AZ3Plus50

Extra low voltage servo drive for brushless and DC motors

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REVISION INDEX						
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1.0	-	Draft	02/08/2023	mb	pm	pm
1.1	-	General update	15/09/2023	mb	pm	pm
1.2	4	Small fixes	22/01/2024	mb	pm	pm
1.3	4	Drawing update	07/01/2025	mb	pm	pm

1. INTRODUCTION

1.1. General information

The aim of this manual is to provide the reader with all the necessary information for a proper installation, operation and service of the servo drive. If you feel unsure about operation, contact your dealer for advice and information or directly contact TEM Electric Motors at info@temdrive.com. Documentation relating to the AZ3 series:

Document	Contents	Id no.
AZ3 series User Manuals	Mechanical installation, Electrical installation, Safety, Specification, Drive configuration	ST.TEC.054.EN_ManualAZ3s ST.TEC.080.EN_ManualeAZ3Plus ST.TEC.081.EN_ManualeAZ3Plus50 ST.TEC.090.EN_ManualeAZ3INT
AZ3 series CAN-bus Manual	CAN description and parameter setting	ST.TEC.071-CANopen-Manual
AZ3 series Modbus RTU Manual	Modbus description and parameter setting	ST.TEC.022.ModbusRTU-AZ3Series-Manual
TEM Interface Manual	Drive configuration and parameter setting tool	ST.TEC.109.EN_TEMInterfaceManual

Read carefully this manual before using the drive. TEM Drive reserves the right to change the information reported in this manual without prior notice because the product is in continuous evolution.

1.2. Disclaimer

No liability is assumed for any damage or breakdown resulting from:

- Failure to observe the information in the instruction manual
- Unauthorized modifications to the servo drive
- Operator error
- Improper work on or with the servo drive

1.3. Copyright

2. SAFETY PRECAUTIONS

Read carefully the following items so that you can safely use the drive avoiding causing injury to the operators, damaging the mechanic components driven by the drive or other objects in the area. Make sure you that all warnings are correctly observed.

MARKING	Meaning of the marking
	Prohibition. Do not do it.
	Obligation. Follow the instruction.
	Warning.

2.1. Preliminary information

These instructions are intended for all who install, operate and service the drive. Read carefully the following instructions before you work on the unit so that you can safely use the drive avoiding causing injury to the operators, damaging the mechanic components driven by the drive or other objects in the area. Make sure you that all warnings are correctly observed.

2.2. Intended use

The servo drive is intended for the use in a “Second Environment”, i.e. industrial environments where the low voltage network does not feed residential buildings. Never use the drive for an application involving serious risk to life or property without ensuring that the system as a whole has been designed to address the risks and that the drive is properly rated and installed for the intended use within the overall equipment or system. Unintended or improper use of the product may result in severe injury to persons and damage to property.

2.3. Restrictions of use

 WARNING	
	• Do not use the servo drive in potentially explosive atmospheres • Do not use the servo drive in areas exposed to harmful oils, acids, gases, vapors, dust and radiation. • Do not use the servo drive in applications with high mechanical vibration and shock loads

2.4. Handling

WARNING	
	• Do not disassemble, modify or repair. This can cause electrical shock, fire and injury. • Do not touch the electronic drive components when power is on. This can result in electric shock or other injury. • Do not allow water or any other fluid to come in contact with the drive. This can result in electric shock or fire.
	• Turn on the power only when the drive is closed in a proper insulating cabinet to avoid electric shock or other injury. • If the drive begins to emit smoke, an unusual odour, or unusual sounds, immediately disconnect the power. Continuous use of the drive in such a state may cause fire. Call your TEM Drive distributor for assistance and/or repair. • Always turn the power off if the drive is not used for long time. Leaks, dust and other material may cause malfunctions and if power is left on with the drive in that state, it may result in fire.

CAUTION	
	• Do not touch heatsink fins or discharge / braking resistors. These parts may be hot and can cause burning if you touch them.

2.5. Transportation and installation

WARNING	
	• Do not install or operate the drive if it is damaged. This can result in electrical shock or fire. • Do not place any inflammable objects near the drive. If an accident occurs in which flame is emitted, this could lead to fire. • Do not install in any location where the drive could come into contact with water or other fluids. This can result in electric shock or fire.
	• Operate under the environmental conditions prescribed in this instruction manual. Operations under any other conditions may result in malfunction. • Install an emergency stop device that fits with system specifications. The drive alone cannot stop operation immediately, thus resulting in an accident or injury.

CAUTION	
	• Always turn the power off when removing the drive from its support.

2.6. Wiring

WARNING	
	• First shut off input power and wait at least 5 minutes before touching terminals and wires on equipment that is connected to drive power side. Touching the terminals and wires before that time could result in electrical shock.

	• A qualified expert must do electrical construction work. Connection of input power by someone who does not have that expert knowledge may result in fire or electric shock.
	• Connect output terminals (motor side) correctly. Incorrect connections may result in injury or electric shock.
	• The following steps must be performed before wiring:
	  ○ Turn off all input power.
	  ○ Wait at least 5 minutes and check to make sure that the on state LED is no longer lit.
	  ○ Use a tester that can measure DC voltage (60 V DC or more) and check to make sure that the voltage to the DC main circuits (across +VDC and -VDC) is 45 V or less. If these steps are not properly performed, the wiring will cause electrical shock.
	• Check to make sure that the input power voltage is within the limits of the rated power voltage indicated on the manual. If the input power voltage do not respect these conditions, this may result in fire.

CAUTION	
	• Do not attach devices with built-in capacitors (such as noise filters or surge absorbers) to the outputs (motor side) terminals. This could cause a fire

2.7. Operations

In the event of deviations from normal operation switch the drive off. Example of deviations are increased temperatures, noise, vibration. In case of a motor standstill disconnect the drive form the supply system before start troubleshooting.

WARNING	
	• Do not overload the drive over its capabilities. The use of the drive over its maximum service factor may cause serious accidents through overheating and fire. • Do not touch terminals when electrical power is going to the drive even if the motor is stopped. Touching the drive terminal while power is connected to it may result in electrical shock. • Do not touch the drive when the hands are wet. Such action may result in electric shock.
	• If parameters are set incorrectly, the drive may have some damage or unexpected movement. Be sure to set the drive parameters correctly.

CAUTION	
	• Use a motor that conforms to the specifications of the drive and power supply. If the motor being used does not conform to those specifications, not only will the motor not rotate correctly but also it may cause serious accidents through overheating and fire.

2.8. Modification of parameters

WARNING	
	• Do not modify parameters before reading carefully this manual. An incorrect set of the parameters can cause injury or accidents.

2.9. Maintenance and inspection

WARNING	
	• Do not replace parts. This could be cause of electric shock, fire and bodily injury. To replace parts, call your TEM drive distributor.

	• The equipment must be inspected periodically. If the equipment is not inspected and maintained, errors and malfunctions may not be discovered and that could result in accidents.
	• Before inspection performs the following steps
	  ○ Turn off all input power.
	  ○ Wait at least 5 minutes and check to make sure that the on state LED is no longer lit.
	  ○ Use a tester that can measure DC voltage (60 V DC or more) and check to make sure that the voltage to the DC main circuits (across +VDC and -VDC) is 45 V or less. Performing an inspection without carrying out these steps first could lead to electric shock.

2.10. Disposal

WARNING	
	• If you dispose of the drive, have it done by a specialist in industry waste disposal (*). If you dispose of the drive by yourself, this can result in explosion of capacitor or produce noxious gases, resulting in injury. (*) Persons who specialize in the processing of waste and known as "industrial waste product collectors and transporters" or "industrial waste disposal persons". Please observe any applicable law, regulation, rule or ordinance for industrial waste disposal.

3. GENERAL INFORMATION

AZ3Plus50 is an extra-low voltage drive designed for the control of AC/DC brushless motors and DC motors. The high versatility of this product is demonstrated by the position feedbacks available (Hall, incremental, absolute encoder and sensorless), the different kind of inputs (analog and digital) and outputs (digital, power PWM) and the communication interfaces (CAN, Modbus); furthermore it is available in both integrated and stand-alone versions. The drive can also manage an electromechanical brake or a braking resistor without relay/contactor.

3.1. Full specifications

FULL SPECIFICATIONS	
POWER STAGE	
Supply voltage	24 V to 60 V DC (maximum limits 20 V to 62 V DC)
Output current	50 A continuous* ÷ 80 A Peak (5s)*
Maximum output power	3000 W*
TECHINICAL CHARACTERISTICS	
Operating temperature	-25 °C ÷ +60 °C
Motor types	Brushless AC, Brushless DC, DC motor
Position feedback	Hall Switches (120°), incremental encoder, absolute encoder (SSI, BiSS, EnDat), sensorless
CONTROL	
Control loops	Torque current, speed and position
Control modes	Digital inputs, analog input, DS402
DS402 modes	Profile velocity, profile torque and profile position
INPUTS	
Digital	General purpose (10 V to 48 V DC)
	4 digital inputs plus 2 optional (start and stop button, limit switches, change dir. etc.)
Analog	0 ÷ 10 V, ±10 V
	1 analog input plus 2 optional (Sin/Cos encoder*, potentiometer, PLC analog signals, etc.)
STO	1 STO plus 1 optional TD input (Torque Disabling)
HF inputs	2 optional high frequency digital inputs (pulse and direction control, second encoder*, etc.)
Motor protection	Input for motor thermistor (NTC)
OUTPUTS	
Logic	Configurable digital outputs (maximum output current 200mA)
	2 digital outputs plus 2 optional (fault signaling, position reached, etc.)
Power outputs with PWM control	Braking resistor, electromechanical brake
Emulated encoder	Optional channels for emulated encoder output
COMMUNICATIONS	
Communications protocol	CAN / CANopen DS402, Modbus RTU (over RS485), UART, optional ethercat*
PC SOFTWARE	
Parametrization	Basic & advanced views
Diagnostic	Virtual oscilloscope, monitor panel
Commands	Remote command panel

*@ 25°C

4. INSTALLATION AND WIRINGS

Read carefully the safety precautions reported in chapter 2.5 and in chapter 2.6 before wiring operations!

Carefully follow the instructions below, before installing the drive and integrate it into your system.

4.1. Installation environment

Remember that the drive is an electronic device; check carefully that the installation environment is appropriate:

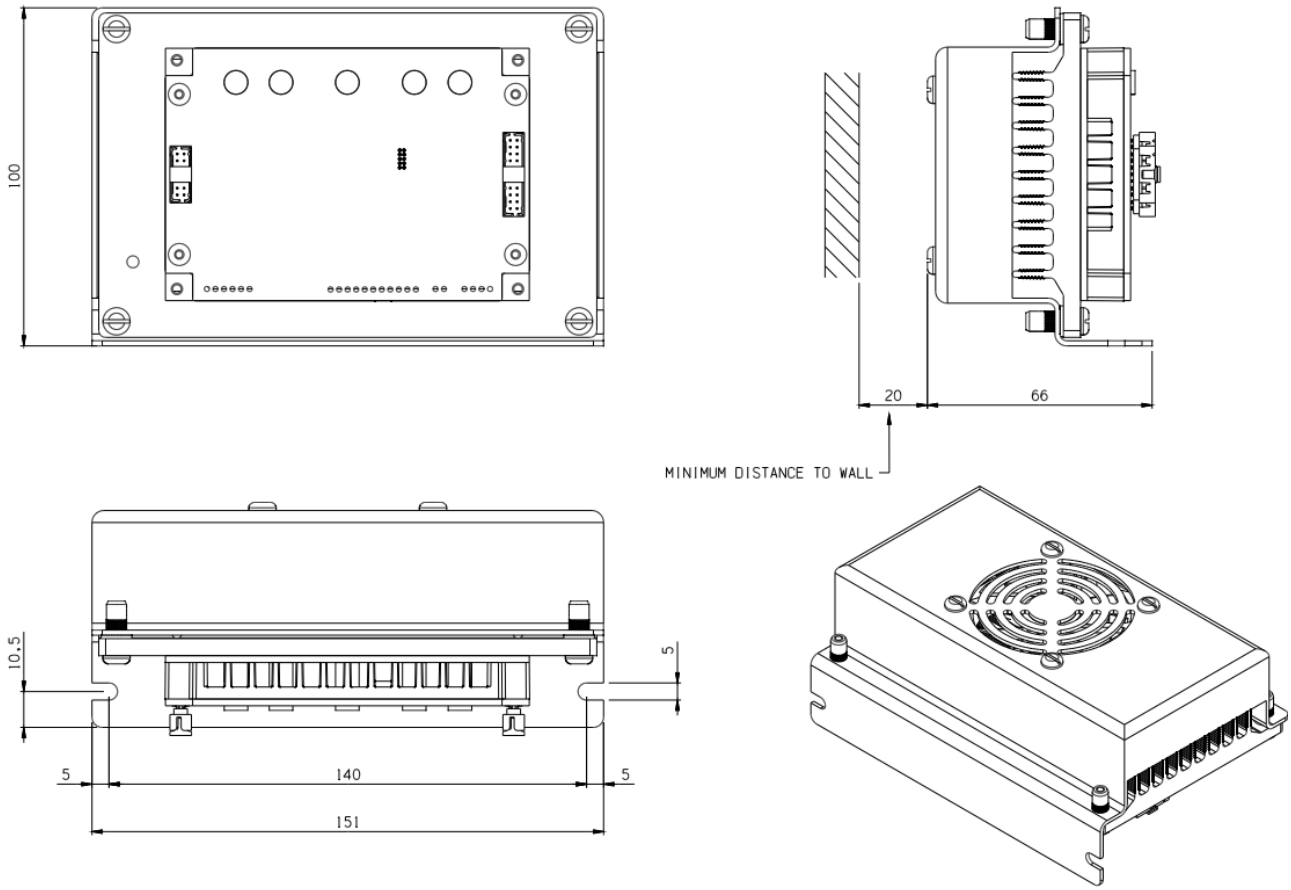
- Do not install in any location with high temperature, high humidity, moisture condensation and freezing.
- Avoid installing location where there is the possibility of exposition to water, large amounts of dust, metallic fragments or corrosive gases.
- Operate in areas where the temperature is within the limit temperatures.
- Do not install in any location that can be subject to large amounts of vibrations.
- Do not install in any location that contain any kind of flammable or explosive substances.

4.2. Mechanical installation

During the installation of the drive, take care of distances between others objects in order that the wiring can be carried out easily and the drive can dissipate the heat generated during operation.

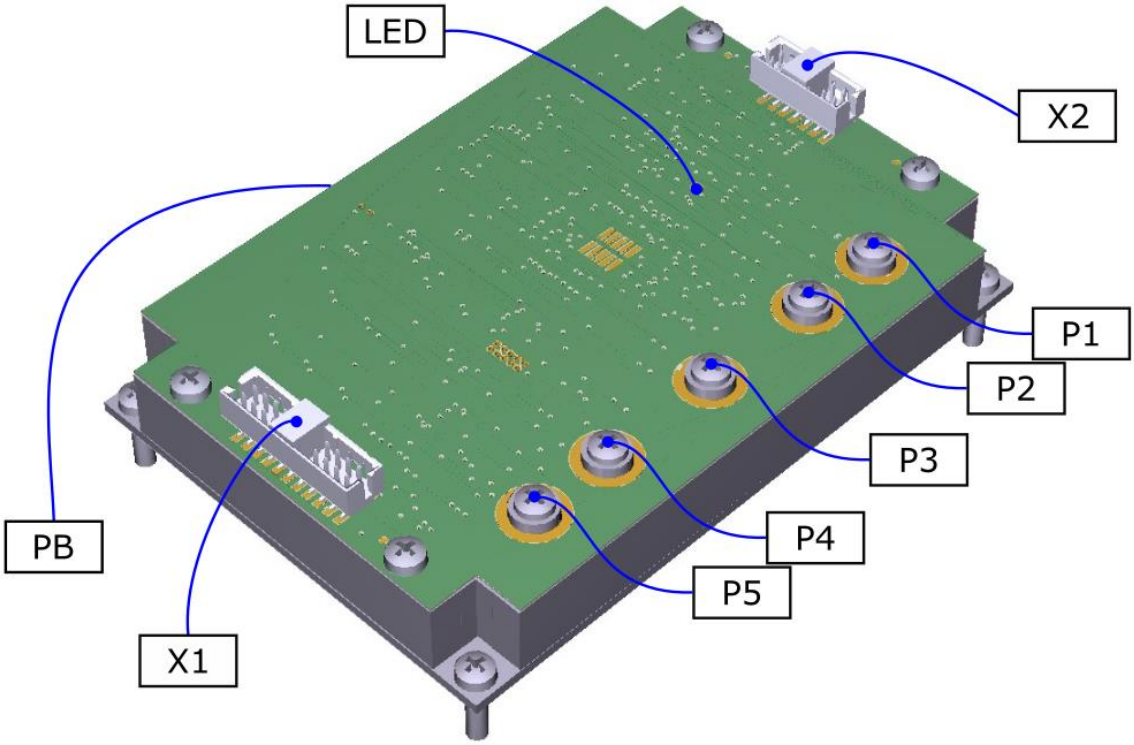
4.3. Mechanical drawings

In the following image the dimension of the drive are showed with all the measures in mm.



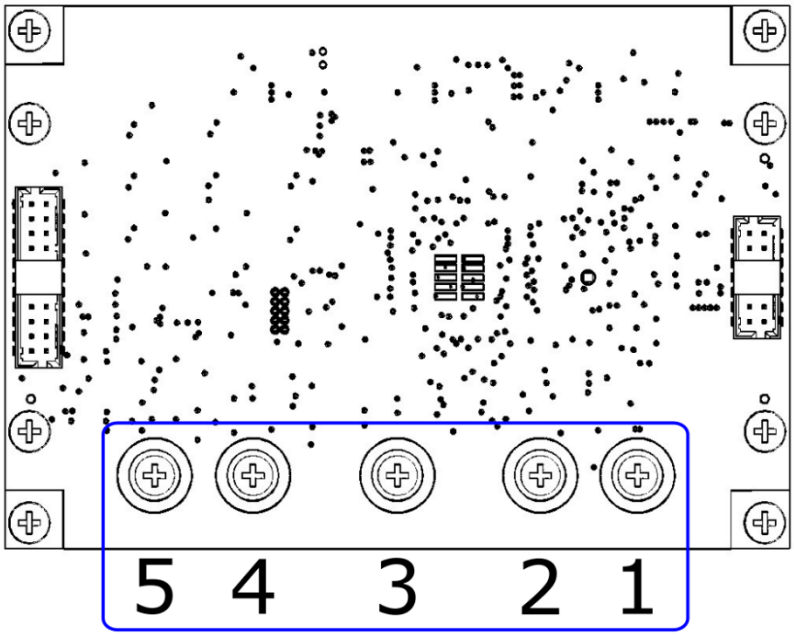
4.4. Electrical connections

During connection of terminals, work with power disabled. The image below shows AZ3Plus50 connectors.



4.4.1. POWER CONNECTIONS

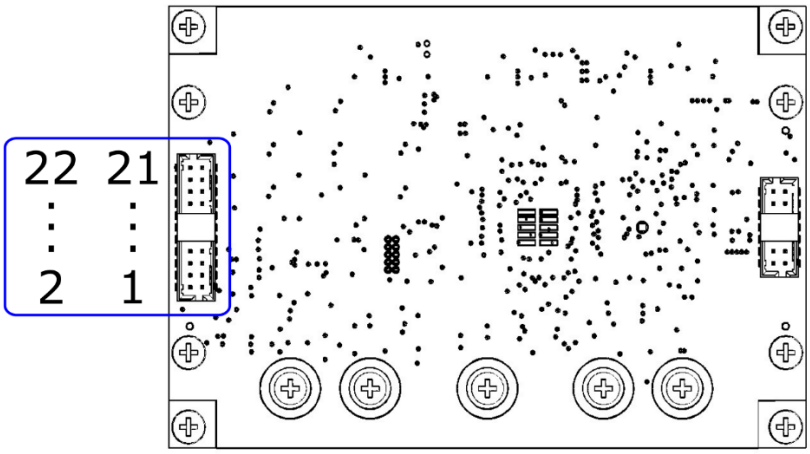
The holes for the power connections are made for M4 screws. Tighten the screws with a torque between 0.5 Nm and 1 Nm. To prevent the screw from unscrewing, use split washers. Use a cable with a ring terminal and with adequate size according to the expected current.



PIN	DESCRIPTION	
1	+VDC	Positive supply
2	W -M	brushless motor W phase DC motor negative pole
3	V	brushless motor V phase
4	U +M	brushless motor U phase DC motor positive pole
5	GND	Ground

4.4.2.X1 CONNECTOR

X1 is a Molex 0878326022. The following image shows X1 pin-out.

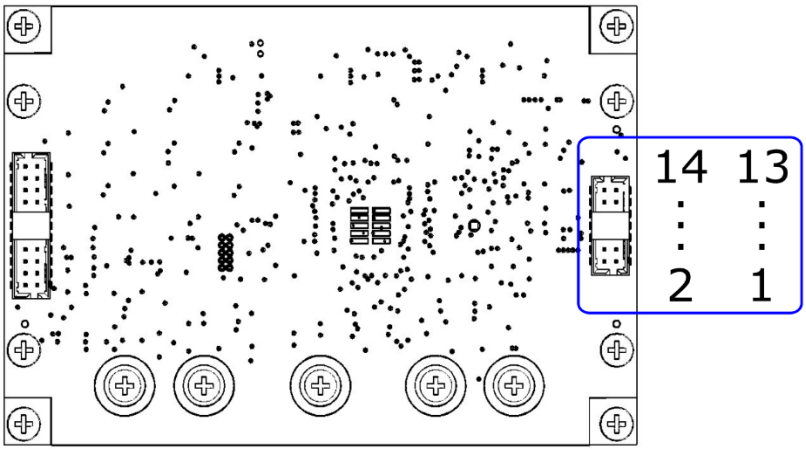


PIN	DESCRIPTION
1	CANL
2	CANH
3	CANL
4	CANH
5	RS485 for Modbus communication – B/-
6	RS485 for Modbus communication – A/+
7	UART for PC software communication – RX
8	UART for PC software communication – TX
9	Ground
10	Ground
11	Analog input #1
12	Digital output #2
13	Power output #2
14	Digital output #1
15	Digital input #3
16	Digital input #4
17	Digital input #1
18	Digital input #2
19	Ground
20	Internally connected to positive supply
21	Connect to the STO relay
22	Connect to the STO relay

The counter-part of this connector is a Molex 511102251 to be used with the socket contacts Molex 503948051.

4.4.3.X2 CONNECTOR

X2 is a Molex 0878325623. The following image shows X2 pin-out.



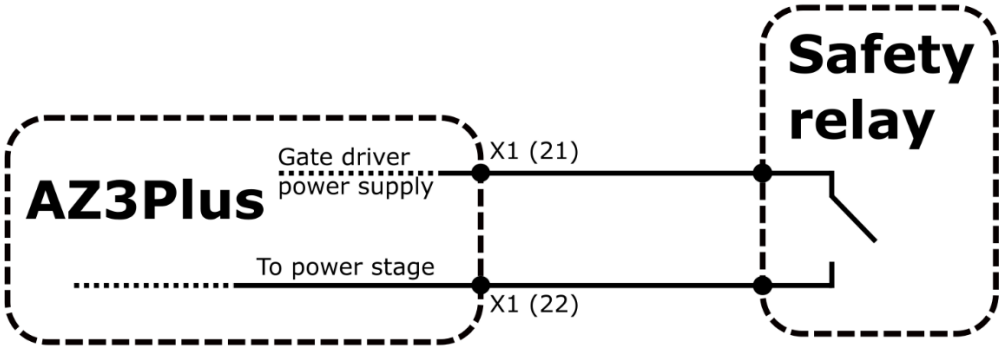
PIN	DESCRIPTION
1	Incremental encoder – CHA+
2	Hall signal – W
3	Incremental encoder – CHA-
4	Hall signal – V
5	Incremental encoder – CHB+
6	Hall signal – U
7	Incremental encoder – CHB-
8	Motor thermistor
9	Incremental encoder – CHZ+
10	Supply +5V DC
11	Incremental encoder – CHZ-
12	Ground
13	Internally connected to positive supply
14	Power output #1

The counter-part of this connector is a Molex 511101451 to be used with the socket contacts Molex 503948051.

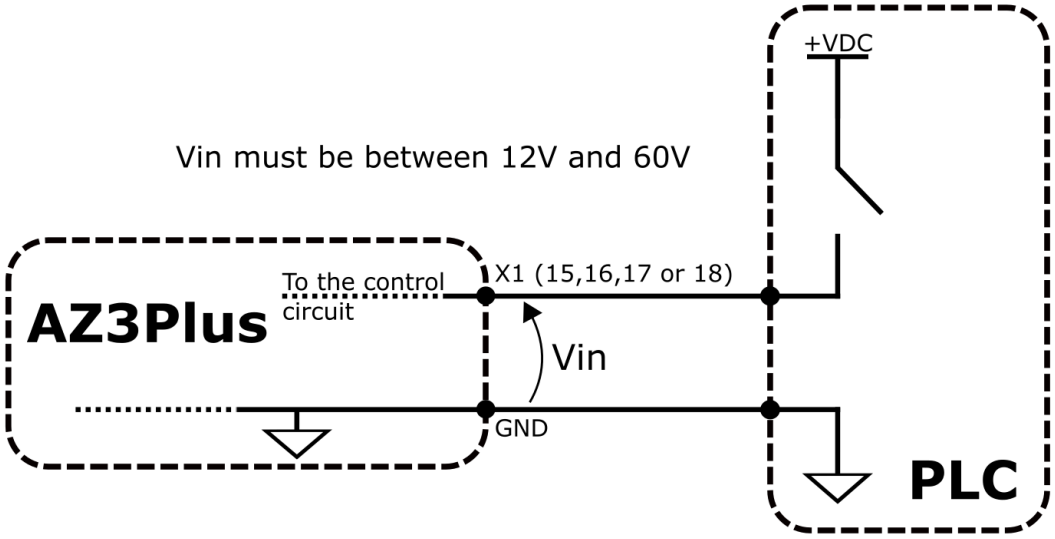
4.4.4. HOW TO CONNECT

Read carefully the following instruction, non-observance of this specification may damage the drive!

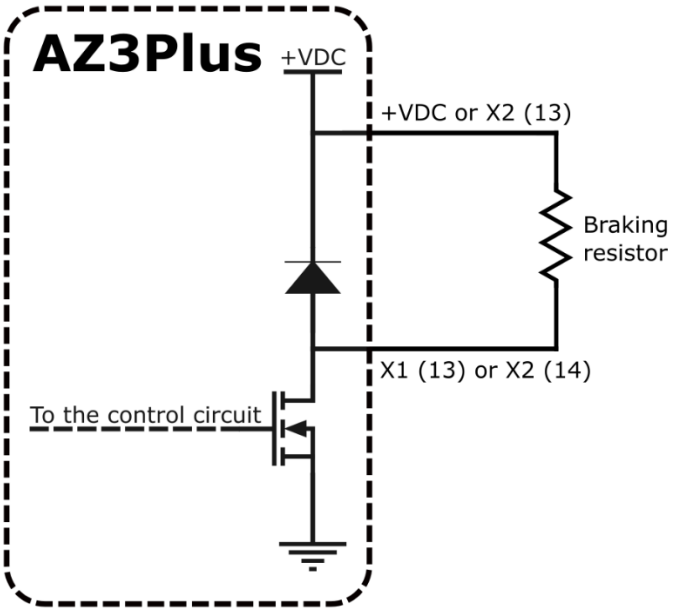
- To enable the power stage, pins 21 and 22 of connector X1 must be short-circuited. In the images below a connection examples is shown.



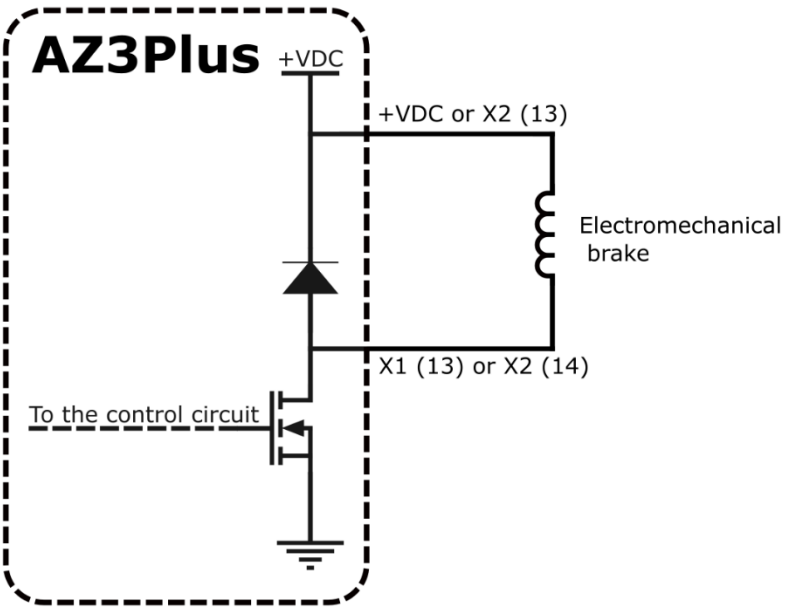
- AZ3Plus50 has four digital inputs with the following schematic. The input digital inputs voltage must be between 12 V and 60 V. In the images below a connection examples is shown.



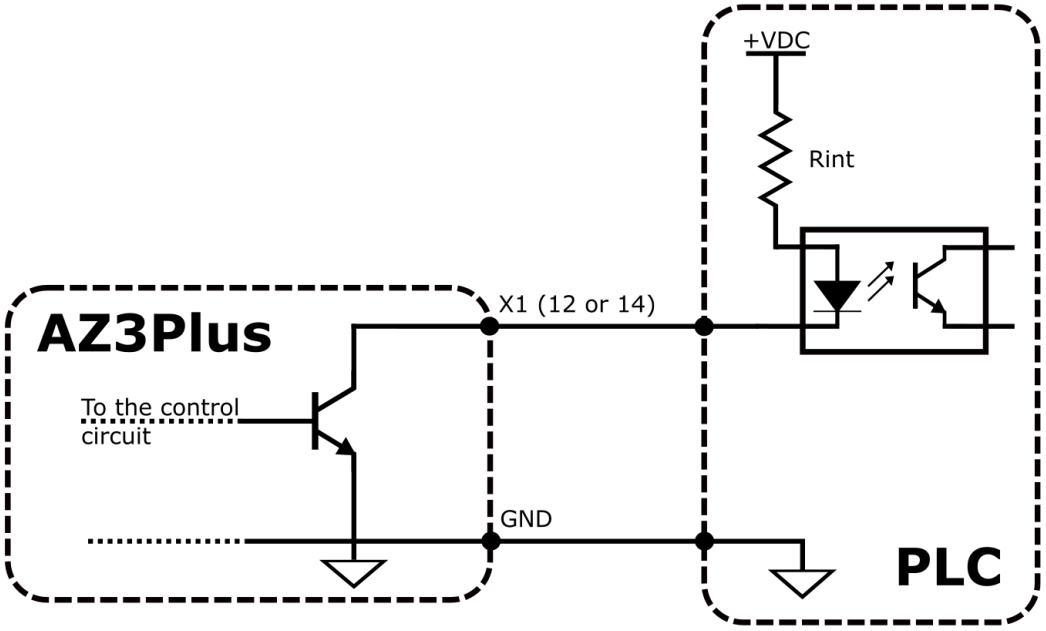
- Through power output 4 of X1, the drive can manage a braking resistor without relay/contactor. The braking resistor must not be lower than 30 Ω. To manage smaller resistances, use an external MOS. The drive has an optional output to manage the external MOS.



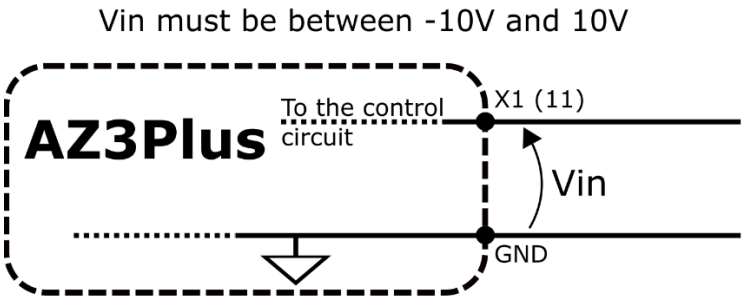
- The drive can manage an electromechanical brake without relay/contactor. The current of the electromechanical brake must not exceed 1.5 A.



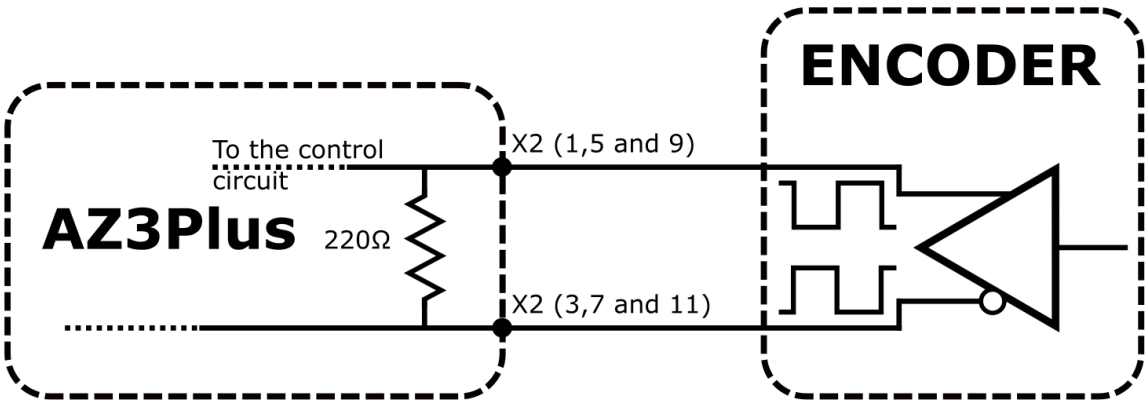
- AZ3Plus50 has two digital outputs with the following schematic. Do not exceed an input current of 100 mA. Non-observance of this specification may damage the drive. In the images below a possible connection example.



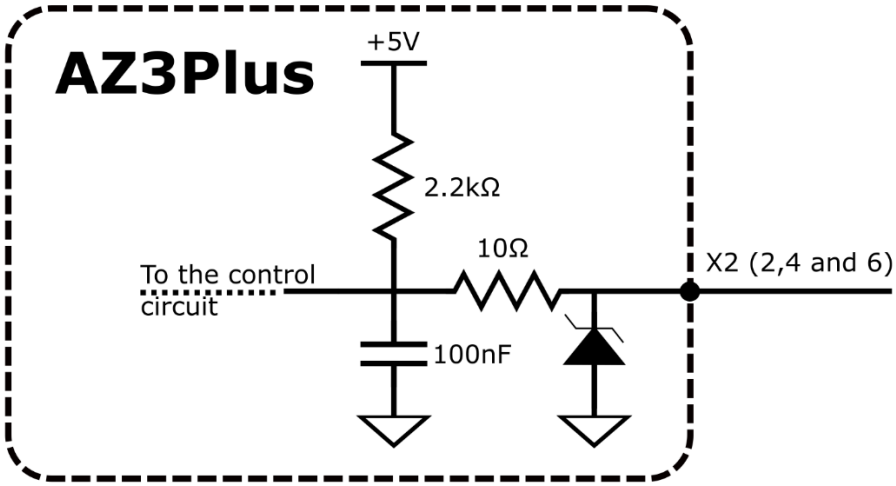
- AZ3Plus50 has two analog inputs, whose input voltage must be between -10 V and +10 V.



- The input stage schematic of channels of incremental encoder is showed in the image below (the encoder output differential voltage must be between -7 V and 12 V).

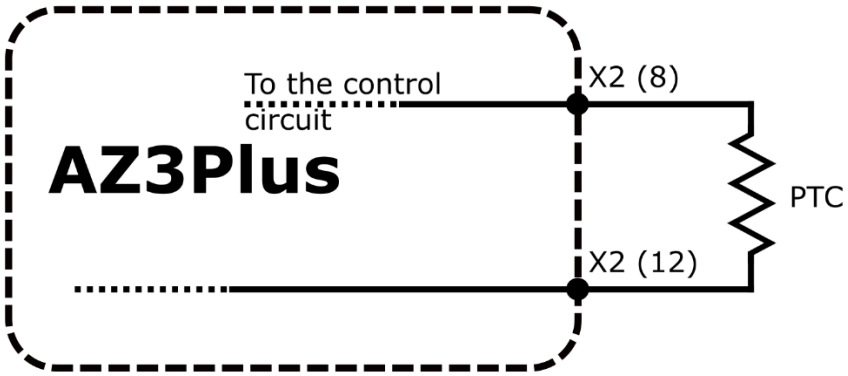


- The input stage schematic of channels of Hall encoder is showed in the image below.



Refer to chapter 5.3.2 for Hall sequence.

- In the images below an example of how connect PTC motor thermistor with the AZ3Plus50.



- In order to properly connect the communication protocols note that termination resistor is not integrated in the circuit.

5. DRIVE CONFIGURATIONS

Read carefully the safety precautions reported in chapter 2.5 and in chapter 2.6 before wiring operations!

AZ3Plus50 has a wide set of parameters that allow to configure the drive. Be careful when configuring the drive because an incorrect set of the parameters can cause injury or accidents. It is possible to configure all the following parameters using TEM interface (refer to TEM interface manual). During normal operation (no error), the drive LED blinks and has a white colour. If the drive does not blink and has different colours, it is in fault condition (refer to chapter 7).

To configure your drive use the TEM Drive software interface downloadable from the website www.temdrive.com and refer to the ST.TEC.109.EN_TEMInterfaceManual.pdf manual or get help from a TEM operator (contact us at info@temdrive.com).

5.1. Saving parameters

Once the drive has been configured with the selected parameters, these must be saved. In order to save parameters, set to 65766173h the parameter *Store all parameters*.

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Store all parameters	UNS16	SV1	-	0	0÷1.0E9	INDEX SUB	1010h 01h	HR	449 450

5.2. Drive data

The drive data must be configured in order to avoid malfunctions or failures.

5.2.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
V bus max*	FLOAT	DD1	V	60	0÷100	INDEX SUB	203Dh	HR	60 61
Nominal current rms*	FLOAT	IC1	A	30	-100÷100	INDEX SUB	203Eh	HR	68 69
Alimentation power*	FLOAT	AD1	W	3.36	0÷1.0E6	INDEX SUB	2053h 02h	HR	318 319

*These parameters once changed, must be saved. The new value assigned to this parameter will become operational only after a power reset.

5.2.2. CONFIGURATIONS

Nominal current rms is the nominal current of the drive, *Alimentation power* is the power absorbed by the drive with power stage disabled and *V bus max* is the maximum input voltage.

5.3. Motor data

AZ3Plus50 can control DC motors and AC Brushless motors with incremental encoder or Hall switches as feedback sensors.

5.3.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Motor type*	UNS16	MTY1	-	10	0÷65535	INDEX SUB	6402h 00h	HR	176
Max motor speed	UNS32	SF1	User units	3000	0÷2.0E6	INDEX SUB	6080h 00h	HR	85 86
MOTOR POLES PAIR*	UNS16	DD5	-	4	0÷16	INDEX SUB	203Ah	HR	65
Motor rated torque*	UNS32	TC4	mNm	2300	0÷1.0E9	INDEX SUB	6076h	HR	273 274
Motor rated current*	UNS32	TC5	mA	16000	0÷1.0E9	INDEX SUB	6075h	HR	275 276
ENCODER TYPE	S16	DD2	-	0	0÷10	INDEX SUB	2039h	HR	62
Encoder phase* displacement	FLOAT	PHC3	[rad]	3.14	-6.28÷6.28	INDEX SUB	2052h 03h	HR	185 186
Phasing in progress	COIL	DF1	-	0	-	INDEX SUB	2018h (bit 0)	COIL	1
Start phasing	COIL	DF2	-	0	-	INDEX SUB	2018h (bit 1)	COIL	2
auto-phased motor*	COIL	DF6	-	0	-	INDEX SUB	2018h (bit 5)	COIL	6

*These parameters once changed, must be saved. The new value assigned to this parameter will become operational only after a power reset.

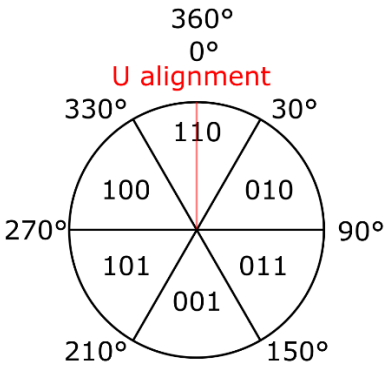
5.3.2. CONFIGURATIONS

It is necessary to set to 1 *Motor type* in order to control DC motor. *Motor type* can be set to all the others value in order to control a brushless motor but is advisable to set the variable to 10 as described in DS402 specification.

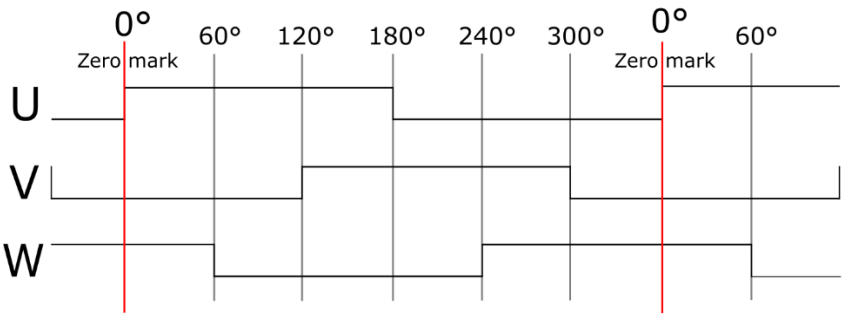
Motor rated torque and *Motor rated current* must be set in function of the motor nameplate data.

Through *ENCODER TYPE* it is possible to choice between Hall encoder (*ENCODER TYPE* equal to 2), incremental encoder with Hall (*ENCODER TYPE* equal to 0), absolute encoder (*ENCODER TYPE* equal to 4) and sensorless (*ENCODER TYPE* equal to 3).

Motors with Hall encoder, in order to work properly with AZ3Plus50, must be phased with the Hall states positioned relative to the U alignment as described in the image below (Hall states are in U, V, W sequence).



AZ3Plus50 can handle incremental encoder with Hall, with every displacement between U phase rising edge and zero mark. The displacement is configurable through *Encoder phase displacement*, for example if zero mark is positioned exactly on U phase rising edge, then *Encoder phase displacement* must be set to zero. In the following image is possible to understand how setting *Encoder phase displacement* in order to obtain the desired displacement.



EXAMPLE: if a motor has an incremental encoder with Hall with a displacement between U phase rising edge and zero mark of 180° (3.14 rad), it is sufficient to set *Encoder phase displacement* to 3.14.

AZ3Plus50 can perform an auto-phasing routine for motors with incremental encoder with Hall.

Prior to start with the auto-phasing routines, disconnect the motor from the load and if a brake is connected to the motor, disengage it with directs control as described in chapter 5.8. Factor parameters must be set properly before starting with auto-phasing routine.

In order to start the auto-phasing routines set to 1 *Phasing in progress* and wait until *Phasing in progress* become zero. After auto-phasing procedure is ended, save all the parameters and restarts the drive. At drive restart check that *auto-phased motor* is set to 1.

In case of absolute encoder it is necessary to carry out an initial phasing routine.

In case of sensorless control it is necessary to make sure to have correctly configured the motor parameters.

5.4. Factors

Factors calculation permits to configure the drive in function of the input references and the desired units of measure.

5.4.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Gear ratio motor* revolution	UNS32	FS1	rounds	1	0÷400000	INDEX SUB	6091h 01h	HR	89 90
Gear ratio shaft* revolutions	UNS32	FS2	rounds	1	0÷400000	INDEX SUB	6091h 02h	HR	91 92
Velocity encoder* resolution motor revolutions	UNS32	FS3	round/s	1	0÷400000	INDEX SUB	6090h 02h	HR	93 94
Velocity encoder* resolution increments per second	UNS32	FS4	Incr/s	8192	0÷400000	INDEX SUB	6090h 01h	HR	95 96
Feed constant feed*	UNS32	FS5	-	1	0÷400000	INDEX SUB	6092h 01h	HR	97 98
Feed constant shaft* revolutions	UNS32	FS6	rounds	1	0÷400000	INDEX SUB	6092h 02h	HR	99 100
Position encoder* resolution motor revolutions	UNS32	FS9	rounds	1	0÷400000	INDEX SUB	608Fh 02h	HR	105 106
Position encoder* resolutions encoder increments	UNS32	FS10	-	8192	0÷400000	INDEX SUB	608Fh 01h	HR	107 108
Velocity factor* numerator	S16	FS11	-	60	0÷32767	INDEX SUB	6094h 01h	HR	109
Velocity factor* denominator	S16	FS12	-	1	0÷32767	INDEX SUB	6094h 02h	HR	110
Polarity	UNS16	FS13	-	0	0÷65536	INDEX SUB	607Eh	HR	111

*These parameters once changed, must be saved. The new value assigned to this parameter will become operational only after a power reset.

5.4.2. CONFIGURATIONS

Performs the following steps to set factors in order to configure the drive starting from the encoder to the linear actuator.

- *Position encoder resolution motor revolutions* and *Position encoder resolutions encoder increments* perform the calculation of resolution of the encoder mounted on the motor.

$$Position\ encoder\ resolution = \frac{Position\ encoder\ resolutions\ encoder\ increments}{Position\ encoder\ resolution\ motor\ revolutions}$$

The drive counts every edge of the two encoder channels, so there is a factor 4 between encoder resolution and motor revolutions.

EXAMPLE: the application has an encoder with 2048 pulses for round, *Position encoder resolutions encoder increments* must be set to 8192 and *Position encoder resolution motor revolutions* must be set to 1.

- Use *Gear ratio motor revolution* and *Gear ratio shaft revolutions* in order to calculate the gear ratio.

$$Gear\ ratio\ factor = \frac{Gear\ ratio\ motor\ revolution}{gear\ ratio\ shaft\ revolutions}$$

EXAMPLE: with a gearbox with reduced ratio of 30, for every gearbox revolution the motor does 30 revolutions.

In this case:

$$Gear\ ratio\ motor\ revolution = 30, \qquad gear\ ratio\ shaft\ revolutions = 1$$

$$Gear\ ratio\ factor = \frac{30}{1}$$

- Use *Feed constant feed* and *Feed constant shaft revolutions* in order to calculate the measurement distance per one revolution of the output shaft of the gearbox.

$$Feed\ constant = \frac{Feed\ constant\ feed}{Feed\ constant\ shaft\ revolutions}$$

EXAMPLE: if every revolutions of the shaft of the gearbox (or of the motor if there are not gearboxes) correspond in a linear movement of 11.5 user unit:

$$Feed\ constant\ feed = 23, \qquad Feed\ constant\ shaft\ revolutions = 2$$

$$Gear\ ratio\ factor = \frac{23}{2}$$

It is not possible to write directly 11.5 in *Feed constant feed* because the type of this parameter is unsigned.

- Use *Velocity encoder resolution motor revolutions* and *Velocity encoder resolution increments per second* in order to calculate the velocity encoder resolutions.

$$Velocity\ encoder\ resolution = \frac{Velocity\ encoder\ resolution\ increments\ per\ seconds}{Velocity\ encoder\ resolution\ motor\ revolutions}$$

Velocity encoder resolution is different from *Position encoder resolution* only if two different encoder are used for position feedback and for velocity feedback. In all the others cases those two values must be equal.

As described for *Position encoder resolution* the drive counts every edge of the two encoder channel, so take care about factor 4. With Hall encoder this value is automatically set in function of the motor poles, but however is recommended to set it in the appropriate way.

- *Velocity factor numerator* and *Velocity factor denominator* are used in order to match the velocity unit to the user-defined velocity unit.

$$Velocity\ value = \frac{Velocity\ internal\ value * feed\ constant}{Velocity\ encoder\ resolution * gear\ ratio} * \frac{Velocity\ factor\ numerator}{Velocity\ factor\ denominator}$$

  EXAMPLE: if the user want to use rpm instead of rps, *Velocity factor numerator* must be set to 60 and *Velocity factor denominator* must be set to 1.

If different units of measure between position measurement and velocity measurement are needed, the advice is to set before feed constant for reach the desired position unit of measure and then with *Velocity factor numerator* and *Velocity factor denominator* adjust velocity unit of measure.

$$Position\ value = \frac{Position\ internal\ value * feed\ constant}{Position\ encoder\ resolution * gear\ ratio}$$

5.5. Analogic set point

The AZ3Plus50 drive has two configurable analog inputs.

5.5.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
User range 1	FLOAT	AI1	-	1000	-1.0E9÷1.0E9	INDEX SUB	2045h 02h	HR	249 250
Offset 1	FLOAT	AI2	-	0	-1.0E9÷1.0E9	INDEX SUB	2045h 03h	HR	251 252
Zero threshold 1	UNS16	AI3	-	5	0÷65535	INDEX SUB	2045h 04h	HR	253
User range 2	FLOAT	AI4	-	1000	-1.0E9÷1.0E9	INDEX SUB	2046h 02h	HR	254 255
Offset 2	FLOAT	AI5	-	-500	-1.0E9÷1.0E9	INDEX SUB	2046h 03h	HR	256 257
Zero threshold 2	UNS16	AI6	-	1	0÷65535	INDEX SUB	2046h 04h	HR	258
Selector 1	UNS8	AI7	-	2	0÷255	INDEX SUB	2045h 01h	HR	259L
Selector 2	UNS8	AI8	-	4	0÷255	INDEX SUB	2046h 01h	HR	259H
SET POINT SELECTOR	S16	DD3	-	0	0÷10	INDEX SUB	2038h	HR	63

5.5.2. CONFIGURATIONS

To activate the analog input module, *SET POINT SELECTOR* must be set to 1, or to 3 for the combined use with digital inputs.

The adaptation of the analogic inputs in order to generate a set point is done through the following steps.

- Inputs are adapted to desired user range through the following equation:

$$Setpoint = FilteredValue * \frac{1}{ADC\ range} * User\ range + offset$$

  - The value of the controlled variable (variable connected to analog input) is set to 0 if the value readed from ADC is below the value contained in *Zero threshold*.

Two selectors (*Selector 1 and Selector 2*) connect the adapted analog input to the preferred variable.

- 0: unused.
- 1: *Target velocity* (refer to chapter 6.1).
- 3: *Target position* (refer to chapter 6.2).
- 4: *Target torque* (refer to chapter 6.3).

EXAMPLE: in order to control the speed of the motor through the analog input 1, from -1500 rpm to 1500 rpm, with an input voltage variable form -10V to 10V, the analog input variables must be configured as follow:

$$Selector\ 1 = 1$$

$$User\ range\ 1 = 3000$$

$$Offset\ 1 = 0$$

The other variables can be left to the default values.

5.6. Digital commands

Four digital inputs can be used in order to control the behaviors of the drive. It is possible to configure both the operation to do at the rising edge of the digital input and the operation to do at the falling edge.

5.6.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
DI1 rise selector	UNS8	DI1	-	0	0÷255	INDEX SUB	2047h 01h	HR	320L
DI1 fall selector	UNS8	DI2	-	0	0÷255	INDEX SUB	2047h 02h	HR	320H
DI2 rise selector	UNS8	DI3	-	0	0÷255	INDEX SUB	2047h 03h	HR	321L
DI2 fall selector	UNS8	DI4	-	0	0÷255	INDEX SUB	2047h 04h	HR	321H
DI3 rise selector	UNS8	DI5	-	0	0÷255	INDEX SUB	2047h 05h	HR	322L
DI3 fall selector	UNS8	DI6	-	0	0÷255	INDEX SUB	2047h 06h	HR	322H
DI4 rise selector	UNS8	DI7	-	0	0÷255	INDEX SUB	2047h 07h	HR	323L
DI4 fall selector	UNS8	DI8	-	0	0÷255	INDEX SUB	2047h 08h	HR	323H
Speed value 1	S32	DI9	-	0	-1.0E9÷1.0E9	INDEX SUB	2048h	HR	324 325
Speed value 2	S32	DI10	-	0	-1.0E9÷1.0E9	INDEX SUB	2049h	HR	326 327
Position value 1	S32	DI11	-	0	-1.0E12÷1.0E12	INDEX SUB	204Ah	HR	328 329
Position value 2	S32	DI12	-	0	-1.0E12÷1.0E12	INDEX SUB	204Bh	HR	330 331
Torque value 1	S16	DI13	-	0	-10000÷10000	INDEX SUB	204Ch	HR	332
Torque value 2	S16	DI14	-	0	-10000÷10000	INDEX SUB	204Dh	HR	333
SET POINT SELECTOR	S16	DD3	-	0	0÷10	INDEX SUB	2038h	HR	63

5.6.2. CONFIGURATIONS

To activate the digital input module, *SET POINT SELECTOR* must be set to two, or to three for the combined use with analog inputs.

Every digital input edge can be configured as described in the following table.

Value of selector	function	Operating mode*
0	Unused	-
1	*Control word* set to 15 (power stage enabled) and *Target velocity* set to the value contained in *Speed value 1*	Profile velocity
2	*Control word* set to 15 (power stage enabled) and *Target velocity* set to the value contained in *Speed value 2*	Profile velocity
3	*Control word* set to 15 (power stage enabled) and *Target position* set to the value contained in *Position value 1*	Profile position
4	*Control word* set to 15 (power stage enabled) and *Target position* set to the value contained in *Position value 2*	Profile position
5	*Control word* set to 15 (power stage enabled) and *Target torque* set to the value contained in *Torque value 1*	Profile torque
6	*Control word* set to 15 (power stage enabled) and *Target torque* set to the value contained in *Torque value 2*	Profile torque
7	*Target velocity* set to 0	Profile velocity
8	*Target torque* set to 0	Profile torque
9	*Control word* set to 6 (power stage disabled) and *Target velocity* set to 0	Profile velocity
10	*Control word* set to 6 (power stage disabled) and target torque set to 0	Profile torque
11	Position reset (*Position actual value* set to 0)	Position profile
12	*Control word* set to 15** (power stage enabled)	All
13	*Control word* set to 7** (power stage disabled)	All
14	*Control word* set to 6** (power stage disabled)	All
15	*Control word* set to 2** (power stage disabled)	All
16	*Control word* set to 0 (quick stop)** (power stage disabled)	All
17	Reset error	All
26	clockwise rotation looking at the shaft	All
27	anti-clockwise rotation looking at the shaft	All

*refer to chapter 6

**To understand the effects of these operations refers to chapter 6.4

EXAMPLE: it is possible to enable the power stage and set the speed to 3000 with digital input 1, disable the power stage with digital input 2, set the speed to 500 and enable the power stage at the rising edge of digital input 3, set speed to 0 and disable power at the falling edge of digital input 3.

$$Speed\ value\ 1 = 3000$$

$$DI1\ rise\ selector = 1$$

$$DI2\ rise\ selector = 14$$

$$Speed\ value\ 2 = 500$$

$$DI3\ rise\ selector\ 1 = 2$$

$$DI3\ fall\ selector\ 1 = 9$$

5.7. Outputs feedback

AZ3Plus50 has two configurable digital outputs.

5.7.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Output 1 selector	UNS8	OF1	-	0	0÷255	INDEX SUB	204Eh 02h	HR	187L
Output 2 selector	UNS8	OF2	-	0	0÷255	INDEX SUB	204Eh 03h	HR	187H

5.7.2. CONFIGURATIONS

Through *Output 1 selector* and *Output 2 selector* is possible to choice which feedback monitor connect to the output.

- 0: unused.
- 1: output set to 1 if drive works properly and to 0 in case of fault.
- 2: output set to 1 when position target is reached (refer to chapter 6.2).
- 4: Complementary of case 1.

5.8. Electromechanical brake

AZ3Plus50 could directly handle an electromechanical brake.

5.8.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
AUX PWM OUT 1 SEL	UNS8	AXO1	-	0	0÷5	INDEX SUB	204Eh 05h	HR	266L
BRAKE 1 MODE SEL	UNS8	AXO3	-	1	0÷100	INDEX SUB	204Eh 07h	HR	267L
BRAKE 1 POW VALUE	UNS8	AXO4	%	100	0÷5	INDEX SUB	204Fh 02h	HR	267H
Brake activation	COIL	DRF8	-	0	-	INDEX SUB	2019h (bit 7)	COIL	24
Brake value	COIL	DRF9	-	0	-	INDEX SUB	2019h (bit 8)	COIL	25
START	COIL	BKS1	-	0	-	INDEX SUB	201Bh (bit 0)	COIL	81
NOT READY TO SWITCH ON	COIL	BKS2	-	0	-	INDEX SUB	201Bh (bit 1)	COIL	82
SWITCH ON DISABLED	COIL	BKS3	-	0	-	INDEX SUB	201Bh (bit 2)	COIL	82
READY TO SWITCH ON	COIL	BKS4	-	0	-	INDEX SUB	201Bh (bit 3)	COIL	83
SWITCHED ON	COIL	BKS5	-	0	-	INDEX SUB	201Bh (bit 4)	COIL	84
OPERATION ENABLED	COIL	BKS6	-	1	-	INDEX SUB	201Bh (bit 5)	COIL	85
QUICK STOP ACTIVE	COIL	BKS7	-	0	-	INDEX SUB	201Bh (bit 6)	COIL	86
FAULT	COIL	BKS8	-	0	-	INDEX SUB	201Bh (bit 7)	COIL	87
FAULT REACTION ACTIVE	COIL	BKS9	-	0	-	INDEX SUB	201Bh (bit 8)	COIL	88
brake disengage time	UNS16	DRS3	ms	0	0÷65535	INDEX SUB	2051h 01h	HR	303
brake engage time	UNS16	DRS4	ms	0	0÷65535	INDEX SUB	2051h 02h	HR	304

5.8.2. CONFIGURATION

To use electromechanical brake through the drive, is first of all necessary to connect the power output to the brake internal module through *AUX PWM OUT 1 SEL.*

$$AUX\ PWM\ OUT\ 1\ SEL\ = 1$$

Connect the internal brake handler to power output.

Brake value must be set with the duty cycle that commands the on state of the MOS that controls the current flowing on the brake (open drain MOSFET).

When the state of DS402 becomes *Operation enabled*, after a waiting time defined in *brake disengage time*, brake is disinserted. *brake disengage time* permits to disinsert brake only when the engine delivers sufficient torque to keep the load stable, this is fundamental for example in the applications involving a suspended load. It is possible to disinsert brake only if there are not errors and if TDI is enabled.

When the state of DS402 becomes different from *Operation enabled*, after a waiting time defined in *brake engage time*, brake is engaged. In case of fault or if TDI becomes disabled, brake is engaged.

The operation described above defines the normal brake behavior (selectable by setting *BRAKE 1 MODE SEL* to 0). It is possible to engage and disengage brake in others conditions.

If *BRAKE 1 MODE SEL* is set to 1, brake is disengaged and engaged in function of the DS402 state and the coils value (from BKS1 to BKS9). If a coil is set to 1, in the corresponding state of the ds402, brake is disinserted. Vice versa if the coil is set to 0, in the corresponding state of the ds402, brake is engaged. For example, if the DS402 state machine is in *operation enabled* state and *OPERATION ENABLED* (BKS6) coil is set to 1, then the brake is disinserted. In this configuration *brake disengage time* and *brake engage time* are not used.

If *BRAKE 1 MODE SEL* is set to 2, brake is engaged and disengaged in the same condition of the case *BRAKE 1 MODE SEL* equal to 0, but brake is also engaged when the actual value of the controlled variable is 0.

Enabling *Brake activation* is possible to directly control the brake. When *Brake activation* is enabled brake are controlled by the state of *Brake value*. If *Brake value* is 1 then brake is disinserted, viceversa if it is 0, brake is engaged. When *Brake activation* is enabled, the other brake management modes are overwritten.

EXAMPLE: in an application in a motor is mounted a brake with engage and disengae time equal to 10 ms. Brake is connected to the power output 1 of the drive. In this application is necessary to engage brake when *Velocity actual value* is 0, in case of fault and when the power stage is disabled. parameters must be configured as follow:

$$AUX\ PWM\ OUT\ 1\ SEL\ = 1$$

$$Brake\ value = 95$$

$$BRAKE\ 1\ MODE\ SEL = 2$$

$$brake\ disengage\ time = 10$$

$$brake\ engage\ time\ = 10$$

5.9. Start-up option

With AZ3Plus50 it is possible to configure which status of the DS402 reach at the power on of the device.

5.9.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Ready to switch on is reached at start up	COIL	DRF2	-	0	-	INDEX SUB	2019h (bit 1)	COIL	18
Operation enabled is reached at start up	COIL	DRF3	-	0	-	INDEX SUB	2019h (bit 2)	COIL	19

5.9.2. CONFIGURATION

At the start-up of AZ3Plus50, when power is provided to the drive, three possible DS402 states (refer to chapter 6.4) can be reached in function of the state of *Ready to switch on is reached at start up* and *Operation enabled is reached at start up*.

If no one of this flags are set to 1, then at the start up the drive reaches the DS402 state “Switch on disabled”.

When *Ready to switch on is reached at start up* is set to 1, then the drive reach the DS402 state “Ready to switch on”, when instead *Operation enabled is reached at start up* is set to 1 (or when this two flags are both set to 1), the drive reach the DS402 state “Operation enabled”.

5.10. Braking behaviour

It is possible to configure the behaviours of the drive when it works like a generator.

5.10.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Braking resistor value	FLOAT	BR1	Ω	0	0÷1.0E9	INDEX SUB	2053h 01h	HR	314 315
Braking resistor max power	FLOAT	BR2	W	0	0÷1.0E9	INDEX SUB	2053h 03h	HR	316 317
AUX PWM OUT 1 SEL	UNS8	AXO1	-	0	0÷5	INDEX SUB	204Eh 05h	HR	266L
V bus max*	FLOAT	DD1	V	60	0÷100	INDEX SUB	203Dh	HR	60 61
Nominal current rms*	FLOAT	IC1	A	30	-100÷100	INDEX SUB	203Eh	HR	68 69
Motor rated torque*	UNS32	TC4	mNm	2300	0÷1.0E9	INDEX SUB	6076h	HR	273 274
Motor rated current*	UNS32	TC5	mA	16000	0÷1.0E9	INDEX SUB	6075h	HR	275 276
Alimentation power*	FLOAT	AD1	W	3.36	0÷1.0E6	INDEX SUB	2053h 02h	HR	318 319

*These parameters once changed, must be saved. The new value assigned to this parameter will become operational only after a power reset.

5.10.2. CONFIGURATIONS

AZ3Plus50 takes care to limit the braking in order to avoid that the engine regenerates more energy than can be dissipated. In order to protect the drive is necessary that the following data are correctly inserted.

Drive data:

- *V bus max:* it is the maximum value of tension that can be reached by the drive. This value must be set in function of the alimentation. Do not exceed over 60V.
- *Nominal current rms:* nominal current of the drive. It is fixed to 30 and is recommended to do not change it.
- *Alimentation power*: Drive alimentation absorption. It represents the consumption of the drive with power disabled.

Motor data:

- *Motor rated torque*: rated torque of the motor.
- *Motor rated current*: rated current of the motor.

To improve the breaking performance it is possible to connect to the drive a braking resistor (refer to chapter 4.4.2).

It is possible to connect the braking resistor to power output and to connect it to the resistor internal handler through *AUX PWM OUT 1 SEL*.

$$AUX\ PWM\ OUT\ 1\ SEL\ = 3$$

Connects the internal resistor handler to power output.

To use correctly the drive and the braking resistor, *Braking resistor max power* and *Braking resistor value* must be set with braking resistor data.

EXAMPLE: in an application in order to improve the breaking performance, a braking resistor of 10 Ω and 600W is connected to the power output of the drive.

$$AUX\ PWM\ OUT\ 1\ SEL\ = 3$$

$$Braking\ resistor\ value = 10$$

$$Braking\ resistor\ max\ power = 600$$

5.11. Motor thermistor

AZ3Plus50 can handle motor thermistor.

5.11.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Thermistor check activation	COIL	DRF7	-	0	-	INDEX SUB	2019h (bit 6)	COIL	23

5.11.2. CONFIGURATIONS

It is possible to connect to AZ3Plus50 the thermistor of motor in order to check motor temperature. Setting to 1 *Thermistor check activation* the motor temperature control is automatically activated. AZ3Plus50 is configured to support thermistor with a temperature-resistance characteristic according DIN44081/DIN44082.

6. OPERATING MODES

Read carefully the safety precautions reported in chapter 2.5 and in chapter 2.6 before wiring operations!

AZ3Plus50 could support the following operating modes.

- Profile velocity mode
- Profile position mode
- Profile Torque mode

This operating mode follow the specification of DS402. It is possible to commands the drive through the operating modes using TEM interface (refer to TEM interface manual).

6.1. Profile velocity mode

This operating mode permits the velocity control of the motor also in conditions of load changes.

6.1.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Control word	UNS16	CM1	-	0	0÷65535	INDEX SUB	6040h 00h	HR	156
Modes of operation*	S8	CM2	-	3	-128÷127	INDEX SUB	6060h 00h	HR	157L
Target velocity	S32	CM4	User units	0	-2.0E6÷2.0E6	INDEX SUB	60FFh 00h	HR	158 159
Profile acceleration	UNS32	SF2	Speed user units/s	1000	0÷2.0E6	INDEX SUB	6083h 00h	HR	87 88
Profile deceleration	UNS32	PRF1	Speed user units/s	1000	0÷2.0E6	INDEX SUB	6084h 00h	HR	40 41
Invert speed feedback	COIL	DF7	-	0	-	INDEX SUB	2018h (bit 6)	COIL	7
Max profile velocity	UNS32	PC6	User units	3000	0÷2.0E6	INDEX SUB	607Fh 00h	HR	289 290
Velocity actual value	S32	MV7	User units	0	-2 E9÷2.0E9	INDEX SUB	606Ch 00h	IR	124 125

* This parameter once changed, will become operational only when power stage is disabled.

6.1.2. CONFIGURATION

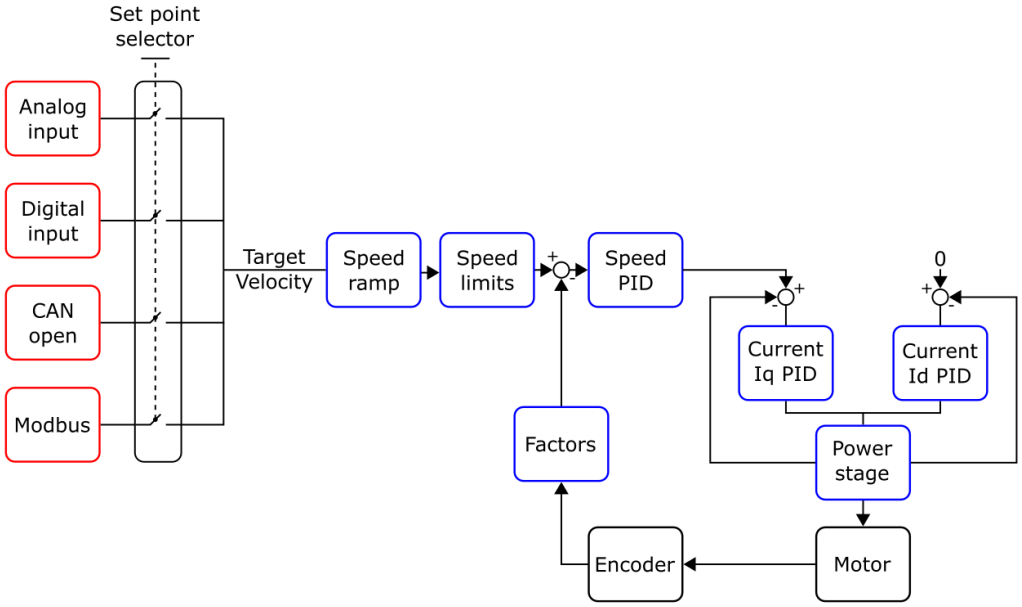
To control the motor velocity through AZ3Plus50, *mode of operations* must be set to 3 as defined in DS402 specification.

Target velocity is the velocity set point and can be modified through CAN or Modbus, analog inputs (refer to chapter 5.5) and digital inputs (refer to chapter 5.6). *Max profile velocity* can be used in order to limit the set point velocity that can be set through *target velocity* (speed limits block in the image below).

Profile acceleration and *Profile deceleration* permits to modify the speed linear ramp (speed ramp block in the image below), they must be set according to the time within which the operating speed is to be reached.

Velocity actual value is the feedback of the actual velocity. Setting *Invert speed feedback* to 1, it is possible to invert the value read in *Velocity actual value*.

AZ3Plus50 *Profile velocity mode* control loop is showed in the image below.



6.2. Profile position mode

In profile position mode the drive control the position of the shaft.

6.2.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Control word	UNS16	CM1	-	0	0÷65535	INDEX SUB	6040h 00h	HR	156
Modes of operation*	S8	CM2	-	3	-128÷127	INDEX SUB	6060h 00h	HR	157L
Target position	S32	PC1	-	0	-1.0E18÷1.0E18	INDEX SUB	607Ah 00h	HR	279 280
Profile acceleration	UNS32	SF2	-	1000	0÷2.0E6	INDEX SUB	6083h 00h	HR	87 88
Profile deceleration	UNS32	PRF1	-	1000	0÷2.0E6	INDEX SUB	6084h 00h	HR	40 41
Invert Position feedback	COIL	DF5	-	0	-	INDEX SUB	2018h (bit 4)	COIL	5
Reset Position	COIL	DF12	-	0	-	INDEX SUB	2018h (bit 11)	COIL	12
Min position range limit	S32	PC2	-	-100000	-1.0E18÷1.0E18	INDEX SUB	607Bh 02h	HR	281 282
Max position range limit	S32	PC3	-	100000	-1.0E18÷1.0E18	INDEX SUB	607Bh 01h	HR	283 284
Soft min position limit	S32	PC4	-	0	-1.0E18÷1.0E18	INDEX SUB	607Dh 01h	HR	285 286
Soft max position limit	S32	PC5	-	0	-1.0E18÷1.0E18	INDEX SUB	607Dh 02h	HR	287 288
Max profile velocity	UNS32	PC6	-	3000	0÷2.0E6	INDEX SUB	607Fh 00h	HR	289 290
Profile velocity	UNS32	PC7	-	1000	0÷2.0E6	INDEX SUB	6081h 00h	HR	291 292
Position actual value	S32	MV5	-	0	-2 E9÷2.0E9	INDEX SUB	6064h 00h	IR	121 122

* This parameter once changed, will become operational only when power stage is disabled.

6.2.2. CONFIGURATIONS

To control the shaft position through AZ3Plus50, *mode of operations* must be set to 1 as defined in DS402 specification.

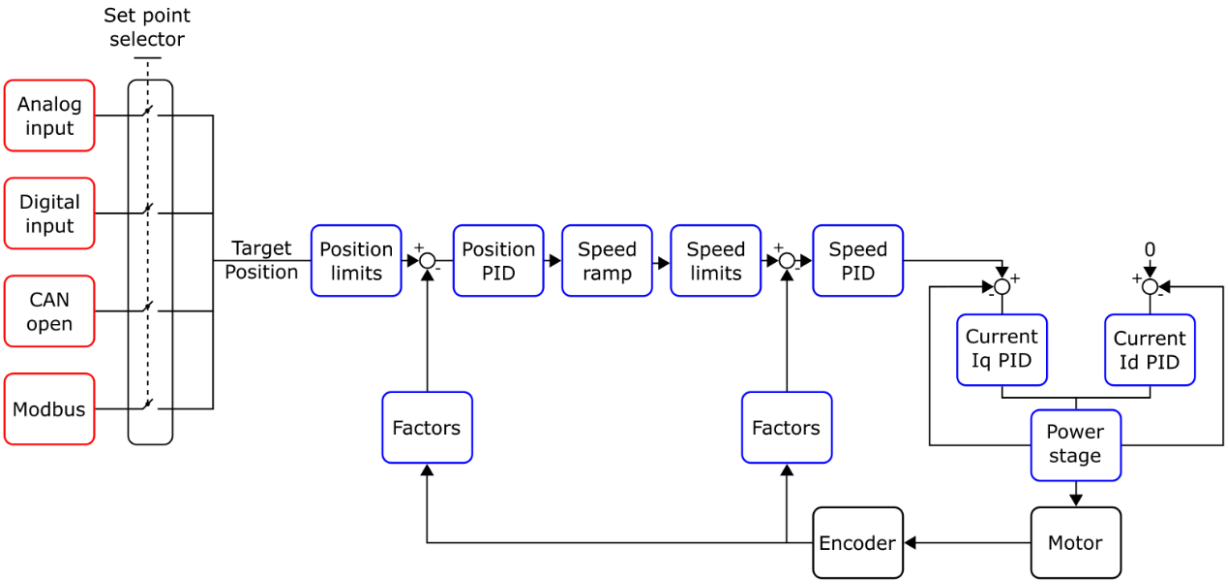
Target position is the position set point and can be modified through CAN or Modbus, analog inputs and digital inputs.

Soft min position limit and *Soft max position limit* define the absolute position limits for the *Target position* and the *Position actual value*. If the shaft moves over these limits power stage is disabled. *Min position range limit* and *Max position range limit* shall limit the numerical range of *Target position*. These parameters are summarized in the position ramp block in the image below.

Position actual value is the feedback of the actual position. Setting *Invert position feedback* to 1, it is possible to invert the value read in *Position actual value*.

Profile acceleration, Profile deceleration and *Max profile velocity* have the same functions that in Profile velocity mode. *Profile velocity* defines the operating speed used in order to reach *Target position*.

AZ3Plus50 *Profile position mode* control loop is showed in the image below.



6.3. Profile torque mode

Profile torque mode is used in order to control the torque applied to the load.

6.3.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Control word	UNS16	CM1	-	0	0÷65535	INDEX SUB	6040h 00h	HR	156
Modes of operation*	S8	CM2	-	3	-128÷127	INDEX SUB	6060h 00h	HR	157L
Target torque	S16	TC1	‰ of rated torque	0	-10000÷10000	INDEX SUB	6071h	HR	270
Max torque	UNS16	TC2	‰ of rated torque	10000	0÷10000	INDEX SUB	6072h	HR	271
Max current	UNS16	TC3	‰ of rated current	10000	0÷10000	INDEX SUB	6073h	HR	272
Motor rated torque**	UNS32	TC4	mNm	2300	0÷1.0E9	INDEX SUB	6076h	HR	273 274
Motor rated current**	UNS32	TC5	mA	16000	0÷1.0E9	INDEX SUB	6075h	HR	275 276
Torque slope	UNS32	TC6	‰ of rated torque/s	1000	0÷1.0E9	INDEX SUB	6087h	HR	277 278
Torque actual value	S16	MV1	‰ of rated torque	0	-10000÷10000	INDEX SUB	6077h	IR	116

* This parameter once changed, will become operational only when power stage is disabled.

**These parameters once changed, must be saved. The new value assigned to this parameter will become operational only after a power reset.

6.3.2. CONFIGURATIONS

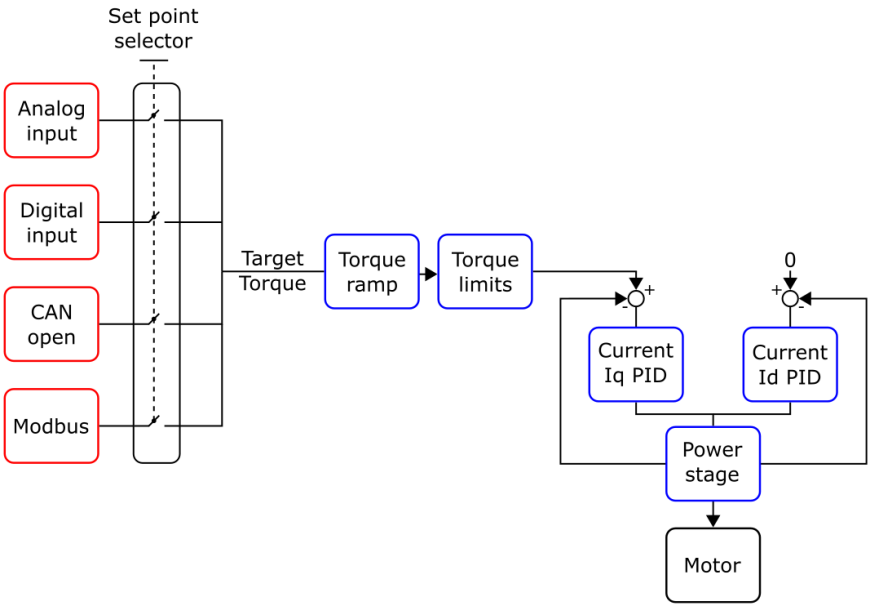
To control the motor torque through AZ3Plus50, mode of operations must be set to 4 as defined in DS402 specification. In order to make operative the change in operating mode, power stage must be disabled (refer to chapter 6.4).

Target torque is the torque set point and can be modified through CAN or Modbus, analog inputs and digital inputs.

Torque slope permits to modify the torque linear ramp, it must be set according to the time within which the operating torque is to be reached (torque ramp block in the image below).

Max torque indicate the maximum value of *Target torque* configurable. *Max current* defines the maximum current that can be generated in function of the configured *Target torque* (torque limits block in the image below).

AZ3Plus50 *Profile Torque mode* control loop is showed in the image below.



6.4. Drive commands

AZ3Plus50 firmware is based on DS402 state machine.

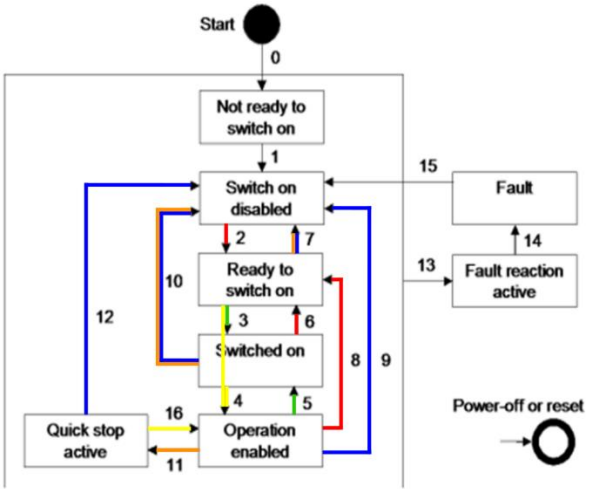
6.4.1. PARAMETERS

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
Control word	UNS16	CM1	-	0	0÷65535	INDEX SUB	6040h 00h	HR	156
Status word	UNS16	SW1	-	0	0÷65535	INDEX SUB	6041h 00h	IR	26
Shutdown option code	S16	DRS6	-	1	-32768÷32767	INDEX SUB	605Bh	HR	306
Disable operation option code	S16	DRS7	-	1	-32768÷32767	INDEX SUB	605Ch	HR	307

6.4.2. CONFIGURATIONS

Control word move the DS402 state machine from a state to another.

- *Control word* = `SHUTDOWN_CODE = 6` (red transitions in the image below)
- *Control word* = `SWITCHON_CODE = 7` (green transitions in the image below)
- *Control word* = `SWITCHON_ENABLEOP_CODE = 15` (yellows transition in the image below)
- *Control word* = `DISABLE_VOLTAGE_CODE = 0` (blue transitions in the image below)
- *Control word* = `QUICK_STOP_CODE = 2` (orange transition in the image below)
- *Control word* = `DISABLE_OP_CODE = 7` (green transitions in the image below)
- *Control word* = `ENABLE_OP_CODE = 15` (yellow transitions in the image below)
- `AUTOMATIC TRANSITION` (black transitions in the image below)



Operation enable is the only state in which the power stage is enabled.

Using *Shutdown option code* it is possible to define the drive behaviours in transition 8. If *Shutdown option code* is equal to 1, then drive set the controlled variable (speed in Profile velocity mode and Profile position mode, torque in profile torque mode) to 0 and perform a linear ramp. If *Shutdown option code* is equal to 0 then the drive directly disable power stage without controlling the controlled variable.

Disable operation option code does the same operation in transition 5.

Status word permits to check the actual state of the DS402 states machine.

Status word	*DS402 state machine*
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

6.5. PID tuning

The drive control loops must be tuned in order to make the system work properly.

For current PID tuning use the analytical way or contact your TEM Drive distributor (info@temdrive.com).

The parameters to configure for ID loop tuning are:

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
ID KP	FLOAT	IDP1	-	0.2	-1.0E21÷1.0E21	INDEX SUB	202Ch	HR	14 15
ID KI	FLOAT	IDP2	-	200.0	-1.0E21÷1.0E21	INDEX SUB	202Dh	HR	16 17
ID KD	FLOAT	IDP1		0	-1.0E21÷1.0E21	INDEX SUB	202Eh	HR	18 19

The parameters to configure for IQ loop tuning are:

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
IQ KP	FLOAT	IQP1	-	0.2	-1.0E21÷1.0E21	INDEX SUB	202Fh	HR	24 25
IQ KI	FLOAT	IQP2	-	200.0	-1.0E21÷1.0E21	INDEX SUB	2030h	HR	26 27
IQ KD	FLOAT	IQP1		0	-1.0E21÷1.0E21	INDEX SUB	2031h	HR	28 29

For speed PID and position PID tuning, contact your TEM Drive distributor or use TEM interface (refer to *ST.TEC.109.EN_TEMInterfaceManual.pdf*).

The parameters to configure for speed loop tuning are:

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
SPEED KP	FLOAT	SP1	-	0.001	-1.0E21÷1.0E21	INDEX SUB	2032h	HR	34 35
SPEED KI	FLOAT	SP2	-	0.02	-1.0E21÷1.0E21	INDEX SUB	2033h	HR	36 37
SPEED KD	FLOAT	SP1		0	-1.0E21÷1.0E21	INDEX SUB	2034h	HR	38 39

The parameters to configure for position loop tuning are:

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
POSITION KP	FLOAT	PC8	-	1.0	-1.0E21÷1.0E21	INDEX SUB	2035h	HR	293 294
POSITION KI	FLOAT	PC9	-	0	-1.0E21÷1.0E21	INDEX SUB	2036h	HR	295 296
POSITION KD	FLOAT	PC10		0	-1.0E21÷1.0E21	INDEX SUB	2037h	HR	297 298

7. FIELD BUSES AND PARAMETERS TABLE

Basic instructions for using the drive with CAN Open and the list of parameters accessible via CAN Open over CAN-bus is available in document *ST.TEC.071-CANopen-Manual.pdf*.

Basic instructions for using the drive with Modbus RTU and the list of parameters accessible via Modbus RTU over UART or over RS485 is available in document *ST.TEC.022.ModbusRTU-AZ3Series-Manual.pdf*.

8. ERRORS AND DIAGNOSTICS

The drive monitors the working parameters and generates alarms or errors when necessary, according to the values set in the alarm parameters; the drive informs the user about the active errors, by the multicolour LED. It is possible to reset the drive using PB button or digital input (refer to chapter 5.6), once the errors are debugged.

8.1. Parameters

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
RAM errors counter	UNS8	DLH4	-	0	0÷255	INDEX SUB	2057h 06h	IR	39L
RAM index	UNS8	DLH5	-	0	0÷255	INDEX SUB	2057h 07h	IR	39H
Error code 1	UNS16	DRL1	-	0	0÷65535	INDEX SUB	205Ah 01h	IR	48
Error code 2	UNS16	DRL2	-	0	0÷65535	INDEX SUB	205Bh 01h	IR	55
Error code 3	UNS16	DRL3	-	0	0÷65535	INDEX SUB	205Ch 01h	IR	62
Error code 4	UNS16	DRL4	-	0	0÷65535	INDEX SUB	205Dh 01h	IR	69
Error code 5	UNS16	DRL5	-	0	0÷65535	INDEX SUB	205Eh 01h	IR	76
Error code 6	UNS16	DRL6	-	0	0÷65535	INDEX SUB	205Fh 01h	IR	83
Error code 7	UNS16	DRL7	-	0	0÷65535	INDEX SUB	2060h 01h	IR	90
Error code 8	UNS16	DRL8	-	0	0÷65535	INDEX SUB	2061h 01h	IR	97

8.2. Diagnostic

Errors are diagnosed through led and through drive parameters.

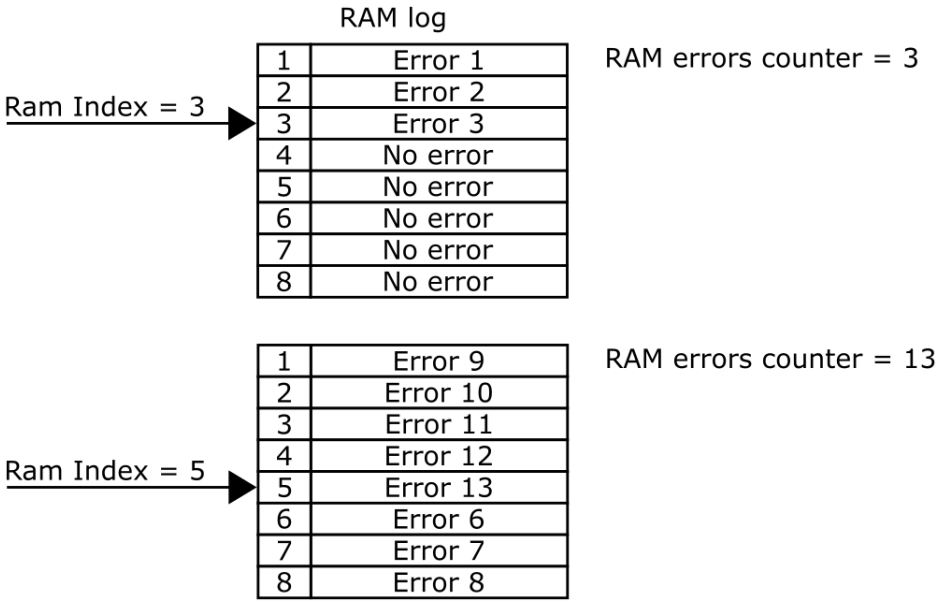
The following table summarizes the possible errors with the corresponding code and with the corresponding LED colour:

LED colour	Code	Type
Blinking white	-	DRIVE OK
Blue	8257	ENCODER NOT CONNECTED
Blue	8258	OVER VOLTAGE ERROR
Purple	8259	UNDER VOLTAGE ERROR
Red	8260	OVER CURRENT U
Red	8261	OVER CURRENT V
Red	8262	OVER CURRENT W
Light blue	8263	OVER TEMPERATURE
Blue	8264	I2T ERROR
Light blue	8266	THERMISTOR ALARM ERROR
Yellow	Da 16449 a 24732	INTERNAL ERROR

To understand which error is currently active or which errors occurred during the current work cycle, is possible to check *Error code x* parameters.

To read correctly the errors RAM log, the circular buffer logic must be used. *RAM index* is the index of the error currently active (or of the last error occurred, if there are no active errors) and *RAM errors counter* is the number of errors in the log.

EXAMPLE: In the image below, an example of how the RAM log buffer works is showed.



9. TROUBLESHOOTING

To solve AZ3Plus50 errors is necessary knowing the error code. Errors code can be read either via RAM log or via Diagnostic panel in TEM interface (refer to *ST.TEC.109.EN_TEMInterfaceManual.pdf*).

9.1. Parameters

Variable	Type	Code	Unit	Default	Range	Can open address		Modbus logical address	
EEPROM autophasing data cleaning	COIL	DRF11	-	0	-	INDEX SUB	2019h (bit 10)	COIL	27
EEPROM parameters cleaning	COIL	DRF12	-	0	-	INDEX SUB	2019h (bit 11)	COIL	28
EEPROM total cleaning	COIL	DRF13	-	0	-	INDEX SUB	2019h (bit 12)	COIL	29

9.2. Problem solving

Code	Possible causes	Suggested operations
8257	• Problem in encoder's cables.	• Check that the encoder is correctly connected to the drive.
8258	• Error in the wiring of the power supply. • Errors in braking behaviour configuration (refer to chapter 5.10).	• Check the power supply voltage and compare it to the supply limits. • Check the braking behaviour configuration (refer to chapter 5.10).
8259	• Error in the wiring of the power supply. • High current absorption of the board.	• Check the power supply voltage and compare it to the supply limits. • Check the section and length of the power supply cables.
8260 **8261** **8262**	• Mechanical obstacle or too high friction. • Errors in the wiring of the motors.	• Check that motor load is not blocked • Check that the motor is correctly connected to the drive.
8263	• The drive is working over its power capabilities. • The drive cannot dissipate enough heat	• Reduce the service of the motor • Check that the drive is installed correctly
8264	• The drive is working in too high temperature condition	• Check the drive working environment
8266	• The motor is working in too high temperature condition	• Check the motor working environment
16449	• Firmware error type 1	• Contact your TeMec Drive distributor
24641	• Firmware error type 2	• Restart the drive
24706 to 24711 **24713 to 24717** **24719 to 24731**	• EEPROM parameters data corrupted	• Follow this operation: ○ Restart the drive If the error persist ○ Set *EEPROM parameters cleaning* (operation possible also via TeMec Interface) in order to clean the pages of the memory corrupted. ○ Reset Drive ○ Reconfigure the drive If the error persist ○ Set *EEPROM total cleaning* (operation possible also via TeMec Interface) ○ Reset Drive ○ Reconfigure the drive ○ If the motor was auto phased, re-execute the autophasing operation If error still persist contact you TeMec Drive distributor

Code	Possible causes	Suggested operations
24712 **24718**	• EEPROM phasing data corrupted	• Follow this operation: o Restart the drive If the error persist o Set *EEPROM autophasing data cleaning* (operation possible also via TeMec Interface) in order to clean the pages of the memory corrupted. o Reset Drive o If the motor was auto phased, re-execute the autophasing operation If the error persist o Set *EEPROM total cleaning* (operation possible also via TeMec Interface) o Reset Drive o Reconfigure the drive o If the motor was auto phased, re-execute the autophasing operation If error still persist contact you TeMec Drive distributor
24705 **24732**	• EEPROM corrupted	• Follow this operation: o Restart the drive If the error persist o Set *EEPROM total cleaning* (operation possible also via TeMec Interface) o Reset Drive o Reconfigure the drive o If the motor was auto phased, re-execute the autophasing operation If error still persist contact you TeMec Drive distributor

10.MAINTENANCE AND INSPECTION

Read carefully the safety precautions reported in chapter 2.9 before maintaining and inspecting the drive!

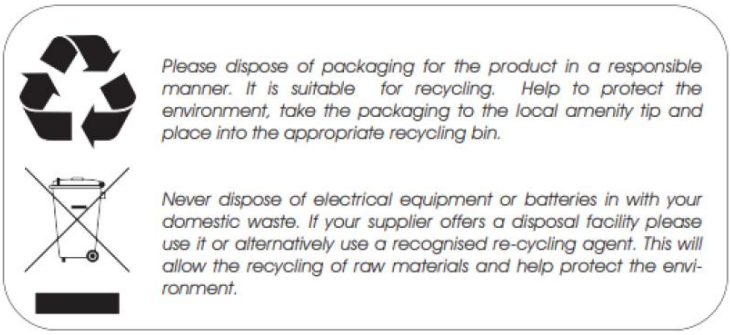
Inspect periodically the drive to ensure that the environment is always appropriate to the drive operation and to detect any sign of failure or malfunctioning.

- Visually check that the environment where the drive is placed is not subject to large amounts of dust, traces of water or other liquids, traces of condensate. If any of these elements is to be found, improve the environment or reconsider the positioning of the drive.
- Check using a thermometer that the environment temperature is within the operation temperature limits. If it is not, improve the environment or reconsider the positioning of the drive.
- Check that the load current and the board temperature is not much different from the values measured during a normal operating cycle. If it is not, check that the mechanical system is not subjected to high frictions or overloading.
- Check that all mounting screws and screw terminals are tightened firmly; if any of them is loose, tighten it.

11. DISPOSAL

Read carefully the safety precautions reported in chapter 2.10 before disposing the drive!

Contact a specialized agent in industrial disposal respecting to the local regulations.



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