rotation direction, by acting on the bit 1 of the register “Hardware config”:

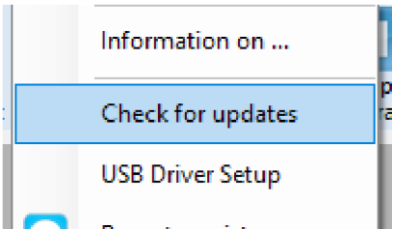
Register	Name	Description
Rhwconfig	*Hardware configuration*	Set the default rotation direction of the motor encoder

Bit	Stato	Description
1	L	Standard rotation increments (CW)
	H	Inverted rotation increments (CCW)

fIRmwaRE upDatE

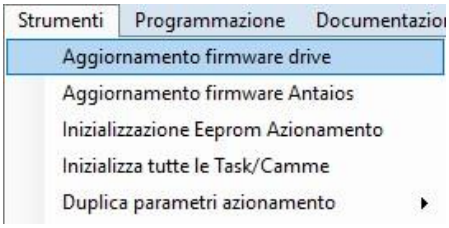
f IRmwaRE upDatE

• Update StepControl to the latest version,by clicking on “Help“ - “Check for updates” from the menu bar.



• Powerthe drive and connectthe USB cable.

• Click on “Instruments->Drive firmware update” from the menu bar.

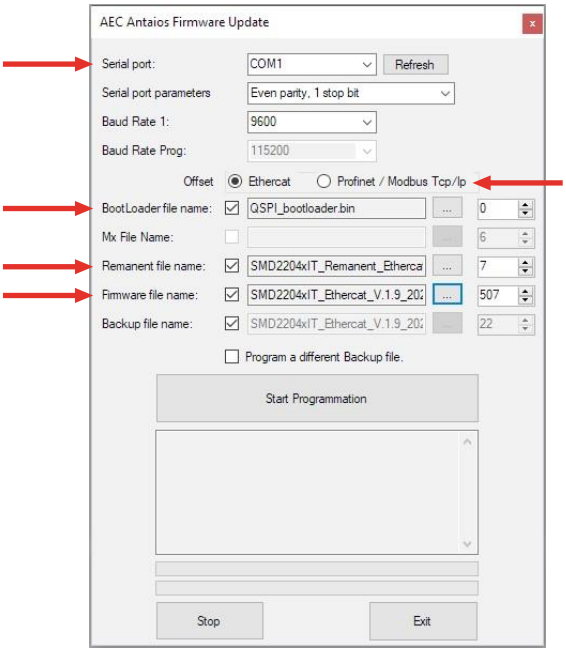


- Select the model of the drive.
- Select the "Serial port".
- Load the firmware update file, by clicking on the button 
- Click on "Start Programming".
- If the update has been completed correctly, the loading bar will stop and a dialog box with the message "Switch off the drive" will appear.
- Shut down and re-power the drive.
- Enable the communication by clicking on the icon  which will turn red.
- Disable the drive by clicking on the icon  .
- Select the function "Instruments-> Drive Eprom initialize" to reset the data that may be remained into the drive.
- Now it is possible to upload a project into the drive.
- Disable the communication by clicking on the icon  which will turn green.
- Shut down and re-power the drive. The drive has been updated.

EtherCAT DRIVES

- Power the drive and connect the USB cable.
- Click on "Instruments->Antaios firmware update" from the menu bar.

- The following dialog box will appear.



• Select the "Serial port".

• Select the protocol.

• Load the "Bootloader" file from the update folder, by clicking on the button ...

• Load the "Remanent" file from the update folder, by clicking on the button ...

• Load the firmware update file from the update folder, by clicking on the button ...

• Click on "Start Programming".

• If the update has been completed correctly, the loading bar will stop and a dialog box with the message "Programming sequence completed" will appear.

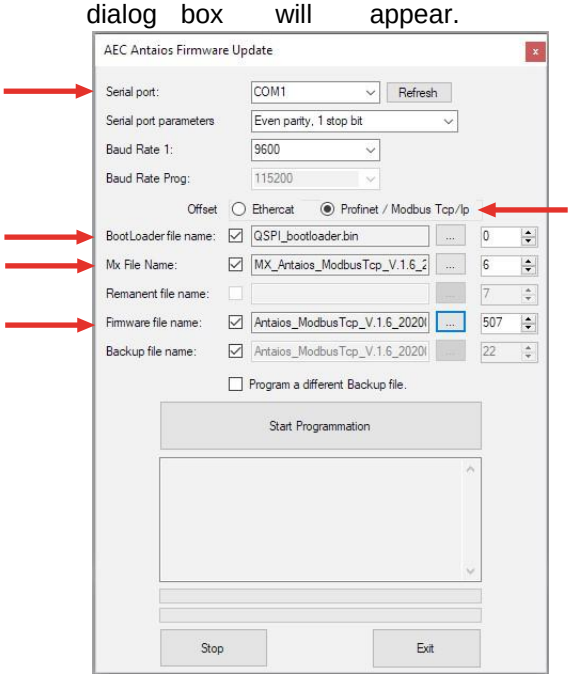
• Shut down and re-power the drive. The drive has been updated.

Modbus TCP/IP / Profinet DRIVES

• Power the drive and connect the USB cable.

• Click on "Instruments->Antaios firmware update" from the menu bar.

• The following dialog box will appear.



• Select the "Serial port".

• Select the protocol.

• Load the "Bootloader" file from the update folder, by clicking on the button ...

• Load the "Mx" file from the update folder, by clicking on the button ...

• Load the firmware update file from the update folder, by clicking on the button ...

• Click on "Start Programming".

• If the update has been completed correctly, the loading bar will stop and a dialog box with the message "Programming sequence completed" will appear.

• Shut down and re-power the drive. The drive has been updated.

following control

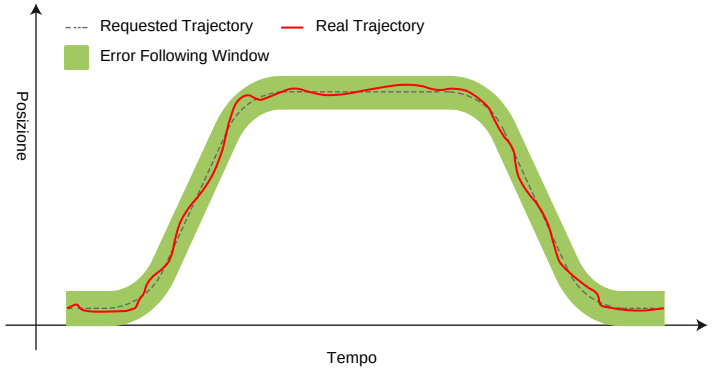
general characteristics

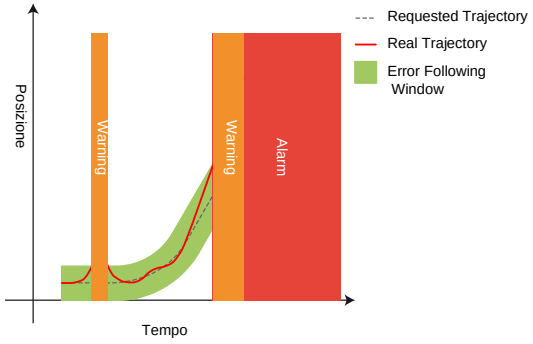
The following control uses the feedback of an encoder connected to the motor, in order to verify real-time the correct movement and positioning of the motor itself.
The control constantly check the actual position and the encoder quota, in order to report a warning or an alarm in case the difference between the two quotas exceeds a configured threshold.
The following warning advise that the difference between the quotas exceeds the configured threshold and automatically resets in case the following error re-enters in the parameters set.
The following alarm, instead, in case the following error exceeds the threshold set, disables the drive and reports the fault state.
In this case it will be necessary to intervene and to reset the alarm to restore the system.

CAUTION!!!
The warning notice and the intervention of the following alarm can be masked by setting to 1 the bit 4 of the register Rmaskwrn (Warning smask) and Rmaskalm (Alarms mask).

The following error is automatically reset when the drive is disabled.
To deactivate the following control:

- Set to 0 the register Rflwwrn to disable the “Following warning” control
- Set to 0 the register Rflwmax to disable the “Following alarm” control





parameters

The Following control can be configured by setting the parameters below:

Register	Name	Description
Rmotenc	*Motor Encoder Pulse*	Set the number of pulses per revolution of the motor encoder
Rflwmax	*Maximum Following Error*	Define the intervention threshold of the following alarm in encoder pulses (set 0 to deactivate the control)
Rflwwrn	*Warning Following Error*	Define the intervention threshold of the following warning in encoder pulses (set 0 to deactivate the control)
Rflwtim	*Following Error Filter Time*	Set the filter time of the following error: the following alarm is signaled only if the following error exceeds the threshold set for a time equal or greater than the filter time. The following warning is signaled as soon as the following error exceeds the warning threshold without being filtered.
Rmaskalm	*Alarm Mask*	By setting to 1 the bit 4 the intervention of the following alarm is deactivated

Rmaskwrn	*Warning Mask*	By setting to 1 the bit 4 the intervention of the following warning is deactivated
Rflwdisp	*Actual Following Error Display*	Show the actual following error in encoder pulses
Rflwmem	*Max Absolute Following Error*	Store the maximum absolute following error occurred
Rflwmemp	*Max Positive Following Error*	Store the maximum positive following error occurred
Rflwmemn	*Max Negative Following Error*	Store the maximum negative following error occurred

PosItIoN CoNtRol (SmaRt moDE aND SERvo moDE)

gENERal ChaRaCtERIstICs

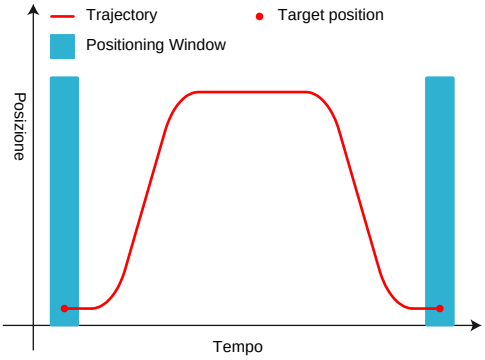
One of the main characteristics of the Smart and Servo modes is the impossibility for the motor to “lose steps”.

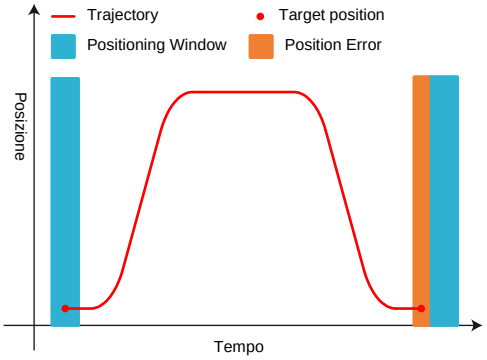
This doesn’t mean that, applying a load greater than the maximum torque of the motor, the same will move, but that the drive is able to bring back the motor at the correct position soon as the conditions of the load permit it, modulating in the most efficient way the supplied current and the retrieval speed.

As already stated, since the movement of the motor (intended like parameters of current, accelerations and velocity) is controlled by the following error, it may occur cases in which, at the end of the requested movement, the device is not correctly positioned, but it is in delay of a certain number of encoder pulses.

In this case, the position control has the task to verify that the differnce between the requested quota and the real quota doesn’t exceed the value set in the positioning window, reporting the correct positioning or a position error.

The control funtion will report a position error also in case, with the motor in standstill, the load will take the motor out of position.





paRamEtERs

The position control can be configured by setting the parameters below:

Register	Name	Description
Rmotenc	*Motor Encoder Pulse*	Set the number of pulses per revolution of the motor encoder
Rflwmax	*Maximum Following Error*	Define the intervention threshold of the following alarm in encoder pulses (set 0 to deactivate the control)

Rflwwrn	*Warning Following Error*	Define the intervention threshold of the following warning in encoder pulses (set 0 to deactivate the control)
Rflwtim	*Following Error Filter Time*	Set the filter time of the following error: the following alarm is signaled only if the following error exceeds the threshold set for a time equal or greater than the filter time. The following warning is signaled as soon as the following error exceeds the warning threshold without being filtered.
Rmaskalm	*Alarm Mask*	By setting to 1 the bit 4 the intervention of the following alarm is deactivated
Rmaskwrn	*Warning Mask*	By setting to 1 the bit 4 the intervention of the following warning is deactivated
Rflwdisp	*Actual Following Error Display*	Show the actual following error in encoder pulses
Rflwmem	*Max Absolute Following Error*	Store the maximum absolute following error occurred
Rflwmemp	*Max Positive Following Error*	Store the maximum positive following error occurred
Rflwmemn	*Max Negative Following Error*	Store the maximum negative following error occurred

Quota REallgNmENt

gENERal ChaRaCtERIstICs

The VectorStep drives permit to realign the actual position and the enocder quotas “on the fly” at the occurrence of an event.

The realignment consists of setting some default values in the registers “actual position”, “motor encoder quota” and “exernal encoder quota”.

The triggering event can be the reading of an input managed in interrupt, a command sent via fieldbus, or sent by the internal program.

The realignment procedure starts when the register Rlineupcmd (Line-up command) is written: the command register (managed at bit) permits to define which quotas to align.

In case of realignment through input, the definition of the quotas to be aligned occurs by setting the register Rlineupdef (Line-up definition).

During the realignment, the interrupts of the drive are suspended in order to guarantee the maximum processing speed and the simultaneous process of all the quotas to be realigned.

At the end of the procedure, the command is reset by the drive

CAUTION!!!
It is unadvisable to use this function during deceleration ramps.

pARAmEtERs

The realignment quota can be configured by setting the parameters below:

Registro	Nome	Description
Rlineuppos	*Position line-up quota*	Set the realignment quota of the actual position. (At the activation of the realignment this value is copied in the position register)
Rlineupmotenc	*Motor Encoder line-up quota*	Set the realignment quota of the motor encoder quota. (At the activation of the realignment this value is copied in the motor encoder quota).

<table>
<tr><td>Rlineupextenc</td><td>External Encoder line-up quota</td><td>Set the realignment quota of the external encoder quota. (At the activation of the realignment this value is copied in the external encoder quota).</td></tr>
<tr><td>Rlineupdef</td><td>Line-up definition</td><td>Define the quotas to be aligned at the activation of the quota alignment input:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>Enable the actual position realignment</td></tr>
<tr><td>1</td><td>Enable the motor encoder quota realignment</td></tr>
<tr><td>2</td><td>Enable the external encoder quota realignment</td></tr>
<tr><td>[3..15]</td><td>Reserved</td></tr>
</table>
The alignment input is defined by associating the function “Align quota” with any of the drive inputs, from the “Inputs parameters” window.</td></tr>
<tr><td>Rlineupcmd</td><td>Line-up command</td><td>Activate the procedure of alignemnt of the quotas set:
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>Align the actual position</td></tr>
<tr><td>1</td><td>Align the motor encoder quota</td></tr>
<tr><td>2</td><td>Align the external encoder quota</td></tr>
<tr><td>[3..15]</td><td>Reserved</td></tr>
</table></td></tr>
</table>

CAUTION!!!

In case of realignment of more than one quotas (axis quota, motor encoder and/or external encoder) transfer the commands bit at the same moment in order to guarantee that the procedure is performed simultaneously.

moDulE quota (Roll-ovER)

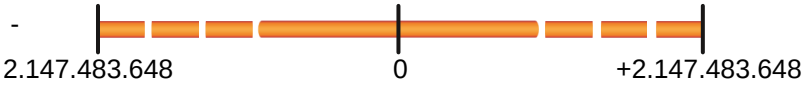
gENERal ChaRaCtERIstICs

The definition of a module quota permits the drive to work on a circular quota (cyclic), which results particularly useful in all “rotative” applications in which the drive cyclically perform the same run (rotary tables, conveyor belts etc.)

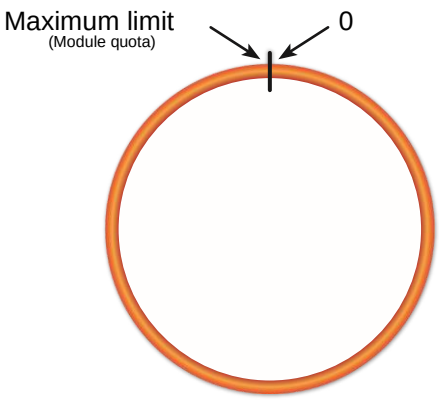
The working quota is “closed” in a loop between a minimum limit (fixed at 0) and a maximum limit (defined by the module quota).

Standard quota management

(Signed32)



Module quota management



Moving the motor forward, at the exceeding of the upper limit, the quota returns to 0 and continues to increment. In the opposite case, with the motor moving backward, at the exceeding of the lower limit, the quota is imposed at the value of the module quota, continuing to decrement.

In addition to the module quota, it is possible to define if the requested quota must be reached by performing only forward or only backward movements, or by selecting the shortest path. In this way, it is possible to indicate the absolute

quota inside the module range, and the quota is reached also if the drive must perform a “roll-over” of the quota (a passage through the zero or the maximum value).

Using the mode “Always forward direction”, in case it is requested a positioning at a quota lower than the actual one (eg. actual position = 500 and requested position = 400), the new position is reached by moving forward until the upper quota, returning to quota 0, and then moving forward until the requested quota is reached.

The same concept is valid for the “Always backward direction” mode, but reaching the requested quota by moving backward.

In “minimum distance” mode, the drive chooses the direction of movement, in order to cover the shortest distance..

Eg.:

	Only forward direction		Only backward direction		Minimum distance	
	Example A	**Example B**	**Example A**	**Example B**	**Example A**	**Example B**
Module quota	800	800	800	800	800	800
Actual quota	400	500	400	500	650	50
Requested quota	500	400	500	400	50	650
Rotation direction	Forward	Forward	Backward	Backward	Forward	Backward
Total travel	100	700	700	100	200	200
						

The module quota function can be configured by setting the parameters below:

Register	Name	Description
Rmodulpos	*Position module quota*	Set the module quota for the actual position.
Rmodulmotenc	*Motor Encoder module quota*	Set the module quota for the motor encoder.
Rmodulextenc	*External Encoder module quota*	Set the module quota for the external encoder.
Rmodulcmd	*Module command*	Enable and define the positioning mode in Module quota:

Bit	Description
0	Enable the position module in only forward direction
1	Enable the position module in only backward direction
2	Enable the position module in minimum distance
3	Enable the motor encoder module quota
4	Enable the motor encoder external quota
[5..15]	Reserved

automatIC savE of thE posItIoN at thE shut-DowN

gENERaL ChaRaCtERIstICs

The SMD2204 is able to detect the voltage loss or a level of voltage lower than the minimum admitted value (23Vdc).

When this event occurs, the drive disables the output of current to the motor and saves actual position of the axis in the non-volatile memory, exploiting the residual charge of the power stage capacitors.

At the restart, the SMD2204 has the task to verify the quota saved in NVRAM and to report possible incongruencies.

In case the data is congruent, the saved value is copied in the register *"Rposactsaved"* and the flag of valid data is set: otherwise, both the saved quota register and the signalation flag will be equal to 0.

CAUTION!!!

In case of voltage loss with the motor in movement, the drive will save the quota reached at the moment of detection of the event. Even in case of congruent data, therefore, the saved quota con be considered valid only if the motor has not performed further movemnt caused by the load inertia or external actions (eg. operator intervention).

CAUTION!!!

In case the supply voltage has oscillations, the save of the quota is executed only at the first detection of voltage loss. The automatic save sequence is re-enabled at the restart of the drive.

CAUTION!!!

This function exploits the residual charge of the capacitors to perform all the necessary procedures for the writing of the data in the non volatile memory. In some cases, the availableenergy may not be sufficient to complete the procedure correctly..

CAUTION!!!

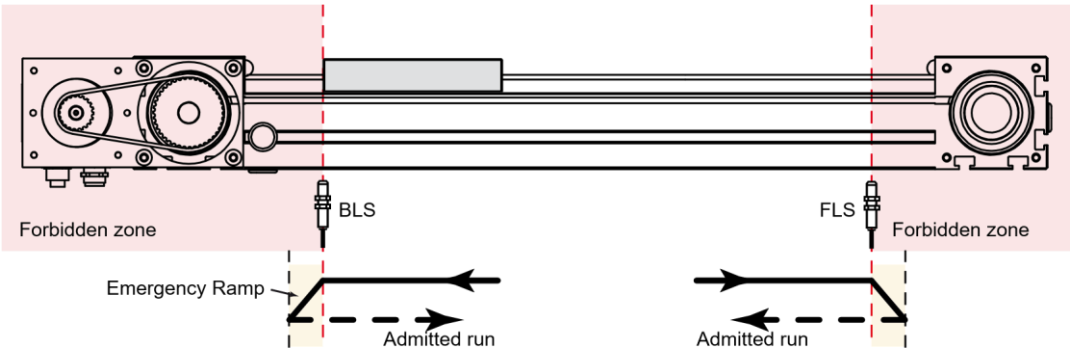
It is task of the operator to evaluate the the conditions, and possibly restore the actual quota by using the data saved at the shut-down..

paRamEtERs

<table>
<tr><th>Registro</th><th>Nome</th><th>Description</th></tr>
<tr><td>Rposactsaved</td><td>Saved Position</td><td>Contain the axis quota saved at the last shut-down.</td></tr>
<tr><td>Rposactsavedflag</td><td>Saved Position Flag</td><td>
<table>
<tr><th>Bit</th><th colspan="2">Description</th></tr>
<tr><td rowspan="2">0</td><td>H</td><td>Valid saved data</td></tr>
<tr><td>L</td><td>Invalid saved data</td></tr>
<tr><td>[1..15]</td><td colspan="2">Reserved</td></tr>
</table>
</td></tr>
</table>

hardware limit switches

The SMD2204 is able to manage independently the limit switch sensors, aborting possible movements in progress. The interruption of the movement occurs on the rising edge of the overtravel signal, by commanding a movement stop in emergency ramp (ABORT); any other movement, in the same direction of the interrupted one, is ignored, and only movements in the opposite direction are accepted..



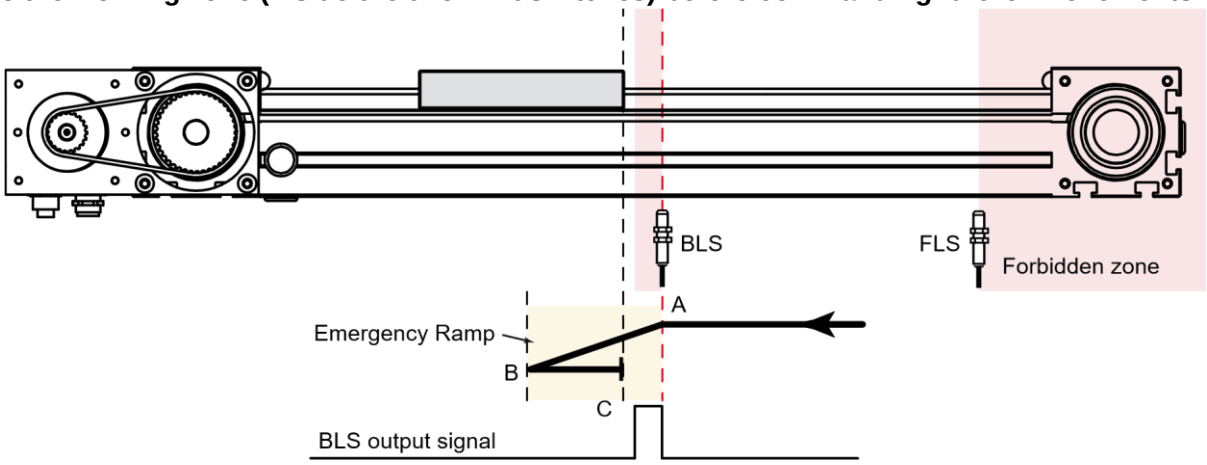
Register	Name	Description
Rflag	*Flag Register*	Enable the limit switches management

Bit		Description
4	H	Enable BLS limit switches management
	L	Disable BLS limit switches management
5	H	Enable FLS limit switches management
	L	Disable FLS limit switches management

	ABORT	ABORT

CAUTION!!!

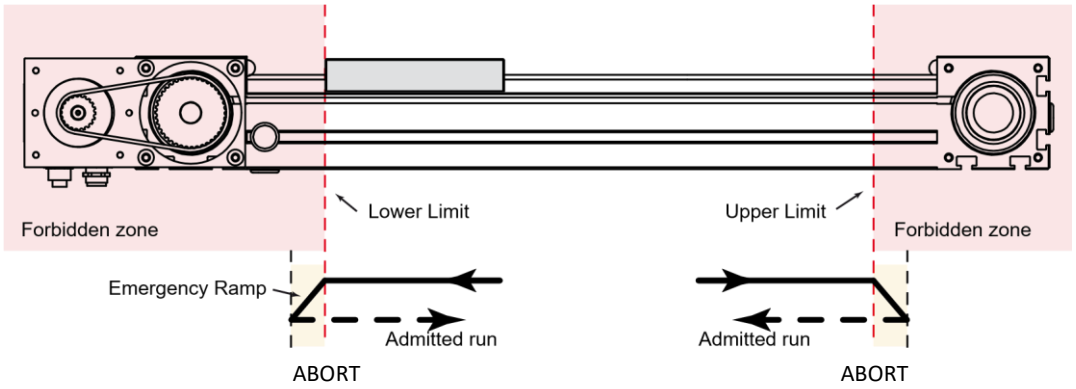
After commanding a movement in opposite direction with respect to the forbidden one, the drive reenables the possibility to move in both directions. Make sure that the motor has been brought inside the working zone (inside the two limit switches) before commanding further movements.



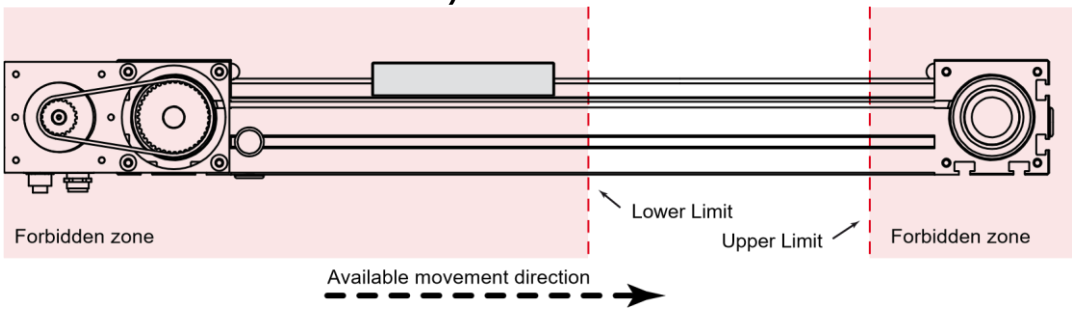
As shown in the illustration above, the drive blocks the movement after the intervention of the back limit switch (point A), braking the motor in emergency ramp until it stops in the point B.
In the point B, each movement command toward the the same direction of the interrupted movement will be aborted by the drive. If the motor is shifted to a point which is not inside the working area (eg. point C), the drive re-enables the possibility of movement in both directions, so from the poin C it will be possible to move the motor towards the point B.

SoftwaRE lImIts

It is possible to let the drive manage software limit switches in order to limit the working stroke of a system: the upper limit quota defines the maximum value that the actual position of the axis can take, and the lower limit quota defines its minimum value.
Any movement command outside this quotas range is aborted or ignored by the drive, excepting homing commands.



CAUTION!!!
If the actual position of the axis is outside the admitted zone at the moment of enabling of the software limits management, the drive will accept only movements toward the enabled direction (return movements from the forbidden zone)



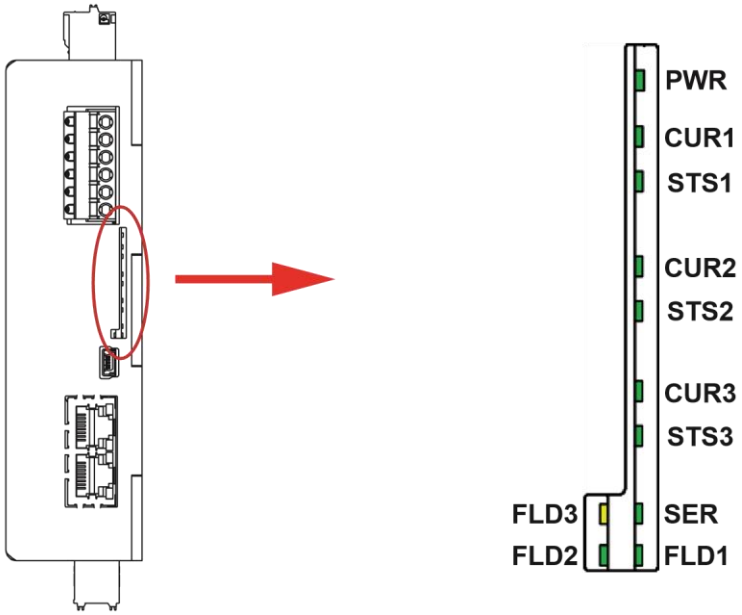
Per utilizzare la gestione delle quote limite è necessario, prima di abilitarne la gestione, definire il valore della quota limite inferiore e quello della quota limite superiore.

Registro	Nome	Description
Rupplim	*Upper Limit*	Upper limit quota
Rlowlimit	*Lower Limit*	Lower limit quota
Rflag	*Flag Register*	Enable the limit quota management

Bit		Description
2	H	Enable lower limit quota management
	L	Disable lower limit quota management
3	H	Enable upper limit quota management
	L	Disable upper limit quota management

SIgNalatIoN lEDs

The SMD2204 drives are provided with 11 signalation leds:



LED PWR

LED	Status	Description
PWR	●	Logic_Supply voltage lack
	●	Logic_Supply voltage present

IED CuR

LED	Status	Description
CUR	●	No current
	●	Reduced current
	●	Nominal current
	●	Boost current

IED sts

LED	Status	Description
STS	●	Drvie is starting
	●	Drive OK
	●	Thermic protection is active
	●	Alarm is active or BOOT mode is active

		Power_Supply voltage lack

LED SER

LED	Status	Description
SER		USB communication is not active
		USB communication is active

LED FLD

For the FLD Led signlations, see the protocol manual.

DRIVE INFORMATION

GENERAL INFORMATION

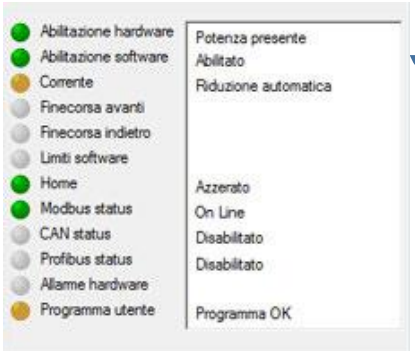
By using StepControl©, it is possible to display the general information about the drive:

- Drive model
- Firmware version
- Hardware version
- Serial number
- Operation mode
- Status
- Operating temperature
- Working temperature
- User program status
- Antaios firmware version
- Antaios hardware version

STATUS INFORMATION

They permit to know the actual status of the drive and they are helpful to look for the root causes of possible malfunctions:

- Hardware enable
- Software enable
- Current
- Forward limits
- Backward limits
- Software limits • Home status
- Modbus status
- CAN status
- Profibus status
- Hardware alarm
- User program



alaRms

The drive is able to notify hardware and software alarms that occurred, in order to give useful information for the acknowledgment and the resolution of possible anomalies. The possible alarms are

- HW overcurrent
- SW overcurrent
- I^2T intervention
- Position
- Following
- Temperature
- Digital outputs overload
- Over voltage
- Under voltage

In the Status window, the alarms are notified with a red LED and the relative red icon.

WaRNINgs

In addition to the alarms, the drive is able to notify warnings that occurred, in order to acknowledge possible abnormal conditions in advance. The possible warnings are

- HW overcurrent
- SW overcurrent
- I^2T intervention
- Position
- Following
- Temperature
- Digital outputs overload
- Over voltage
- Under voltage
- Limited output current from V_{bus}
- Saturated PI regulator
- Current limit is active

In the Status window, the warnings are notified with an orange LED and the relative orange icon.

DIagNOsIs aND REmoval of aNomalIEs

The drive is able to manage several protection functions.
When an alarm is generated, the motor is immediately stopped and the anomaly is simultaneously notified through the STS LED, the fieldbus and the alarm output (if configured).
The drive is also able to provide prior indications about functioning anomalies or warnings.

The occurrence of a warning does not intervene on the functioning of the motor, but it permits to notify through the Status registers abnormal conditions that might lead to an alarm intervention.
To restore a drive in fault state, it is necessary to reset the active alarms, or to disable and re-enable the drive: this operation can be executed through I/O, user program or fieldbus. **ALARMS DETAILS**

Type of alarm	Cause	Actions
HW Overcurrent	The current supplied by the the drive exceeds the maximum admitted current. 1. Fault of the drive (defective device, MOSFET failure, ecc) 2. Shortcircuit between phases (A, A-, B, B-) 3. Shortcircuit towards the earth 4. Motor burned 5. Shortcircuited or damaged cables	1. Disconnect the motor cable and enable the drive. If the alarm persists, replace the drive. 2. Check that the motor phases are not shortcircuited, that the cables are intact and properly connected. 3. Measure the insulation resistance between the motor phases and the earth; in case of bad insulation, replace the motor. Measure the windings resistances 4. of the motor; in case they are not balanced, replace the motor. 5. Check the integrity of cables and connectors.
SW Overcurrent	The current requested by the positioner exceeds the maximum configured threshold. 1. Dynamic is too high 2. Phase Advance is too high	1. Reduce the acceleration/deceleration ramps and the maximum speed. 2. The inertia of the load doesn't permit too high Phase Advance values.
Over Voltage	The supply voltage exceeds the maximum allowed limit. 1. Voltage peak 2. The regenerated energy cannot be absorbed	Measure the supply voltage on the connector M1 and make sure that it is included within the permissible ranges. 1. Make sure that possible fluctuations or voltage peaks don't generate a voltage outside the permitted range. 2. Increase the capacity of the supply stage.
Under Voltage	The supply voltage is lower than the minimum allowed limit. 1. Voltage is too low 2. The output capacity of the power supply stage is not sufficient	Measure the supply voltage on the connector M1. 1. Increase the supply voltage 2. Increase the capacity of the supply stage.
Temperature	The temperature of the drive exceeds the maximum configured threshold. 1. Lacking or insufficient ventilation 2. Insufficient distance between the units 3. Heat sources proximity	1. Increase the ventilation to improve the exceeding heat dissipation. 2. Increase the distance between the units to improve the air flow. 3. Move the unit away from heat sources.

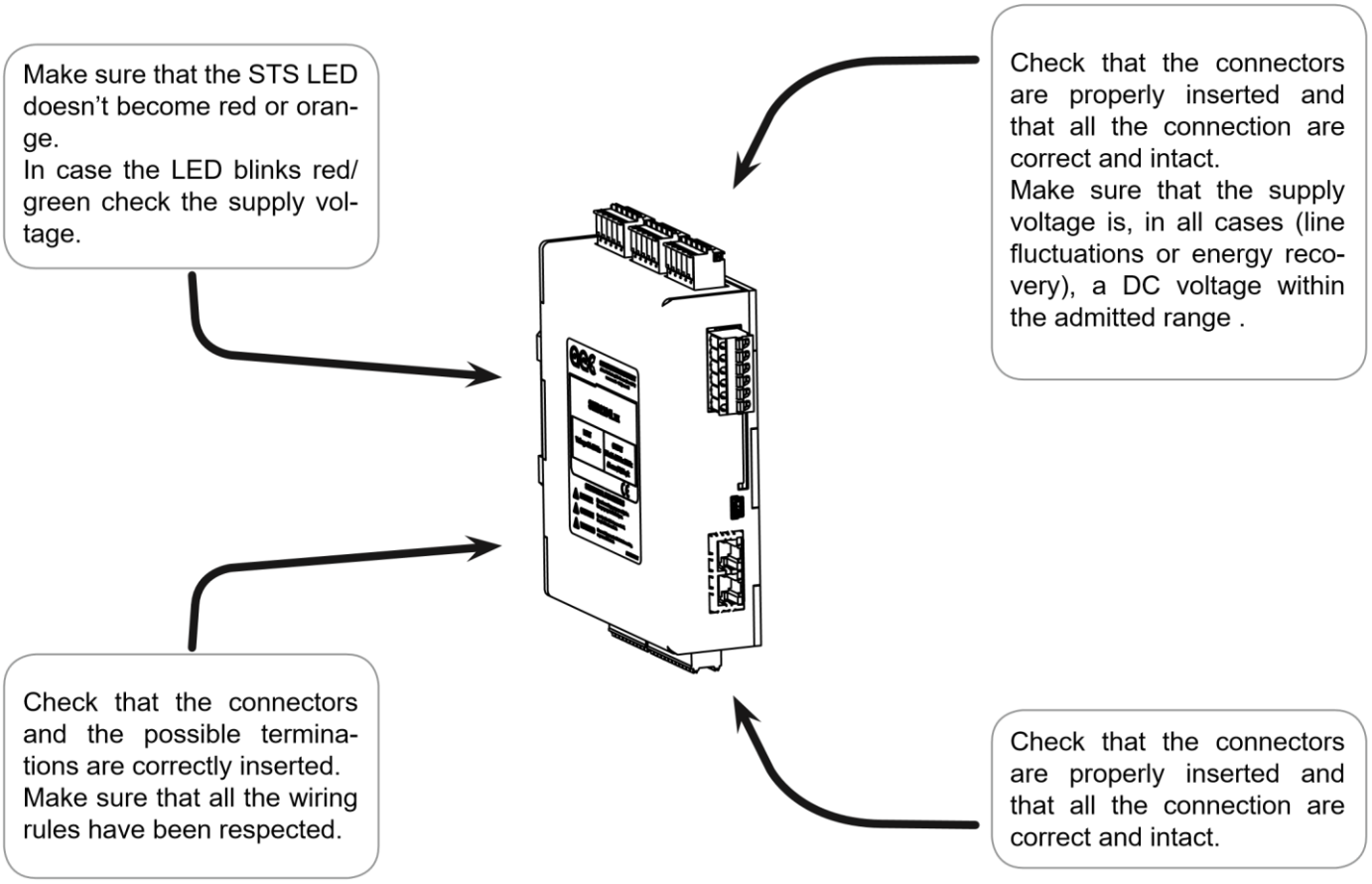
Type of alarm	Cause	Actions
I²T	The working dynamics or the system calibration generate a too high thermal image of the motor.	Check that the motor is properly sized for the application and that the calibration of the parameters of the control loops is correct.
Output overload	The current supplied by the digital outputs is too high. 1. Shortcircuit 2. The load absorbing is too high	Remove the shortcircuit on the load. 1. Check that the requested current by the load is compliant with the characteristics 2. of the digital output.
Following	The following error exceeds the configured threshold. 1. The motor doesn't respond to the commands 2. The error threshold is too low	1. Check that the motor correctly follows the requested target. Make sure that the requested torque does not exceed the motor torque; optimize the parameters of the control PID; reduce accelerations and decelerations. 2. Set an higher error threshold.
Position	The position error exceeds the configured threshold. 1. The motor doesn't respond to the commands 2. The error threshold is too low	1. Check that the motor torque is sufficient to keep the position; check the calibration of the position PID 2. Set an higher error threshold.
Encoder phase	The drive doesn't recognize any valid encoder. 1. Wrong encoder connection 2. Encoder phase is interrupted 3. Load blocked during phasing	Check the correct power supply of the encoder; in case of long cables, pay particular attention to the wiring layout. Use shielded cables and keep the power cables separated from the signal cables. 1. Check the connection of the phases 2. Check the enocder cable 3. Remove the cause of the load blocking
Phase A error	The drive doesn't recognize the phase A of the motor. 1. Interrupted cable 2. Damaged connector	Check the integrity of the cable 1. Check the integrity of the connector pins 2. and that the connector is well fixed.
Phase B error	The drive doesn't recognize the phase B of the motor. 1. Interrupted cable 2. Damaged connector	Check the integrity of the cable 1. Check the integrity of the connector pins 2. and that the connector is well fixed.

Type of warning	Cause	Actions
HW Overcurrent	The current supplied by the the drive is close to the maximum admitted current. 1. Fault of the drive (defective device, MOSFET failure, ecc) 2. Dispersion between phases (A, A-, B, B-) 3. Dispersion towards the earth 4. Motor burned 5. Shortcircuited or damaged cables	1. Disconnect the motor cable. If the notification persists, replace the drive. 2. Check that the iintegrity of the insulation between the phases. 3. Measure the insulation resistance between the motor phases and the earth; in case of bad insulation, replace the motor. Measure the windings resistances 4. of the motor; in case they are not balanced, replace the motor. 5. Check the integrity of cables and connectors.
SW Overcurrent	The current requested by the positioner is close to the maximum configured threshold. 1. Dynamic is too high 2. Phase Advance is too high	1. Reduce the acceleration/deceleration ramps and the maximum speed. 2. The inertia of the load doesn't permit too high Phase Advance values.
Over Voltage	The supply voltage is close to the maximum allowed limit. 1. Voltage peak 2. The regenerated energy cannot be absorbed	Measure the supply voltage on the connector M1 and make sure that it is included within the permissible ranges. 1. Make sure that possible fluctuations or voltage peaks don't generate a voltage outside the permitted range. 2. Increase the capacity of the supply stage.
Under Voltage	The supply voltage is close to the minimum allowed limit. 1. Voltage is too low 2. The output capacity of the power supply stage is not sufficient	Me ısure the supply voltage on the connector M1. 1. Increase the supply voltage 2. Increase the capacity of the supply stage.
Temperature	The temperature of the drive is close to the maximum configured threshold. 1. Lacking or insufficient ventilation 2. Insufficient distance between the units 3. Heat sources proximity	1. Increase the ventilation to improve the exceeding heat dissipation. 2. Increase the distance between the units to improve the air flow. 3. Move the unit away from heat sources.
I^2T	The working dynamics or the system calibration generate a too high thermal image of the motor.	Check that the motor is properly sized for the application and that the calibration of the parameters of the control loops is correct.

Output overload	The current supplied by the digital outputs is too high. 1. Shortcircuit 2. The load absorbing is too high	1. Remove the shortcircuit on the load. 2. Check that the requested current by the load is compliant with the characteristics of the digital output.

Type of warning	Cause	Actions
Following	The following error is close to the configured threshold. 1. The motor doesn't respond to the commands 2. The error threshold is too low	1. Check that the motor correctly follows the requested target. Make sure that the requested torque does not exceed the motor torque; optimize the parameters of the control PID; reduce accelerations and decelerations. 2. Set an higher error threshold.
Position	The position error is close to the configured threshold. 1. The motor doesn't respond to the commands 2. The error threshold is too low	1. Check that the motor torque is sufficient to keep the position; check the calibration of the position PID 2. Set an higher error threshold.
Limited current from V_{BUS}	The bus voltage does not permit to supply the requested current at the actual working speed. It indicates that in the current condition the motor is not able to supply he nominal torque. 1. Supply voltage is too low 2. Working speed is too high 3. Wrong motor parameterization	Increase the supply voltage, reduce the working speed, check the motor parameterization.. 1. Increase the supply voltage 2. Rreduce the working speed 3. Check the motor parameters
Saturated regulator	The drive is not able to meet the current requested at the actual working conditions (voltage and speed). 1. The requested current/torque/speed are not compatible with the system characteristics	The drive is supplying the whole available power, but it isn't able to meet the current/ torque/speed request. 1. Increase the supply voltage (if possible), reduce the current/torque/speed request, modify the defluxing parameters. The motor defluxing reduces the torque for the benefit of the speed. Modify these settings only if strictly necessary and in any case with knowledge of the facts..
Limitazione di corrente attiva	The drive is limiting the current supplied to the motor. 1. The register Rcurtorque has a value not equal to 0 and lower than the nominal current.	In case a current limitation is not required, set the parameter Rcurtorque to 0, or to a value higher than the nominal current.

PRELIMINARY CHECKS



Preliminary checks on the mechanics:

- Check that the motor is free to rotate and that there aren't mechanical impediments
- Make sure that during the movement no electromagnetic holding brakes intervene
- Make sure that the mechanical coupling is correct, not loose, and that there are no torque peaks.
- Make sure that the requested dynamics are compatible with the characteristics of the servo-drive
- Check that the motor doesn't generate anomalous noises. **thE motoR DoEsN't RotatE**

Category	Cause	Corrective action
Parameters	Wrong control mode	Check the selected control mode: Open loop (sensorless) Closed loop (encoder is required)
	Wrong function mode	Check the configured function mode: Current Velocity Position Step/Direction
	SW enabling	Check that the device enables the current output.
	Current limitation	Make sure that the parameter Rcurtorque is not set at a too low value that does not permit to overcome the breakaway friction of the system.
	Maximum speed	Check that the parameter Rvelmax is not equal to 0.
	Target absent	Make sure that the drive receives a target compatible with the selected function mode.

	Software limits	Make sure that the requested quota is within the range defined by software limits.
Category	**Cause**	**Corrective action**
Connections	HW enabling	Check that the power stage is properly supplied (HV_ Power). In case an enabling input is configured, check the presence of a valid logic state at the input.
	Overtravel	In case the automatic management of the limit switches is enabled, make sure that the BLS (Backward Limit Switch) and the FLS (Forward Limit Switch) inputs are not active.
	Step and DIR signal absence	In case of Step and direction function mode, check the connection of the signals Step IN and DIR
Installation	The shaft of the motor is blocked	Disable the drive and disconnect the motor from the mechanical part. Try to rotate the shaft with an hand; in case it is blocked, contact the seller. In case of electromagnetic brake, open the brake before making this test.

thE RotatIoN Is Not smooth

Category	Cause	Corrective action
Calibration	The gains of the position loop are too low	Increase the proportional gain Kp of the velocity loop
	Unstable speed reference	In case of reference from analog, check that the signal is stable and not disturbed (show Rvel through the oscilloscope). In case of step and direction mode, check that the signal in frequency is stable and not disturbed.
Connections	Disturbances on the reference signal	Check the connection and the shielding. Move away the signal cables from the power cables. Provide the proper filters on the power cables.

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Category	Cause	Corrective action
System	Position command error	Make sure that the target quota sent to the drive is correct; in case of step and dir mode, check that the number of pulses generated by the controller is correct: repeat the test several times and check that the number of pulses is always the same. Incase the number of pulses varies, check the correct functioning of the controller.
	The characteristics of the command does not meet the requested requirements	Make sure that the target quota and the movement parameters have the same measuring unit. In step and direction mode, make sure that the Step IN signal is not deformed or too short.
Calibration	The gains of the position loop are too low	In closed loop mode, check the calibration of the position loop.
Parameters	Positioning window is too wide	Reduce the value of the positioning window (Rdeadpos)
	The frequency of the Step signal exceeds 1 MHz.	Reduce the driving frequency; modify the resolution of the motor.
	Wrong motor resolution	Check the setting of the motor resolution.

	Velocity loop Kp is too high	Reduce the velocity Kp in order to per stabilize the behavior of the motor when it's stopped.

Category	Cause	Corrective action
Connection	The following signals are not stable: • Drive enable (if configured) • Current reduction (if configured) • Step IN (Step and direction mode)	Check the connection and shielding of the signals. Separate the signal conductions from the power conductors. Check the functioning of the controller (HOST)
Installation	The inertia of the load is high	In case of load oscillations also after the best calibration of the control loops, increase the torque deliverable by the system (motor and drive)

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Category	Cause	Corrective action
System	The zero signal is not recognized	Make sure that the homing input is activated.
	Homing speed is too high	Reduce the zero point search speed.
Connection	Unstable zero signal	By using an oscilloscope, make sure that there are no bounces of the zero signal. Check the wiring and take the proper actions in order to reduce possible disturbances.
	Zero signal absence	Make sure that the signal is properly connected and the cable is intact.

aNomalous NoIsE

Category	Cause	Corrective action
Parameters	The gains of the control loop are too high	Reduce the proportional gains of the control loop.
Connessione	Mechanical resonances	Check the parameterization of the system and the mechanical installation od the device.
	Motor bearings	Disconnect the motor from the load and check if the noise is referable to the motor bearing.
	Electomagnetic noise, mechanical noise of the gears...	Disconnect the motor from the load and check if the noise is still present.

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Category	Cause	Corrective action
Parameters	Wrong start-up parameters	In the startup parameters of the drive, define the function "Autorun"
	Invalid program	Make sure that a valid program is present

Category	Cause	Corrective action
Parameters	Parameter is not saved	All the modifications are transferred in the drive RAM. To make them definitive, send the save in NVRAM command.

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