TEMEC®
DRIVE

AZ²

QUICK START GUIDE

FOR ONE OR TWO INDEPENDENT MOTORS

INDEX

1. GENERAL INFORMATION

AZ² is a full electronic motor drive designed for the control of two DC motors in low voltage applications. The power stage is based on MOS transistor technology, controlled by a pulse width modulation (PWM). A digital signal processor (DSP) elaborates the control data, generates the output waveforms and manages the communication interfaces.

The AZ² drive is designed for the open loop control of linear actuators driven by DC motors but its use can be extended to any application involving the control of DC motors. For this reason in the following manual the terms motor and linear actuator, forward/backward and open/close are synonymous.

1.1. Technical characteristics

TECHNICAL DATA	
Supply voltage	12 V to 48 V DC, maximum ripple 20%
Output current	Code AZ2048D01000000: Maximum 10 A / motor, S3 – 30% – 5 minutes service factor
	Code AZ2048D01500000: Maximum 15 A / motor, S3 – 30% – 5 minutes service factor
PWM frequency	10 kHz
Quiescent current	50 mA
Inputs	1.7 – 12 V DC ON, 0 – 0.7 V DC OFF 8 inputs for commands and limit switches 4 inputs for pulse signals (max 1 kHz) Pull-up/down (10 kΩ) settable for each input type
Outputs	2 NPN open collector (max 50 mA – 24 V DC) General fault and one with programmable function
Output auxiliary voltage	12 V DC, maximum 50 mA
Diagnostic	Blinking codes with multicolour LED
Operating temperature	-20…+60°C
Dimensions and weight	Code AZ2048D01000000: 86x72x28 mm (LxWxH); 67 g
	Code AZ2048D01500000: 86x72x44 mm (LxWxH); 130 g

Table 1: AZ² technical data

1.2. Board overview

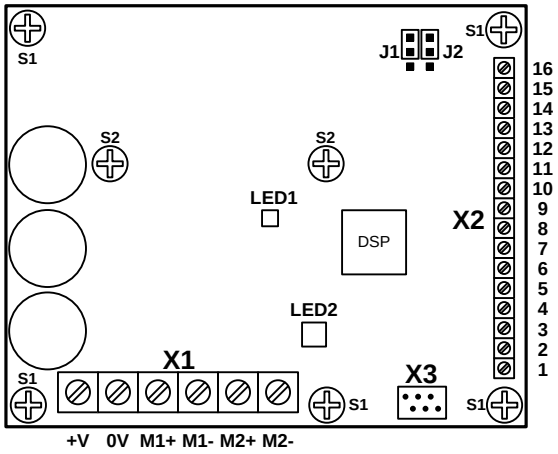

Figure 1: main board components

Component	Function
X1	Power terminal for power supply and motor output connections
X2:1 - X2:8	Signal terminals for inputs
X2:9 - X2:12	Signal terminals for pulse inputs
X2:13	Fault output
X2:14	Configurable output
X2:15	Auxiliary voltage GND and inputs GND
X2:16	Auxiliary voltage +12 V
X3	Connector for communication with PC application or fieldbus interface
J1	Jumper for inputs 1-8 pull-up/down configuration
J2	Jumper for inputs 9-12 pull-up/down configuration
LED1	DSP red LED
LED2	Diagnostic red/green/blue (RGB) LED
S1	Holes for fixing screws
S2	Holes for heat sink fixing screws

Table 2: main components

2. Commands connection

The user can set for every input from 01 to 12:

- the reversed logic working mode; enable this bit if the pull-up resistor is selected and a normally open contact is connected to the terminal or if the pull-down resistor is selected and a normally closed contact is connected to the terminal, otherwise leave it disabled;

- a delay for the OFF to ON transition;
- a delay for the ON to OFF transition.

For example, the parameters for input number 1 are:

Label	Function	Range	Default value
DI00	Reverse input 01 logic	ON / OFF	OFF
DI01	Input 01 turn on delay	5 – 500 [ms]	10
DI02	Input 01 turn off delay	5 – 500 [ms]	10

The commands are configured as hold-to-run but can also work in one-press mode changing the following parameter:

Label	Function	Range	Default value
DI36	Sets inputs in one-press mode	ON / OFF	OFF

The function of the digital output at terminal X2:14 can be set using this parameter:

Label	Function	Range	Default value
DI37	Sets function of output X2:14	See software application AZ² Interface	FAULT

For every input set “Reverse input XX logic” bit following Table 3:

	Normally open contact	Normally closed contact
Pull-up resistor	**Enable** reverse logic	Disable reverse logic
Pull-down resistor	Disable reverse logic	**Enable** reverse logic

Table 3: instructions for setting the reverse logic input mode

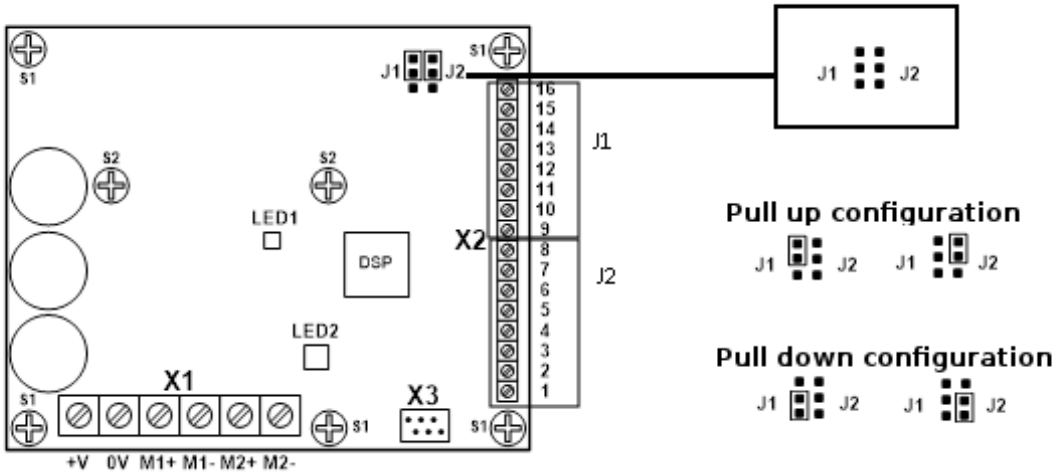

Figure 2: Jumper pull-up/pull-down configuration for input groups 1-8 and 9-12

For pull-up configuration, connect switches between input terminal and the ground terminal (15).
For pull-down configuration, connect switches between input terminal and the supply terminal (16).

3. OPERATION OF TWO MOTORS IN SYNCH MODE

In this operation mode, the drive can control the movement of two motors trying to move them in in synchronous, basing on the encoders signals. The applied voltage follows the desired ramp set by the user but at the same time the drive increases or decreases the voltages depending on the position error.

The user can set two electronic limit positions thanks to the encoder's signals but the drive can also work with two mechanical limit switches.

The movement stops when the relative limit signal goes high (electronic or mechanic), when a current limit is achieved, when the command is released or the STOP signal goes high.

All the parameters are set independently for both motors and for the opening and closing movement.

When the drive is not applying voltage to the motor, the terminals are short-circuited to ground.

N.B: to operate the motor in synchronous mode a successful homing procedure has to be done.

3.1. Connections and commands

Below is a connection scheme:

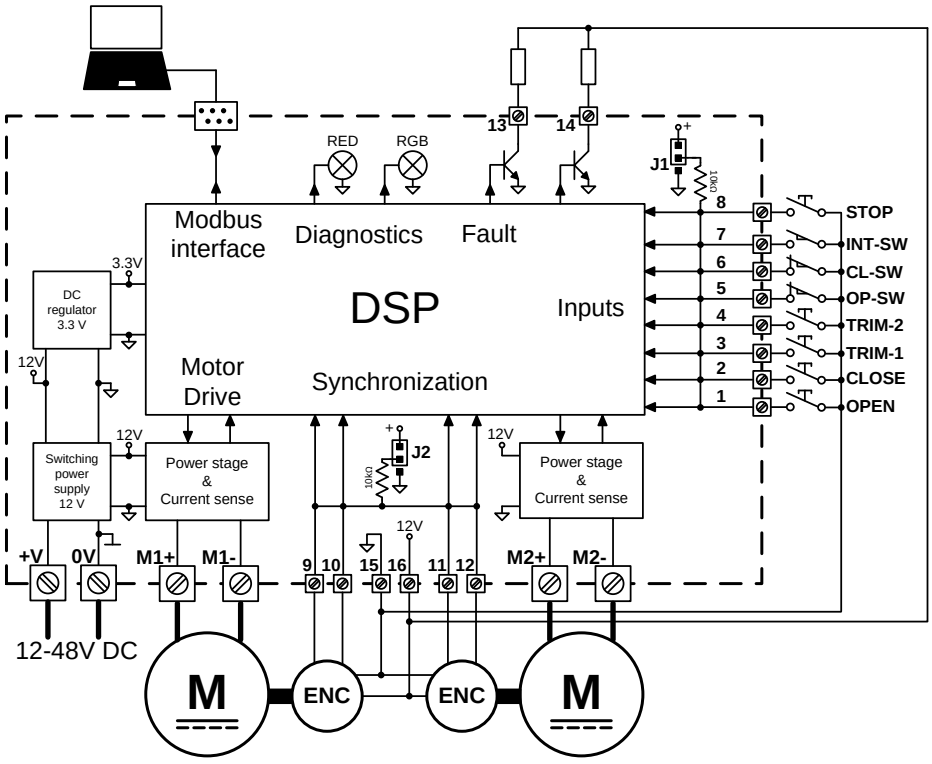

Figure 3: connection scheme example in synchronous mode with pull up jumper configuration and normally open contacts

The meanings of the acronyms is:

Label	Function
OPEN	Open / forward command
CLOSE	Close / backward command
TRIM-1	Motor 1 trimming mode enable
TRIM-2	Motor 2 trimming mode enable
OP-SW	Open limit switch
CL-SW	Close limit switch
INT-SW	Intermediate switch
STOP	Stop command

3.2. Trimming mode

The user can drive the motors independently using the trimming function during the assembly or for resetting the correct mechanical setup in fault cases.
The trimming commands are only hold-to-run:

- motor 1: press and hold TRIM-1 and use OPEN and CLOSE to move the actuator forward or backward;
- motor 2: press and hold TRIM-1 and use OPEN and CLOSE to move the actuator forward or backward.

No limits work when the motor moves in trimming mode, not mechanical limit switches neither electronic ones. The motor can stop only for overcurrent, command release or STOP command.
The user must run the homing procedure, described below, to restore the normal functioning of the drive after every movement in trimming mode.

3.3. Homing function

At the first start, after the mechanical assembly and first alignment, the user must execute a homing procedure so that the drive can detect the encoder connections and initialize the position counters.
It is recommended to give the homing command so that each motor can run **at least 3 seconds** before reaching the home position otherwise the drive will fail in the detection of encoder's connections and will pass in block state. This detection is done only during the first homing execution, so **do not change encoder's connections afterwards!**
The drive will move both motors applying on them the homing ramp when both commands TRIM-1 and TRIM-2 are high for more than 3 seconds. Depending on the parameters (see Table 4), the user can choose between two homing types:

- **limit switch homing**: the home position is achieved when the limit switch is pressed and both motors are stopped reducing the voltage until 0 V, in S104 ms; if any motor current exceeds the limit, the drive stops both motors and pass in block state;
- **current detect homing**: the home position is achieved when the current of both motors exceeds the limit set by the parameters; the motor whose current overcomes the threshold

is stopped disconnecting its terminals from the power stage (no voltage applied) for S113 = 500 ms; every pressure of the limit switches is ignored.

The following parameters configure the homing function:

Label	Function	Range	Default value
SG01	Enables automatic homing at start-up	ON / OFF	OFF
SG02	Enables current detect homing	ON / OFF	ON
S104	Homing voltage	-48 – 48 [V]	-12
S108	High threshold of nominal current control during homing	1 – 11 [A]	5

Table 4: homing parameters

- **SG01**: if enabled, the drive executes a homing procedure at every start without needing any command;
- **SG02**: if this bit is set the homing will stop when the current exceeds the homing current limit otherwise the drive stops the motor when the limit switch is pressed;
- **S108**: the drive uses two threshold one for start and one for the normal run, in the same way as described in 4.3.

The user can stop the homing procedure using the STOP command; in this case, the drive reduces the voltage to 0 V in S104 ms.

It is always recommended to execute a homing procedure after the power reset. The drive stores the encoders count when power turns off but this does not happen if the motors are running in the moment of the blackout. **Enable SG01 or use limit switches to avoid overtravel and consequent damages to things or people.**

3.4. Normal run

After the successful completion of the homing procedure, the user can operate the drive in the normal mode. When the drive receives a command, it imposes the voltages on the two motors following the behaviour and the parameters described in 4.2. At the same time, the drive calculates the position error and corrects the output voltages, increasing that of the slower motor and vice versa. The user can increase or decrease the reaction time and the compensation strength of the drive in the misalignment correction increasing or decreasing parameter SG03. If the drive cannot maintain the error under the desired value (see 5.1), it stops the motors and passes in the block state.

The drive starts to impose the deceleration ramp when the position counter approaches to the value defined by parameters S100 or S101. Then the drive stops the motors short-circuiting their terminals when they achieve the limit position.

Excluding errors, other circumstances that can stop the motors are:

- the command is released;
- the STOP command is pressed;
- the mechanical limit switch is engaged.

In all the above cases, the drive stops the motor applying the deceleration ramp.

Better performances can be obtained if the supply voltage is higher than the maximum voltage set on the motors because the drive can both decelerate the faster motor but also accelerate the slower one.
The following parameters configure the normal mode function:

Label	Function	Range	Default value
SG03	Compensation strength	1 – 32000	1024
S100	Close limit pulses number	-2147483647 – 2147483647	0
S101	Open limit pulses number	-2147483647 – 2147483647	65535

Table 5: synchronism parameters

4. OPERATION OF TWO INDEPENDENT MOTORS

In this operation mode, the drive can control the movement of two motors independently, applying on them the desired voltage and following the desired ramps, set by the user. The movement stops when the relative limit switch signal goes high, when the current limit is achieved, when the command is released or the STOP signal goes high.

All the parameters are set independently for both motors and for the opening and closing movement.

When the drive is not applying voltage to the motor, the terminals are short-circuited to ground.

4.1. Connections and commands

Below is a connection scheme showing all possible commands and devices that can be connected to the board:

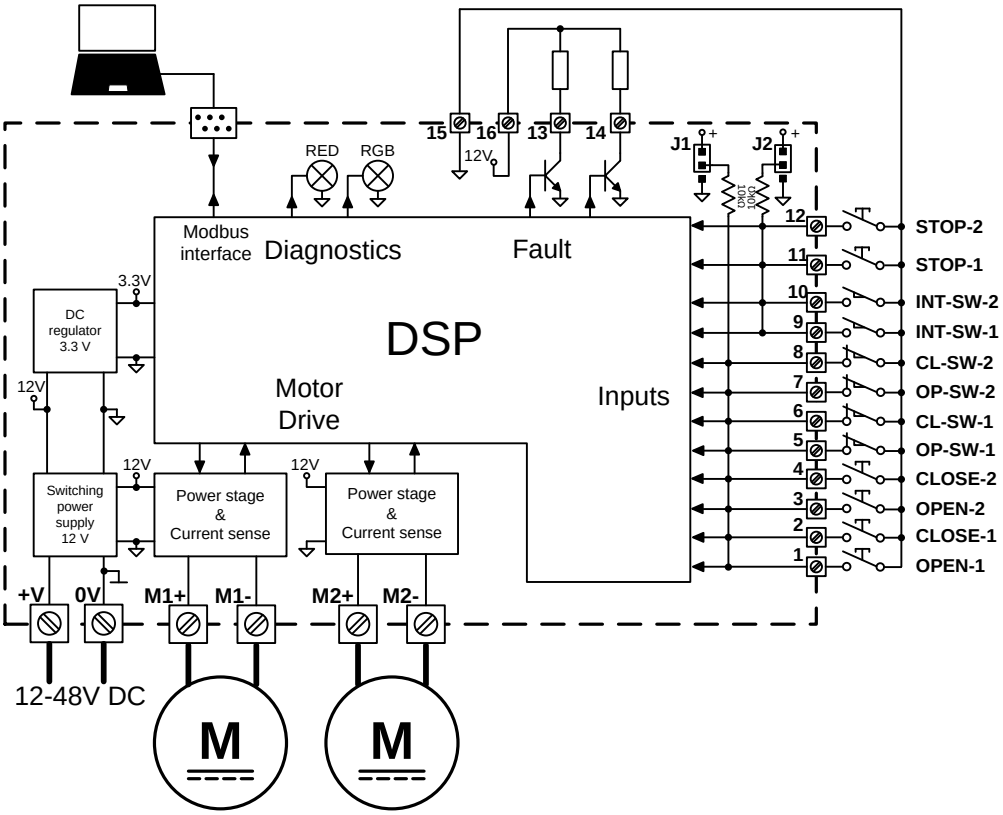

Figure 4: connection scheme example in independent mode with pull up jumper configuration and normally open contacts

For each of the two motors:

Label	Function
OPEN	Open / forward command
CLOSE	Close / backward command
OP-SW	Open limit switch
CL-SW	Close limit switch

INT-SW	Intermediate switch
STOP	Stop command

4.2. Ramps

The following figures show the behaviour of the drive applying the ramps. The example is the acceleration and deceleration ramp for motor 1 during the opening movement:

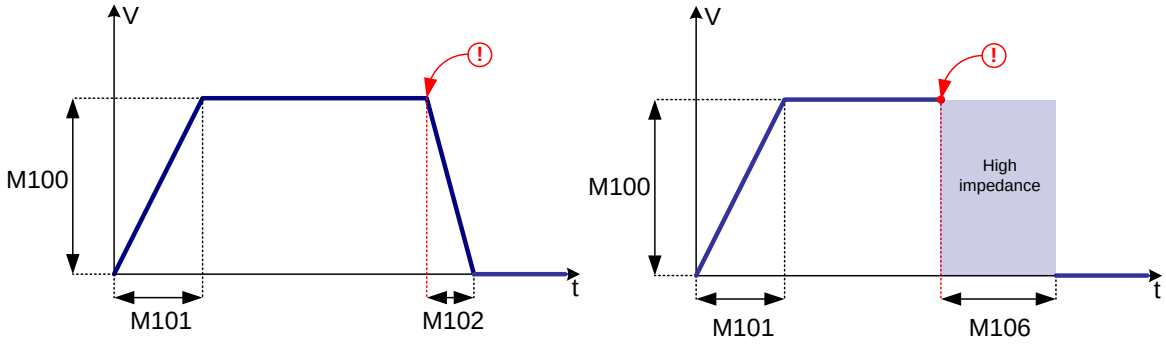

Figure 5: ramp waveform example in case of normal stop (left) and overcurrent (right)

In both cases the full voltage is applied gradually, following a ramp long M101 ms.
In the first case the motor stops because the drive reduces the voltage until 0 V, in M102 ms. Excluding errors, this happens if:

- the command is released;
- the STOP command is pressed;
- the limit switch is engaged.

When an overcurrent is detected the drive behaviour follows Figure 5 (right): the motor terminals are disconnected from the power stage (no voltage applied) for M106 = 500 ms and the stop is achieved by inertia.
The ramps applied to the motors are set using three parameters. For example the open ramp of motor one is set by:

Label	Output	Function	Range	Default value
M100	Motor 1	Open voltage	10 – 48 [V]	24
M101	Motor 1	Open acceleration ramp	100 – 3000 [ms]	500
M102	Motor 1	Open deceleration ramp	100 – 3000 [ms]	500

The user can set different ramps for the two motor and for each direction.

4.3. Current limits

The drive monitors the current absorption during all the motor movement using two threshold, one for the start phase and the second during the rest of the run as shown in this Figure 6:

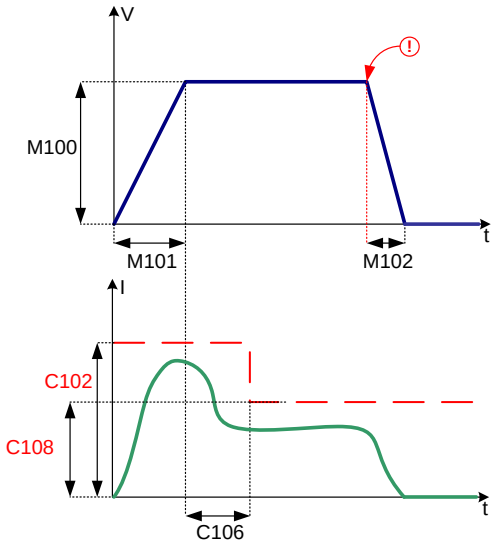

Figure 6: current monitoring parameters

The first threshold is used during for a time given by the sum of M101 and C106 = 1 s. The user can set the nominal current threshold C108, while the inrush one C102 is calculated as 2 times the first value.
The drive can either go in block state or not when the current limit is exceeded, depending on the user choice. If the block is disabled (C107 = OFF), the drive will read the overcurrent as a limit switch permitting only the movement in the opposite direction.
The parameters below configure the current limit functions for the open current of motor 1:

Label	Output	Function	Range	Default value
C107	Motor 1	Enables the block in case of overcurrent during opening	ON / OFF	ON
C108	Motor 1	High threshold of nominal current control during opening	1 – 20 [A]	10

The user can set different current limits for the two motor and for each direction.

5. 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 LED2, using a blink code (200 ms ON, 300 ms OFF, 2 s pause).
The following table summarizes the possible errors and the corresponding blink code:

LED2 colour	Blinks number	Source	Type
Blue	1	Global	Power supply over voltage
Blue	2	Global	Power supply under voltage
Blue	3	Global	Over temperature
Green	1	Motor 1	Overcurrent during opening acceleration
Green	2	Motor 1	Overcurrent during opening
Green	3	Motor 1	Overcurrent during closing acceleration
Green	4	Motor 1	Overcurrent during closing
Green	6	Motor 1	Open limit switch loss
Green	7	Motor 1	Close limit switch loss
Red	1	Motor 2	Overcurrent during opening acceleration
Red	2	Motor 2	Overcurrent during opening
Red	3	Motor 2	Overcurrent during closing acceleration
Red	4	Motor 2	Overcurrent during closing
Red	6	Motor 2	Open limit loss
Red	7	Motor 2	Close limit loss

5.1. Global errors

The global errors are related to the entire drive, not directly imputable to a single motor fault:

- power supply over voltage;
- power supply under voltage;
- over temperature;
- loss of synchronism: the drive cannot compensate the synchronism error and the misalignment between the two motors exceeded the set value of pulses.

The parameters associated to the over voltage error are:

Label	Function	Range	Default value
A001	Value of the maximum supply voltage	12 – 60 [V]	60

The parameters associated to the under voltage error are:

Label	Function	Range	Default value
AU02	Value of the minimum supply voltage	12 – 60 [V]	11

The parameters associated to the over temperature error are:

Label	Function	Range	Default value
AT01	Value of the maximum temperature	0 – 90 [°C]	80

5.2. Motor specific errors

In addition to the overcurrent errors during opening and closing described in paragraph 4.3, each motor has other four errors associated to its functioning:

- open limit loss: the drive detected a possible movement with no active commands due to a change in the state of the mechanical open limit switch or the encoder count;
- close limit loss: the drive detected a possible movement with no active commands due to a change in the state of the mechanical close limit switch or the encoder count;

For the error of open limit loss the configuration parameters are:

Label	Output	Function	Range	Default value
AP10	Motor 1	If enabled, the drive blocks in case of error	ON / OFF	OFF
AP13	Motor 1	Delay of the error detection	1 – 5000 [ms]	1000
AP14	Motor 1	Number of occurrences of the error before block	1 – 10	1
AP20	Motor 2	If enabled, the drive blocks in case of error	ON / OFF	OFF
AP23	Motor 2	Delay of the error detection	1 – 5000 [ms]	1000
AP24	Motor 2	Number of occurrences of the error before block	1 – 10	1

For the error of close limit loss the configuration parameters are:

Label	Output	Function	Range	Default value
AC10	Motor 1	If enabled, the drive blocks in case of error	ON / OFF	OFF
AC13	Motor 1	Delay of the error detection	1 – 5000 [ms]	1000
AC14	Motor 1	Number of occurrences of the error before block	1 – 10	1
AC20	Motor 2	If enabled, the drive blocks in case of error	ON / OFF	OFF
AC23	Motor 2	Delay of the error detection	1 – 5000 [ms]	1000
AC24	Motor 2	Number of occurrences of the error before block	1 – 10	1

6. TROUBLESHOOTING

LED2 colour	Blinks number	Source	Type	Possible causes	Suggested operations
Blue	1	Global	Power supply over voltage	1. Error in the wiring of the power supply. 2. Regenerative effect of the motor during the deceleration.	1. Check the power supply voltage and compare it to the supply limits. 2. Reduce the deceleration ramps duration.
Blue	2	Global	Power supply under voltage	1. Error in the wiring of the power supply. 2. High current absorption of the board.	1. Check the power supply voltage and compare it to the supply limits. 2. Check the section and length of the power supply cables.
Blue	3	Global	Over temperature	1. The drive is working over its power capabilities. 2. The drive cannot dissipate enough heat.	1. Reduce the service of the motor. 2. Check that the drive is installed correctly.
Green / Red	1	Motor 1 / 2	Overcurrent during opening acceleration	1. Mechanical obstacle or too high friction. 2. Mechanical overload of the actuator. 3. Current limit is too low and/or acceleration ramp is too fast.	1. Check the movement of the actuator. 2. Check that the load is within the mechanical specifications of the actuator. 3. Increase the current limit and/or decrease the acceleration ramp duration.
Green / Red	2	Motor 1 / 2	Overcurrent during opening	1. Mechanical obstacle or too high friction. 2. Mechanical overload of the actuator. 3. Current limit is too low.	1. Check the movement of the actuator. 2. Check that the load is within the mechanical specifications of the actuator. 3. Increase the current limit.
Green / Red	3	Motor 1 / 2	Overcurrent during closing acceleration	1. Mechanical obstacle or too high friction. 2. Mechanical overload of the actuator. 3. Current limit is too low and/or acceleration ramp is too fast.	1. Check the movement of the actuator. 2. Check that the load is within the mechanical specifications of the actuator. 3. Increase the current limit and/or decrease the acceleration ramp duration.
Green / Red	4	Motor 1 / 2	Overcurrent during closing	1. Mechanical obstacle or too high friction. 2. Mechanical overload of the actuator. 3. Current limit is too low.	1. Check the movement of the actuator. 2. Check that the load is within the mechanical specifications of the actuator. 3. Increase the current limit.
Green / Red	6	Motor 1 / 2	Open limit loss	1. Reversible movement of the actuator. 2. The mechanical limit switch switched off with no active commands.	1. Check the movement of the actuator and use a brake if the application cannot be reversible. 2. Check the mechanical contact of the limit switch.
Green / Red	7	Motor 1 / 2	Close limit loss	1. Reversible movement of the actuator. 2. The mechanical limit switch switched off with no active commands.	1. Check the movement of the actuator and use a brake if the application cannot be reversible. 2. Check the mechanical contact of the limit switch.